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DRUITT'S

SURGEON'S VADE-MECUM.

A MANUAL OF MODERN SURGERY.

EDITED BY

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TO

MY UNCLE,

HENRY NEWTON,

LATE OF THE BOMBAY CIVIL SERVICE,

I DEDICATE THIS, THE TWELFTH, EDITION OF

Druitt's Surgeon's Vade-mecum,

IN GRATEFUL ACKNOWLEDGMENT OF THE UNVARYING KINDNESS,

SYMPATHY, AND HELP, SUCH AS FEW CAN GIVE,

WHICH I HAVE RECEIVED FROM HIM.

PREFACE.

Few medical works have been more widely known and appreciated than Druitt's "Surgeon's Vade-mecum." In England, I am informed that 50,000 copies have been sold, whilst in America it has been so highly appreciated that a copy was issued by the Government to each surgeon serving in the Federal Army during the great Civil War. These facts would at once suggest that it was desirable to alter the book as little as possible. But owing to Dr. Druitt's ill-health he was unable to edit the last two editions with his old skill and energy; in the last, indeed, he was obliged to share the labor with Professor John Wood, of King's College Hospital, and Mr. R. W. Parker. The latter surgeon illustrated and revised the chapter on Tumors, and gave much help in the portions dealing with gun-shot injuries. His work has been but little altered. Mr. Wood revised the latter two-thirds of the book—a somewhat delicate task during the life of the author—and he seems to have limited himself to making considerable additions, in which he stated his own views and practice. Naturally, these additions contained very valuable material, and I have retained them, with acknowledgment of their source when they contained anything originating with Professor Wood.

It will be seen from the above that the work has not been thoroughly edited for at least ten years; and when I say that in the eleventh edition, which appeared in 1877, antiseptic surgery is regarded as still on its trial, ligatures are left hanging from wounds, the extra-peritoneal method is recommended in ovariotomy, and we are told to hang a box of Macdougall's powder under the bedclothes to keep down the stench of a stump, it will be obvious to any who understand the far-reaching importance of these points that radical change was necessary. Again and again I tried to patch, but with such a poor result that the attempt invariably resulted in rewriting. The twelfth edition consequently differs much from the eleventh; scarcely a paragraph of the latter remains unaltered; and in most parts only the sense of the old book has been embodied with other material in the new.

The chapter on Diseases of the Eye has been replaced by a short account of the injuries of that organ, for which I am indebted to my friend Mr. A. Quarry Silcock, Assistant Surgeon to St. Mary's Hospital and to the Royal Ophthalmic Hospital, Moorfields. Notwithstanding this omission, and in spite of my utmost endeavors to compress, the book has increased considerably in size. This is due to many causes, especially to the greatly increased range of subjects with which I have had to deal, the greater prominence which I felt it necessary to give to pathology, the introduction of short sections on "surgical diagnosis," and of others, here and there, on "general principles," to the replacement of many old illustrations by a number of considerably larger ones, and the addition of a copious index.

Those familiar with former editions will notice that the division of chapters into numbered sections has been abandoned, and that the accounts given are more continuous.

The "author" or the "writer" refers to Dr. Druitt; for shortness' sake I have written either in the third or first person.

My sources of information have been Holmes's "System of Surgery," König's excellent "Lehrbuch der Chirurgie," Hüter's "Grundrisse der Chirurgie," many parts of the "Deutsche Chirurgie," edited by Billroth and Lücke, and, to a much less extent, Nélaton's "Traité de Pathologie Externe." Birch-Hirschfeld's "Lehrbuch der pathologischen Anatomie" and the sixth edition of "Green's Manual of Pathology and Morbid Anatomy" have served me as references in pathology; whilst in medicine I have consulted Fagge, Bristowe, and Quain's "Dictionary." Erichsen's "Surgery," of which I recently read the proofs and revises, I have rather avoided, lest obvious plagiarism should creep in; but to it and to its editor my warmest acknowledgments are certainly due. In the section on operative surgery also the effect of Mr. Beck's teaching is very evident. Minor references are made in the text.

Seventy-three new woodcuts have been added, and among them an almost complete series illustrating the ligation of arteries. These were drawn from operations on the dead subject, and most of them are of life-size: they are intended to show, *not* the anatomy of the artery, but the wound as it really is; and it is hoped that they will enable the student easily to perform the operations on post-mortem subjects, if he will place the book alongside the limb to be operated upon.

STANLEY BOYD.

CONTENTS.

PART I.

CHAPTER I.

THE ETIOLOGY OF DISEASE.

CHAPTER II.

LOCAL DISTURBANCES OF THE CIRCULATION.

CHAPTER III.

INFLAMMATION.

CHAPTER IV.

ULCERATION.

CHAPTER V.

SUPPURATION AND ABSCESS.

CHAPTER VI.

MORTIFICATION.

CHAPTER VII.

SCROFULA AND TUBERCULOSIS.

CHAPTER VIII.

LEPROSY (ELEPHANTIASIS GRÆCORUM); GLANDERS AND FARCY.

CHAPTER IX.

VENEREAL DISEASES.

CHAPTER X.

TUMORS.

CHAPTER XI.

SEPTIC DISEASES OF WOUNDS.

PART II.

INJURIES.

CHAPTER XII.

GENERAL EFFECTS OF INJURIES.

CHAPTER XIII.

SUBCUTANEOUS INJURIES—CONTUSIONS.

CHAPTER XIV.

WOUNDS.

CHAPTER XV.

GUNSHOT WOUNDS.

CHAPTER XVI.

EFFECTS OF HEAT—BURNS AND SCALDS.

CHAPTER XVII.

THE EFFECTS OF COLD.

CHAPTER XVIII.

EFFECTS OF THE POISONS OF HEALTHY ANIMALS.

CHAPTER XIX.

ANIMAL PARASITES—ENTOZOA—VEGETABLE PARASITES.

CHAPTER XX.

DISSECTION OR POST-MORTEM WOUNDS.

CHAPTER XXI.

EFFECTS OF POISON GENERATED BY DISEASED ANIMALS.

PART III.

INJURIES AND SURGICAL DISEASES OF VARIOUS TISSUES, ORGANS, AND REGIONS.

CHAPTER XXII.

SURGICAL DISEASES OF THE SKIN.

CHAPTER XXIII.

INJURIES AND DISEASES OF BURSÆ, TENDON SHEATHS, MUSCLES, AND TENDONS.

CHAPTER XXIV.

INJURIES AND DISEASES OF LYMPHATIC VESSELS AND GLANDS.

CHAPTER XXV.

INJURIES AND DISEASES OF BONE.

CHAPTER XXVI.

DISEASES OF BONE.

CHAPTER XXVII.

INJURIES AND DISEASES OF JOINTS.

CHAPTER XXVIII.

DISEASES OF THE HIP-JOINT, OR MORBUS COXÆ.

CHAPTER XXIX.

INJURIES OF ARTERIES—ARTERIAL HEMORRHAGE AND HÆMATOMA.

CHAPTER XXX.

INJURIES AND DISEASES OF THE VEINS.

CHAPTER XXXI.

INJURIES AND DISEASES OF NERVES.

CHAPTER XXXII.

INJURIES OF THE HEAD.

CHAPTER XXXIII.

INJURIES AND DISEASES OF THE SPINE AND SPINAL CORD.

CHAPTER XXXIV.

DISEASES OF THE HANDS AND FEET, CLUB-FOOT, AND OTHER DEFORMITIES OF THE LIMBS.

CHAPTER XXXV.

INJURIES OF THE ORBIT AND ITS CONTENTS.

CHAPTER XXXVI.

DISEASES AND INJURIES OF THE EAR.

CHAPTER XXXVII.

INJURIES AND DISEASES OF THE SOFT PARTS OF THE FACE.

CHAPTER XXXVIII.

INJURIES AND DISEASES OF THE CHEST.

CHAPTER XXXIX.

THE SURGERY OF THE ABDOMEN.

CHAPTER XL.

HERNIA.

CHAPTER XLI.

INTESTINAL OBSTRUCTION.

CHAPTER XLIX.

MEANS OF PRODUCING INSENSIBILITY TO PAIN.

CHAPTER L.

ARTIFICIAL RESPIRATION.

CHAPTER LI.

SLINGS AND BANDAGES.

CHAPTER LII.

MINOR SURGERY.

CHAPTER LIII.

OPERATIONS FOR THE LIGATION OF ARTERIES.

CHAPTER LIV.

AMPUTATIONS AND EXARTICULATIONS.

CHAPTER LV.

EXCISION OF BONES AND JOINTS.

THE

SURGEON'S VADE-MECUM.

PART I.

CHAPTER I.

THE ETIOLOGY OF DISEASE.

THE word surgeon, a contraction of chirurgeon (*chirurgien*, from χείρ and ἔργον), signifies one who cures abnormal conditions by *working* or operating upon them with the hand. Most cases, therefore, requiring manual treatment are placed in that division of the healing art called surgery; but this branch now deals also with many cases in which no such treatment is necessary or possible.

To be a good surgeon, a thorough general knowledge of medicine, and of the sciences upon which the whole healing art is based, is absolutely essential.

MORBID CONDITIONS AND THEIR CAUSES.

The cases which surgery is called upon to treat may be divided roughly into those of injury, disease, and the results of injury or disease. Although every one knows the difference in meaning implied by the terms injury and disease as commonly used, it is found, when we come to consider the etiology of morbid conditions in general, that no line can be drawn between injuries and diseases. Many cases occur which it is impossible to place under either one head or the other.

Disease may be either *inherited* or *acquired*. In some cases of *inherited disease*, as syphilis, it is probable that the actual cause of the disease exists in the ovum or spermatozoa at the time of conception, but in the great majority influences similar to those which produce the general resemblance between children and parents are at work, and the tendency to grow abnormally, to perform function imperfectly—the tendency to disease, in short, rather than the disease itself, is inherited. The so-called tubercular diathesis is an example of this. But cases of inherited disease are due to the handing down by parents to their offspring either of the actual causes of disease or of the abnormal tendencies of their tissues, which the parents had acquired from influences external to their organisms. It would seem, therefore, that all primary morbid conditions are ultimately due to the action of causes external to the economy; once acquired, such conditions may or may not be handed down from parents to offspring; but probably no condition of primary disease is without its secondary results upon the body at large, and in many cases these results are more striking than the primary disease.

The *causes* of primary acquired disease may probably all be ranged under two headings:

1. Abnormal Food Supply.—
   - Quantitative.
     - Hyperæmia.
     - Anæmia.
   - Qualitative.
     - Imperfect blood formation.
     - Imperfect purification.
     - Introduction of poisons, foreign bodies, etc., from without.
2. Abnormal Physical Conditions.—Including injuries of all kinds—gross and fine.

The great majority of the causes of disease require no explanation of their nature, properties, etc.; but there is one group which has of late years come to occupy a most important position in medicine, and which is so peculiar and so little generally known as to demand a short special notice. We mean the vegetable parasites. They may fall into either of the above classes, according as they produce disease by their chemical or mechanical action.

The *vegetable parasites* of practical importance in surgery all belong to the *Schizomycetes*. The *Oïdium albicans*, or parasite of thrush, may be a yeast; and the *Actinomycetes*, or ray-fungus, and the *Chionyphe Carteri*, found in Actinomycosis and Madura foot respectively, may be moulds; but the botanical position of all three, and even the existence of the latter, is doubtful, whilst the diseases are comparatively unimportant.

The *Schizomycetes* are very small, unicellular, achlorophyllous organisms, the cells being round, oval, dumb-bell-shaped, rod-shaped, straight or curved, or filamentous. They consist, as a rule, of structureless protoplasm; but their resistance to alkaline and dilute acids makes it probable that they have an outer coat of a substance like cellulose. All multiply by transverse division—the rods almost always, if not always, across their long axis, the spheres sometimes across only one diameter, again across two diameters at right angles to each other. In certain of the rod-forms spore-formation has been shown to alternate with fission—a most important point, as the spores are very much more tenacious of life than the adult organisms. The spores form in the rods in some instances, in others only after the rods have grown into long filaments (*leptothrix*).

The organisms formed by fission may separate at once from the parents and proceed to divide separately, or multiplication may go on without previous separation, the result being long chains or more or less spherical aggregations, according as the division takes place along one or two lines. These spherical collections are often embedded in a viscid substance—*zoöglœa.* Division is very rapidly carried out, and each newly formed cell may at once undergo fission. Cohn has calculated that one bacterium may have 16,000,000 descendants in twenty-four hours.

Some of these organisms never move, but most are seen in both active and resting states. The round forms show only Brownian movement when single, but in chains they exhibit a slow locomotion. The straight and twisted rod-forms move backward or forward without turning, and rotate rapidly on their long axes. One or two cilia have been seen in many forms, but it is said that the cell may move rapidly whilst the cilia are motionless, and *vice versâ*. Free supply of oxygen is closely related to active movement, but does not always excite it.

Having learned to recognize these organisms, the questions of their life-requirements, of the best methods of destroying them, and of their distribution in nature, must be considered; in order that, by attention to one or all of these points, we may prevent the entry of bacteria into the body and into wounds, this being the most important task of the surgeon.

CONDITIONS OF LIFE. FOOD.—Like all other living things, bacteria must be supplied with the elements of which they consist, to make up for wear and tear. These elements are, *carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur, calcium, magnesium, and potassium*; and some of the hydrogen and oxygen must be supplied in the form of *water*. It is characteristic of the order that, unlike animals, they can obtain their nitrogen from ammonia and ammoniacal compounds; but, unlike green plants, they are unable to obtain their carbon from carbonic acid. They can take it from tartaric and other organic acids, or from carbohydrates. Tartrate of ammonia (Cohn's fluid) will, therefore, serve to supply nitrogen and carbon to many of these plants; but others, and especially those which invade the tissues of living animals, will not grow unless provided with a highly organized soil. The *reaction of the soil* has an important influence, alkalinity being far more favorable than acidity to most species.

With regard to *oxygen*, most bacteria require a supply of this element in the free state; the relation of free oxygen to mobility is marked. There are, however, many bacteria which can live for a considerable time without free oxygen, obtaining their supply from the organic compounds which they decompose. It is said by Pasteur that free oxygen is absolutely fatal to one or two species.

Water is an absolute necessity for the development of bacteria: nothing that is dry ever decomposes. The *concentration* of a solution makes a great deal of difference with regard to the organisms that will grow in it, some preferring more or less dilute, others concentrated solutions of the same substances.

Most organisms withstand desiccation for long periods.

TEMPERATURE.—The range of temperature favorable to the growth of each organism varies considerably, both in extent and in position upon the scale. Speaking generally, a temperature about that of the human body is the most favorable. Many hardy species will multiply freely at temperatures far removed from this: but without certain limits, be they narrow or wide, each organism multiplies first more slowly, then not at all, and finally becomes rigid and motionless. The rigor caloris passes at once into death, but the rigor frigoris induced even by —220° F. does not kill many forms, and it is not certain that cold *kills* any. It simply inhibits their growth and action. Development of all forms ceases, however, below 40° F., and of many forms at a much higher point; it ceases also at 120°–130° F., and many species are killed by this temperature. Boiling for a few minutes kills the majority of organisms. Spores, however, will resist boiling for several hours; a temperature of 240° F. maintained for thirty minutes probably destroys even these, but *dry* spores of *B. anthracis* (the most resistant known) are not killed by 284° F. in less than three hours.

Rest is necessary for the development of some bacteria, and is favorable for all.

The struggle for existence and survival of the fittest is nowhere more obvious than among these organisms. If germs of several kinds exist in a fluid, *cæteris paribus*, those which are most numerous have the advantage and will crowd out other forms. But probably the requirements of no two species are exactly alike, so one form may be more suited to the existing conditions than the others, and will more or less rapidly obtain possession of the field. As circumstances alter, perhaps owing to the vital action of this organism itself, they become less favorable to it, more favorable to other forms which then become more and more numerous, the original one dying out. Very slight differences, so slight as to elude detection at present, may prevent or favor the development of an organism; and it is thus, probably, that we are to account for the localization of the inflammations which characterize so many general infective diseases—*e. g.*, of the bowel in typhoid, and also for the immunity which many people exhibit with regard to certain of these diseases, though they are, perhaps, much more exposed to infection and, presumably, take in the virus in larger quantity than others who suffer from them. When shall we be able to recognize the difference between a lung, a synovial membrane, or a gland in which the tubercle bacillus grows readily, and similar organs in which it does not grow?

It is, however, probable that many of the above differences between individuals may be due to non-entry of organisms in spite of exposure to them, or to their entry only in numbers which the tissues can overcome. For animals are exposed like men to these parasites, but the mortality is very small among them compared with that which can be brought about by directly inoculating them with pure cultivations of the organisms which cause various diseases.

On the other hand, *anything which depresses the vital activity of a part renders the growth of organisms in that part more easy*, as is seen in the numerous cases of suppuration after subcutaneous injury, of osteomyelitis after injury, of tubercular lesions appearing under unfavorable hygienic conditions in people previously strong.

METHODS OF PREVENTING THE DEVELOPMENT OF, OR OF DESTROYING BACTERIA.—It is always more easy to prevent development than to destroy actively growing organisms; but, generally, means which will check development will also, when applied more strongly, kill the germs.

Development of organisms in a suitable soil may be prevented by—abstraction of water; by keeping the soil at a temperature above or below that at which organisms can multiply; in most cases by the removal of oxygen; by adding to the soil one of the many substances known as *antiseptics* from their power of destroying septic and allied organisms—methods founded upon what we know of their life-requirements; or the soil may be sterilized and the further entry of bacteria from without prevented. The actual cautery is sometimes used by surgeons to destroy tissues invaded by some virulent locally infective poison, as that of hospital gangrene; otherwise *heat* has no place as an antiseptic in surgery. *Cold* in the shape of ice-bags is frequently employed and probably the temperature of the tissues is reduced sufficiently to impede or prevent the multiplication of many cells; at the same time, free access of blood is permitted, transudation is increased, and a chance is afforded that organisms may be carried away by the lymph-stream and distributed in small numbers among healthy tissues to die there. "*Dry dressings*" are much used, the idea being to dry up all discharge as it escapes from a wound, and thus to prevent putrefaction, so that a large wound may heal beneath such a dressing just as a smaller one frequently heals beneath a scab. Generally, such dressings are impregnated with some antiseptic, to render them safe, even though they may be unable to dry up all discharge. *Removal of oxygen* is never employed in surgery to prevent development of organisms.

The use of *antiseptic substances* for the purpose of preventing decomposition in wounds is now almost universal in surgery. These bodies vary greatly in their power of destroying microörganisms. At first they were tested, and somewhat rudely, as to the percentage of each required to prevent putrefaction or stinking decomposition; this percentage was spoken of as the *efficient strength* of the antiseptic. Putrefaction was thus chosen because decomposition of wound-discharges was obviously intimately related to the occurrence of wound-diseases, and the change was easily recognizable by smell and clinically also by discoloration of the dressings; but there are many objections to it as a scientific test. In the first place, putrefaction has no exact meaning; it is a very complex process, a number of different but varying organisms—many as yet but little known—being found in putrid materials; the *Bacterium termo*, a non-pathogenic fungus, is the most constant, and to it are attributed the foul-smelling bodies. Next, septic diseases, though generally connected with wounds in which bacteria are found, are not necessarily connected with putrid or offensive wounds. And, lastly, diseases, apparently the same as certain of the so-called wound-diseases, may arise without any discoverable wound. The term *septic wound-diseases*, therefore, must be taken as meaning diseases which originate in connection with wounds in which bacterial decomposition is going on—often, but not necessarily, putrid decomposition. An antiseptic must be regarded as an agent which is inimical not only to the organisms of putrefaction but to bacterial decomposition of all kinds; and lastly, it must be noted that the object of *antiseptic surgery* is now, not simply the prevention of putrefaction of wound-discharges, but the shielding of these fluids from every form of bacterial change. This may be done—1, by killing all bacteria which approach the wound; 2, by rendering the conditions such that organisms, though they may live, cannot develop; 3, by preventing access of organisms to an aseptic wound. Of these methods the first is certainly the safest in practice. Koch ("Ueber Desinfection," *Mitth. a. d. Gesundheitsamte*, vol. i., 1881) points out that with regard to an antiseptic substance we must know, 1. Whether it will kill *all* microörganisms; and to decide this point he tests them upon the spores of *B. anthracis* or of the bacilli of malignant œdema found in garden-soil—the most resistant organisms known. 2. Its behavior to the less resistant organisms—bacilli, bacteria, and micrococci. 3. The percentage of it required to prevent the development of germs in suitable media. 4. Practical points, such as the concentration required to produce the above effects, the necessary duration of action, the influence of various fluids used as solvents in developing the action of the antiseptic, etc.

To determine these points Koch dipped threads in fluids or substances containing spores, bacilli, etc., and dried them; they were then exposed for varying times to the action of the antiseptic in different forms and varying strengths; and, finally, they were placed upon solid culture-soils and the microscope was employed to tell whether any of the organisms developed, as also was the inoculation of animals. The results thus obtained were the following:

Carbolic Acid.—Five per cent. (1 in 20) fails to destroy spores in forty-eight hours; but bacilli (*B. anthracis*) are killed in one minute. The concentration necessary to prevent the development of various organisms differs much; from 1 in 850 for splenic fever spores to 1 in 400 for germs falling from the air. The most potent form is a watery solution. The vapor of pure carbolic acid does not act well; and the compounds of carbolic acid come distinctly after the pure substance, sulphocarbolate of zinc being the most powerful.

The high place taken in surgery by carbolic acid is due to its almost instantly fatal effect upon adult organisms and its power of inhibiting development of spores; it is practically useless as a destroyer of spores.

Chloride of Zinc.—Five per cent. failed to kill spores in a month, and was without effect in preventing their development. One per cent. failed to kill *M. prodigiosus* in forty-eight hours. The undoubted value of $ZnCl_2$ in surgery is, according to these facts, inexplicable; further observation is necessary.

Corrosive Sublimate.—One per thousand destroyed the spores in one minute; this, then, is the only antiseptic capable of employment in surgery which will *certainly* disinfect a surgeon's hands when they are just washed in the lotion. Care must be taken to remove all soap from a part to be disinfected with sublimate, as the two are said to form a compound of little antiseptic value. 1 part in 20,000 will prevent the development of spores.

Koch points out that for practical purposes no disinfectant is reliable unless it does its work (*i. e.*, destroys spores) in less than twenty-four hours. Of a large number of substances examined, carbolic acid (1 in 20), corrosive sublimate (1 per cent.), osmic acid (1 per cent.), permanganate of potash (5 per cent.), bromine, chlorine, and iodine were the only ones which stood the test; and of these osmic acid and permanganate of potash cannot be used on account of cost and other reasons.

The percentage of an antiseptic which must be present to *prevent development* of an organism varies with the organism, and largely with the amount of albumen and the salts present in the culture-soil. The following results were obtained by Koch for spores of *B. anthracis* in a solution of meat peptone:

Oil of mustard	1 in 33,000
Sublimate	1 in 20,000
Chromic acid	1 in 8,000
Salicylic acid	1 in 1,500
Eucalyptol	1 in 1,000
Carbolic acid	1 in 850
Boracic acid	1 in 800
Borax	1 in 700

Koch found that whenever they could be used, watery solutions were more effective than oily or alcoholic, the latter being sometimes quite inefficient; thus Volkmann reports a fatal case of splenic fever from catgut prepared in carbolic oil from the intestine of a sheep dead of the disease, and used as ligatures after the amputation of a breast. When placed in contact with water-containing tissues, some of the antiseptic will diffuse and the watery solution will be active, but oily solutions are useless as germicides when applied to dry objects.

Distribution in Nature.—Bacteria exist wherever putrescible and fermentescible material is present—*i. e.*, their distribution is that of higher vegetable or animal life. In the polar regions, above the line of vegetation on mountains, or in mid-ocean, they may be absent or very rare; thus Tyndall found that putrescible but sterile fluids in flasks opened high on the Alps often evaporated to dryness without any decomposition. They increase rapidly in number with density of population. They are found in the earth to the depth of one metre ordinarily; they exist in all water, except such as comes from Artesian wells; and the air contains them together with the spores of moulds, yeast cells, and other organic and inorganic dust. The supply to the air is kept up by the wind sweeping over the dry and powdery remains of substances which have putrefied; and from the air organisms are deposited upon every surface exposed to it. But even in large towns organisms are not always so numerous in air that a wound or a sterile fluid cannot be left exposed for a minute without the certainty that decomposition will set in; in Edinburgh, Lister found that after half an hour's exposure of some urine, only three moulds grew. It may, in some parts, however, be impossible to pour fluid from a flask into tubes without imminent danger of putrid decomposition. Ordinarily, the spores of moulds are much commoner in air than organisms of putrefaction; the latter seem to have their special habitat in water, a drop of which will almost certainly infect a sterile solution.

Relation of Bacteria to the Body.—Bacteria in numbers are taken in with every breath, and with almost every mouthful of food and drink. Those entering the air-passages are deposited on the mucous membrane of nose, mouth, pharynx, and larger bronchi; they exist only in the tidal air, the complemental being free from particles of all kinds. Organisms do not develop in the acid gastric juice, but below the entry of the bile and pancreatic ducts they become numerous, giving rise to products similar to those of pancreatic digestion. The mucous membranes are as much outside the body as the skin; but inanimate particles pass through them, so it is probable that some of those organisms which are universally present are also constantly passing through them into the tissues. The skin is absolutely protective against them, but the smallest breach of continuity enables them to enter. Certain organisms—those of the infective diseases of wounds—almost always enter through wounds, whilst others—those of the acute specific fevers—enter as a rule through mucous membranes; but probably no organism is absolutely bound to one mode of entry.

Having actually entered the body, the bacteria fall into two classes of great clinical importance, according as they are able or unable to live and grow in the tissues. Those which grow and give rise to disease are called *pathogenic;* those which die or are eliminated without giving rise to disease are *non-pathogenic.* The line between these classes is not sharply defined, organisms which grow only in specially predisposed individuals or parts uniting those which never grow in the body to those which almost always grow when introduced into the tissues.

The organisms which are constantly present in the bronchi and alimentary tube, and which enter freely in proportion to the number taken in with the air or food, are *non-pathogenic;* they either die in the tissues or are eliminated by the kidneys. They do not die immediately, and when injected in quantity into the blood may appear alive in the urine. Among these organisms must be placed the bacteria of putrefaction. These by their action in the discharges of wounds produce the chemical poison which is apparently the cause of septic intoxication, and its milder varieties—septic traumatic and hectic fever. Only very exceptionally do they exist alive in the tissues; and it may be stated roundly that an antiseptic dressing never becomes putrid from organisms which have escaped from the tissues into the wound.

The *pathogenic* organisms are fortunately not universally present; but now and again certain of them enter the tissues by one or other of the above channels. The person then is in imminent danger of the diseases to which they give rise.

The class of *infective diseases*, or diseases due to the action of pathogenic organisms, is probably a very large one, and is divisible into two groups, *local* and *general;* the former being due to organisms which multiply at their point of entry, and spread thence only by continuity of tissue, whilst in the latter the organisms enter and probably multiply in the blood, causing injurious changes in it, sometimes settling and exciting secondary inflammations.

In the tissues bateria may produce by their life-action compounds which are *pyrogenous* or fever-exciting, others which are *phlogogenous* or inflammation-exciting, whilst others again produce actual necrosis of the surrounding cells. Before they can produce local lesions they must settle—*i. e.*, be arrested at some spot. Some organisms multiply in the blood and are found in the vessels everywhere; others form small masses which become arrested in the finer vessels; others grow in lymphatics, others again in certain tissues only.

Just now germs are in the ascendant; the tendency is to find one as the cause of any obscure disease. It is therefore necessary to insist upon stringent proof before accepting any such discoveries. This proof consists: (1) in demonstrating the constant presence of an organism, recognizable by its form, mode of growth, or physiological action, throughout, or in the *early* stages of the disease; (2) in isolating this organism and obtaining pure cultures of it; (3) in inoculating animals with pure cultures and producing the disease in them. As animals frequently are not subject to diseases of man, the latter part of the proof is sometimes difficult to carry out.

Classification of Bacteria.—Some botanists (Nägeli) believe that all the Schizomycetes are modifications, due to external circumstances, of a very few forms; they are thought to adapt themselves so rapidly to surrounding conditions that within the limits of an experiment they may be seen to change their form, and distinct evidence of altered physiological activity may be obtained. According to this view, it depends upon external circumstances whether the micrococcus of erysipelas or gonorrhœa or the bacillus of tubercle or glanders develops from one of the primary forms. None of these organisms is specific and cannot be regarded as a species in classification. Others (Cohn, Koch) hold that there are a great number of specific forms characterized by shape, size, mode of growth when cultivated, and physiological action; and in prolonged cultivations they have failed to find evidence of variation such as is described above. Many bacteria indistinguishable by form and size have markedly different modes of growth and physiological actions, and preserve them; they will therefore be different species. The increase and diminution in the virulence of organisms reported by various experimenters have sometimes been unreal (Davaine); and when real (Pasteur's *attenuation* of the poisons of splenic fever and chicken-cholera) do not prevent specific classification, for the organisms are quite recognizable by their form, size, and modes of growth in solid soils, and they never produce any disease other than splenic fever or chicken-cholera.

The question of the *mutability of bacteria* is, however, still *sub judice*. At present the balance of evidence is decidedly against it, so we shall assume that there are many distinct species of bacteria and adopt Cohn's classification of them. He divides the Schizomycetes into the following orders:

1. Sphærobacteria, or Micrococci.—Round or short oval cells, single, in chains or zoöglœa-masses.
2. Microbacteria, or Bacteria. (The latter name is unhappily used also for the whole class.)—Cylindrical or oval cells of which the length is not more than twice the breadth, single, in pairs, chains, or zoöglœa-masses; not known to form spores.
3. Desmobacteria, or Bacilli.—Cylindrical, length more than twice the breadth, often growing into long unbranched filaments; zoöglœa-masses rare, but short chains and swarms common. Spores have been found in many forms.
4. Spirobacteria, or screwlike organisms. Of no importance surgically. *Spirochæta Obermeieri* of relapsing fever is the chief.

Each order contains one or two genera, and these again species. The latter are classed according as they are pigment-forming (*chromogenic*), fermentative (*zymogenic*), or *pathogenic*. We shall encounter many of each kind in the following pages.

The student should diligently practise the various methods of staining and recognizing these organisms. Detection of a specific form will often determine the diagnosis of a doubtful case. To those who have perfected themselves in the methods of pure cultivation a great field of research in the etiology of disease is open.

CHAPTER II.

LOCAL DISTURBANCES OF THE CIRCULATION.

These are due to causes acting primarily, not upon the heart nor upon the vascular system as a whole, but upon a portion of the latter only; secondarily, however, local changes must be followed by general, as the vascular system contains a fairly constant quantity of blood. A local disturbance may complicate a general one, being, in fact, induced by local causes ordinarily too slight to do so. General circulatory disturbances are therefore of great importance surgically, but works on medicine must be consulted for a description of them.

Local departures from the normal state produce either too little or too much blood in a part, conditions known as *anæmia* or *hyperæmia*. Such variations are common physiologically; they become pathological when they exceed the physiological limits in duration or degree.

Anæmia.

Local Anæmia.—The word is used loosely to express either partial or complete bloodlessness of a part (also diminution of red corpuscles in the blood).

Causes.—Conditions obstructing the entry of blood—*e. g.*, uniform compression of the vessels of a part, as by Esmarch's bandage or free effusion beneath the skin or fascia; constriction of arteries by ligature or compression by tumors, abscesses, etc.; diminution of the lumen of arteries by thickening of their walls from simple or syphilitic endarteritis, or by contraction induced by ergot, cold, etc.; blocking of the vessel by thrombosis or embolism; and, lastly, arrest of function.

Symptoms and Results.—Anæmic parts are pale, shrunken, dry, and cooler than normal, the symptoms increasing with diminution of blood-flow.

In chronic *partial anæmia* these signs are all present; and, in addition, growth is slow and perhaps imperfect; so also is function—*e. g.*, sensation is dulled; adult parts atrophy or degenerate fattily, or both atrophy and degenerate; and cramps of muscles often cause much pain, as is seen in the legs of old people with degenerate arteries. Such chronic malnutrition greatly diminishes the resisting power of tissues to injury, and renders them prone to inflammation easily running into ulceration or gangrene.

Total anæmia in man continued beyond a few hours inevitably causes death of the part. Some tissues resist anæmia longer than others; the intestine dies sooner than skin or muscle. If the anæmia be not of sufficient duration itself to cause death, this may still result from inflammation setting in upon restoration of the circulation. Thus Cohnheim found that by rendering a rabbit's ear bloodless and keeping it so for periods of eight to forty-eight hours, he could produce any stage of inflammation—œdema, purulent infiltration, hemorrhagic infiltration, gangrene; anæmia therefore causes that change in the vessel-walls which is the essential lesion of inflammation.

When an artery is obstructed, the result to the parts it supplies depends upon the anastomoses of the vessel beyond the obstruction. If these are very free, either with branches of the same trunk above the obstruction, or with other unobstructed arteries (branches of the mesenteric, ulnar, or radial), the effect upon the circulation may be practically nil, blood being immediately carried into the trunk beyond the obstruction by collateral channels. When the anastomosis is less free, as in the case of the femoral, a time follows obstruction in which it is doubtful whether *collateral circulation* will be established throughout the limb, and upon the distance to which blood penetrates depends the fate of the limb. Sometimes, even here, there is scarcely any sign of embarrassment; at others, œdema which soon subsides occurs; or a toe is lost, or, again, the limb dies up to the knee. Ordinarily, the limb remains pale for a few hours, and would become cold but for external warmth, and the functions of its muscles and nerves are more or less depressed; within twenty-four hours the surface is generally slightly redder and two or three degrees warmer than that of the opposite limb, owing to full dilatation of all collateral channels diminishing the resistance to the entry of blood to a minimum. This dilatation is certainly reflex, inhibition of the vasoconstrictor nerves being excited by some stimulus arising in the anæmic parts; but prolonged anæmia has probably much to do with it, acting as on the removal of Esmarch's bandage. The duration of the dilatation varies, doubtless with that of the precedent anæmia; it may continue some days, and is often accompanied by burning pain. Ultimately collateral vessels, previously small, become larger, thicker walled, and tortuous from increase in length, and pulsation may return in the trunk beyond the obstruction; there is no evidence of the formation of new vessels. If the obstruction is gradual, the probability of the establishment of collateral circulation is always greater than under opposite conditions.

But the result is very different when the artery beyond the obstruction has none but capillary anastomoses. The secondary branches of the cerebral, retinal, pulmonary, splenic, and renal arteries are examples of these so-called *terminal* arteries; and the renal, splenic, and retinal arteries themselves almost solely supply their respective organs.

If such an artery is suddenly and completely blocked, its branches contract, and the area supplied by it becomes anæmic; then, as the contraction gives way, Cohnheim says that blood regurgitates from the veins and distends every vessel, the region now becoming swollen and dark with blood, whilst round it is a bright red ring due to dilatation of the neighboring vessels and their capillaries. From these blood doubtless enters the most external capillaries of the area, but the resistance soon becomes too great, and it stagnates. Ultimately, as the vessels die, corpuscles pass through their walls and infiltrate the tissues largely. Such lesions are called *infarcts*. But when gravity or valves oppose the return of blood through veins, the area of the obstructed artery remains pale.

Litten gives another account of infarction, viz., that it never occurs from veins unless intravenous pressure is much increased, as in the renal by clamping the cava at the diaphragm. Under ordinary circumstances, it is always due to the existence of small arteries, such as the twigs from the phrenic, suprarenal, lumbar, and spermatic arteries to the kidneys. When the renal artery is tied, these enlarge, and a large quantity of blood enters the part by them; the pressure in them is not sufficient, however, to maintain circulation and vitality, though some blood reaches the renal vein, infarction and swelling of the kidney being greater when this is tied than when it is open. This, Litten says, proves that venous regurgitation is not the cause of infarction; whilst the fact that no infarction occurs, even though the renal vein be open, after the renal artery has been rendered truly *terminal* by stripping the kidney out of its bed of fat, shows that small arteries entering through the capsule are the cause of this phenomenon. Both Litten and Cohnheim agree that the corpuscles do not pass out through ruptured vessels, but Cohnheim makes them escape after prolonged anæmia has altered the vessel-wall as in the rabbit's ear, whilst Litten states that the escape begins immediately after the obstruction, and is due simply to mechanical stretching of the capillaries and small veins.

Whichever view is correct, it is certain that infarction does not follow the obstruction of some terminal arteries—*e. g.*, that of retina and divisions of cerebral arteries; the supplied areas remain anæmic, the cells lose their nuclei, swell, and then undergo fatty change, forming a yellow, usually wedge-shaped mass on section. When infarction has occurred the patch gradually becomes decolorized, whilst the tissues undergo the above changes. The fatty material may be absorbed, leaving a depressed scar; or a firm cheesy mass may remain, surrounded by scar-tissue, and ultimately calcify. Obstruction of a terminal artery therefore leads to death of the part supplied by it, but the ordinary signs of gangrene are absent because the parts are prevented from drying and shielded from the causes of putrefaction, and the part falls into a state of necrobiosis. In this condition it affords a soil in which organisms grow much more easily than in living tissues; and either the plug which blocks the vessel may contain them (see pyæmia), or they may reach the area separately through the blood.

Treatment.—Removal of the cause wherever possible. Measures calculated to improve the general health. Proper exercise, methodical friction, and flannel or lambswool about the affected part will be useful in chronic local anæmia. In these cases patients should be cautioned against even such slight injuries as are commonly inflicted in cutting nails, and against exposure to cold. Nothing can be done for the blocking of terminal arteries, except to prevent such a condition of clots in the veins leading from wounds as shall cause them to break down.

Hyperæmia.

This may be of two kinds: (1) *Arterial* or *active*, (2) *venous*, *passive*, or *mechanical*.

Active Hyperæmia. Causes.—Conditions diminishing arterial resistance in a part, the general arterial pressure being maintained. They may be arranged in three groups: (1) those producing dilatation by direct action upon the arterial wall; (2) those acting reflexly, inhibiting the vaso-constrictor action of the sympathetic by exciting the sensory nerves of the part; (3) those inhibiting the action of the sympathetic through vaso-dilator nerves, such as the chorda, the nervi erigentes, or the auricularis magna of the rabbit; but the universal existence of such nerves is not established.

1. Influences Acting Directly on the Vessel-wall.—Stimulants and irritants differ only in degree; a stimulant causes the muscular coat to contract, an irritant injures its contractility, and it yields before a distending force. Dilatation from actual injury of the muscular coat is the cause of the hyperæmia which accompanies inflammation, and is, surgically, the most important form. The cause of the inflammation, be it mechanical,

chemical, or physical, actually damages, and consequently impairs the functions of the muscular and all other tissues in the wall of the vessel. In these cases the stimulus required to cause contraction of a vessel is greater than normal, and perhaps even the drawing of a needle across an exposed arteriole may be ineffectual.

Hyperæmia is frequently secondary to anæmia, as shown by the free general bleeding after the removal of Esmarch's bandage, and that dilatation which facilitates the establishment of collateral circulation (page 26), is doubtless in great measure thus accounted for. It is due sometimes to fatigue of the nervous and muscular structures concerned in maintaining the preliminary state of contraction, and always to more or less malnutrition of the muscular coat.

The sudden removal of external pressure after this has been exercised for a long time produces hyperæmia, in some cases with dangerous consequences. Thus the sudden emptying of a peritoneum tightly distended with fluid, of a greatly distended bladder, especially when the patient is standing, or the removal of a large tumor, may lead to fainting, because the great abdominal veins dilate and contain a large proportion of the blood. Smaller vessels may under these circumstances rupture, giving rise to the blood often mixed with the last urine drawn from chronically distended bladders, and which may tinge the urine for days after the first emptying of the bladder Aspirating a pleura often shows a similar result. In these cases the muscle of the vessel walls, accustomed to assistance, appears to be unequal to the strain thus suddenly thrown upon it, and it may be days before it recovers its ordinary power.

Warmth up to 118° F. produces direct relaxation; and, as it has this effect in parts of which all nerves have been divided, part at least of its ordinary action must be direct. Above 118° it causes a preliminary contraction which may pass directly into heat-rigor and death, if the temperature is sufficiently raised. The immediate anæmia is seen in the white spot found if a drop of hot sealing-wax is quickly removed from a hand upon which it has fallen; the subsequent persistent dilatation from injury of muscle is also well known.

Moderate cold will maintain for a long time pallor or blueness of the skin, or a mottled condition, white with purple patches—the blood moving slowly through the latter. But after the application of an icebag for a few hours, the skin will usually be found bright red, the vessels being dilated and the blood passing rapidly through them.

2. Influences Either Directly or Reflexly Preventing the Action of the Vaso-constrictor Nerves.—Section of the sympathetic in the neck produces redness of the side of the head and neck, perhaps even of the arm, sometimes accompanied by sweating; redness of the conjunctiva, secretion of tears, flattening of the cornea from diminished intraocular tension, contracted pupil and ptosis. It many cases these symptoms are not ordinarily present, but are brought on by slight exertion. The abnormal may be two or three degrees higher than the normal side.

Such symptoms are met with in rare cases of stabs and gunshot wounds of the neck.[1] Hutchinson reports cases of fractured clavicle with injury to the brachial plexus, causing paralysis of the arm, accompanied by all these symptoms; in others, only narrowing of the pupil and of the palpebral fissure have indicated injury of the sympathetic. Similar results are noted in some cases of tumors in the neck pressing on and causing degeneration of the sympathetic; goitres are among the commonest.

[1] Weir Mitchell, Morehouse, and Keen, Gunshot Wounds and other Injuries of Nerves.

Strange to say, no hyperæmia of the extremities has been recorded after section of their nerves, but Waller and Weir Mitchell produced hyperæmia and rise of temperature between the fourth and fifth fingers by freezing their ulnar nerves at the elbow.

Excitation of the central end of a sensory nerve produces reflex dilatation of the vessels of the part supplied by it, but rise of arterial tonus elsewhere, the result being active hyperæmia. The probability is that irritants act earliest and most easily upon the sensory nerves ; then upon the vessels themselves. Consequently, the slightest stimuli—such as friction, stimulant liniments, etc.—probably produce redness in this way. It seems that the production of hyperæmia in superficial parts often leads to anæmia of viscera beneath them, which perhaps explains the action of fomentations, etc., in relieving inflammation of deep organs.

Collateral hyperœmia (page 26) has been attributed to increased pressure upon the collateral vessels. But that these specially dilate must be due to some reflex inhibition of the vaso-constrictor nerve, for the effect of blocking an artery is to raise, for a longer or shorter time, the pressure throughout the arterial system. Local dilatation implies a local cause, and this might be anæmia, were it not that surrounding vessels, which are not rendered anæmic by the obstruction, dilate to supply the anæmic area.

So-called *compensatory hyperœmiœ* must be mentioned here, though the nervous mechanism arranging for them is not understood. In these, after removal of an organ, the blood which should go to it passes to the organ or organs which are capable of taking on its functions ; after nephrectomy, the blood goes to the other kidney, and if this is seriously diseased the patient dies; after removal of the spleen in animals increased blood-supply goes to lymphatic glands, marrow of bones, and other lymphatic structures.

3. Some hyperæmiæ are believed to be due to *excitation of vaso-inhibitory or vaso-dilator nerves*. But little is known about them. V. Recklinghausen says that these hyperæmiæ are more acute and run a more rapid (often quite short) course than the above, are generally accompanied by neuralgic pains, and often by increased secretion of the glands in the affected area and exudation into the tissues or desquamation of epithelium from the surface. Blushing from shame, anger, alcohol, indigestion, affords at once a physiological and pathological example, but the chorda and the nervi erigentes are the types of vaso-dilator nerves.

V. Recklinghausen regards as examples the hyperæmiæ accompanying neuralgiæ of the branches of the fifth ; herpes zoster and the many wheals, papules, and erythemata which break out upon the skin with burning pain ; the results of neuritis secondary to injury coming on after a week or more, producing hyperæmia, with pains and often swelling, recurring perhaps periodically and ending in that painful, thin, tense, shiny, and hairless condition known as glossy-skin. Finally v. Recklinghausen places joint-lesions occurring in ataxy, myelitis, hemiplegia, etc., as neuroses allied to vaso-dilator neuroses.

SYMPTOMS.—Bright redness, elevation of temperature even to six or eight degrees above that of the opposite side, sense of pulsation, hyperæsthesia and sometimes pain ; in glandular organs or parts the secretion is sometimes increased, some swelling is always present, varying with the vascularity of the part. The blood at first rushes through the widened vessels with excessive rapidity, the distinction between the axial and plasmatic layers being lost, and the blood in the veins being red and often pulsating. But the initial rate of flow sinks if the general arterial pressure falls, as is usual after a time. The transudation from the vessels is increased in every case, but until the lymphatics are unequal to the task of carrying it off no œdema occurs.

As a rule, redness and swelling have completely disappeared post mortem. Hemorrhages not uncommonly occur during active hyperæmia, especially if the vessels of the part are diseased, or of new formation.

Treatment.—In all directly excited cases removal of the cause: also in reflex cases where the cause is discoverable; the removal of any source of irritation in the course of a nerve resulting from injury; the application of belladonna or of liq. plumbi fort.; and attention to digestion and the bowels.

4. Passive, Venous, or Mechanical Hyperæmia (Congestion).—In this condition a part contains in its capillaries and veins an excess of blood in a more or less venous state, these vessels being wider and the blood-stream in them slower than normal.

Causes.—Either diminution of the forces which carry on the circulation, or direct obstruction to the return of blood by the veins; congestions resulting from the former cause are called *hypostatic*, from the latter *obstructive*.

The great cause of *hypostatic congestion* is cardiac weakness, but similar diminution in the driving force may result from obstruction in the arterial path, and incompetence of the valves in veins will tend in a similar direction. Practically, however, hypostatic congestions mean those due to cardiac failure. This results from senile decay, exhausting illness, fatty degeneration, uncompensated valve disease, high fever, etc. Under these conditions a sharp lookout must be kept to prevent hypostatic congestions.

These are best seen in the lungs. When the heart is acting weakly, the result will be more obvious the longer the circuit through which it has to drive the blood, consequently blood will tend most to lag in the lower and hinder parts of the lungs, which in dorsal decubitus are the lowest parts—*i. e.*, the intravenous pressure due to gravity is highest here. If the patient changes his position little, this high pressure is almost constantly maintained, distending vessels which are imperfectly nourished; moreover, those parts of the lung always move least and are still further hampered by the position in bed, so little help from movements is derived by the circulation. Consequently the lower and hinder parts of the lungs become darkly congested; they do not collapse when the chest is opened, but feel heavy and more solid and contain less air than the upper anterior parts; on section a quantity of bloody fluid, more or less frothy, can be pressed from the tissues and cavities of the lung and the part is usually softened. This condition not unfrequently passes into one of catarrhal pneumonia and real consolidation of lung (*hypostatic pneumonia*). Everywhere the circulation is more or less abnormal, and doubtless this helps in the production of bedsores over the sacrum and heels; but irritation and anæmia from constant pressure, friction, and perhaps contact with urine, etc., plays the chief part.

Obstructive congestions result from heightened intrathoracic regurgitant pressure, from uncompensated valve disease, from thrombosis of main veins, or from complete or partial occlusion of them by external pressure which does not proportionately affect the arteries; the fillet in bleeding, and the contracting connective tissue in cirrhosis of the liver act in this way.

When a vein is blocked, the effects vary according to the ease with which the blood contained in it can find its way by other channels to the heart. This may occur without the slightest difficulty, or, on the other hand, it may be impossible. The difference between the obstructive and hypostatic cases is this, that in the former the arterial pressure is undiminished; consequently the intravenous pressure is greatly increased. If no movement of blood occurred from a certain point in an artery up to the obstruction in the vein, the pressure all along the column would be that of the artery at the above-mentioned point; but some lateral escape of blood generally occurs, some movement of the column, some friction is overcome, and the arterial pressure is proportionately diminished in the veins—progressively so as the circulation becomes reëstablished.

Signs and Results.—The signs of venous congestion are primarily three: blueness or cyanosis, slight swelling from overfull vessels, and diminished temperature, both due obviously to the slowness of the circulation through the part. Certain results follow, varying in intensity with the duration of the congestion and with the intravenous pressure; they are, *œdema* from transudation of fluid from the vessels; *escape of red corpuscles* either by diapedesis or actual rupture of vessels; *wasting of elements* of a part—*e. g.*, liver-cells—from constant pressure of distended vessels; *thickening of soft parts* by increase of connective tissue. In cases where the circulation is not reëstablished, *moist gangrene* is, of course, the result.

Treatment of Local Venous Congestions.—Remove any removable obstruction to the circulation. Elevate the part moderately to favor return of blood by the veins; systematic friction toward the heart may act similarly. Wrap the part in cotton-wool, and place hot bottles in the bed, but *not* in contact with the limb, to keep up the temperature.

To prevent hypostatic congestions, change the position of the patient frequently, that gravity may not act for long together against the circulation in the same set of veins; and get the patient out of bed into a chair as soon as possible.

Should the heart be acting weakly or irregularly, easily digestible fluid food must be given often and regularly, and digitalis may be tried.

Should gangrene threaten, means must be taken to prevent decomposition of the part.

CHAPTER III.

INFLAMMATION.

As the great majority of morbid conditions met with in practice are of an inflammatory nature, the importance of an accurate acquaintance with all that is known concerning inflammation is self-evident.

Definition.—Inflammation is the succession of changes which take place in a living tissue as the result of some kind of injury, provided that the injury be insufficient directly to destroy its vitality (Sanderson). Certain nutritive disturbances may also excite it.

Etiology.

It must always be remembered that there are two elements to be considered in the production of every morbid process—the tissue-elements and some injurious influence acting upon them; also, that the former possess a power of resisting such influences which varies in different individuals, in the same individual in different states of bodily health, and even in different parts of the same individual. Thus, a cause which produces inflammation in one person or in one part will fail to do so in another person or another part.

The effect produced by an injurious influence upon the tissues varies directly as its *intensity*, and, up to a certain point, as the *duration of its action*. A cause may be of such slight intensity as to produce no deleterious effect, unless it act for some time; and no matter how long it act, it may never produce the higher stages of inflammation. Increase the strength, or both the strength and time of action of the cause, and the inflammation becomes *pari passu* more intense, till perhaps gangrene results.

The *extent* of an inflammation is limited to the area of action of its cause. *Spread* of an inflammation implies precedent spread of its cause; *chronicity* implies continuous action of the original, or equivalent causes.

Immediately an injurious influence ceases to act, all cells, not hopelessly damaged, tend to recover by their innate power; thus Lister has seen inflammatory stasis resolve in an amputated limb. Recovery is greatly assisted by a suitable supply of blood.

The etiology of inflammation has been worked out partly in the wards, but chiefly in the laboratory of the experimental pathologist. The *exciting* causes may be ranged under the following heads:

1. Simple Anæmia.—By excluding blood from a part for a sufficient length of time, any desired stage of inflammation may be produced on allowing the circulation to reëstablish itself (Cohnheim). This is seen on returning to the abdomen bowel which has been strangulated, when inflammation—previously absent—sets in; also, sometimes, on relieving strangulations of other parts, as limbs.

2. Mechanical Injuries.—Subcutaneous injuries of this kind, even though severe, rarely present any symptoms of inflammation; microscopically the tissues show early stages of the process. The passage of a knife through tissues is probably so injurious as to kill a microscopic layer of tissue on each side of it, and free exudation of fluid and cells follows from the vessels in the immediate neighborhood, which dilate freely. But if the wound is protected from further irritation, this is all over within 24 or 30 hours, and healing begins. As a rule, *prolonged* action of such injuries is prevented; but a tight stitch may excite even suppuration round it beneath an antiseptic dressing, and tension in an aseptic wound or abscess cavity owing to imperfect drainage is believed to act similarly; yet it must be rare indeed for the tension under such circumstances to be greater than it often is in cases of effusion into joints and subcutaneous extravasations which do not lead to inflammation. Friction, again, delays healing, and keeps up an inflammation.

3. Physical Injuries.—*Heat* is a frequent cause of inflammation as seen in burns, scalds. One must distinguish between destruction of tissue and inflammation, and certainly much of the latter which follows burns of the second and higher degrees is due to infection of the raw surface. A cautery plunged into a muscle produces no more inflammation than a subcutaneous injury, if the part is kept aseptic (Hüter); for though an intense irritant, its action extends little beyond the tissues it kills and is of short duration.

Cold is a very frequent cause of inflammation. Intense cold acts like intense heat; but numerous cases of bronchitis, pneumonia, Bright's, etc., are attributed to draughts, wettings, and such mild influences. Its *modus operandi* is unknown (see Green's *Pathology*, 6th edit., "Inflammation").

4. Chemical Injuries.—Severe chemical irritants are, as a rule, permitted to act only for a short time; if the injured surface is kept aseptic, they excite little inflammation. But experimentally certain substances may be introduced into the body which will act *strongly and continuously*. These are the conditions necessary for suppuration, which follows when croton oil, for example, is thus used; no organisms are present in the pus. Again, granulating surfaces may be caused to suppurate by the prolonged action of very dilute antiseptics, as carbolic acid. Morbid tissues do produce mild irritants, such as urate of soda, but it is extremely doubtful whether they ever form bodies capable of exciting the formation of pus. Nevertheless, chemical irritants are the great causes of suppuration, of wounds, and of the for-

mation of abscesses, as shown in the next two paragraphs, which are separated from this for convenience only.

5. Putrefaction of Discharges.—Many of the compounds formed in the putrid decomposition of wound-discharges are very irritating, and a constant supply of them is kept up by the bacteria which have gained entrance to the wound; more or less free suppuration results. Certain of these irritants are absorbed and excite inflammation along lymph-channels; and others act as general poisons producing fever and other symptoms.

6. Presence of Certain Organisms in the Tissues.—Many inflammations are due to the action of various organisms—*e. g.*, tubercles, erysipelas, abscesses of farcy, and probably hospital and spreading gangrene. So long as they are supplied with food, these organisms furnish a constant supply of irritant bodies of all degrees of intensity; they may therefore excite any degree of inflammation. By invasion of neighboring tissues they cause spread of inflammation *by continuity*; when carried to distant parts by lymph or blood streams they may excite *secondary or metastatic* inflammations similar to the primary; and finally they explain the infectiousness of certain inflammatory processes.

It would seem that many specifically different organisms produce irritants of about equal strength, and consequently though each specific inflammation has its special characteristics of site, course, etc., no degree of inflammation can be regarded as peculiar to the action of any one organism. To take suppuration, the pus of ordinary acute abscesses invariably contains micrococci, sometimes singly, sometimes in chains; Cheyne (*B. M. J.*, 1884, vol. ii. p. 646) thinks that these are different forms. Pure cultivations of them excite suppuration when inoculated in healthy animals. The micrococci of acute osteomyelitis, of pyæmia, of gonorrhœa, the bacilli of farcy, differ again from each other; but all unite in producing suppuration. In chronic abscesses organisms are not found, in some perhaps because they have disappeared, having been present early; but many of these abscesses are of tubercular origin. The fluid in tubercular abscesses excites tuberculosis when inoculated upon animals, but it contains no bacilli; Koch thinks that the bacilli have died, leaving spores, which cannot be stained by any process yet known. Acute suppuration therefore seems to be due, as a rule, to the presence of organisms; but occasionally the conditions required to cause it by ordinary mechanical or chemical irritants are actually brought about by surgeons; needless to say, they should always be avoided. Almost all the inflammation attributed to injuries of all kinds seems really due to secondary infection of the injured part by organisms. This necessarily occurs in injuries accompanied by breach of continuity of skin or mucous membrane which are not treated antiseptically; much more rarely subcutaneous lesions become infected by organisms which, like the micrococci so constantly found in the pus of ordinary acute abscesses, have entered through mucous membranes. This accounts for the great clinical difference which formerly existed between subcutaneous and compound injuries.

7. Abnormal Nervous Influence.—Certain inflammations, such as herpes zoster, rashes, and acute bedsores following injuries and diseases of the central nervous system, have led to the belief that irritation of nerves is a cause of inflammation. This is, however, by no means well established.

In addition to the above *exciting* causes, there are many *predisposing*. *Any conditions which lower the general health*, and therefore the vitality of the tissue-elements, *predispose to inflammation*. As before noted, incapacity to resist certain causes of disease—*e. g.* that of tuberculosis—may be congenital and inherited. It is the experience of all, that inflammatory processes are common in people who are "out of health." Certain diseases, such as Bright's and diabetes, specially predispose to inflammation.

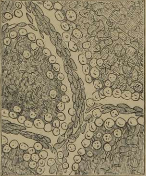
Process of Inflammation.

Our knowledge of the process of inflammation, like that of its etiology, is due almost entirely to experimental pathology. The fundamental experiment is the observation of the changes which ensue in a transparent part of a living animal after or during the action upon the part of some irritant. The process as then revealed is essentially the same in warm- and cold-blooded animals, and it serves to explain the clinical symptoms of inflammation and the changes noted in the tissues of man after death.

When the irritant chosen is of *moderate* intensity and allowed to act *continuously*, the whole process of inflammation, from beginning to end, may be watched under the microscope. The first effect of most irritants is to produce an *active hyperæmia* or *determination of blood;* the arteries dilate considerably, and blood rushes swiftly through them, being still bright red, and perhaps pulsating in the veins. At first the calibre of the vessels may vary somewhat, being now smaller, now larger; but after a time, *dilatation increases steadily.* The acceleration of flow continues, but sooner or later gives place to *retardation;* the vessels are so wide, however, that in spite of this the discharge of blood from the veins is greater than normal. *Dilatation* with *retardation of flow* is the earliest effect characteristic of inflammation, and is due to actual damage of the muscular coat, extending thence to the inner, and increasing the resistance which is naturally offered by the vessel-wall to the passage of blood. As the inflammation progresses, dilatation increases up to a point beyond that caused by section of the vasomotor nerves; it affects the arteries chiefly, then the veins, and the capillaries but little. It varies with the blood-pressure, the muscle of the vessel being paretic or paralyzed.

As the injury to the endothelium increases, the resistance to the circulation becomes greater and the flow slower; the dilated vessels act almost as rigid tubes, each heart-stroke is felt in the capillaries or even the veins, and in diastole individual corpuscles can be recognized even in the arteries. So soon as retardation of the flow is established, the plasmatic zone in the veins becomes more marked, and the number of white corpuscles (*loiterers*) naturally seen there increases rapidly. At first these corpuscles roll slowly along the wall, there they stick for a shorter or longer time, but are ultimately carried away by the current, finally they become fixed and gradually form an irregular lining to the vessel, one, two, or even three cells thick (Fig. 1). Necessarily they greatly obstruct the lumen of the vessels and increase the obstruction. To a less extent, they adhere also in the capillaries. In the latter, as the circulation slows, red corpuscles accumulate to such an extent that they look like red cords, and appear much larger than natural. But before this stage is reached, all onward movement of the blood has ceased; for a time the corpuscles sway to and fro with the pulse (*oscillation*), then become quite still (*stasis*), and ultimately clotting occurs (*thrombosis*), indicating death of

Fig. 1.



After one of the original drawings in Dr. W. Addison's *Experimental Researches on Inflammation, etc.*, Lond., 1843–45. It shows the axial stream of red corpuscles, the plasmatic zone with heaped up leucocytes, and the latter after they have passed into the tissues.

the vessels. Stasis may, however, continue for a long time without passing into thrombosis; thus after three days' complete stasis, Paget found the contents of the vessels fluid. That the return of blood by the veins of a part in these advanced stages of inflammation diminishes progressively, goes without saying.

By using an irritant of suitable intensity, any stage of inflammation may be produced almost instantly; a grain of mustard on a frog's web causes stasis in its immediate vicinity before the experimenter can get a view of the part; but passing outward from the centre he finds every stage of the above-described process—oscillation, full dilatation with very slow circulation, and copious heaping up of white corpuscles, then full dilatation with more or less retarded flow, and ultimately less dilated vessels with accelerated blood stream between the inflamed area and the normal. These conditions will not, however, be found in regular zones, as the cause does not spread uniformly from the centre.

The above are the *vascular phenomena of inflammation;* but if, during the course of an advancing inflammation, attention is directed to the *tissues round about the vessels*, it is early noted that they become cloudy or granular, soaked with fluid and infiltrated with cells, like white blood corpuscles; often fine threads of fibrin appear; here and there red corpuscles are seen singly or in groups. This exudation causes *swelling* if it remains within the tissues, but it may in great part escape from a free surface, and perhaps form a coagulum upon it, obscuring the view. Normally, lymph transudes from the capillaries and fine veins, and with it a few leucocytes, the vessel-wall acting as a kind of filter, even with regard to the soluble constituents of the blood, for lymph is not liquor sanguinis. In inflammation the filter is more or less altered by the action of the irritant upon the vessel-wall, and by the stretching to which the wall is subjected; and as a result the filtrate or that which passes out is more or less altered in *quality* and *quantity*. Albumen passes through the vessels of an inflamed part much more readily than through normal vessels. Injection under normal pressure shows that there are no apertures left in the vessel-walls, even after the escape of red corpuscles; and the microscope reveals no structural change.

The effect of simple stretching by heightened blood-pressure is seen in the œdema of venous obstruction. Speaking generally, inflammatory exudation contains more albumen, phosphates, and carbonates than œdema fluid, and tends to coagulate; but in all these particulars it falls behind blood plasma. The more intense the inflammation the more nearly does the exudation approach the composition of plasma, the less intense the more like is it to œdema fluid. The number of leucocytes, too, increases with the intensity of the process, and in the most intense forms red corpuscles are found in excess of the white. As regards *quantity* of exudation, Lassar tied a canula into a lymphatic trunk of a dog's leg, and then excited acute inflammation of the paw by dipping it in hot water; almost immediately the rate of flow increased and soon reached eight times the normal. For a short time the lymphatics sufficed to remove the exudation, but then the latter became too great, and swelling of the foot occurred, whilst both lymphatics and veins (as we have seen) are fully dilated. Subsequently, the lymph-flow diminished as the lymphatics became blocked by coagula and compressed by œdema. At first clear, the fluid soon became turbid from white corpuscles with occasional red ones.

The *cells* found in the tissues in inflammation are ascribed to two sources: multiplication of the fixed tissue-cells (Virchow, Stricker); and white blood corpuscles (Cohnheim). Few, if any, pathologists now hold the former to be their only source, but many look upon the white corpuscles in this light, whilst others think that the new cells spring from both tissue-elements and leucocytes.

The *vascular origin* of a very large number, if not of all the cells, in ordinary acute inflammations, by escape through the vessel-wall of those cells which have become fixed against it, is certain. The escape may not begin for some time after the wall-zone has formed, and it may go on rapidly or slowly; but with patience it is not very difficult to see. Leucocytes probably work out partly by their spontaneous movements, but they are much aided by intravascular pressure, which alone causes the exudation of red corpuscles, for compression of the main artery arrests the most active escape of corpuscles. Thrombosis has a like effect. Leucocytes pass out chiefly from small veins, red corpuscles chiefly from capillaries—*i. e.*, each vessel lets out that which it contains (p. 50). No cells escape from arterioles. It has been seen (p. 50) that the capillaries do not become packed with stationary red corpuscles until an advanced stage of the process, long after the wall-zone has formed in the veins; in other words, the capillaries become packed and red corpuscles escape in quantity only in severe inflammations. A few red corpuscles pass out in almost all cases, and frequently several pass quickly through the same spot in the vessel-wall, forming a "punctiform hemorrhage" visible to the naked eye. The richer a tissue is in capillaries, the more numerous will be the red corpuscles in an inflammatory exudation.

With regard to the *tissue origin* of pus-cells, whilst the adherents of Stricker have been able to find unmistakable evidence of the multiplication of the cells of most tissues when inflamed, the followers of Cohnheim have watched with equal care and have seen none. Thus, Dowdeswell for eight days made daily drawings of a group of connective tissue cells in a toad's tongue; they showed no change other than degenerative. Whenever certain appearances in a tissue have been ascribed to multiplication of its cells, a portion of the tissue, dead some days, has been rendered aseptic and placed among living tissues; it there excites a little inflammation, leucocytes invade it and produce the appearances attributed to multiplication of its cells. But observations of this kind do not disprove the occurrence of the latter phenomenon. As inflammation is always due to some injury, it seems *à priori* unlikely that a damaged cell will at once begin to multiply, and Lister long ago showed that the functions of certain cells, especially pigment, muscle, and ciliated cells, were depressed and annulled by irritation. Weigert, too, has demonstrated that in all except the mildest inflammations, proper staining and microscopic examination will reveal dead cells. But different cells, and especially cells of different kinds, resist injurious influences with varying power; and further, many causes which seem to act upon all the cells of a part do not really act so uniformly. Thus it is conceivable that an influence which damages one cell may merely stimulate another and excite it to make use of the abundant food-supply consequent upon the hyperæmia. It is in the less intense forms of inflammation, and on the confines of the more severe ones, that multiplication of the tissue elements may be looked for. It is best seen in mucous catarrhs, in which the discharge contains numbers of cells believed to be epithelial, capable of performing movements upon the warm stage; the free desquamation, also, in many inflammations of the skin, indicates rapid multiplication of the cells of the rete. As above stated, the evidence is most conflicting concerning the multiplication of cells of deeper tissues; and the question has been rendered more difficult by Senftleben's account (p. 60) of regenerative processes in connective tissue cells, which Cohnheim regarded as distinct from inflammation, but as frequently occurring during that process. Multiplication of cartilage cells undoubtedly occurs in rheumatoid arthritis, but all would not admit this to be an ordinary inflammation.

However formed, small round cells accumulate in greater or less numbers in the tissues or pass off from a free surface. In the former case, the elements of the infiltrated tissue frequently disappear before them, being probably killed by the inflammation, and then eaten up by the leucocytes.

SUMMARY.—We learn from the above that inflammation is a process started by injury and tending to produce death of the affected part; that, as a rule, the causes of inflammation act upon all the tissues of a part, but the most striking results are vascular, and unless vessels are affected by an injury, no process recognizable as inflammation ensues. The vascular phenomena appear to be due to a " molecular change " in the vessel-wall, evidenced by a paralytic dilatation under the intravascular pressure; by a resistance to the circulation which may be so great that, in spite of the fullest dilatation of all vessels, the circulation is brought to an absolute standstill, and which always causes some retardation of flow; and by the escape of the constituents of the blood in abnormal quantity and quality.

The influence of intravascular pressure in producing dilatation of the vessels and in causing the increased exudation must be carefully borne in mind with regard to treatment. It must not, however, be thought that this pressure is increased in inflamed parts as a result of the dilatation of the arteries; on the contrary, it is diminished in the capillaries and veins, from which exudation occurs, in proportion as the resistance in the arterioles produces slowing of the circulation.

It seems probable that where the injury is so slight that it produces dilatation with only slight retardation of flow, multiplication of the more resistant cells may occur, but the evidence of this is very conflicting. In almost all inflammations damage of the tissue-elements is shown by their cloudy, granular, and swollen appearance, by their softness, by the presence of more or fewer which are obviously dead, and by the actual disappearance of many before invading leucocytes; also by depression of the functions of each, perhaps following on a period of morbid exaltation from over-stimulation best seen in the case of sensory nerves.

Analysis of the Clinical Signs.

The *clinical signs of inflammation* are, *redness, heat, swelling, pain* (rubor, calor, tumor, dolor of Celsus), *impaired function* (functio læsa), and *fever*. The last sign is a general one, the rest are local. Frequently all are not present; there may be only one—*e. g.*, swelling, and the diagnosis from swelling due to new growth may be very difficult. It will depend largely on the history, the existence of a cause, and the result of treatment.

1. *Redness* is due to the following condition chiefly—to distention of the vessels with blood. It varies from bright red to almost blue (seen in the edges of sinuses, etc.) according to the rate of flow of the blood. Numerous small extravasations of red corpuscles (*ecchymoses*) give a red or purple color which does not disappear under pressure; often, too, the tissues are stained the color of raw ham by coloring matter derived from broken-down corpuscles, as is seen on pressing over many recent patches of syphilitic rashes. Lastly, a dusky brownish-red color is frequently noticed over hemorrhagic and gangrenous inflammations, due also to hæmoglobin. Redness may be concealed by superjacent healthy tissue, a very thin layer often sufficing; on the other hand, it may be present from simple hyperæmia.

2. *Swelling* is the most important sign of inflammation, often the only one discoverable clinically. *Distended vessels* produce a slight fulness, but this

is insignificant compared with the effect of *exudation*. The swelling may be diffuse or circumscribed, and have either fluid or solid characters; it may be very slight or very great, due to exudation weighing several pounds. The exudation varies in quantity and quality according to the nature, intensity, and duration of action of the cause, and to certain vital and structural peculiarities of the parts acted upon. Thus serous membranes are prone to the formation of lymph and adhesions, mucous membranes to suppuration; the more vascular a part and the looser its structure, the freer will be the exudation and the more likely is it to contain red corpuscles. Exudation is therefore most abundant from a free surface (serous or mucous), next so into loose connective tissue, and most scanty into the substance of solid organs, tendons, bones, etc.

But the *quality* of the exudation depends very largely upon the cause of the inflammation. As the intensity of the latter increases the exudation changes in character (page 51), but peculiarities of the cause other than its irritant power come into play in this respect. The process of inflammation is continuous and no sudden change takes place in the exudation; nevertheless certain forms of exudation are spoken of as though they were distinct, and similarly we speak of forms or stages of inflammation which derive their names from the form of exudation by which they are characterized. Arranged according to the intensity of the process from which they result, these forms of exudation are, the serous, sero-fibrinous, fibrinous, cellular; sero-purulent, purulent; hemorrhagic.

The *serous* exudation results from the action of the milder irritants. It occurs constantly around foci of intense inflammation—*e. g.*, acute abscesses, and as the early stage of advancing inflammations; in other cases the inflammation never passes beyond the stage of serous exudation. But should the intensity of the process increase, the percentage of leucocytes rises, more ferment and fibrinoplastin are forthcoming, and fibrin in greater or less quantity forms. The exudation is *sero-fibrinous* and contains flakes or large loose coagula of lymph, or a layer of lymph covers the cavity in which the fluid lies, or threads of fibrin form in the meshes of connective tissue. Sometimes the fluid is in great part or wholly absorbed, leaving the lymph, and the exudation then appears to be *fibrinous*. The lymph is yellow-white and consists of leucocytes in a fibrinous network; it varies considerably in firmness, shading off into connective tissue on the one hand and into pus on the other. These forms of exudation are best seen in serous cavities, joints, etc., but they are frequent elsewhere, and especially in the union of wounds by first intention.

Croupous and diphtheritic membranes occur only on mucous surfaces and surfaces of wounds. They were formerly regarded as layers of fibrin, but they differ from fibrin in their chemical reactions. They are said to be due to death of the tissue elements, which being bathed in exudation-fluid undergo a coagulation and very soon lose their nuclei and become unrecognizable as cells. Wandering leucocytes also undergo this "coagulation-necrosis." A membrane is called *croupous* when it involves only the epithelial layer of a mucous membrane, *diphtheritic* when it extends to the mucosa—an arbitrary distinction. Many causes produce the same anatomical result, so a "diphtheritic" membrane does not mean that it results from the action of the virus of diphtheria.

Advancing a stage higher, and the exudation passes through *sero-purulent* to *purulent*—*i. e.*, the number of leucocytes in the fluid increases greatly. But this is not all; formation of fibrin no longer occurs, and it is this, really, which makes the difference between a purulent and the higher degrees of sero-fibrinous exudation. How coagulation is prevented is unknown.

Weigert speaks of this peculiarity, common to all causes of suppuration, as the pus-poison (Eitergift); but as chemical and perhaps mechanical irritants, which, at first or when acting mildly, cause a sero-fibrinous inflammation, may later on produce suppuration, it is doubtful how far the description of a special property is justifiable. Coagulation never occurs on a mucous membrane until the epithelium is destroyed, and it is surmised that epithelial cells inhibit coagulation like the endothelium of vessels. Besides possessing this property, to induce suppuration the cause must be of considerable intensity and act for some hours.

In the most intense inflammations, the capillaries are almost universally injured and filled with slowly moving or stationary red corpuscles and a few white. Red corpuscles are then pressed out in myriads, far in excess of the leucocytes, into the interstices of the tissue, and the exudation acquires a more or less blood-tinged aspect. Formation of fibrin is here also inhibited. *Hemorrhagic* exudations are best seen in cases of spreading traumatic gangrene (from intensity of the irritant) and in the tubercular or cancerous pleurisy (largely from impaired resistance of the vessels). Obviously, a hemorrhagic exudation as a rule renders the prognosis as regards the vitality of the part, and even the life of the patient, very grave, but it is not uncommon in cases of moderate cellulitis of the legs of old people to see the skin purple over large areas from escape of red corpuscles.

Lastly there is a large class of cases characterized by *cellular infiltration* of the tissues, the leucocytes accumulating in and eroding the tissues whilst the fluid is absorbed as it escapes. These cases are typical *chronic* inflammations, many of them lasting for years. They are called *productive* (Cohnheim), for they heal, if they heal at all, by the production of fibroid tissue (page 59). The *causes* of such inflammations must be constantly or frequently acting irritants of slight intensity. Thus we find granulation-tissue forming around embedded ligatures, splinters, bullets; on raw surfaces exposed to air or to the contact of dressings; around subcutaneous injuries from contact with exudations and necrosed tissue undergoing changes preparatory to absorption. But perhaps the most typical inflammations of this kind are those which are classed together as infective granulomata, because they are general infective diseases characterized by tumor-like formations of granulation-tissue. Some of these certainly, and all probably, are due to the presence of organisms. The most important are the tubercular and syphilitic inflammations.

3. Heat.—As a rule, an inflamed external part is hotter than a symmetrically placed but healthy part. Corresponding parts must, when possible, be compared; of course, under similar conditions. The temperature of external parts being naturally lower than that of internal organs, increased supply of arterial blood will cause their temperature to approach more and more nearly that of the interior, but it can never quite reach this point. In inflammations so severe that the quantity of blood passing through a part is less than normal, the temperature is *depressed*. Inflammation does not cause increased formation of heat in a part, for the chemical activity of inflamed tissues is depressed. The most careful measurements of the temperatures of blood going to and returning from inflammatory foci have led to this conclusion, which is supported by the fact that the temperature of an inflamed pleura has often been found lower than that of the healthy one. Of course, in cases of fever, the temperature of an inflamed external part may be higher than the normal temperature of the interior. In very chronic inflammations no sense of increased heat may be perceptible, the rate of circulation may be so nearly normal, or healthy superficial parts may cover the morbid focus.

4. Pain.—The nerve-endings in an inflamed part are suffering with the rest of the tissues from the action of some irritant which keeps them more or less excited, so that there is often spontaneous pain, or a slight extra stimulus—as pressure, friction—produces pain. Frequently the finest nerve-fibres are exposed to a pressure greatly above normal from fulness of the vessels and effusion, and the latter must often contain chemical irritants—the results of the action of microörganisms or of morbid animal cells. These are examples of the constant irritants to which nerves may be subjected. The effect of pressure in causing pain is well shown when an inflamed part is allowed to hang down, so that the effect of gravity is added to the heart-force and the vessels dilate. Pain from these causes is most marked in inflammations of unyielding parts, or of parts confined by fascia: under such circumstances it is often "throbbing," the throbs coinciding with the heart-strokes and the injection of more blood into the part. Certain kinds of pain are characteristic of certain structures; thus bones and ligaments ache; skin smarts or burns; an inflamed pleura, when stretched, feels as if torn or stabbed. In the early stage of inflammations involving nerves of special sense, these become overstimulated; thus, sounds in inflammations of the ear, and flashes of light in those of the eye, precede the abolition of function of the nerve in question. Pain may be absent even in acute inflammations, and not uncommonly is so in chronic cases in spite of the presence of extensive disease. In typhoid conditions, pain is, apparently, often not perceived. Being a subjective symptom, the patient's statements regarding it have frequently to be discounted.

5. Functio Læsa.—Impaired function is due chiefly to the injury done to the tissues by the cause of the inflammation and by the inflammatory process; but partly to the fact that discharge of many functions brings fresh irritants, such as pressure, friction, into play; there is therefore, when possible, a voluntary avoidance of function. Thus an inflamed joint is fixed, and often no weight is borne upon it; inflamed gut is paralyzed and fails to pass on the contents; and so forth.

6. Fever.—The term *fever* implies elevation of the body-temperature, such elevation being usually accompanied by secondary symptoms. It is so frequent and so important a symptom that the temperature of every surgical case should be taken every morning and evening at least, and in serious febrile cases every four hours. The *normal temperature* of internal parts undergoes tolerably regular diurnal variations: thus, the rectal temperature of adults usually reaches a minimum of 97.5°–98° F. between 5 and 6 A. M., rises to a maximum of 99°–99.5° between 5 and 6 P. M., and after 8 P. M. falls again slowly. A maximum over 99° is certainly uncommon. The total variation is generally under two degrees, and the times at which the maximum and minimum are attained vary considerably. The temperature of external parts varies greatly, and is always less than that of the interior. When the axilla is used for taking a temperature it is converted into a closed cavity by carrying the arm across the chest; it takes about twenty minutes to reach its full temperature, and even then may be several degrees below the rectal temperature in old people (imperfect cutaneous circulation, Charcot). The mouth is subject to many cooling and heating influences. So, to ascertain as nearly as possible the temperature to which internal parts are exposed, a thermometer should be introduced two or three inches up the rectum. Where great accuracy is not required, the axilla, closed for five minutes, may be used.

Causes and Varieties of Fever.—Rise of temperature may theoretically be caused by *increased production* or *diminished loss* of heat, or by both together. Diminished loss of heat is of altogether secondary importance; it occurs in fevers in which the skin is dry and pale, and especially during chills and the cold stages of rigors; but the skin may be flushed and moist during the highest fever. Increased production of heat is the great cause of rise of temperature; for a fever-patient raises the temperature of a bath more quickly, or to a higher point, in a certain time, than a healthy man, and increased CO_2 and urea discharge proves increased combustion of tissue. This oxidation is not due to direct combination of oxygen of the blood with the tissues; but the latter store the former and combine with it apparently in obedience to nerve-influence. Thus it is possible for the temperature in certain cases to rise after death. There is probably a centre above the medulla which controls heat-formation, and certain cases of *nervous* fever seem due to interference, direct or reflex, with this centre or its efferent channels. Next, experiment and observation have shown that simple fractures and considerable contusions are followed by distinct fever (*simple traumatic*), and that this is due partly to absorption from the extravasation of fibrin-ferment which is pyrogenous, and partly to nerve-irritation. When the discharges of a wound become septic they excite more or less inflammation and fever until granulation is well established; this fever is due to absorption of products of putrefaction, many of which are pyrogenous, and is called *septic traumatic*. Then come cases of simple *inflammatory fever* due to absorption of the products of inflammations not connected with wounds, though caused in many cases by locally infective organisms. The fevers (*primary*) of general infective diseases, which give rise to no local inflammation sufficient to account for them, follow; and of these, septic infection, typhus and intermittent fever may be taken as types. Lastly, there are several fevers of the etiology of which we at present know little—*e. g.*, the fever of gout or of acute rheumatism. There is no line between the fevers of locally and generally infective diseases (p. 39), cases due both to the absorption of poisons from circumscribed foci of disease and to the growth of organisms in the blood itself being frequent.

SYMPTOMS AND COURSE.—Fever of all degrees of severity is met with. It is called *mild* from 99.5° to 101°; *moderate* from 101° to 103°; *severe* from 102° to 104°; very severe from 103° to 106°; above this point the condition is spoken of as one of *hyperpyrexia;* and the danger to life when the temperature rises above 106° is, in most cases, extreme.

Whatever the severity of the fever, diurnal variation occurs, and generally as in health; sometimes, however, the type is *inverted*, the maximum being in the morning and the minimum in the evening. When the daily variation is less than 2°, the fever is *continued;* when the variation exceeds 2°, the fever is *broken* or *remittent;* and when a non-febrile period intervenes between accessions of fever, the fever is *intermittent;* when the febrile and non-febrile periods alternate regularly, the fever is *periodic*.

Three stages of fever are described—*onset*, *acme*, and *decline;* they are best marked in the acute specific fevers, which serve as types. The *onset* may be sudden or gradual, the temperature running up rapidly to a great height or mounting by a degree or so daily. It is accompanied, especially when sudden, by general malaise, and usually by nausea or vomiting, chilliness, rigor or convulsion, elevation of pulse, and more or less severe headache. The more severe symptoms occur in severe cases; vomiting is especially common in children, and in them convulsions generally replace the rigors of adults.

A *rigor* is made up of three stages, *cold*, *hot*, and *sweating*. At first, the patient complains of cold, and shivers more or less violently for 5, 10, or even 30 minutes. The skin is pale, perhaps bluish at the extremities, but a thermometer shows that it is hotter than normal. Careful observation has shown that the temperature is generally 100°–101° before the rigor begins, and it continues to rise during the shivering. This is followed by a longer or shorter period of dry burning heat with high temperature (*hot stage*), after which the patient breaks out into a perspiration which may be very free, and just before and during this the temperature falls, sinking to or even below normal from a maximum of perhaps 104°–106° (*sweating stage*). The patient is left weak and exhausted. The ultimate cause of a rigor is unknown; it frequently announces the formation of pus, but still more often it has nothing to do with suppuration. It is believed that some poison in the blood induces strong contraction of the superficial vessels and greatly increased production of heat; the sensory nerves of the skin under these circumstances actually convey to the heat-centre a sense of cold as compared with the temperature of internal parts. The pathology of a rigor is, therefore, much the same as that of an ordinary shiver from cold. A *chill* is a less severe form; there is no shivering and no sweating, but a sense of cold water running down the spine alternates with a sense of heat and flushing.

In the *acme* of a fever, the temperature is at its highest and shows to which type it belongs; skin hot and dry as a rule, but sweating is usual in remittent forms (hectic, pyæmia); thirst, anorexia, furred tongue, confined bowels generally; urine scanty, high colored, containing excess of nitrogen (generally as urea) corresponding to the amount of fever; in high fever a little albumen is not uncommon, and sometimes there is marked albuminuria—many cases being probably infective, due to the elimination of the causes of the fever through the kidneys; pulse quickened, 100–120, full and bounding at first, becoming more compressible, smaller, and more frequent (140–180, even 200) as, the fever continuing, the arterial tone relaxes, and finally the heart fails; respiration quickened to 25–30 per minute, considerably more frequent in children; CO_2 in excess varying with height of fever. The increase in elimination of nitrogen and carbon bears witness to the heightened tissue-waste, which keeps up the fever and leads to proportionately rapid wasting and loss of strength; and the alimentary tract being much disordered, repair is imperfect. Headache may be present; sleep is broken, or there is great wakefulness. After a time—varying with the nature, degree, and duration of the fever and the strength, idiosyncrasy, and previous habits (especially as regards drink) of the patient—delirium, at first nocturnal, comes on; it is generally low and muttering, but in early stages may be violent. Continued fever produces more severe effects than remittent, even though the maximum of the latter be somewhat higher; for during the remission tissue-waste decreases, digestion and repair go on, and the viscera escape for a time from the high temperature which seems to play an important part in producing cloudy swelling and fatty degeneration of them. Blood drawn during this stage into a wide vessel is often buffed and cupped from rather slow coagulation and a running into irregular masses and consequent rapid sinking of the red corpuscles.

The effect of continued high fever is generally to produce what is known as the *typhoid state;* but the cause of the fever and the constitution of the patient have much to do with it, for the typhoid state occurs *cœteris paribus* much sooner in some fevers and in some individuals than in others. In it the patient lies in a state of somnolence or stupor, with muttering delirium, noticing nothing, asking for nothing, but drinking when food is given, slipping down in bed and assisting himself in no way. The skin is hot and dry until the death-agony, when sweat breaks out; the face pale or flushed and dusky; sordes collect on lips and teeth, and the skin is quite dry, brown, and often thickly coated, or it may be red and dry. There may be diarrhœa, and albuminuria is common; the motions are passed unconsciously. The pulse is small, frequent, and compressible, and these characters become more and more marked. Respiration is frequent and shallow; hypostatic congestion of the lungs and bedsores are frequent. In surgery the typhoid state occurs most markedly in septicæmia.

The *decline* of the fever may be sudden (*crisis*), or gradual (*lysis*). Subsidence by crisis is often accompanied by free (*critical*) sweating, sharp diarrhœa, or passage of urine depositing a copious precipitate of urates. When fever is gone, the patient is left more or less weakened and emaciated; but excessive waste has ceased, the tongue cleans, digestion and assimilation go on, strength is daily gained, and degenerate organs may recover completely. Sometimes albuminuria remains, having probably been due to an infective nephritis.

But, instead of recovery, *death* may occur at any period from hyperpyrexia; from cardiac failure and collapse with a subnormal temperature; or from slow exhaustion.

Prognosis.—Throughout the course of a fever we watch the temperature to learn how much waste is going on, and the pulse to note the effect upon the heart—a pulse becoming smaller, more compressible, and more frequent, with a steady or falling temperature, being of evil omen. Difficulty in taking food, sleeplessness, great loss of strength, and the presence of the typhoid state render the prognosis proportionately grave. Hyperpyrexia indicates imminent danger. Continued fevers are, of course, more exhausting than remittent or intermittent reaching the same height.

Terminations of Inflammation.

Resolution or return to the normal is the most favorable and the most frequent. The irritant is removed or ceases to act; then, by degrees the tissue-elements repair the damage done to their substance and resume the normal discharge of their functions, the vessels contract, the abnormal resistance subsides, the circulation quickens, escape of fluid diminishes, and loitering corpuscles are caught up into the stream. Even though stasis have occurred at points, the apparently solid masses of corpuscles break up, bit by bit, and finally all move on. The fluid exuded is carried away by lymphatics and veins, the corpuscles either find their way again into the circulation directly or through the lymphatics, or they undergo fatty degeneration and disintegration and are then absorbed. The many cells and small portions of tissue which may have perished are completely and perfectly regenerated by the cells remaining. The extent to which the tissue-elements are capable of repairing losses is not known, and could hardly be expressed if it were. It is certain, however, that most tissues are possessed of regenerative power—that epithelium gives rise to epithelium, connective tissue cells to connective tissue, muscle to muscle; but adult nerve ganglion-cells and the epithelium of certain glands are believed not to possess this power.

Healing by Scar-formation.—Should the inflammation lead to extensive destruction of tissue, by ulceration, suppuration, gangrene, or cellular infiltration, healing, if it occur, takes place by the formation of *granulation-tissue*, and later, of a *scar*. This is often the case also after destruction of parts by injury.

Granulation-tissue consists of cells and bloodvessels in a little homogeneous matrix, the cells being chiefly, if not entirely, leucocytes, and the bloodvessels mostly of recent origin. Unless new vessels form, the tissue neither grows nor develops into fibrous tissue, but very probably undergoes fatty degeneration. So long as an inflammation is spreading fast, no new vessels form among the leucocytes which crowd the tissue at its edge; but as the irritant ceases to act or becomes very slight, new vessels form among the cells, which increase rapidly in numbers, and a line of granulation-tissue limits the inflammatory process (*demarcating inflammation*). But in some cases (*gray granulation*), although the inflammation is quite stationary, no new vessels form—perhaps owing to some peculiarity in the cause.

New vessels develop as offshoots from existing capillaries. A conical process springs from the wall of a capillary and rapidly grows out among the cells till it joins another process or a vessel. Solid and very thin at first, it thickens, nuclei appear in it, and finally a central canal forms and opens into vessels at each end. From it fresh offshoots may start, and thus vessels are formed rapidly. In granulating wounds they may begin as early as the second day.

Ziegler states that among the round cells of the tissue are some like pus corpuscles with bi- or tri-fid nucleus; the rest have one large, round, obscure nucleus. The former are dead, and are either thrown off in discharge as pus cells or eaten up by the latter cells, which increase in size, whilst their nuclei become clear, oval, and vesicular. From their resemblance now to epithelial cells they are sometimes called *epithelioid*: *fibroblast* is a better word. The fibroblasts increase in number, partly by division; some are seen containing more than one nucleus, and after ten or twelve days giant-cells with many nuclei appear, formed either by division of the nuclei of fibroblasts without that of the cell-bodies, or by blending of multinucleated fibroblasts. Finally the fibroblasts outnumber the small round cells, they become spindle-shaped or branched, are pressed closely together in the deeper layers of the tissue, and perhaps coalesce. Then their ends and borders form fine fibrils, which join others from neighboring cells, to form longish bands; more fibrils form in the matrix. Many cells disappear in this process, the rest lie on the surface of the fibrous bundles as connective tissue cells. We now have very vascular connective tissue, which accounts for the marked redness of recent scars. But they ultimately become paler than normal skin, for *inflammatory tissue always contracts strongly*, and the great majority of its vessels disappear in the process. This contraction may do great harm, producing much deformity, preventing movement of joints, causing stricture of mucous canals, destroying by its pressure the parenchyma of glands, compressing vessels, and causing dropsy, etc.

The more chronic the process and the fewer the vessels, the less the tendency to form fibrous tissue, the more numerous the giant-cells, the greater the tendency to degeneration such as will be described under "Tubercle" and "Syphilis." The few giant-cells formed in healthy granulation-tissue are thought to fibrillate like the fibroblasts.

In the formation of inflammatory tissue it is probable that the neighboring connective tissue cells multiply and aid in the regeneration. By irritation with chloride of zinc, Senftleben destroyed the central cells of the cornea, whilst the anterior lamina remained intact and prevented infiltration with leucocytes from the conjunctival sac. After two or three days the cells round about sent long processes, upon which nuclei appeared, into the injured area, and the protoplasm thickened at these spots and formed new corneal corpuscles, the regeneration being ultimately complete. Similar processes almost certainly go on in tissues recovering from inflammation, but they are difficult to observe on account of round-celled infiltration.

Non-absorption of Exudations — Desiccation — Degeneration — Elimination.—Sometimes resorption of a fluid or corpuscular exudation does not occur: as a rule, however, fluid is absorbed, whilst cells and fibrin undergo fatty degeneration and remain as a dry cheesy mass which often calcifies in course of time. Such masses excite a chronic inflammation, and the formation round about them of a capsule of fibrous tissue. Caseous masses may soften and become irritating after long quiescent periods, and be eliminated by suppuration.

Portions of tissues killed by inflammation or otherwise are, *per se*, irritants to living tissues; they are practically *foreign bodies.* The fate of foreign bodies in the tissues varies with their *nature* and the *amount of irritation* they excite. By nature they may be capable or incapable of absorption: in the latter case they become encapsuled, or eliminated by ulceration and suppuration; in the former they are absorbed or eliminated according to the intensity of the irritation they produce. Speaking generally, all animal products are capable of absorption. This is carried on by fibroblasts which lie upon the surface and work into the substance of the foreign body, gradually eroding it; thus portions of dead tissue—even bone—blood-clots, ligatures, decalcified sponge, etc., are gradually replaced by granulation-tissue, for the growth of which they at first form a support. In such granulation-tissue, giant-cells are generally numerous.

If, however, the foreign body be so irritant that cells cannot live in close contact with it, and this generally is due to the presence of putrefactive or other organisms, it is thrown off by ulceration. In other words, it excites the formation of a band of granulation-tissue in the living tissues round about it; these are softened and eroded, and the body loosened until it can be removed, or is pushed out by growth of granulations. When the body is a portion of the tissues—*e. g.*, a piece of bone, its connection with the living parts is eaten through by the cells, and it is set free. The greater the density and the less vascular the tissue, the more slowly does it ulcerate; *sloughs* of tendons, fasciæ, and bone are weeks or months in separating.

DEATH.—Inflammation may cause death by affecting a vital organ—*e. g.*, heart or kidney, and impairing its functions, by producing œdema and closure of the glottis, by ulcerating into vessels and causing hemorrhage and so forth; by exhaustion from the accompanying fever or profuse discharge; and, later, by the damage it leaves behind—*e. g.*, thickened or contracted heart-valves or strictured urethra.

VARIETIES OF INFLAMMATION.

Although the pathological process of inflammation is always essentially that which we have described (page 50), and can only arbitrarily be divided into stages, there are many points which serve for classification.

Etiologically, inflammations are separated into two most important classes: (*a*) the *non-infective* or *simple*, due to all ordinary injuries, including the action of products of putrefaction upon wounds; and (*b*) the *infective*, due to the growth of pathogenic organisms in the tissue. The latter are distinguished mainly by their *tendency to spread*, either by infection of neighboring parts by continuity, or of parts at a distance; but an infective inflammation may be quite stationary. When virus from an inflammatory focus is conveyed by lymphatics or bloodvessels to distant parts and there excites inflammation, this latter is called *secondary.* Sometimes the appearance of a secondary inflammation is accompanied or preceded by disappearance of the primary disease, as if the morbid process had been transferred from one part to the other; such secondary inflammations are called *metastatic.* In many cases metastases are due to carriage of the cause of inflammation from the primary to the secondary focus, but we cannot as yet explain, for example, the subsidence of insanity, asthma, or severe pain in the heart or stomach, upon the appearance of an attack of typical gout.

So constant and distinctive are the characters of certain inflammations that one is led to the belief that each of them has a special cause, and such inflammations are called *specific*. Many of them are infective—*e. g.*, tubercular, syphilitic, glanders, erysipelas; but of others the nature is less plain—*e. g.*, gout and rheumatism.

According to their real or supposed causes inflammations are often termed *traumatic, strumous, tubercular, syphilitic, rheumatic*, etc.; or *idiopathic* or *spontaneous* when no cause is discoverable.

The time-relations of inflammatory processes allow them to be roughly separated into *acute* (of quick course and generally of considerable intensity), *chronic* (the reverse of acute), and *subacute*, a vague intermediate class.

According to their intensity, inflammations are divided into *sthenic*, generally circumscribed and characterized by strongly marked symptoms, and *asthenic*, generally diffuse, tending to produce extensive sloughing, often presenting but slight local signs, whilst adynamic symptoms are frequent.

The duration and intensity of inflammations vary with the duration and intensity of their causes, but the resistance offered by the tissues must also be taken into account.

The seats of inflammation are generally indicated by taking the Greek name of the tissue or organ and adding the termination *-itis*; thus periostitis, myositis, hepatitis, orchitis, nephritis.

Inflammation is said to be *parenchymatous* when its effects are manifested chiefly in producing degenerative changes in the essential elements of an organ, as in acute Bright's; *interstitial*, when the exudation occupies the connective tissue spaces between these cells; *catarrhal*, when it affects mucous membranes.

According to the naked eye effects they produce, inflammations are spoken of as *destructive, œdematous, adhesive, gangrenous*.

The classification of inflammations according to the nature of the exudation, into *serous, suppurative, hemorrhagic*, etc., enables us to describe most accurately the stage which the morbid process has reached.

General Principles of Treatment.

"The schools say," to quote from William Addison, "Find out the disease of the patient, classify, name, treat, and cure it." Experience and Nature say, "Find out the temperament, constitution, and habits of the patient. . . . . Make the classifying of the disease subordinate to the study of the individual, and the treatment of the disease subordinate to the treatment of the man."

The actual treatment of inflammation resolves itself into two parts, *local* and *general*, and the former may be *preventive* or *curative*.

Preventive Treatment.—Such inflammation as results from accidental injuries or from necessarily inflicted wounds and other surgical procedures, we cannot prevent. It will be very difficult, probably impossible, to prevent inflammatory processes, the causes of which enter by the respiratory or alimentary tracts—*e. g.*, spontaneous abscesses. But it is possible so to guard most wounds that they shall neither be irritated by products of putrefaction nor invaded by infective organisms; and success in this practically abolishes all dangerous inflammations, and those scourges of surgical practice, the general infective diseases of wounds. By a proper treatment of wounds the causes of simple inflammations also can be in great measure avoided.

The antiseptic treatment introduced by Lister had for its object the prevention of putrefaction in wounds, and was based upon the assumption (at that time) that putrefaction, like fermentation, was due to the growth of organisms in putrescible material. But measures adapted to the above end had the advantage of protecting the wound from most pathogenic organisms also. As these and their effects upon the body became better known, the object of antiseptic surgery widened into the protection of wounds from all organisms whatsoever, and the word *aseptic* has enlarged its meaning so as to express this state of freedom. Any mode of treatment adapted to prevent the growth of organisms is called *antiseptic;* to merit this title it is by no means necessary to work with carbolic acid and gauze dressings. The details of antiseptic treatment will be given under the treatment of wounds; and there will be noticed also the means by which tension, friction, and other sources of irritation may be avoided. Here it may be said that every part threatened with inflammation should be kept *absolutely at rest* in the most comfortable position.

Curative Treatment. — When inflammation has already set in, the following points must be attended to.

1. Removal of the Cause.—*Foreign bodies, or irritating substances—e. g.,* urine, must be removed; *tension* relieved by removal of sutures, punctures, incisions, or drainage; *friction* by absolute rest and perhaps uniform elastic compression of the part; *septic irritation* lessened by drainage and disinfection of the wound. At the same time care must be taken that the part is not unnecessarily exposed to the irritation of antiseptic substances, frequent dressings, injections, or other evidences of meddlesome surgery. In some cases attempts have been made to destroy the causes of infective inflammations after they have settled and begun their work, by injections of carbolic acid (1 in 20) or of tr. iodi—*e. g.* in erysipelas, acute abscess, and scrofulous inflammations; but the success has not been great. The disinfection of inflamed wounds is commonly attempted and with excellent results, though absolute asepsis is not attained in many cases. Perhaps cold in some instances prevents the development of infective germs, as when a wounded joint is surrounded by ice. Again, in locally infective diseases, as hospital gangrene or soft chancres, especially when sloughing, attempts are made to destroy the whole inflammatory focus together with its cause by the actual cautery or powerful chemicals like chloride of zinc or fuming nitric acid. Lastly, certain drugs are known empirically to act curatively in certain inflammations—*e. g.,* colchicum in gout, the salicylates in rheumatism, mercury in early, and iodide of potassium in later lesions of syphilis; but whether these act by destroying the cause or preventing its development is unknown.

2. The Diminution of Intravascular Pressure and the Prevention of Tension from Exudation.—This has been shown (page 53) to be most important. It was formerly effected by bleeding the patient to faintness—*i. e.,* to fifteen ounces or more in a healthy adult. But general bleeding has been almost completely abandoned, because the loss of large quantities of blood is not easily made up, weakens the patient, renders him more liable to septic disease and less able to bear prolonged illness. The effect of general bleeding can be produced without actual loss of blood by hot baths, by the administration of aconite (see page 67) in minim doses frequently, or by saline purgatives given freely to take fluid from the blood and cause dilatation of the intestinal vessels. All these methods are depressing.

As a rule, local treatment by the following methods sufficiently reduces intravascular pressure and limits exudation. *Elevation of the part* is the first and a very important means to this end; an inflamed part should always be raised. Then gravity diminishes the arterial pressure and renders the outflow by the veins more easy, so pressure in the capillaries and veins of the part is markedly diminished. The arteries of a limb thus raised contract considerably and the veins tend to collapse. The removal of exudation by lymphatics is favored. Still further to diminish the intravascular pressure compression of the main artery has been practised, Neudörfer says, with much success; and Campbell, of New Orleans, went so far as to tie the femoral to check inflammation of the knees. Gamgee recommended the following plan of *uniform elastic compression* for inflammation, especially of limbs, before suppuration has set in. Raise the part as much as possible for five minutes, then, while still elevated, place round it a large quantity of cotton-wool and bandage firmly over this. Dilatation of vessels and exudation are thus prevented, external resistance being increased to compensate for the loss of resistance by the vessel-wall. An elastic bandage gently and uniformly applied has been similarly used. The part should be slung high.

Warmth applied by frequently renewed fomentations or prolonged local warm baths is most valuable. It dilates fully all the vessels of a part and diverts a portion of the blood which would be driven through the inflamed area; relaxes the tissues, soothes pain, and promotes perspiration. Warmth may be suitably applied at almost any stage of inflammation. Fomentations are pieces of coarse flannel folded in four, wrung out of boiling water by means of a coarse towel or special wringer, applied as hot as can be borne, and covered by a layer of oiled silk one inch larger than the flannel in all directions; this again is covered by plenty of cotton-wool and fixed by a bandage. When there is a wound, boracic lint should be used instead of flannel; by these a foul ulcer may be rendered quite sweet. Fomentations must be changed every two or three hours; they are much cleaner than poultices, which may however be used when there is no wound. *Cold* produces contraction of skin and vessels as a first effect, but after a few hours the superficial vessels become fully dilated, so ultimately intravascular pressure is probably reduced here also. Cold depresses the functions of living cells, both those of the body and those of invading parasites; by its effect on the latter it may prevent their development and allow of the removal by lymphatics of the few which have entered, but it lessens the resistance of the tissues and checks repair. Warmth, on the other hand, stimulates the performance of function, quickens absorption, and, whilst encouraging growth of organisms, it renders more active the animal cells which oppose them in the struggle for existence. The patient's feelings often decide well whether to employ cold or heat, and should generally be respected. The usual practice is to employ cold in the *early* stages of inflammation; once an inflammation is well established, and especially if it be such that the circulation in parts may be actually less than normal, cold is inadmissible lest it cause sloughing.

Cold is applied in various degrees. Bits of thin linen may be dipped in cold water or *evaporating lotion* (alcohol meth. and water āā), and laid upon the part, *freely exposed:* they must be frequently renewed. *Cold irrigation* acts more strongly; place a bit of lint on the inflamed part, and suspend a jug of water over the part and let the water drip from a siphon rag. Mackintosh cloth must be so arranged as to convey the water to a basin on the floor. *Bladders or India-rubber bags of crushed ice* may be packed round the part, but they are hard to apply closely and to keep in position. When applied to young children it is well to use India-rubber bags in flannel. The most perfect way of applying cold is by *Leiter's lead tubes*, coiled closely and accurately round the part, whilst a slow constant stream of cold or iced water passes through them and is regulated by a screw clip on the India-rubber tube connecting them with a can of water above the head.

Astringents.—In inflammations of the skin, and especially of mucous membranes, astringents seem to cause contraction of the vessels and tissues generally, and therefore to act beneficially. The more acute the case the milder the astringent; acetate of lead is one of the least irritating. Most of these bodies are antiseptic.

Local bleeding in certain cases—*e. g.*, acute iritis, otitis media, and orchitis has an excellent effect, quickly relieving pain, and being often followed by subsidence of symptoms. It may be effected by the application of leeches, by the opening of two or three small veins, like those of the scrotum, by cupping, punctures, or scarifications. How local bleeding acts is unknown; sufficient blood is not taken to depress the pulse, and even if it were drawn directly from the vessels of the affected part these would fill again immediately. The effect of scarifications and cupping is doubtless due in great measure to the escape of exudation and relief of tension, but this does not account for the effect of leeching. Some suggest that a reflex contraction of the vessels of the inflamed part is caused.

Leeches should not be applied to loose tissues (eyelid, prepuce) or they will be followed by œdema. To make them bite, wash the part well and smear a little milk on it, or make some punctures with a lancet and apply the leeches to them. Hold the animals in a cloth, not with exposed fingers; or put them in a test-tube, and keep their heads thus applied to the skin. Never pull them off forcibly, but touch them with salt, when they come off. Bleeding may be encouraged by fomentation, if necessary. To stop it—and this should always be done before a patient is left for the night—use perchloride of iron or small bits of matico leaf pressed for a few minutes on the dried bites. A full-sized leech will draw two drachms, and another drachm may flow afterward.

Wet cupping is never done now, but *dry cupping* is still used in inflammation of internal organs, especially the kidney. Cupping glasses in which the air has been rarefied by holding them a very short time over a large spirit-flame are applied to the skin of the loin or other part; rapidly the skin rises into the glass as the air cools, the subcutaneous vessels become full of blood and many capillaries rupture. This is repeated several times. It appears to influence beneficially the circulation through the deep organs, but we do not know how it acts.

Counter-irritation is another mode of treatment of which the action is obscure, but its chief effect is probably a reflex contraction of the deep vessels; for the few superficial vessels dilated by a blister and the amount of fluid in the brain can scarcely have any effect on the circulation at large, Brown-Séquard caused contraction of the renal vessels by irritation of the skin of the loin. It is a very different matter when dilatation of all the abdominal or cutaneous vessels is caused to relieve superficial or visceral inflammations respectively.

Counter-irritation is used to check some acute deep inflammations—*e. g.*, laryngitis, bronchitis; or to promote absorption in chronic inflammations—*i. e.*, chronic synovitis or arthritis. Never counter-irritate over pus nor near the seat of an acute inflammation until its activity has been subdued.

The commoner counter-irritants are: lin. camph. co., tr. iodi, lin. iodi, lin. ol. crotonis; ung. hydrarg. co. (Scott's dressing), ung. sabinæ; liq. and empl. cantharidis; the actual cautery.

3. The Relief of Tension from Exudation.—Elevation, belladonna, and frequent fomentation, with uniform pressure if it can be borne, will frequently reduce very great tension from œdema in twenty-four hours. Should these means fail, should pain be great or sloughing imminent, multiple punctures with a lancet, or a fewer short incisions as long as a scalpel is wide, may be made here and there into the subcutaneous tissue, superficial veins being avoided. The part must then be well fomented, or placed in a warm bath, a little bleeding being beneficial.

4. The Alleviation of Pain.—This will be effected in many cases by measures undertaken for the foregoing reasons—*i. e.*, the removal of all sources of irritation, the provision of rest, and especially the relief of tension within

the tissues by elevation, punctures, or incisions. Both heat and cold have a numbing effect, and it is common to use, combined with heat, a mixture of equal parts of ext. bellad. and glycerine painted thickly on the surface (carefully avoiding any broken skin), and renewed with every fomentation or less often. The belladonna is believed to have the additional advantage of causing contraction of the vessels. Used thus, even on large surfaces, it very rarely causes symptoms of poisoning. Cold *lotio plumbi fort.* as an evaporating lotion has a remarkably soothing and constringent effect, and Hutchinson's method of allowing a lead and opium lotion to drip on to lint covering a stump or operation wound acts well, lead being an excellent antiseptic. Should local means fail, bromide of potash, chloral, conium, hyoscyamus, belladonna, or opium may be given by mouth; or, in place of the latter, which disturbs digestion, furs the tongue, and confines the bowels, morphia may be used subcutaneously, its ill effects being less marked.

These are the remedies usually employed to combat inflammation. In the following pages the special use of each will be pointed out.

General Treatment.—The patient's room should be quiet, thoroughly ventilated, and kept at a temperature of 60°–64°; the patient should not be too warmly covered.

Diet.—Waste is so rapid during fever, inflammatory or other, that the patient requires as much of the most nourishing food as he can take; but digestion is almost always disordered, and of this the state of the tongue and bowels and the patient's feelings are the index. Rarely, a patient enjoys even solid food when highly febrile. Always give most food when the temperature is low. In severe cases food must be given in small quantities and often, and all must be fluid; meat broths, and jellies, whey, barley water, lemonade and acid fluid drinks, arrowroot, and similar farinaceous foods, milk, raw eggs beaten up in milk, egg and brandy mixture (B. P.), or egg-flip, peptonized milk gruel or beef-tea. Milk, eggs, and the peptonized foods are the most important. In milder forms, or with recovery, give first milk puddings containing eggs, boiled white fish, and then chicken, game, and roast mutton. Plenty of drink should be given throughout. The value of stimulants in large quantities to tide over a few hours of danger from cardiac failure seems established. But it is doubtful whether frequent stimulation of the heart and other tissues does good in prolonged fevers; here stimulants should be used as sparingly as possible. It is the custom with many surgeons, however, to give large quantities of alcohol in hectic fever and in the typhoid state. Small quantities with food may sometimes aid digestion and whet appetite.

1. The great majority of surgical fevers appear to be secondary to some local lesion whence pyrogenous material is absorbed into the blood; in their treatment, therefore, attention is naturally first directed to the sources of absorption with a view to *removing their cause.* If a wound is present, always look to it first; see that it is well drained, that the discharges are kept as sweet as possible by use of antiseptics; endeavor to subdue any inflammation; open any collection of pus. The prophylaxis of fever is even more important than its cure, and may be effected in the case of the septic and infective diseases of wounds by antiseptic treatment.

2. A rare cause of nervous fever is the direct pressure of a large clot upon the brain, and this must naturally be treated by trephining and removal of the clot.

When local means fail or are unavailable, resort must be had in severe cases to general antipyretic treatment.

Means of Reducing Temperature.—The general cold bath, the cold pack, cold sponging, and Thornton's ice-cap, consisting of Leiter's lead tubes coiled into the shape of a close-fitting skull-cap, placed upon the head and kept cool by the circulation of iced water. The latter is a very effective and most convenient method. In prolonged fevers these remedies should be used to prevent the rise to the maximum, not continuously. During the cold bath and cold pack especially, the rectal temperature should be carefully watched; it will fall two to three degrees after cessation of treatment, and if too much depressed, marked shock may result. Of drugs, quinine in 5 gr. doses every three to four hours, or in one 20 to 40 gr. dose, is that most often used; the headache and deafness it causes are often distressing. Salicylic acid has a similar but less powerful effect, and is of value chiefly in rheumatic affections. Aconite in doses of ♏j every five minutes, up to ♏xx or xxx, affords great relief in the *early* stages of inflammatory fever, softening the pulse, moistening the skin, and relieving headache; it must not be given in prolonged fevers, nor where the heart is already weak.

Confined bowels often increase fever, especially of the inflammatory type; and in most cases of this sort a saline purge acts well at the beginning. It must be remembered, however, that when a patient is taking little food, his bowels will not act naturally every day.

In chronic inflammation, of tubercular origin especially, *change of air* is most beneficial, that of the seaside being generally preferable. So also after exhausting suppuration or fever, such change greatly quickens both general and local restoration. Weakly patients must not be sent to cold bracing places at first; external warmth is as helpful to them as pure air. Endeavor in every way to strengthen the general health.

CHAPTER IV.

ULCERATION.

Definition.—Ulceration means erosin of tissues, the destruction progressing for the most part without the formation of visible masses of dead tissue, and being, therefore, *molecular* as contrasted with the *molar* destruction which constitutes gangrene.

An *ulcer* is an open sore formed by the above process, the epithelium being completely destroyed at some points, though here and there the interpapillary portions may be left; but in the deeper kinds loss of substance may affect every tissue of a part down to the bones. This excludes cases of intertrigo and vesication in which the horny layer only of the epithelium is lost; also cases in which papillæ covered by epithelium are enlarged, as in mucous tubercles, and the granular condition of mucous membranes which results from prolonged purulent catarrh. The term ulcer is applied also to erosions of surfaces other than cutaneous or mucous—*e. g.*, of a cardiac valve or of articular cartilage.

Molecular death is essential to the formation of an ulcer, and may be brought about by *inflammation* or by *degeneration*, as is best seen in malignant ulcers.

Etiology. Predisposing Causes.—All influences which depress the vitality of the whole body or of the tissues of a part. Such are (*general*) the liability to tubercle or scrofula; gout, scurvy, severe syphilis, old age; malnutrition and anæmia: (*local*) distance from the heart (lower limb); incompetent heart, degenerate arteries, varicose veins; the existence of the milder degrees of inflammation; sudden and extensive lesions of the cord from injury, inflammation, or hemorrhage, resulting in acute paraplegia; rare lesions of the brain generally from hemorrhage or wound, producing hemiplegia; loss of sensation in a part from injury of sensory nerves.

Exciting Cause.—Inflammatory ulcers are due to the causes of inflammation acting upon surfaces with intensity sufficient to produce slow death of the tissues. Ordinary injuries of all kinds, the irritation of septic discharges, and infection of the tissues by pathogenic organisms. As with abscess so with ulceration, it is probable that the cause in "spontaneous" cases is some microörganism; many are due to some specific virus, as the tubercular or syphilitic.

Lack of blood supply, from pressure of the multiplying cells on their vessels, is regarded as a main cause of ulceration of malignant growths; but short life and tendency to early degeneration may well be characteristic of the cells. Inflammation probably plays a part in the production of many malignant ulcers. The degeneration and disintegration of tubercle, an inflammatory product, connects the inflammatory and degenerative forms of ulcer.

Pathology of an Inflammatory Ulcer.—This is the pathology of the formation of an abscess, but the process occurs in a surface-tissue, not deeply in the substance of parts. Advancing from the margin toward the centre of an inflamed area in which ulceration is about to occur, we should find, first, active hyperæmia with increased fluid exudation; then progressive slowing of the circulation in fully dilated vessels, arrest of leucocytes, and finally of red corpuscles, escape of both with fluid into the tissues, stasis, and finally thrombosis at the centre, which appears blue in contrast to the red skin round about. The cuticle here is raised by fluid and easily brushed off, leaving a raw surface. Fermentative changes will now probably increase the irritation, so also may improper dressing. Leucocytes in great number infiltrate the dying or dead central tissues, which quickly disappear before them; then the cells also die and come away with exuded fluid and fine particles of dead tissue which have escaped absorption and have become detached. Living leucocytes, too, wander to the surface. If the irritation continue, ulceration will advance, either base or edges or both, breaking down and coming away in the discharge as above described. The irritation may at any time increase and cause the death of portions of tissue so considerable (*sloughs*) that white corpuscles fail to erode them and they adhere for a time to the surface of the ulcer. These cases connect ulceration with inflammatory gangrene. Fig. 3 really represents an ulcer.

When extension of ulceration ceases either at certain parts or universally, granulation tissue develops and the surface *cleans*—*i. e.*, all shreds or dead tissue are cast off and the base becomes bright red and covered with closely set rounded prominences, the size of small pins' heads, each of which consists of a central capillary loop surrounded by cells, and possessing neither nerves nor lymphatics. These structures are called *granulations*, and give the name to the round-celled vascular tissue of which they consist. They are not tender, and do not bleed readily. As they develop the discharge becomes healthy pus. Growing rapidly, probably both by multiplication of its own cells and by development of leucocytes escaped from its vessels, it fills up all irregularities and then advances almost to the level of the skin. When only a gentle slope is left from the margin to the floor, epithelium shoots in from the former and gradually covers the surface. The epithelial cells most probably arise only from the epithelium at the margin, but some think that they spring also from flattened-out leucocytes. The granulation tissue in the deeper parts forms fibroid tissue rapidly (p. 59), and this contracts, drawing together the margins of the ulcer. The amount of contraction possible varies with the mobility of the surrounding skin, but the ultimate scar is generally much smaller than the original raw surface and may be (as in the scrotum) comparatively insignificant.

Clinically, ulcers are primarily grouped in three classes: 1. *Simple* or *traumatic*, due to injuries and probably to infection by common organisms. 2. *Specific*, due to a virus like the tubercular or syphilitic. 3. *Malignant*. The two former inflammatory groups will alone be dealt with now.

SITUATION.—Ulcers may occur anywhere on cutaneous or mucous surfaces; on the latter they are generally specific, on the former often so. The leg is far more commonly affected than other parts, being rather imperfectly nourished, most exposed to injury, often the seat of varicose veins and of degenerate arteries.

There are many *varieties* of the simple inflammatory ulcer, of which the following are the chief, with their characteristics. In describing an ulcer it is necessary always to note the condition of the base, the edge, the surrounding parts, the discharge, and also pain and tenderness.

Every ulcer has two stages, *healing* and *spreading*, and often a third when it is *stationary*. The *healing ulcer* is taken as the standard with which all others are compared. Its *base* is formed of *healthy* granulations (page 68), is not adherent to deeper parts, and passes gently into the *edge*. This is formed by a fringe of epithelium in which three zones are often seen on drying the edge. Starting from the granulations, first a narrow red line, contrasting with the moist granulations, and consisting of a single layer of cells; then a bluish band several cells thick; and lastly a white broader band of sodden epithelium, outside which is normal skin. The *surrounding parts* are normal to the eye and touch, and the *discharge* is good pus, unless the part is aseptic and carefully dressed, when a serous fluid only escapes. There is no *pain* or *tenderness*.

The object of *treatment* is to protect from all irritation, and is best effected by using some absorbent substance impregnated with a mild antiseptic, and changing the dressing as seldom as possible. Wash the ulcer and parts around with carbolic or mercuric chloride lotion, cover the sore with protective, and apply a good pad of gauze, salicylic or iodoform wool. Another excellent plan is to dust a sore with crystalline iodoform, and then cover it with a good pad of wool and leave it perhaps for days. Or the sore may be dressed once or twice a day with boracic or salicylic ointment, or with boracic lint and lotion. To apply the latter, or any moist dressing, cut a pattern of the ulcer in protective and diminish it as the ulcer heals. From this cut a bit of lint, wring it out of the lotion and lay it in the sore; two or three bits may be used if this is deep. Cover the lint with a bit of oiled silk, *one-eighth inch* to *one-quarter inch larger than it* in all directions. No bit of lint must be exposed or it will dry, and matter will bag beneath it. The latter dressings require changing once or twice daily to keep things sweet. At each dressing a little boracic lotion, or carbolic (1 in 40) if the ulcer is foul, should be run over the sore from a little wool steeped in it, and the surrounding parts should be gently cleaned. The wool should then be burnt.

Occasionally the granulations are too luxuriant, projecting considerably beyond the level of the skin, and preventing epithelium from shooting in. Nicely adapted pressure, especially over the granulations at the edge, by means of a ring or two of lint placed outside the oiled silk, often suffices; a lotion of sulphate of zinc or copper may be used as an astringent: or the marginal granulations may be rubbed down every other day with caustic.

As an ulcer heals it is often found that islets of epithelium appear on its base, where interpapillary portions of the rete Malpighii have escaped destruction, and greatly hasten healing. In large sores on firm parts, a time is sooner or later reached when contraction, and with it spread inward of epidermis, ceases. The healing of such sores may be much hastened by Reverdin's *skin-grafting*. For this to succeed, the ulcer must be granulating, and the discharge moderate and not markedly septic. Little *snicks* of skin including just the tips of the papillæ (the deeper cells of the rete being the essential part) are pinched up with forceps and cut off with scissors from the arm or other part, and placed here and there on the surface; each is covered by a bit of protective, and over all a wool or boracic dressing is placed and left for three or four days. Often the *grafts* seem to disappear as the opaque horny layer desquamates; but if successful, they reappear in three or four days as little white islands whence cuticle spreads. Unless contraction of the base goes on at the same time, the scars are always liable to break down. A case of syphilitic infection by a graft taken from a man suffering from early secondary syphilis has been recorded.

In the treatment of *every* ulcer, rest with slight elevation of the part is favorable; at night the foot of the bed should be raised. Bandages must be carefully applied with uniform pressure, and constriction above the sore specially avoided, the roller being always *pinned* and not tied.

The *spreading ulcer*. The *base* is smooth or irregular, covered by a thin gray or yellow layer of disintegrating dead tissue; *edge* sharply cut, irregular, perhaps a little undermined, *surrounding parts* infiltrated and hyperæmic for a short distance round; *discharge* watery, turbid from leucocytes and microscopic débris of tissue; pain and tenderness may be great.

The *inflamed ulcer* is characterized by the above signs in a marked degree: redness, heat, and swelling spreading widely from the margin and the part being the seat of constant pain especially when dependent. The discharge is often sanious and small sloughs may form. The true *sloughing* ulcer is generally due to the irritation of a specific virus.

Treatment.—If rest, elevation, some mild antiseptic, and uniform pressure do not remove these conditions, boracic fomentations, changed every three hours, are the best application. In some cases of ulcer slowly spreading without obvious cause and probably from an infective process, salicylic ointment containing gr. xx or xxx ad ℥j, acts admirably.

The *irritable ulcer* is characterized chiefly by severe nocturnal pain. Generally situate near one or other malleolus, it is usually small, shallow, with a fixed irregular *base*—pits and prominences alternating; the *edge* and *parts around* are often chronically infiltrated; the *discharge* watery. On going over the surface carefully with the blunt end of a probe, one or more spots may probably be found which are exquisitely tender. A nerve exposed here is supposed to be the cause of the pain; and the irritation of it seems to inhibit healing. If ordinary treatment and the use of anodyne ointments, especially ung. plumb. acetatis, fails, the whole base of the ulcer may be destroyed with caustic, or the tender spots may be found and little cuts made just above them to divide the exposed nerves (Hilton).

The *weak* or *œdematous ulcer* is characterized by large pale swollen granulations projecting above the level of the skin. It frequently results from poulticing.

Astringent applications, or iodoform with a wool-dressing, and uniform compression will generally set matters right.

The *indolent* or *callous ulcer.* This is one of the commonest forms in out-patient practice. The *base* is smooth and glassy, and of a pale ashy color, like a mucous membrane. Sometimes, however, it displays a crop of weak fungous granulations; foul sloughs which take long to separate are common. The *edge* rises almost vertically, is very thick and hard from inflammatory infiltration, which extends widely into the tissues round about. Frequently too the *base* rests upon deep fascia, or dense infiltration extends between it and a subjacent bone; so the ulcer does not move over subjacent parts. The *discharge* is ichorous, often very offensive, and produces an eczematous condition of surrounding parts. *Pain* and *tenderness* are slight or absent.

These ulcers last for months or years, now better now worse; in the early stages perhaps healing completely once or twice, but soon breaking down again. They may be quite stationary for long periods, but generally gain ground on the whole, ultimately covering many square inches and perhaps extending horizontally around the limb, producing a more or less complete *annular* ulcer.

Treatment.—The two special obstacles to healing in this form are the irritation of the foul discharge and the rigidity of the base and edges from inflammatory thickening.

It is very difficult to render the part sweet. The part may be thoroughly cleansed with sublimate lotion, dried, sprinkled with iodoform, covered with a uniformly thick layer of salicylic wool, and kept firmly bandaged from the foot up; or boracic fomentations frequently changed will render a foul ulcer fairly sweet in two or three days, when some more permanent antiseptic dressing may be applied. A general application of caustic to the base and edges may precede the above treatment. Filling the cavity of the ulcer with ung. resinæ or iodide of starch sometimes acts well. Rest and elevation are very helpful.

Constant pressure is employed to remove thickening, either by careful firm bandaging with a calico bandage, by strapping according to Baynton's plan, or by the application of Martin's "strong rubber bandage."

Before strapping an ulcer the discharge should be fairly sweet unless the strapping can be daily renewed. The part being quite clean and dry, place a pad of boracic lint, three or four layers thick, and considerably larger than the ulcer, over it. Then beginning one inch below the sore apply straps one and one-half inch broad and once and a half the circumference of the limb and pad in length, up to one inch above the sore. The centre of each strap should be placed opposite to (*not* over) the centre of the ulcer and the ends crossed over the pad; each strap should cover two-thirds of the strap below it. They may be drawn pretty tight, but the compression must be uniform, and the parts below must be supported by a firm bandage. The strapping may be changed twice a week.

Martin's bandage is applied on the naked sore. *Before rising* it is to be coiled around the limb, from foot to knee, *only just tight enough* to keep its position; when standing the limb swells and the bandage gets tighter. If the discharge is very free a layer of antiseptic wool may be laid over the ulcer. At night, the bandage is to be sponged and hung up to dry; the leg is to be well washed with boracic lotion and the ulcer dressed with it or with some other application *containing no oil.* In the morning the limb is to be again washed, dried, powdered with oxide of zinc and starch (āā), boracic acid, ʒj ad ℥j, and the bandage applied. The perspiration and discharge often excite a troublesome dermatitis, which may render the employment of this bandage impossible. The boracic acid and dusting powder are efficacious in preventing this; and after a time, a limb is often less irritated than at first.

In the case of chronic ulcers affecting patients of the gouty, bloated, free-living sort, stout women at the menopause, or persons liable to congestive headache, purgatives should be freely used during the cure, and for some time after it, F. 112, 113. With these safeguards against the ill consequences of suppressing a habitual flux, ulcers on the legs may be safely healed—if this is possible.

The *varicose ulcer* is one predisposed to and maintained by the presence of varicose veins. The impaired circulation in the part leads first to malnutrition; exudation is increased, and after a time chronic thickening of the connective tissue results. Slight causes then excite chronic inflammatory congestion of the skin in the lower half of the leg, whence the step to ulceration is a short one. Or when an ulcer is produced by other causes, this congestion and heightened intravascular pressure prevent healing. Or an ulcer may remain after the bursting of a varicose vein; against the occurrence of which accident every patient with varicose veins should be prepared by his surgeon.

The actual sore may assume any of the forms found above and requires similar treatment, but rest and elevation are specially important in severe cases, or the use of an elastic stocking or Martin's bandage when the patient can walk about. In bad cases, it may be advisable to obliterate surrounding veins.

Menstrual ulcer is the name given to ulcers occurring in chlorotic women, and exuding a sanguineous fluid at the time of their monthly discharge, if this be absent. Wounds made in operating may do the same. The chlorosis must be remedied and the ulcer treated according to its state.

General Points in Treatment of Ulcers.—Seek carefully for the predisposing and exciting causes, with a view to removing or specifically opposing them; malnutrition, syphilis, tubercle, gout, and varicose veins are specially important among the former; among the latter, decomposition of discharges, specific irritants, mechanical injuries (friction, etc.), a dependent position, and garters.

Many ulcers must be treated whilst patients go about, but in severe cases, or where it is important to heal the sores as speedily as possible, *rest in the horizontal position* with the leg a few inches above the level of the head should always be insisted upon, and will often change the course of an ulcer. Under any circumstances, long standing is worse than walking, and when sitting, an ulcerated leg should always be placed on the seat of a chair. The foot of the bed may with advantage be raised at night.

Sponge-grafting.—When a deep ulcer is fairly sweet, its filling up may be aided by laying on its floor a *very thin* layer of de-silicized aseptic Turkey sponge; this will be invaded and subsequently eroded (page 30) by leucocytes among which new vessels shoot. As one layer disappears, others may be laid on. The dressings must be infrequent.

The question of *amputation* occasionally arises in the case of ulcers of very large size, and especially when of *annular* form. A wide ulcer of this kind is scarcely curable. Again, these ulcers may, by pain and discharge, be wearing a patient out; or they may be capable of healing under favorable circumstances, but break down in spite of all possible care directly the duties of life are resumed—perhaps because the scar is very tight and adherent to deep parts, or in a situation very liable to injury. Lastly, the healing of an ulcer situate in the flexor fold of a joint may render the limb useless by its contraction.

Fistula and Sinus.

Fistula or *sinus* is an ulcer folded into the form of a tube, and it is generally of the *callous* type; *i. e.*, its surface is smooth and glassy, its surroundings dense, and often of cartilaginous hardness. Large red granulations ("pouting") not uncommonly project from its orifice.

A *fistula* runs between a mucous and cutaneous or two mucous surfaces; a *sinus* simply penetrates among the tissues.

Causes.—Destruction by wound or other injury of the wall of a mucous channel and of the skin-surface over it, or the bursting of an abscess which opens on one or other or both kinds of surface; and the openings fail to close. This failure to close may be due: (1) To excessive destruction of tissue, as in some cases of artificial anus. (2) To the presence of some irritant at the bottom, as a sequestrum or tubercular gland. (3) To irritation by friction from voluntary or involuntary movements of muscles. (4) Imperfect drainage. (5) To the passage of irritant substances—saliva, feces—along the track.

Treatment.—(1) Remove any foreign body and prevent the passage of irritants through the aperture, as by drawing off all urine, or by providing free drainage in another direction.

(2) Give rest by fixation, uniform pressure, or division of muscles (*e. g.*, sphincter ani).

(3) Provide perfect drainage by the insertion of tubes, enlarging existing or making fresh openings, or by slitting the sinus or fistula completely up. For sinuses running far up the rectum and in other inaccessible parts, it may be advisable to tie the tissue to be divided in an elastic ligature which will ulcerate slowly through.

(4) *Sharp-spooning* the wall of a sinus is often useful in stimulating it to granulate and in removing tubercular granulation tissue. Small sinuses are sometimes healed by the application of a red-hot wire to their walls, burns being often followed by very exuberant granulations.

(5) A plastic operation may be necessary.

CHAPTER V.

SUPPURATION AND ABSCESS.

Suppuration means the formation of pus. This may occur upon a free surface—cutaneous, mucous, or serous—or in the substance of tissues or organs. When, in the latter case, the pus occupies a distinct cavity, formed by pushing asunder and destruction of tissues, an *abscess* is said to be present, but when it infiltrates the connective tissue more or less widely, the process is that of *diffuse suppuration*. Suppuration may be *acute* or *chronic*.

Etiology.—Probably any kind of irritant of sufficient intensity would produce suppuration were it caused to act continuously. Thus, many think that *tension* is a great cause of suppuration in imperfectly drained wounds, and that it causes the increase of abscesses. It is probable, however, that, in many cases at least, micrococci find their way into the fluids retained in wounds, and render them chemically irritating, or the cocci may themselves invade the tissues; and in acute abscesses, the original cause persists, and, together with chemical irritants, is forced by the high pressure into the surrounding tissues. Nevertheless tension is a constantly acting irritant of considerable intensity. Suppuration may occur round splinters, bullets, ligatures, and other foreign bodies, either soon after their introduction, or perhaps months or even years after they have been quietly encapsuled in the interior. In the first case, organisms probably enter with the body along its track; the pathology of the second class is not known. *Chemical irritants* fulfil the above conditions when strong antiseptics act continuously on unprotected wounds (*aseptic suppuration*), and when the products of putrefaction of wound-discharges bathe raw surfaces; in the latter case pathogenic organisms may also act. The cause of ordinary acute suppuration unconnected with wounds is, in all probability, the action of organisms. In acute abscesses, cocci are always present, usually in large numbers; they have been cultivated by Ogston and Cheyne, and suppuration has frequently resulted from inoculation with the pure cultures. But there are many kinds of micrococci, some of which do, others which do not cause suppuration; and organisms other than cocci—*e. g.*, the bacilli of farcy and the actinomyces—cause the formation of pus. The organisms obtain entry either through some wound or mucous membrane; and having done so they must settle, grow, and multiply before they can excite local inflammation. Often they are brought to a standstill by some local circulatory disturbance due to injury, cold, etc.; or, as in pyæmia, the cocci may form colonies which become impacted in small vessels; but in many cases there has been no obvious injury, and nothing is known to account for the localization of the morbid process. *Diffuse suppuration* may be due to impaired resisting power on the part of the tissues, but more probably the causes are of greater intensity than those of the circumscribed form.

Chronic suppuration is most frequently tubercular or septic; or many causes may combine to keep up discharge, as in an ill-drained septic abscess, connected with spinal caries in a patient allowed to move freely. The cause of chronic strumous catarrhs and eczemas is uncertain.

PREDISPOSITION.—Inflammation in some people, often scrofulous, but often not obviously so, is easily excited and tends to run on to suppuration; every scratch suppurates, and abscesses in glands, subcutaneous tissues, etc., are frequent. Chronic alcoholism predisposes to this.

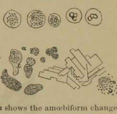
CHARACTERS OF PUS.—These vary much, the classical description being taken from that yielded by a healthy granulating, but not aseptic surface. This is *healthy* pus—*bonum et laudabile*. It is a yellow-white, or greenish opaque fluid, of the consistence of cream, is neutral or alkaline, has a faint smell, and sp. gr. 1.030–1.040. Some pus readily becomes offensive, whilst other specimens do not seem at all prone to putrefy.

Pus consists of two parts which separate on standing; the *corpuscles* which sink as a thick yellow deposit, leaving a layer of more or less clear *liquor puris* above. No fibrin forms in the latter; but a large clot of albumen forms on boiling it or ordinary pus. The addition of an equal quantity of liquor potassæ to pus converts the latter into a gelatinous mass.

Pus contains 87 to 93 per cent. of water, and the solid residue is made up of various albuminoids, with a good deal of fat, some cholesterine and other complex organic bodies; inorganic salts are also present, chloride of sodium being the chief in the serum, phosphate of potash in the corpuscles. Apart from tissue-waste from fever, free suppuration must, therefore, prove a great drain upon the system. Fat and cholesterine increase at the expense of the albumen with the age of the pus.

Microscopically the following elements are found in the pus of an acute abscess: (1) *White corpuscles*, living and dead. The living are recently escaped, and generally few as compared with the dead. They are finely granular, possess rather obscure nuclei, and throw out processes upon the warm stage. The dead cells are round or slightly irregular, much more granular, motionless, and show no nucleus until the granules are cleared up by dilute acetic acid; then a tripartite nucleus is generally seen (Fig. 2, *b*). In older pus some or many cells have undergone fatty degeneration, and may be mere aggregations of fat-granules breaking down at the edge (Fig. 2, *c*); these are unaffected by acetic acid, dissolved by liq. potassæ. (2) Free granules of fatty or albuminous nature. (3) *Red corpuscles* in varying number, generally swollen, colorless, and hard to detect; their coloring matter may give the pus a saffron tinge. (4) *Shreds of tissue* of varying size. (5) *Micrococci*, either in chairs, pairs, or singly. They are distinguished from other granules by their uniform size, by evidence of multiplication, by their resistance to acids and dilute alkalies, but chiefly by the intense manner in which they stain with methyl-violet and other aniline colors. These bodies are present not only in acute abscesses, but whenever pus possesses *infective* properties, as in gonorrhœa, soft-sore, farcy, infective periostitis, microörganisms are found in it. It has already been shown that in gonorrhœa and farcy the pus owes its infective power to these organisms; and it seems likely that similar proofs will shortly be forthcoming in other cases.

Fig. 2.

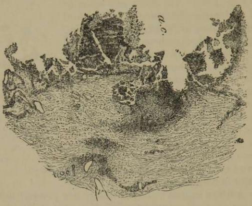


a shows the amœbiform changes of living pus-cells; after Beale. *b* shows common dead pus, with the effects of acetic acid. *c* shows the *granular corpuscles* which are the result of decay of epithelial and all other cells, and the crystals of cholesterine found in caseous degeneration.

The ingredients of pus may vary in the proportion which they bear to each other—*e. g.*, it may be very thick, or very thin, when it is called *ichorous*. This quality probably depends largely upon general conditions, as it is common for purulent discharges to become ichorous with the onset of general infectious diseases. Such pus is frequently *sanious*, as also is ordinary pus, from presence of many red corpuscles. In the second stage of catarrh, the discharge is *mucopurulent*. The pus of chronic abscesses is usually more or less *curdy* or *cheesy*—*i. e.*, it contains small masses, like curds, which consist of aggregated fattily degenerated cells. Material of this kind may line the cavity more or less completely. The pus itself is often thin, and is really an emulsion of albuminous and fatty granules—products of cell degeneration. Shrunken, deformed cells only are seen.

Formation and Course of an Acute Abscess.—Suppose that a man has fallen on his elbow, and that some micrococci have been swept into the bruised and slightly inflamed tissues and settle there. They begin to multiply, producing a constant supply of chemical irritants of considerable intensity, which infiltrate the tissues round about and excite an inflammation that diminishes from the centre. Here the stage of retarded flow with free escape of fluid and leucocytes, together with some red corpuscles, is reached, and the tissues become crowded with small round cells. Passing outward, the retardation lessens and is finally replaced by accelerated flow; the corpuscles escape less and less freely, but excess of fluid passes out after the corpuscles have ceased to do so, causing inflammatory œdema. Sooner or later, the prolonged action of the irritant and pressure of the exudation lead to cessation of circulation at the focus and death of more or less tissue. This, when death is gradual, is eaten up by living leucocytes; but when death spreads rapidly, *sloughs* of various sizes may be found in the pus. The embedding tissue being dissolved, the leucocytes now float freely in fluid which has escaped with them. The organisms grow into the surrounding tissues or are carried into them by lymph-streams, forming fresh centres in the vicinity of the primary focus (Fig. 3, *a*, *c*, to *v*); by annexation of these and by irritation and separation of tissues by tension, the abscess increases, extension

FIG. 3.



Section through a small abscess of skin (farcy), showing the round-celled infiltration around *a c*, the abscess cavity.

being always most marked in the direction of least resistance. Whilst destruction of tissue is proceeding rapidly, no new vessels form; but as this ceases, and first on the deep aspect, a wall of granulation tissue is formed. This may be slowly destroyed on one side, while it extends on the other; and multitudes of leucocytes together with much fluid may escape from its vessels into the abscess cavity. Ultimately, in most cases the abscess reaches a free surface and points there; the tissues become thinner and thinner, bulge at one spot which becomes bluish, or dull red and glazed, and finally the epithelial covering is burst and the pus discharged. The walls then fall together; granulation tissue quickly forms at any spot where it does not already exist, and supposing that reaccumulation of discharge and other sources of irritation are avoided, opposed surfaces quickly adhere, as in union by second intention, and a scar results. From this result of opening, it would seem that tension has a good deal to do with the increase of ordinary abscesses; for we cannot suppose that all organisms have escaped from the cavity with the pus, yet in a day or two under antiseptics and drainage the discharge will be serous. In some specific abscesses extension by ulceration goes on after the abscess is opened.

SYMPTOMS.—These are such as we should expect from an inflammation of high intensity ending in the production of a distinct cavity full of fluid. To take a superficial abscess: the ordinary symptoms of inflammation mark its commencement—redness, swelling, pain, tenderness, and fever. At first bright red and firm, the swelling softens centrally and becomes more dusky, and as the pus increases and the skin progressively thins, it becomes more circumscribed and prominent and ultimately points—*i. e.*, the skin near the middle bulges more than that round about, becomes darker and glazed, ulcerates through, the cuticle bursts and the pus escapes. As the swelling softens *fluctuation* becomes evident, and the early detection of this is one of the tasks of the *tactus eruditus* of the surgeon. Fluctuation is the sense communicated to the fingers of one hand laid upon a bladder filled moderately full of water when the fingers of the other hand are pressed upon some other part; fluid is forced from the latter part into other parts and the resting hand is raised by the wave. To obtain the sign, the *pulps*—*not* the points—of as many fingers as can be accommodated should be placed on the area, and the further the two sets are apart the better; steady, gentle, vertical pressure should then be made with one set of fingers, the other set remaining passive upon the surface (students often voluntarily lift up one set as they press the other down). Often one is able to place only two fingers upon the surface, or even one, when the relative softness only of the part can be taken account of; danger of error increases as the size of the supposed fluid collection lessens. Of course, true fluctuation does not prove the existence of pus, but merely of a circumscribed collection of fluid; and a sensation so like it is yielded by very soft solids and by subcutaneous tissue of which the meshes contain a good deal of œdematous fluid, that mistakes are made even by the most experienced. Great caution is needed, therefore, in diagnosing, by touch alone, abscess in the granulation tissue of *tumor albus* or on the back of a hand swollen from œdema, or where blood has been effused. In cases of doubt a grooved needle should always be put in at the suspected spot, when pus if present will run up along its groove.

When an abscess in a limb is subfascial, œdematous swelling is great and widespread, but it may, for many hours or even days, be impossible to determine its exact site. The diagnosis of pus will then rest upon the intensity and persistence of the inflammation and the character of the fever. It may rest upon the latter alone, or upon the latter with pain and tenderness, in abscess of internal organs.

Pain varies much, being most severe when the pus is rapidly formed and tightly bound down—*e. g.*, in the mamma or a tendon-sheath or the dense fibrous tissue of the finger. In the latter instance especially it is throbbing. *Tenderness* is generally marked, and the point of maximum tenderness is most useful in localizing a deep abscess.

Fever also varies much. It may be slight with a large abscess, high with a very small one; generally it is proportionate to the acuteness of the mischief, and is much more marked in subfascial and deep abscesses than in superficial ones. Not uncommonly the temperature is 102° to 104°, and continued in inflammations which end in suppuration. The *occurrence* of this is often indicated by chills or an actual rigor, after which the fever is maintained and perhaps rises higher; but if the abscess is not opened, the temperature generally falls a degree or two when a wall of granulation-tissue limits the spread of suppuration and absorption of inflammatory products. Ultimately it may become markedly remittent, as is most often seen in unopened empyemata.

The *lymphatic glands* above an acute abscess are generally enlarged and tender, and there may be lymphangitis.

Special symptoms arise from implication of special parts—*e. g.*, œdema glottidis from abscess in the base of the tongue. By pressure on various passages—trachea, gullet, urethra—others are produced, and abscesses may burst into these canals. Pressure on nerve-trunks often causes pain referred to distant parts, as seen in psoas abscess from pressure on the lumbar plexus. Small vessels become thrombosed before destruction; large ones almost always resist ulceration, even though isolated in the cavity of the abscess. Very rarely a large artery or vein (chiefly carotid or jugular) is eaten into by an abscess which is unopened.

Terminations.—If left to themselves, acute abscesses burrow more or less widely in the tissues, and ultimately burst upon a cutaneous or mucous surface, rarely into a serous or synovial sac, exciting fatal or destructive inflammation of it; as a rule, abscesses of intraperitoneal organs become adherent to the abdominal or intestinal wall, and are discharged through one or other. Very rarely an acute abscess is absorbed. More often it becomes chronic, and rapid is changed for slow advance. Rarely a capsule forms round the collection; the fluid is slowly absorbed, the solid parts caseate and may subsequently calcify or soften.

In the great majority of cases they burst and then heal more or less rapidly, but sometimes *sinuses* or *fistulæ* (page 73) are left.

Chronic or Cold Abscess.

Causes.—Some result from acute or subacute abscesses, others from the breaking down of tubercular infiltrations or from the softening and irritation of old caseous stuff; syphilitic gummata and infiltrations give rise to others. Suppuration may finally occur round foreign bodies which have lain quiescent among the tissues for months or years. A mechanical injury may sometimes be a predisposing cause.

The most characteristic are the so-called *gravitation abscesses*, generally connected with disease of bone, especially the spinal column. A carious focus suppurates, and the pus, which is very slightly irritant, separates or causes absorption by pressure of the most yielding tissues in its neighborhood, and thus forms a sac for itself which extends in the lines of least resistance—within the sheaths of muscles (psoas), along the course of bloodvessels (lumbar arteries, profunda femoris, internal circumflex), whilst all fascial and connective tissue round about thickens considerably by inflammatory hyperplasia. Such abscesses have been known to extend from the spine to the internal malleolus; they are surrounded by a dense fibroid wall, of reddish-gray color, containing few vessels, and lined by a layer of cheesy stuff; large and small offshoots run in various directions, abscesses in the loins, groins, and buttocks being often continuous at the spine; the cavity is crossed by numerous strands containing large bloodvessels and nerves; and the pus is thin, curdy, and contains few if any living cells, most being highly degenerate. Bits of bone and calcareous matter are often present. Organisms have never been found, but as the pus produces tuberculosis in animals, Koch supposes that the spores of bacilli, which cannot as yet be stained, are present. It will be noted that the pus runs from a small focus in the direction of gravity and least resistance, the greater part of the sac forming little or no pus, but being simply a bag to hold it.

Symptoms.—Ordinarily of slow formation, cold abscesses sometimes develop rapidly without any acute symptoms; or gravitation abscesses may quite suddenly become obvious, as when they pass from the abdomen beneath Poupart's ligament. The soft parts over them show no sign of inflammation; no pain, tenderness, or heat; but these may be present to a slight extent. Fever is absent or there is a slight evening rise. Fluctuation is the plainer the nearer the abscess is to the surface.

Acute exacerbations occur in some cases, especially the chronic abscesses of the mamma and bone. Pain in abscess of bone may be frequent and severe.

PROGRESS AND TERMINATION.—Abscesses of this kind may advance slowly, and finally the skin over them inflames, ulcerates, and gives way. They may remain quiescent for years. Complete absorption may occur. Their fluid contents may be absorbed, leaving dry cheesy stuff encapsulated in the shrunken sac; this may act as a focus whence general tuberculosis may arise. Not uncommonly acute symptoms supervene in a chronic case, and the abscess runs on rapidly toward rupture.

TREATMENT.—To prevent suppuration the ordinary treatment, general and local, of inflammation must be used—rest, belladonna, and fomentations acting best as a rule. The bowels should be kept gently open. Such treatment hastens suppuration if it must occur.

So soon as pus is known to exist, and can be reached without exposing the patient to danger, it should be let out; because, if left, the abscess will get larger, and, therefore, take longer to heal, destroy more tissue, pull the patient down more by pain and fever, and the scar left by bursting (ulceration of skin) is large and irregular. Sometimes a patient's fear of the knife may be yielded to, and the abscess allowed to burst, but in the following cases the surgeon's aid is imperatively demanded.

1. Whenever an abscess tends to spread and burrow rather than to come to the surface. This is the case chiefly when it forms beneath the dense fascia, such as the deep fascia, tendon sheaths, or the capsules of organs like the testis. These structures yield but slowly to inflammation, and the pus instead of coming to the surface burrows beneath them to great distances among the muscles and tendons (in axilla, ischio-rectal fossa, hand), often causing necrosis of the latter by pressure, and ultimately leading to irremediable matting of the parts, destroying the parenchyma of important organs (testis, mamma), and producing extreme pain and constitutional disturbance. Hence all abscesses beneath fasciæ, among tendons, or under the thick cuticle of the fingers should be freely opened as soon as the existence of pus is determined.

2. In cases of diffused suppuration, especially that due to extravasation of urine, the incisions being quite as much to permit the escape of the cause of the morbid process as its products.

3. Whenever an abscess is so situate that it may burst into a joint, the pleura, or peritoneum, or beneath the deep fascia; or when it compresses and may burst into mucous channels.

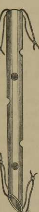
4. When a large scar is to be avoided, as in the face or neck.

In many of the above cases it is better to incise too early, before pus has formed, than too late. A whitlow taken early and properly treated, will, however, often subside, and a most painful incision is thus avoided.

Abscesses may be opened by transfixion with Syme's sickle-shaped knife, or by incision with a narrow straight bistoury, when the abscess is deep. Either is to be introduced vertically till diminished resistance shows that a cavity is reached or till pus escapes along the blade which may be slightly rotated. The cut is then enlarged sufficiently as the knife is withdrawn. It should generally be made at the lowest part, that the abscess may drain naturally; or, if the skin is too thin to live at any spot, the opening may be made here, a counter-opening being used if necessary. Its direction should be that in which it is most likely to remain open—*e. g.*, vertical in the groin, and it should be parallel to any considerable vessels or nerves. If no chloroform is given the knife must be held short like a pen to prevent its entering too far, and the surgeon must be prepared for any sudden movement of the patient. When there is the slightest danger of wounding a deep vessel, *Hilton's method* should be employed; by it pus may be safely evacuated much earlier than in any other way. With a knife cut through the skin and deep fascia; then push on a director through the deep structures till pus runs up along it. Now pass a pair of sinus forceps along the director, and by opening its blades tear a sufficient opening in the abscess wall; and by withdrawing the instrument with the blades open leave a lacerated track which will not readily unite. Thus may be opened deep abscesses in the orbit, axilla, neck, abdomen, and thigh.

The matter may now be gently pressed out by sponges on each side of the incision, or discharge will come through the dressing very shortly. Having emptied the cavity, steps must be taken to keep it so. This may, in some cases, be effected by a thoroughly free incision and subsequent uniform pressure, a little bit of the dressing being tucked in between the lips of the cut for twenty-four hours. But usually it is better, and often absolutely necessary, to employ one or more *drainage tubes*. The opening need then be only large enough to admit a tube of calibre sufficient to drain the cavity. The tubes should be of red rubber, and be kept in 1 in 20 carbolic lotion, of all sizes, cut and threaded as in Fig. 4. The deep end is generally best cut obliquely, the superficial must be cut square or more or less obliquely, so as to lie *exactly on the level of the skin and in the plane* of the wound, or the pressure of the dressing will push the sides of the tube together and prevent drainage. It is a great mistake to carry a tube across a cavity, leaving an inch too much at each end and tying the ends together. The length of the tube is found by introducing some blunt instrument along the track it is to occupy and marking the point to which it enters. The tube may be pushed in alone with a rotatory movement, or it may be placed in position with Lister's *sinus forceps* (Fig. 5). If there is any difficulty in introducing the tube, or in the case of a fresh wound, it is often advisable not to remove it till the third day, when it will have formed a track for itself; otherwise it is well to remove it at the first dressing, to free it from clot. Too much care cannot be given to the arrangements for drainage; and several openings may be required for one abscess.

Fig. 4.



A drainage tube, cut and threaded. It should be 8 to 10 in. long, and the loops 2 in. Any length may be cut from either end.

Some kind of antiseptic dressing should always be used. In out-patient cases, salicylic or the more expensive iodoform wool is very convenient: it must be one and one-half to two inches thick if the abscess is of any size. Small dressings about the face and neck may be fixed on with collodion. These dressings need be disturbed only when some moist discharge appears on the surface, when pain or fever make it probable that something is wrong in the wound, or when a tube needs shortening.

Fig. 5.

Lister's sinus-forceps.

In the absence of these indications the dressing may remain until all is supposed to have healed. Pads of carded oakum are another reliable and cheap dressing, but they discolor the skin.

For large abscesses gauze dressings are best. In all cases the diseased part and everything brought into contact with it should be thoroughly purified.

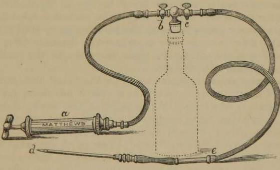
Inflammation round an abscess generally subsides after the pus is let out; but where the abscess is only a small part of a spreading inflammation, no ocal treatment is better than boracic fomentations changed every three hours.

In strumous nodules, subcutaneous and glandular abscesses, remove *as much as possible* of the granulation tissue containing cheesy foci with a sharp spoon; it may be done very thoroughly in many cases through an opening of small size. Bleeding is slight and soon checked by pressure. Some crystallized iodoform should then be spread over the interior of the cavity, a tube inserted, and the dressing applied. In the larger abscesses, especially those formed by gravitation, little can be done in this way; and in examining the interior with the finger, which it is right always to do, great care must be taken not to tear the bands of vessels crossing the cavity. Any cheesy material within reach may be removed.

The opening of these abscesses was formerly regarded with dread by surgeons, for the discharges putrefied and bagged in the cavities, many patients died within a few days of septic poisoning, and many more later on of hectic, albuminoid disease, and exhaustion from profuse discharge. Billroth, ten years ago, said, "Be thankful for every day that they remain closed." Consequently they were allowed to reach sizes which are never seen now, for they are dealt with immediately they can be reached. Their successful treatment may indeed be regarded as one of the greatest triumphs of antiseptic surgery, for frequently it is impossible to drain the irregular cavities thoroughly, and everything depends upon keeping them aseptic. Under this treatment patients with long sinuses leading to large cavities are kept almost or quite afebrile, even for years, in excellent general condition—the health beginning to improve immediately the abscess is opened, and dressing being required only once a week or less frequently.

Every now and again aspiration cures a chronic abscess, but success is so rare that the instrument is not often employed for this purpose. A syringe aspirator, with a graduated glass barrel, is the best; a cheaper form, the bottle aspirator, is shown in Fig. 6. The needles should vary in size from

FIG. 6.



The bottle aspirator.

that of a fine hypodermic needle to that of a No. 6 English catheter; most should have only a terminal aperture, for the vacuum cannot be turned on till all openings are buried, but one or two large ones may have a couple of lateral openings near the point. *Before use, the entire instrument should be filled with 1 in 20 carbolic* and then emptied. The vacuum is then produced. The part is washed with 1 in 20 lotion, the needle pushed into the abscess and the vacuum turned on. If there is doubt as to the depth or presence of fluid, turn on the vacuum so soon as the aperture of the needle is buried and then push it slowly on; when reached, the fluid rushes into the syringe. If the abscess is large and deep and the pus curdy, a needle with lateral apertures may be used, and should these become blocked, the piston may be gently lowered and some pus forced back into the cavity. The insertion of a glass T-tube, with a clamped India-rubber tube on the foot of the T, in the pipe connecting the needle with the aspirator, enables the operator to start with aspiration and to end with siphon-action. After use the aspirator should be thoroughly washed, *first with water* and then with 1 in 20 carbolic.

If the abscess is already open and septic, most perfect drainage should be established, and the discharge received in an antiseptic dressing. An attempt may be made to render the cavity aseptic by slitting it up, if small, cutting away blue thin edges, scraping out the granulation tissue with a sharp spoon, rubbing the wall with solution of chloride of zinc (gr. xx ad ℥j), and applying crystallized iodoform to it; or large cavities may be distended under some pressure with 1 in 40 warm carbolic lotion, care being taken not to force the lotion into the surrounding tissues. An anæsthetic must be given for this treatment, which generally fails. If drainage cannot be made perfect, advantage may be derived from daily flushing the cavity with iodine lotion (tr. iodi ʒj, ad aq. Oj), or other mild antiseptic.

After-treatment.—Rest and dressing as required. The tube is taken out and cleaned at each dressing, and the part carefully wiped with carbolic lotion lest any organisms may have entered a short distance along the line of discharge. The tube must be shortened as the discharge diminishes, and removed as soon as possible, for in some cases it keeps a sinus open. Often, however, it is necessary and very difficult to keep a sinus patent to prevent bagging, as when the sinus leads to a carious spine. Steady diminution of discharge without signs of bagging will then show when a tube may be shortened; experimental withdrawal is sometimes permissible. Premature constriction of deep parts must be got over by dilatation with French bougies or graduated steel sounds, cautiously used.

Rise of temperature, malaise, and perhaps local pain, especially if at all persistent, necessitate careful examination of the abscess. The discharge may have become septic, and the fever be due to septic absorption. Or drainage being imperfect, bagging may have occurred, tension and absorption of inflammatory products being the results; on relieving this the fever subsides. The fever may be due to causes at a distance from the abscess; and in cases of chronic abscess one must never forget the possibility of the occurrence of general tuberculosis.

Rarely in septic abscesses, and chiefly in the thigh and neck, ulceration extends into a large artery or vein: the accident has sometimes been attributed to the pressure of a tube. When possible, the cavity should be freely opened, the circulation being controlled and a determined attempt made to tie the bleeding point. Should this be impossible, plugging only remains in venous hemorrhage; but in arterial, ligature of the main trunk nearer the heart has been successful, and should be practised before having recourse to amputation where this can be done, unless indeed the part is already destroyed by inflammation.

Hectic Fever (ἑκτικός, habitual).

Causes.—The chief is the continued absorption of poison from decomposing pus; the larger the surface the greater the likelihood of hectic, but imperfect drainage and tension render it much more certain. It is the rule to find hectic with ill-drained septic cavities, whilst foul ulcers of equal extent do not generally cause it; improvement of drainage affords relief in the former case. Remove the cause—*e. g.*, an ill-drained cavity or disorganized joint—and the fever ceases.

So long as chronic abscesses remain unopened and sweet, hectic fever never occurs; but (p. 78) the fever accompanying an acute suppuration—*e. g.*, empyema—may, if prolonged, assume this type. Fever of hectic type occurs also in malignant lymphadenoma, and occasionally in other malignant growths. Many prolonged fevers tend to assume a remittent character.

Symptoms.—Remittent fever is the chief, the temperature varying from 99° to 102.4°. The evening rise is accompanied by heat and thirst, and may be preceded by chills or even a rigor; the early part of the night is restless; toward morning with fall of temperature come sleep and most profuse sour sweating. The pulse is 90–100, becoming softer, smaller, and more frequent as the case goes on. Loss of flesh and strength is marked; the eyes become sunken and very bright; a bright red patch on the cheeks, especially in the evening, contrasts with the anæmia of the general surface. The tongue becomes strawberry-red at the tip and edges, and there is great tendency to diarrhœa. The urine deposits urates copiously, and often contains a little albumen. The mind remains clear for a long time, then wandering at night occurs. The patient sinks from sheer exhaustion, generally becoming quietly unconscious a day or so before death. Or the end may be ushered in by more acute septic poisoning with typhoid symptoms. Before this, bedsores are common.

Treatment.—Establish the freest drainage and combat decomposition. If the part can be removed entirely, this should of course be done before the patient has sunk too far.

All the most nourishing food the patient can take should be given, and chiefly in the morning when the fever is low: there is no objection to a little wine with food to stimulate and aid digestion, but the enormous quantities of alcohol sometimes given are probably worse than useless.

For diarrhœa, look carefully to diet; give raw meat, and everything cool; aromatic sulphuric acid (F. 2, 61, 64, 66), with small doses of opium, and sometimes chalk, bismuth, gallic acid. Sulphuric acid relieves sweating also (F. 3, 43, etc.).

Albuminoid Degeneration.

This is, surgically, the most important degeneration, so frequently does it assist hectic in causing the death of patients suffering from chronic suppuration. It is doubtful whether it is to be regarded as a metamorphosis or an infiltration.

Causes.—Albuminoid degeneration is almost always secondary to some primary disease, generally *prolonged suppuration* from some cavity, much more rarely from the surface of a simple or malignant ulcer; it sometimes occurs in severe syphilis, malaria, and a few other diseases. Almost all its causes are due to infective processes, and Birch-Hirschfeld suggests that the degeneration may be due to an infective cause.

Morbid Anatomy.—In certain cells of certain organs a substance appears which is firm, almost colorless, homogeneous, waxy-looking, translucent in thin sections, takes a mahogany-brown color from a watery solution of iodine (healthy parts being pale yellow), and a red color from a watery solution of methyl-violet (1 in 10). The substance is nitrogenous, differing from albumen chiefly in its color reactions, resistance to digestion, and slighter tendency to putrefaction.

The earliest stages are discoverable only by the microscope: a little later, in some organs pale waxy points may be seen—*e. g.*, the glomeruli in the kidneys, Malpighian corpuscles in the spleen (sago-spleen). Finally, the degenerate patches enlarge and blend, and the whole organ becomes considerably swollen, stiff, somewhat brittle, and looks like white wax; it preserves its general outline.

The change begins in the media and intima of small arteries and in capillaries, whence it spreads to the connective tissue of the organ; lymphoid cells and smooth muscle-fibres also undergo the change; but statements vary as to whether the epithelial elements of glands are subject to it. The most recent authors say that these merely atrophy.

The chief *seats* are the liver, spleen, kidneys, adrenals, lymphatic glands, and the mucous membrane of the intestine, especially the large; in advanced cases other parts may be affected. The above organs are not affected in any constant order.

Symptoms.—Greatly impaired blood-forming power, albuminuria, diarrhœa, even intestinal ulceration and hemorrhage, with anæmia, marasmus, and death as the ending. The course is slow. The spleen can usually be felt uniformly but not greatly enlarged; so also the liver, its edge being sharp and in consistence like India-rubber, and its size often great.

Advanced disease of this kind is generally held to contraindicate serious operations. A very few cases of advanced disease have, however, been recorded in which removal of suppurating foci by amputation has been followed by great improvement; it would, therefore, seem right to operate in spite of marked albuminoid degeneration when the primary disease can be *completely* removed and the patient seems able to bear the operation.

CHAPTER VI.

MORTIFICATION.

Mortification and *gangrene* are clinical terms expressing the death of parts in considerable mass. *Necrosis* in its pathological sense means simply death—of a limb or of a cell; but, clinically, it is used to describe death of firm tissues—bone or cartilage—the dead part being called a *sequestrum*. *Sloughing*, on the contrary, applies to soft parts.

Gangrene is sometimes called *constitutional* when it arises without any, or from very slight local cause; cardiac weakness, disease of vessels, or some other remote condition being its chief cause. *Local* gangrene is due to local causes, as when a limb is crushed, a piece of gut is strangulated, or a main artery is torn across.

Signs of Gangrene.—These are *change of color*—to tallowy pallor, to this mottled with purplish-red, or to general lividity; and *loss of all signs of life*—warmth, sensation, spontaneous motion, power of secretion. These must persist for a considerable time to render death certain; and it must be remembered that temperature may be artificially maintained, and that a living muscle may move a dead finger or toe by means of a tendon inserted into the gangrenous part. The next changes that take place render death immediately certain, for the part either dries and shrivels or it remains moist and undergoes putrefaction. When the former changes occur we speak of *dry gangrene* or *mummification;* when the latter, of *moist gangrene.* Mummification arises from causes which obstruct the entry of blood whilst the exit is unimpeded or assisted by elevation; and it is favored by all conditions which favor drying—*e. g.*, exposure to air or envelopment in absorbent dressings, thinness of the part affected, plenty of bone and tendon, no muscle or fluid effusion. When, on the other hand, a large portion of a thick, fat, fleshy limb, gorged with œdema or inflammatory fluid, suddenly or rapidly dies, there is little chance of its drying. The distinction of these two forms is usual, and their differences depend largely upon accidental rather than upon pathological circumstances, and every gradation between the dry and the moist is met with. The extremes only will be described.

In *dry gangrene* the part is at first generally pale or mottled, and not swollen; then shrinks and the skin becomes wrinkled, dry, and of color varying from brown to black, at first perhaps somewhat transparent, showing tendons, etc., through, but ultimately opaque. The living tissues, as a rule, show signs of only moderate inflammation, and the part really dead is soon fairly defined.

In *moist gangrene* the part is more or less swollen, livid, or pale from tension, and bloody bullæ are numerous on its surface. These signs pass gradually into those of health above, perhaps into those of obvious gangrene below. The superficial veins may be marked out by purple staining; the cuticle loosens everywhere and is easily brushed off, leaving a moist surface of various colors—dark red from hæmoglobin, olive-green or ash-gray as decomposition advances. A putrid odor soon becomes strong and the part crackles, being distended with offensive gas.

General Symptoms.—Putting aside such as are due to any general state which may have been present in so-called spontaneous gangrene or to shock in traumatic cases, and also special symptoms connected with the functions of the part—*e. g.*, bowel—involved, the subject of extensive gangrene is sure to be in a condition of great weakness, and the exhaustion is often increased by anxiety and pain. Otherwise gangrene produces marked general symptoms only by throwing septic products into the blood. The symptoms are those of more or less severe septic poisoning, and frequently fatal. They are much more severe in the moist than in the dry form, but even in the latter there is necessarily a zone of dead tissue in contact with and kept moist by the living, in which decomposition can occur.

Etiology.—The causes are *general*, for the most part *predisposing*, and *local* or *exciting*.

General Causes.—All influences which depress the health and impair the resisting power of the tissues favor the death of the latter. They act most directly, however, by inducing cardiac weakness and failure of the circulation in distant parts—especially toes and feet, then finger-tips, nose, and ears. Among such may be mentioned insufficient and unwholesome food often coupled with exposure, loss of blood, and exhausting diseases, especially with prolonged fever and typhoid symptoms. Under these circumstances gangrene—usually *dry*—may arise, without local cause: thus Brodie mentions the case of a drunken man who was largely bled, and his feet became gangrenous. Mortification may occur similarly during diabetes, typhoid, typhus, and, less often, other acute specifics. But local causes may have their share: hence the gangrene of the feet of the starved soldiers after standing in wet and cold trenches before Sebastopol, and the sloughing which is apt to follow the application of blisters to children after measles and scarlatina.

Ergot of rye produces gangrene of extremities and rarely of pressure points. The gangrene is generally dry and preceded by symptoms like those which indicate the presence of calcareous arteries; and the whole disease presents a striking likeness to that form of gangrene which is due to slowly progressive arterial thrombosis. The starvation sure to accompany a diet of spoiled corn is a powerful predisponent. It seems impossible that ergot can produce spasm of arterioles enduring until the parts supplied are dead, as has been asserted. Wood (*Therapeutics*, 2d edit., p. 547) believes that in decidedly toxic doses ergot lowers the arterial pressure, acting as a direct depressant of the heart and vasomotor centres. The gangrene would, therefore, seem to be due simply to anæmia of extreme parts.

Bright's disease, and tricuspid regurgitation, deserve mention as predisposing or even exciting causes of gangrene of the legs, from the tense œdema which they cause.

LOCAL CAUSES.—All act immediately in one, or both, of two ways: (1) they directly destroy the life of the cells of a part; or (2) they arrest or render insufficient the blood-supply—(*a*) by obstruction of arteries, (*b*) by obstruction of veins, or (*c*) by obstruction of all vessels.

Injuries of all kinds either destroy the vitality of a part outright, or, if less intense, excite inflammation which may end in gangrene—usually *moist*—from both injury to the tissues and arrest of their blood-supply.

Gangrene from inflammation has already been described, and will be again referred to under phlegmonous erysipelas and spreading traumatic gangrene. It is due partly to direct injury of the tissues by the cause of the inflammation, partly to arrest of circulation by tension and stasis, and to these causes in varying degree in different cases. It is always of the *moist* kind. The great majority of inflammations leading to gangrene are probably infective. Inflammation (often called erysipelas) frequently arises and runs into sloughing in intensely œdematous legs, either after puncture or without any local injury.

Arterial obstruction is a common cause of gangrene, and is produced in many ways—*e. g.*, rupture, ligature, pressure, spasm, endarteritis obliterans, thrombosis, and embolism. Ordinarily, when a main artery is thus blocked, collateral vessels dilate and carry on the circulation in its area (p. 42); but if this does not occur, gangrene must follow. Often this is of the *dry* kind, but still more often it is *moist;* for though unable to maintain the circulation, collateral vessels are frequently able to pump sufficient blood into the part to keep it from drying subsequently, and the dead part is often large. With the exception of endarteritis obliterans and thrombosis the above causes do not tend to produce a spreading gangrene, but these two often spread, and gangrene mounts up the limb *pari passu.*

Forms of gangrene due to *injuries* of arteries will not be further referred to here; of those due to *disease*, thrombosis and embolism are by far the commonest causes.

1. *Thrombosis* results from disease, usually atheromatous (see "Disease of Arteries"), of the inner coat. Gangrene from this cause is, therefore, met with chiefly after middle life, and in the legs.

The term *senile gangrene* is frequently employed to indicate dry gangrene in the aged, due to thrombosis of calcareous arteries; but, as gangrene in old people may be due to other causes, and thrombosis of such vessels may result in moist gangrene, it should be abandoned.

There seem to be two causes of gangrene—thrombosis and inflammation—of frequent occurrence in the aged, and each depends upon the existence of calcified arteries. Degenerate arteries often give rise to the following premonitory symptoms: itching, formication, numbness and coldness in the feet and legs, with painful cramps, especially of the calf muscles; the tibial pulses are feeble, the arteries rigid.

The irregularity and abnormality of the surface of such vessels and the slowness of the circulation predispose to *thrombosis*, which, starting at any point, slowly spreads. At first, perhaps, only a toe mummifies, then others, and then the gangrene slowly creeps on to the foot. It frequently halts for some days, only again to advance. But little inflammation precedes its advance, and general symptoms are slight, but pain is often extreme. The thrombosis is very extensive; to cause gangrene of half the foot, the clot probably extends into the popliteal, and blocks the vessel so completely that scarcely any blood drips from an amputation wound in the upper third of the leg, and no vessel requires tying, The malnutrition of tissues thus poorly supplied with blood must be extreme. Very slight injuries excite inflammation, and this easily spreads and causes death of the part affected. The second form of gangrene special to old people is *inflammatory*, being predisposed to by malnutrition of the parts; it starts from some slight injury, cutting a corn, treading on a nail, etc., and is either a septic or locally infective process. The swelling is usually slight, but may be considerable; the part, usually one or more toes, becomes purple, and moist gangrene sets in; but the part is so small that it often dries. The signs of inflammation along the advancing edge are strongly marked, and the part is the seat of much burning pain, especially at night. The general symptoms are marked in proportion to the putrefaction that takes place. These cases generally run a much more rapid course than the former; both forms may cease at any spot, often only to recur.

2. *Embolism.*—Bits of fibrin from aneurismal sacs, vegetations from cardiac calves, calcareous plates from arteries and other bodies, are occasionally swept away by the arterial current and lodged in the *main* artery of a limb, often at its bifurcation; thrombosis soon renders the occlusion complete. A sudden severe pain is felt in the limb, and this is rapidly followed by gangrene, which is generally dry, but may be moist. It extends up to the point of the arrest of the embolus.

3. *Endarteritis obliterans* (see "Disease of Arteries") is very rare. An extreme degree of endarteritis may cause such swelling of the intima as completely to occlude the lumen of an artery, or thrombosis may be induced. The disease tends to spread from the periphery toward the centre. It occurs at or before middle life, and without obvious cause, syphilis especially being negatived. It may affect either limb, and runs a chronic course of months or years.

The symptoms are like those of progressive thrombosis of calcareous arteries above described; and are preceded by similar warning signs. But the disease occurs usually in younger patients in whom there is no evidence of general arterial degeneration, and the affected vessel can be felt to become progressively harder and to pulsate more and more feebly until it is left a solid cord, which ultimately shrinks. The pain along the artery may be extreme. If gangrene results, it is very limited in proportion to the arterial obstruction. (See a case by Pearce Gould, *Clin. Soc. Trans.*, 1884.) The disease may subside spontaneously.

4. *Raynaud's disease, or symmetrical gangrene.*—This is a rare disease, characterized by the sudden formation of cold, rather tender, gray-blue, ill-defined, rather painful patches upon the limbs, most commonly of young children, but also of adults. Such areæ are often symmetrical; in other cases one foot or hand only is affected. In the majority of cases the parts become normal after half an hour or a few hours; in the most severe the color deepens to black, bullæ rise, and the skin sloughs, or perhaps a whole finger dies and shrivels. The attacks are paroxysmal, not periodic, may begin with vomiting and yawning, and be followed by passage of urine containing albumen and granular blood

pigment; it is quite a cold weather affection, but attacks occur without special exposure.

Post-mortem, a hemorrhagic infiltration of the discolored tissues has been found. The disease has been ascribed to *spasm of arterioles* due to excitation of sensory nerves by cold and the conveyance of this stimulus to a very hyperæsthetic cord. (T. Barlow, *Clin. Soc. Trans.*, 1883.)

Obstruction of veins is rarely a cause of gangrene, the anastomoses between veins are so free; the common femoral vein is a rare exception. When, however, a main artery is obstructed, even partial obstruction of its vein becomes very serious, and moist gangrene is probable.

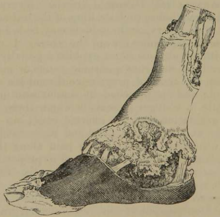
In *strangulation*, which does not stop all circulation, the veins are much more affected than the arteries, and the part consequently becomes extremely congested (p. 47), swollen, and ultimately falls into a state of moist gangrene, as often seen in strangulated bowel.

Arrest of Gangrene.—The cause ceases to spread and its effect similarly ceases to advance. Frequently we cannot tell how an inflammation is arrested, why a thrombus ceases to extend, and so forth ; but upon points like these the arrest of advancing gangrene depends. Gangrene from anæmia —*i. e.*, dry—often ceases just below a joint (ankle or knee) around which the arterial anastomosis is more free than lower in the limb.

When progress of the gangrene is arrested a bright red line of inflammation (called the *line of demarcation*, p. 61) separates the living parts from the dead. And the appearance of this line is most important as a means of *prognosis*, because it shows that the mischief has ceased, and that there is a disposition to repair its ravages.

Separation of the Mortified Part.—It is at this bright red line of demarcation that the dead part is separated by ulceration. A narrow white line, due to elevation of the cuticle by vesicles, appears along the edge of

Fig. 7.



Separation of the dead part in dry gangrene from exposure (King's Coll. Mus.).

living tissue. Separation of the cuticle occurs here, and a chain of minute ulcers is seen under it. These gradually unite and form a chink, which widens and deepens till it reaches the bone (Fig. 7). Granulation tissue forms in and eats away the living tissue wherever it is in contact with the dead; even the bones are at last ulcerated through, and the dead part is cast off (see p. 61) leaving a granulating and suppurating surface. Thus the whole of a mortified limb may be amputated; the bone and tendons separating lower down, and being more slowly detached than the skin, muscles, and bloodvessels, which retract, the resulting stump is irregularly conical. When granulation has duly occurred, this process of separation is unattended with hemorrhage, the vessels being closed by firm adherent thrombi; but when, as in hospital and other forms of moist gangrene, putrefaction or other intensely irritant and mycotic processes are going on close to the thrombi, these may form imperfectly, or soften and break down when formed, and the separation of the slough may be attended with severe hemorrhage.

Diagnosis.—It is often impossible to tell at once whether a part is or is not dead. It may be pale, cold, insensitive, and motionless from injury, cold, and other causes, or swollen, dark blue, and covered with bloody bullæ, and yet recover. The signs which render death of a part immediately certain are due to drying and putrefaction; but these do not set in for some time.

Treatment of Gangrene from Disease.—*General:* Treat any general morbid state which may have predisposed to gangrene, and endeavor to improve the health and strength of the patient. Apart from specific treatment of Bright's, diabetes, etc., the most nourishing and easily digestible diet should be given; a little alcohol with meals may aid digestion. Whilst paying every attention to local hygiene, see that surrounding conditions are favorable, and especially that ventilation is good. Pain, irritability, and restlessness must be allayed by opium in regular small doses, or occasional large ones (gr. j of the powder or ♏xxx of the tincture) as required. A mixture of ammonia and bark (F. 15), is useful.

Treatment.—Remove any local cause, as pressure, a strangulating band, or tension. The latter may very frequently be done, and with the best effect, in all spreading inflammations, in those which so commonly arise in the tensely œdematous legs of cardiac and nephritic subjects, and in cases in which venous obstruction plays a prominent part, by a sufficient number of well-placed incisions, one to two inches long (see "Phlegmonous Erysipelas"). These gape and act probably as much or more by affording a ready means of exit for the causes of inflammation, which are being forced into the tissues, as by relieving tension.

All parts in which gangrene is threatening *should be elevated*, very slightly in cases due to arterial obstruction, considerably in those from obstruction of veins or inflammation. The *preservation of warmth* in the affected part is another important point, and is best effected by wrapping the part in a large quantity of cotton-wool and maintaining a comfortable external temperature.

Of the highest importance is the *prevention of decomposition* in parts, should they die. Threatened tissues should therefore be well washed with soap and warm water, and then with warm sublimate solution; breaches of surface should as far as possible be disinfected with sublimate thickly dusted with crystals of iodoform, and the whole part should then be enveloped in a thick covering of salicylic wool, if this be at hand, and a silk handkerchief sewn over all. It requires changing only when the patient presents symptoms which may be relieved at the wound, or when an offensive smell or any discharge comes through.

When gangrene is established before the patient is seen, the above measures will still be best to arrest its advance, but septic decomposition will have set in and must be kept in check. An antiseptic absorbent wool dressing will favor drying. In moist gangrene it should be changed frequently and be less thick than in aseptic cases, and free and numerous incisions should be made into the *dead* parts to favor the escape of fluids. It is well in moist gangrene to reduce the size of the putrid part as much as possible, so absolutely dead parts may be cut away. All gentleness must be used and a good margin left between the section and the living tissues, any interference with the latter readily lighting up fresh inflammation. To the surface and through cuts antiseptics may be freely applied to the dead parts —iodoform or powdered boracic acid being perhaps the best.

When the soft parts have ulcerated through and retracted, much time may be saved by very gently retracting them with the aid of lateral incisions and dividing the bones with a saw; otherwise natural separation will take many months, and a stump incapable of healing soundly will then be left.

Amputation in Gangrene.—The above may be called the expectant treatment. If successful, it leaves the patient with the longest possible stump: but no line of demarcation may form, and in severe cases the chances of death from septic absorption, pain, and exhaustion are many. Removal of the diseased part has therefore to be considered.

In gangrene from injury primary amputation immediately above is the proper treatment.

In rapidly spreading inflammatory gangrene, unchecked by incisions etc., the only hope lies in high amputation (see "Spreading Gangrene").

In extending gangrene from thrombosis of calcareous arteries high amputation has been practised in a few cases with good result. Hutchinson proposes that amputation through the lower third of the thigh be done when the patients are so bad that they must keep abed. But to obtain viable flaps it is usually unnecessary to go so high. Hutchinson would apply the same treatment to the inflammatory form of senile gangrene, and here again it is probable that amputation below the knee would answer the purpose, antiseptics being used. The prognosis in these gangrenes of old people is very bad when they have passed the ankle.

In gangrene from embolism, amputation should be done immediately above the line of gangrene so soon as this is well established.

In all cases the general state of the patient must be considered and so far as possible improved, before resorting to amputation.

Hemorrhage during the separation of sloughs is best treated by the cautery, simple pressure, or acupressure; these failing, amputation will probably be required.

Mortification from Pressure, Bedsores, Etc.—When a patient is confined to bed with some very tedious and debilitating malady, as a fever —and especially if he has no strength to shift his posture occasionally—the skin covering various projecting bony parts (as the sacrum, brim of the ilium, or great trochanter) is apt to inflame and rapidly ulcerate or slough, and more particularly if irritated by neglect of cleanliness or by the contact of urine. The first thing complained of by the patient is often a sense of pricking, as though there were crumbs or salt in the bed. The part looks red, then becomes excoriated and ulcerates, or turns black and mortifies, frequently right down to the bones. This accident is particularly liable to happen if the spinal cord has been injured. Often these sores do not cause the patient to make any complaint. Similar ones often form where splints or bandages press on bony prominences—*e. g.*, malleoli, iliac spines, inner condyles of humerus. These points should always be guarded by "ring" pads of gauze, wool, or lint.

Treatment.—When long confinement to bed is expected a water-bed should be had if possible. Strong spirit or Eau de Cologne should be regularly applied to the skin of the back and hips, to harden and enable it to bear pressure better. Light friction of dependent parts with the hand greased with some ointment (boracic) should be performed night and morning for five to ten minutes upon all patients unable to change their position freely. If the part seems likely to suffer, in the absence of a water-bed, air pillows, or water-cushions, shaped like a ring, should be arranged to relieve the parts from all pressure, and the patient should be made often to lie on his side or face.

Boracic ointment is the best application for excoriations; for deep sloughs boracic fomentations, and dusting with iodoform if they are very foul. Balsam of Peru is recommended as an excellent stimulant antiseptic in these cases—either pure or diluted with an equal part of vaseline; resin ointment is also very good.

CHAPTER VII.

SCROFULA AND TUBERCULOSIS.

Definition.—Scrofula, or its equivalent, struma, is commonly defined as that condition of body in which the tissues are prone to inflammation of low intensity and protracted course.

Description.—It has been held that certain types of organism manifest the scrofulous tendency or diathesis; but knowledge of temperament, habit of body, complexion, is too indefinite to permit of trustworthy description, and it will therefore be safer to await in each case the manifestations of scrofula rather than venture to predict on such grounds.[1]

The manifestations of scrofula occur in most of the tissues of the body, but foremost comes the absorbent system. Here the lymphatic glands are singled out, and they yield the indolent swellings—enlarged glands—so commonly observed in the neck, and, by suppuration, lead to the puckered scars which point to past inflammatory action.

Other tissues which may suffer are, the skin and mucous membranes; of the former, witness the eczema, frequently pustular, which is common about the head and face (impetigo of the scalp, tinea tarsi, suppurative discharge from the external ear); of the latter, witness the conjunctivitis, coryza, ozæna, otitis media, also the catarrhs of the bronchial tubes, the intestine, the bladder, the vagina, the vulva.

Then connective tissue structures are often affected, witness the frequency of strumous nodules in the skin, subcutaneous abscesses, arthritis, osteitis. Or the several organs of the body, in particular the lungs, kidneys, and testicles, may show the above tendency to chronic inflammation.

In all these cases, wherever the inflammation may localize itself, its characteristics are: (1) that it is apparently easily provoked,[2] (2) that it is

[1] Many, indeed, still hold to the view that a special type of body is found with the scrofulous diathesis. Sir W. Jenner's description of this type (*Med. Times and Gaz.*, 1860, Lecture I. on Rickets) may be given: "Temperament, phlegmatic; mind and body, lethargic; figure, heavy; skin, thick and opaque; complexion, dull pasty-looking; upper lip and alæ of nose, thick; nostrils, expanded; face, plain; lymphatic glands, perceptible to touch; abdomen, full; ends of long bones, rather large: shafts, thick."

[2] We are dealing with the clinical features of scrofula, and this easy provocation of inflammation is undoubtedly a clinical fact, though it may admit of a different pathological interpretation, as we shall see later on.

rarely sthenic, (3) that, once started, the inflammation runs a chronic course.

From these general features we may pass to more special ones characteristic of scrofulous inflammation and easily deducible from the above. First, easy provocation of the inflammation means that we shall often fail to discover an exciting cause—the swelling of the gland or joint seems to arise spontaneously—it "*comes of itself.*" Next, from the fact of the local action not running high, we miss the heat of inflammation (hence the name "cold" applied to scrofulous abscesses), also the redness over the scrofulous abscess which in pointing lacks the vividness of acute inflammation and is more purplish in hue; further, pain is comparatively slight or may be entirely absent. Lastly, owing to the chronicity of the process, there is time for organization of the inflammatory products which have invaded the tissues around the focus proper of the disease, hence the firm thickened base of the scrofulous ulcer with its infiltrated everted edges. This infiltration is sometimes extremely marked in the neighborhood of a scrofulous joint, and may almost fix the joint.

Passing to the *morbid anatomy* which underlies these manifestations, one must separate the affections of skin and mucous membranes from the affections of deeper parts, for this reason, that there is in the former no tendency toward accumulation of the products of inflammation which escape from the surface. But in the deeper affections, these accumulate; and in cases of long duration, examination will commonly show, occupying the centre of the inflammatory focus, be it in lung, kidney, testicle, or lymphatic gland, a material which from its consistence and color has been aptly likened to cheese. Its consistence truly varies much between a puriform liquid on the one hand and a mass of mortary or chalky hardness on the other; but very commonly indeed the cheesy character obtains, and hence the cheesy or *caseous* nodule belongs to the classical description of scrofulous lesions. Without further examination of this cheesy mass, we may say this—that it consists of an amorphous débris, the yellow tint of which it derives from the presence of fatty particles; these fatty particles are the result of degenerative changes and themselves argue chronicity. We shall recur to this point.

Etiology.—Scrofula is highly hereditary, and in very many cases it will be possible to discover a history of some one or other of the above-mentioned lesions on the side of the father or mother. In like manner, the brothers and sisters of the patient may be expected to show in varying degree the same tendency. The manifestations of congenital scrofula do not, as a rule, appear during the first year of life, but from the second year onward during the whole period of active development, they are common; the first two decades of life would cover the period of most active manifestation. In middle age, and thence on, scrofulous lesions are not common. But scrofula may be acquired as well as handed on, and the conditions which tend to engender it are, briefly, improper or insufficient food, overcrowding, damp dwellings—in fact, all those conditions which are included under "Faulty Hygiene." These conditions will clearly have most effect during the period of active growth of the body, and hence another reason for the prevalence of scrofula during the first two decades of life.

It is not uncommon for scrofulous affections to make their appearance for the first time shortly after some recent exhausting disease—*e. g.*, some one of the acute specifics—measles, scarlet fever, smallpox, typhoid; but these must rank rather as accidental predisposing causes, bringing to light a tendency which else might have remained latent.

The relationship of syphilis to scrofula is probably of the same kind—viz., predisposing; but be this as it may, be it is certain that many of the manifestations of scrofula occur in the children of syphilitic parents. The children of parents of tender years, also those of parents advanced in life, are liable to scrofulous affections.

Tuberculosis.

Whilst scrofula is a term used in a clinical rather than in a pathological sense, or at least includes much of the clinical element, tubercle is essentially a pathological term, and hence the subject of tuberculosis will be best approached from the side of pathology.[1]

The term *tubercle* is applied to certain morbid products which are found in the body. These to the naked eye certainly do not present great similarity; they include:

(*a*) Masses of very variable size, ranging from the size of a pea or lentil to that of a billiard ball, rarely beyond this, which masses are of a yellowish color and somewhat cheesy consistence.

(*b*) Minute seed-like or shot-like bodies, which may vary from the size of a pin-head downward, and in color may be either gray and semi-translucent, resembling then a grain of boiled sago, or opaque and white, or yellowish-white.

The former (*a*) go by the name of *crude*, or sometimes *yellow* tubercle; the latter (*b*) by the name of *miliary* tubercle, or of *gray granulation*.

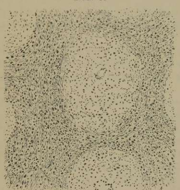
The term yellow tubercle for the large masses is bad; for the smaller masses, we have seen, may also be yellow, and for this same reason the name "gray granulation" cannot be used as synonymous with miliary tubercle, for it names only a *stage* of the miliary tubercle. The grounds on which these two forms are both named tubercle are the following: First, the two forms may frequently be found associated: either miliary tubercles are scattered round about the cheesy mass of crude tubercle, or a patient will be taken with a rapidly fatal illness, and at the post-mortem, miliary tubercles will be found scattered through the tissues of the body, and with them in some organ or tissue of the body a caseous nodule. Next, it is frequently possible to trace the passage of the miliary tubercle from the gray translucent stage to the opaque, white, or yellow stage, and we may readily perceive how from such transformation, and from a confluence of adjacent miliary nodules, it would be possible to build up the larger yellow mass. Lastly, we may actually witness this building-up; for close examination of a nodule of crude tubercle, such, for instance, as we meet with in the brain, will reveal the following structure surrounding the large caseous mass — a delicate grayish-pink layer of granulation tissue, and in this layer minute nodules, answering to the description of typical miliary tubercles. The relationship is so close here that there is no doubting that the large caseous mass is a conglomeration of miliary tubercles which have passed into the yellow stage. The fittingness of the term "conglomerate" tubercle, introduced by Virchow, to designate the mass of crude tubercle, will be apparent, and, indeed, we shall best keep in mind the relation of the two forms of tubercle by speaking of them as *discrete miliary* tubercle and *conglomerate* tubercle. In

[1] We may, however, refer here to the type of organism which is held to manifest the tendency to tuberculosis. The following is Sir W. Jenner's description: Nervous system highly developed; mind and body active; figure slim; adipose tissue small in quantity; organization generally delicate; skin thin; complexion clear; superficial veins distinct; blush ready; eyes bright; pupils large, lashes long; hair silken; face oval, good-looking; ends of long bones small, shafts thin and rigid; limbs straight; teeth cut early; children run alone and talk early.—*Med. Times and Gazette, loc. cit.*

addition to these, which constitute the *nodular* tubercle of Laennec, we have the *infiltrating* variety. In this there is a diffuse cell-infiltration (Fig. 8), transforming the synovial membrane of a joint, for example, into a layer of granulation tissue half an inch thick or more. This variety is very important in surgery, for it is the pathological lesion in many cases of local tuberculosis.

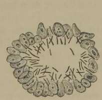
STRUCTURE OF THE MILIARY TUBERCLE. — In the earliest stage, this minute body, which is not bigger than a millet-seed, and is of a translucent gray color, shows under the microscope a dense clustering of cells into which *no vessels penetrate*. The cells are round and quite like leucocytes. We have thus before us a structure which may be likened to a bead of *non-vascular* granulation tissue (Fig. 10). At a later stage, the tubercle being now somewhat bigger, will show, besides the above, cells (*epithelioid*) of larger size, with well-marked oval nuclei resembling epithelial cells; in addition huge multinuclear masses of protoplasm may be found, more especially in the central parts of the knot; these are the so-called *giant cells* (Fig. 9). Traversing this cluster of cells may be found the remains of the connective tissue of the part as a supporting reticulum. In the infiltrating form the microscope usually shows the presence of numerous collections of large cell forms similar to those of miliary tubercle, embedded in the granulation tissue (Fig. 8), in which they are quite invisible to the naked eye. Sometimes these collections are scarce; the granulation tissue is tubercular because of its cause, not because it contains tubercles. Now all the elements above described, round cells, epithelial cells, giant cells, may be found in any granulation tissue (p. 61), and so far there is nothing specific in the structure; but though this is so, the life-history of the miliary tubercle is specific, for the tendency is always toward necrosis—the gray bead becomes

FIG. 8.



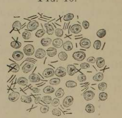
× 70. Section of capsule of hip in a case of hip-joint disease. In the granulation tissue are uniformly distributed tubercles with central giant cells and degenerating epithelioid and small cells. The upper giant cells contained two bacilli Koch).

FIG. 9.



× 700. A giant cell with radially arranged bacilli; from a cheesy bronchial gland in a case of miliary tuberculosis (Koch).

FIG. 10.



× 700. Cellular tissue from the margin of a meningeal tubercle; very numerous bacilli lie among the cells, of which only the nuc ei are stained (Koch).

opaque at its centre, the opacity spreads till it involves the entire bead and a yellow tinge is acquired. Examined now, the cells may be found in large part replaced by a detritus of albuminous and fatty granules, or may present blocks of homogeneous hyaline appearance (coagulation-necrosis of the cells). As a key to this tendency to necrosis the extravascular nature of the structure, which persists throughout, must be remembered; but it is possible that the action of the bacillus (Cheyne) is still more to blame. The caseous mass may remain dry and ultimately calcify, or it may more or less rapidly soften into a puriform fluid, excite inflammation, and tend toward the nearest surface.

PATHOLOGY OF TUBERCULOSIS.—We now come to a very important point. What is the significance of the scattered miliary tubercles which are found so commonly immediately around the caseous nodule? And what is the meaning of the sudden outbreak of an acute disease which reveals, on the death of the patient, the tissues of many, perhaps most, organs strewn with miliary nodules; and then in some out-of-the-way corner, perhaps, a yellow focus of conglomerate tubercle which obviously is of much older date than the scattered miliary bodies? The demonstration of the structural relationship of crude and miliary tubercle is a step toward answering this question, but only a step. The answer would, however, be forthcoming, supposing we could prove the presence of the same poison in the yellow focus of conglomerate tubercle, and also in the discrete miliary tubercles: for then the occurrence of miliary bodies immediately around this focus would find its explanation in an escape of the poison into the parts around—while the sudden outburst of the general disease would be explained by the escape of a particular poison into the blood, the particles being arrested at many points in the tissues. A chemical poison would not produce the localized secondary inflammations.

Arguments based on such reasoning led to the theory of the infectiveness of the caseous mass, and the demonstration of the conglomerate nature of this mass, whose essential unit of structure was a minute bead or granule, led up to the classification of tubercle as one of the *infective granulomata* (p. 55). The infectiveness of tubercle has now been well established (1) by the inoculation experiments, especially of Cohnheim and Salomonsen, who placed fragments of tubercular material in the anterior chambers of rabbits' eyes and produced a local tuberculosis quickly becoming general, and (2) by the investigations of Koch, who has isolated the virus upon which the infectiveness of tubercular stuff depends. The steps in the proof were these:

1. The demonstration, by a special mode of staining, of the constant presence of a specific organism in a tubercular foci.
2. The separation from morbid products and pure cultivation of this organism.
3. The inoculation of animals with the pure cultivation—*i. e.*, with the organism only—and the invariable production in suitable animals of tuberculosis.

Koch's results have been confirmed by other observers, and it may now be considered as well established that the organism (*Bacillus tuberculosis*) described by him is the specific irritant productive of tubercle.[1]

[1] Character of the bacilli: Motionless rods, measuring in length from one-fourth to one-half the diameter of a red blood-corpuscle; in breadth one-fifth to one-sixth the length. Frequently slightly curved. Multiplication takes place by spores; these are oval bodies, two to six, as a rule, in each bacillus. They are most common in the giant-cells (Fig. 9), much less so between the smaller cells (Fig. 10); they are less numerous in chronic cases of infiltrating tubercle, and may be very rare. The bacilli are not known to occur normally outside the animal organism. Cultivation experiments have shown that they are of very slow growth, that to flourish they require a temperature of over 30° C. (86° F.), and that the medium must be either blood serum or meat liquor. Obviously the animal body yields the required conditions.

With this discovery the pathology of tubercle is still only half complete. Why do we not all become tuberculous? The bacilli of tubercle escaping from the body of the tuberculous by various channels must be inhaled as dust by the many—why do the few alone suffer? Obviously the only adequate explanation is that the tissues of some must offer a more favorable soil for the development of the germs than the tissues of others. Therefore, in addition to a specific irritant, there must be a *specific susceptibility* to cover all the facts.[1] With these two data allowed, we may summarize very shortly the chief facts in the pathology of tubercle as follows. The *Bacillus tuberculosis* gains access to the tissues, with air or with the food, the former being the more common mode; having lodged, the soil being suitable, the germ proceeds to multiply *in loco*. The presence of the germ in the tissues is a very mild chronic irritant, and causes corresponding inflammation. The products of inflammation gather around the focus of irritation and take the special structural arrangement which has been described, and show the special tendency toward necrosis which has been noted. This necrosis is the one usual to albuminous tissues, viz., fatty. The rods are carried probably by leucocytes into the parts immediately adjacent, and a series of secondary foci spring up around the primary focus, the secondary foci pass through similar stages toward necrosis, and from proximity blend with the primary focus; thus the process spreads by means of a progressive local infection. There may thus result destruction of half or more of an entire organ, still we have to deal only with a *local* disease. But at any moment the germs may find entry to the blood, either indirectly by way of lymph channels, or by direct access to the blood-stream, the walls of a vein or artery becoming tuberculous and the growth of bacilli actually penetrating their lumina. Being then carried to all parts of the body and lodging here and there, they cause an indefinite number of secondary foci, and the disease now has passed from a *local* to a *general* disease—*acute miliary tuberculosis*. The secondary foci would doubtless pass through stages precisely similar to those just described in the local process, but that death occurs before such is possible—the patient dying with all or most of the miliary nodules in the stage of the gray granulation.

It has long been known that one great danger of patients with scrofulous disease of a bone, joint, or other part is the outbreak of general tuberculosis. Naturally this caused pathologists to regard the cheesy products of scrofulous inflammation as very similar to the cheesy tubercle. It is rapidly becoming more and more certain that there is no difference between them. The microscope shows that in strumous granulation tissue miliary tubercles (Fig. 8) are always, or almost always, present before caseation sets in; and Koch and other observers have shown that the products of scrofulous inflammation when inoculated upon animals, induce ordinary tuberculosis. They have demonstrated *B. tuberculosis* in the inflamed tissues (though often in very small numbers), and have obtained pure cultivations of the bacillus from them. It seems, therefore, that "scrofulous" and "tubercular" are synonymous; that a scrofulous inflammation is caused by *B. tuberculosis*. Some still hold that tubercles and bacilli are grafted on, as it were, to a scrofulous inflammation. But inflammations by causes other than *B. tuberculosis* are not excited and maintained in strumous subjects with such extraordinary ease as to require the hypothesis that the tissues are excessively vulnerable. If the diseased part (gland, synovial membrane, etc.) be *com-*

[1] The inoculation experiments on animals bear this out; for whereas some animals take tubercle with the greatest readiness—*e. g.*, rabbits, guinea-pigs, ruminants—others are very difficult to infect—*e. g.*, dogs and rats. We see here that the tissues offer a more or less favorable nidus to the same poison.

pletely removed, an operation wound in the strumous generally heals well. A strumous or tubercular subject is, therefore, one whose tissues favor the growth of *B. tuberculosis*.

The most important point to be learnt from the above is that every tubercular focus is a danger to parts around by local infection, and also to the system at large by general infection. It is not so certainly fatal as a cancer, for the tubercular material may become encapsuled and calcified or eliminated ; but the probability of infection is so great, and the course of tubercular inflammations so chronic, that it is frequently right to remove the disease completely by the various operations of erasion, excision, or amputation.

Having thus included in the morbid anatomy of tubercle the lesions of scrofula, it remains for us to complete the pathology by showing how the bacilli gain access to the scrofulous gland or joint. Koch's explanation of this is that the access is not a direct one, but that the bacilli entering primarily by the lung or the bowel establish a local tuberculous focus—most probably in some lymphatic gland, and that from this focus bacilli enter the blood stream and accidentally lodge in some part or other of the body. The difference between this mode of infection of the blood stream, and that which gives rise to general tuberculosis, would lie in this, that in the former case only a very limited number of bacilli (Koch says only one) gain access to the blood, in the latter an indefinite number. For the infection of superficial glands—*e. g.*, the cervical—Koch suggests local infection, through some scratch or other of that portion of the skin whose lymphatics drain into the affected gland. Many of the lesions of scrofula would then rank as secondary, whilst lesions of lung would be primary, resulting from direct inoculation. The bowel lesions (tuberculous ulceration) may be the result of direct primary inoculation—*e. g.*, from the ingestion of food containing tuberculous matter; but far more commonly they result from the swallowing of sputa containing bacilli, the patient infecting his bowel from his lungs—this ulceration would be secondary.

Lastly, the tubercle theory of scrofula must account for the skin eruptions and catarrhs of mucous membranes which are frequent in the scrofulous. Have we here also to do with a specific irritation by bacilli? This is a question not yet definitely answered, but it seems not improbable that such is the case. Should this be established then, one of the last remaining objections to the unity of the two diseases would be met. That cheesy glands form secondarily to scrofulous inflammation of skin is well known.

Etiology of Tubercle.—This has been very largely covered in discussing the pathology of the disease, but some points still remain for consideration. We may say first that there is no evidence that the bacilli of tubercle are derived from any other source than the animal organism, nor any evidence that harmless bacteria may, under certain conditions in the body, develop into the poisonous bacilli of tubercle. How is the poison conveyed? In the vast majority of cases the vehicle will be the sputa of a patient already suffering from the disease. The sputa drying on some texture or other—*e. g.*, the handkerchief—will shake into the air with the fluff from the texture, and as dust will be inhaled.[1] The evacuations from the bowel of the phthisical may contain numerous bacilli, but the danger of contamination of the air from this source will, with ordinary cleanliness, be but slight.

Since animals are subject to tubercle, they too will be a source of infection to us, but in a different way, for they do not spit, and the evacuations appear

[1] The long vitality of the tubercle germs must here be borne in mind. In dried sputa they have been found infective after 186 days. See experiments of Fischer and Schill (Koch, Die Aetiologie der Tuberkulose).

to contain the bacilli only exceptionally. On the other hand, the milk of tuberculous cows is undoubtedly in many cases a source of infection, but only when the udders are actually diseased (Koch); and the flesh of tuberculous oxen (Perlsucht) and tuberculous pigs will be poisonous. This last danger, however, is less than it appears, for the tuberculous—*i. e.*, caseous—lesions will be apparent, and will naturally be avoided; the meat will obviously be diseased. With the exception then of the milk, the danger from animals will not be great, and in any case far less than from ourselves. Then, as to *susceptibility;* this, we have seen, plays an important part. We shall have herein an explanation of the hereditary transmission of tuberculosis; it will be that the parent hands down to his offspring tissues suitable for the cultivation of the bacilli—a good soil.[1] We must observe here, that this susceptibility will include build of body, which also may be handed down. This finds application in the narrow, flat, ill-formed chests, chests of small capacity and feeble movements, which are probably associated with feeble ciliary action in the air-tubes. Such chests are handed on from parent to child, and are so frequently observed in those who are or who become tuberculous in their lungs.

The doctrine of distinct special types of body in scrofulosis and tuberculosis (footnotes on pp. 91, 93) will obviously fail with the proof of the identity of the two processes.

Sex, so far as is known, plays no part in the etiology of tubercle. Concerning *age*, it must be noted that cases of congenital tuberculosis or of tuberculosis in the newborn are extremely rare. This means that only very exceptionally will the fœtus become infected *in utero*.

As to *predisposing causes*, these will take effect in the direction of lowering the vitality of the organism. They will be the same as those already enumerated under the etiology of scrofula, viz., overcrowding, damp dwellings, insufficient food and clothing, etc. Dampness in particular bears very strongly on the subject, as shown by the relationship of phthisis and a water-logged soil.

Predisposing causes in the shape of disease, bronchitis, measles, typhoid, etc., may be again mentioned.

Treatment.—For the surgical treatment, by erasion, enucleation, excision, reference must be made to the special sections on diseases of bones, etc. In parts not accessible to the knife it may be possible still to apply local treatment, as in the inhalation of antiseptic vapors in diseases of the lungs; but this treatment is still on its trial, and as yet the results are of doubtful interpretation. We shall in such cases, and indeed in all cases which do not admit of vigorous local treatment, probably do better by endeavoring to increase the resisting powers of the tissues by a hygienic and tonic treatment. This is perfectly scientific treatment, as scientific as the destruction of the organisms themselves would be. To this end are indicated country air, and, in particular, sea air, also that of high altitudes and high latitudes, on account of its purity; a diet in which fats, to the extent to which they can be borne by the stomach and assimilated, should preponderate (cod-liver oil is here of the greatest value and must rank as a food), and drugs of the class of tonics and alteratives—*e. g.*, the mineral acids, bark, quinine, the preparations of iodine, the hypophosphites (*e. g.*, Fellows's syrup), the phosphates (*e. g.*, Parrish's food); acid tonics; light bitter tonics; preparations of iron, according to the age and condition of the patient. It may here be

[1] Heredity will, no doubt, be capable of being explained away in part on the ground that the child inhabits the same dwelling as the parent, and, therefore, is exposed directly to infection if the parent be tuberculous; but there are facts in heredity which do not admit of this explanation.

remarked that iron preparations and cod-liver oil and the phosphates are medicines which are to be taken up by the alimentary tract much in the same way as food; therefore, if a furred condition of the tongue, together with signs of gastric or intestinal disturbance, want of appetite, constipation, etc., exist, it will be best to treat these first by gentle aperients and tonics to the alimentary tract: for this purpose few remedies are more valuable than small doses of rhubarb and soda or rhubarb and magnesia, or, in a child, small doses of castor oil, ♏ v, three or four times daily. Having obtained a clean tongue and regular action of the bowels, the iron and cod-liver oil treatment will find its proper place.

On the subject of scrofula and tuberculosis, consult Dr. Gee's article in Quain's *Dictionary of Medicine;* Green's *Manual of Pathology*, sixth edition; the *Text-Books of Pathology* of Birch-Hirschfeld, second edition, and Ziegler, third edition; and in particular, Koch's article on the "Ætiology of Tuberculosis," in the *Mittheilungen aus dem kaiserlichen Gesundheitsamte*, vol. ii.

CHAPTER VIII.

LEPROSY (ELEPHANTIASIS GRÆCORUM); GLANDERS AND FARCY.

Leprosy is a constitutional disease of chronic course, marked by curious pigmentary changes, by the development of diffuse or nodular infiltrations in the skin, and by perversions of sensibility (hyperæsthesia, anæsthesia). The mucous membranes may suffer as the skin. The patient generally succumbs to a specific form of cachexia. All or many of the above symptoms may be present in the same case, but the cutaneous and nervous symptoms may occur quite separately.

Leprosy is an endemic disease owning a very curious geographical distribution. During the middle ages it abounded in England and Scotland, and, indeed, in Central Europe generally, and hospitals were erected for the care and seclusion of the victims. It lingered in Scotland after it was extinct in England, and last of all in the Shetland Islands. It now flourishes in Norway and Iceland, and is met with also in Spain and Italy. In Crete and Palestine it is found as of old; it infests the East and West Indies, and has been imported into Canada and Honolulu. It seems quite independent of climate and elevation; affects the people of certain villages, not those of neighboring ones. Like all imported diseases, it is usually most prevalent on the sea-coast.

It has not been possible to refer the disease to any particular kind or state of soil—*e. g.*, marsh land—nor to any particular diet (fish); the disease in the past has been treated as contagious, and pathological evidence has somewhat revived this theory, but the conditions necessary for its transmission must be very special. It has been said to be hereditary; but this again has been disputed; so there has been and is still great obscurity as to the conditions under which the disease originates.

Symptoms.—The clinical features of the disease range themselves to form three types—the *macular*, the *nodular* or *tuberculated*, the *anæsthetic*. Prodromal symptoms indicative of general failure of health are usual, extending over weeks or even years.

The *nodular form* begins with the development of spots or patches of a red or red-brown color, which range in size from a sixpenny-piece to the palm of the hand; they may be slightly raised, are tender to the touch, and partly disappear under pressure. The spots are irregularly distributed over the face, trunk, and extremities. This stage is generally spoken of as the *macular form* of the disease; it may persist for weeks or months. Then, or sometimes not till two or three years after, nodules appear, varying from the size of shot up to that of hazelnuts, red-brown in color, firm or soft, the cuticle over them sometimes slightly scaling. They come out in successive crops at short or long intervals. The face is chiefly selected—the eyebrows, nose, lips, cheeks, ears; the diffuse and nodular thickening of these parts produces a peculiar *leonine* aspect of countenance (Fig. 11). The hands,

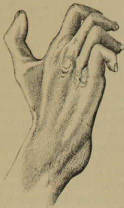
FIG. 11.

Tubercular leprosy. Drawn by Moonesawmy.

feet, limbs, mostly on the extensor aspects, and trunk, may show similar diffuse infiltration and nodules. The course of the thickenings is usually very chronic. Their fate, having reached maturity, may be slow disappearance, patches of pigmented atrophic skin marking their site, or they may break down into indolent ulcers, and by extension to the deeper parts and progressive necrosis produce great destruction—*lepra mutilans*. The mucous membrane of the mouth, tongue, and larynx may suffer similarly, implication of the larynx being shown by a peculiar hoarse voice. Sooner or later a patchy form of anæsthesia of the surface develops, with the progress of the disease the constitution generally suffers, a condition of low vitality is established, and at the end of some eight to ten years the patient dies of cachexia or of some complication: exhausting diarrhœa, lung affections, etc. In England one is very apt at first to mistake nodular leprosy for syphilis, especially if this disease be also present.

THE ANÆSTHETIC FORM.—We have seen anæsthesia appear in connection with the nodular and macular forms of leprosy, but apart from such the anæsthesia may appear in skin which looks quite healthy or in parts of the skin which have previously shown pemphigus bullæ. The anæsthetic patches are very irregular in shape and distribution; often in their midst a patch of normally sensitive skin may be discovered. The anæsthesia is complete, and the patient may burn himself deeply without being aware of it.

FIG. 12.



One form of atrophy present in Oriental leprosy. The muscles of the hand are atrophied, especially those of the fifth finger and the interossei. It will be seen also that the terminal phalanges of some of the fingers have disappeared. Drawn from a patient of Moodeen Sherif, at the Triplicane Hospital, Madras, by C. Moonesawmy Moodelly.

FIG. 13.

Anæsthetic leprosy. Sketch of the hand of a Madras leper, drawn by Moonesawmy. The nails are seen on the metacarpus. The structure of the phalanges has completely disappeared, whilst the skin bearing the nails has been preserved. The nails have then been transferred to the metacarpal bones.

Atrophy of the skin, of the muscular, and, indeed, of almost all the structures beneath the insensitive surface, may occur, and very curious deformities result—*lepra mutilans*. Ulceration may appear in the anæsthetic area. Superficial nerves, like the ulnar, may be felt as thick perhaps as the forefinger.

MORBID ANATOMY AND PATHOLOGY.—Both the clinical course and morbid anatomy of leprosy show its analogy with tubercle and other *infective granulomata*, among which it ranks as the most chronic. Post-mortem examination reveals the presence of a *granulation tissue*, either collected into nodules or diffusely infiltrating, in the skin, mucous membranes, and sometimes deeper structures. Even in the macular form of leprosy this granulation tissue is present in the skin, though only in small quantity. In the anæsthetic form the nerves are found thickened by similar tissue, which, by pressure, destroys their conducting power. The pemphigus bullæ which may precede the development of the anæsthetic patch are perhaps the result of nerve irritation. The disease may spread along the nerve sheaths to the great centres. The parenchyma of organs is more rarely involved.

The microscope shows this granulation tissue to be quite like that of syphilis and lupus, *qu. v.*; large cells are frequent (lepra-cells). The knots are, however, less vascular than those of lupus. The breaking down of the leprosy knots probably results from obstruction of the scanty vessels (*vide* syphilis) feeding the tissue. Of the three forms of granulation tissue, syphilitic, tubercular, and leproid, the last is the most slowly developing. All three forms may show retrogressive changes, and either be absorbed or break down.

Etiology.—In the cells of the growing leprous tissue, an organism, the *Bacillus lepræ*, is constantly present. It is very like that of tuberculosis, but somewhat more slender and pointed at the ends. Multiplication is by spores. The bacilli occur in lepra cells and other smaller ones, rarely between cells. They stain like *B. tuberculosis*. By inoculation of animals it is possible to produce a local leprous lesion, but not a general disease.

Treatment of Leprosy.—The Gurjun oil and the Chaulmoogra oil internally and locally are two of the remedies supposed to have a specific effect on the disease. Iodine, mercury, arsenic have all been tried; also, more recently, creasote and salicylate of soda internally.

The late Dr. Bhau Daji employed a mode of treatment with which he seems to have had considerable success. He died whilst still testing the remedy, and before he had made it public property. Many physicians in Bombay believed it to be the Gurjun or Chaulmoogra oil, with both of which Bhau Daji experimented; but he ultimately laid them aside entirely for the oil of the *Hydnocarpus inebrians*, of which the native name is *Kauti*. He gave the oil in doses of ♏v–x, I believe, and also applied it locally. The treatment is well worth further trial. I have learnt the above from a Civil Servant who knew Bhau Daji well, who watched his cases, and was told by him the name of the drug used.

Apart from specifics, the lines of treatment are removal from the leprous district, and then a supporting dietary with tonics. The local lesions may either be treated on ordinary lines or local applications of the specific remedies may be employed.

In estimating the value of any treatment the naturally chronic course of the disease must be remembered, and also that prolonged periods of quiescence are not uncommon apart from treatment. The good effect of simple attention to hygiene is also marked.

Glanders and Farcy.

These are varieties of one disease due probably to difference in the point of entry in the poison through the nasal mucosa or through a breach of the skin surface. Primarily diseases of the horse-tribe, they are communicable to man and other animals. When the local manifestations affect primarily or chiefly the mucosa of the nasal cavities, the disease is called *glanders*, but when the skin and subcutaneous lymphatics, it is called *farcy*.

These two forms are essentially identical; pus from either will produce the other, and the one form, as a rule, terminates in the other, if the animal live long enough.

The disease, whether as glanders or farcy, may be *acute* or *chronic*.

Acute glanders begins, after a variable period of incubation (three to eight days usually, sometimes three weeks or more), with high fever, often rigors, sometimes vomiting and diarrhœa, and severe pains in the joints. The rigors may be repeated, when the disease closely resembles acute septicæmia or septico-pyæmia; loss of strength is rapid, the typhoid state (p. 58) supervenes, and the patient dies comatose. More or less dyspnœa is often a marked symptom toward the end.

The first signs of the nasal affection are, œdema of the face, especially of the orbits, extending to the scalp; then follows a *continued flow of discharge* from one or both the nostrils, at first thin and serous, then thick and glairy, like the white of an egg, but after a time opaque, purulent, bloody, and horribly offensive. The ulceration of the mucosa, to which this is due, may lead to perforation of the septum or caries of bone.

A *rash* also marks the disease. It begins as red spots, like flea-bites, which soon become papular and shotty, then vesicular and often hemorrhagic, and finally pustular. The pustules burst and leave foul ulcers which may spread. The face is a common seat for the eruption, but it may occur anywhere. Similar pustules appear on the pharyngeal mucous membrane and extend into the bronchi, causing laryngitis and bronchitis. When lying on the back, the nasal discharge runs into the pharynx and causes ulceration of the palate, etc.

Diffuse suppurations now appear beneath the skin, lymphangitis is common, abscesses form in and among muscles, in the substance of organs and in joints.

In *acute farcy* the general symptoms are those above given. The first local symptoms are hard cord-like swellings of the subcutaneous lymphatic vessels and glands, called *farcy-buds*. These break down more or less quickly, leaving foul ragged ulcers discharging a copious thin bloody fluid. Commonly the usual discharge and signs of affection of other mucous membranes appear before death; also the other suppurations mentioned above.

The symptoms are slowly developed, and pauses occur when the above diseases are chronic; they may last even months, with the establishment of a condition like hectic.

The *diagnosis* from acute pyæmia depends upon the presence of nasal discharge, the early development of the rash, and the possibility of infection from glandered horses.

Pathology and Etiology.—In the nodules of glanders and farcy, a bacillus, like, but smaller, than the bacillus of tubercle, has been discovered; it has been cultivated by Schülz and Löffler,[1] and inoculated on horses with production of glanders. It must, therefore, be considered the contagium. The nodules consist of round cells, in which vascularization is very imperfect or absent, degeneration rapid, and the larger cell-forms do not occur. They vary in size from a bean downward; diffuse infiltrations are met with. In the more acute cases all stages of inflammation up to the most acute suppuration are met with. The disease, therefore, differs from the other *infective granulomata* chiefly in its greater acuteness.

Treatment.—Essentially that which is serviceable in septicæmia and pyæmia, *qu. v.* The strength of the patient must be supported by every means at our disposal. Abscesses must be opened, and chloride of zinc or sublimate freely used, to prevent them from acting as sources of infection.

CHAPTER IX.

VENEREAL DISEASES.

This group consists of infective diseases due to poisons communicated from the diseased to the healthy, usually during sexual intercourse. They are introduced here to bring syphilis into its natural position among the infective granulomata. There are three varieties.

1. Gonorrhœa.—An inflammation, generally suppurative, of the mucous membrane of the male or female genitals. It may cause suppuration in

[1] Mitth. a. d. kaiserl. Gesundheitsamte, Berlin, vol. ii.

lymphatic glands, otherwise it usually spreads only by continuity of tissue. Sometimes, however, secondary inflammations of joints, and perhaps of other structures, result.

2. Soft Chancre, Chancroid, Non-infecting Sore.—This is a highly contagious ulcer, capable of being inoculated in almost unlimited succession on the same patient. But that it frequently causes suppuration in the nearest lymphatic glands, it would be a purely local disease; beyond this no *secondary symptoms* ever result.

3. Syphilis.—This is a general infective disease running a very chronic course. At the point of inoculation of the virus, in a month or so, a papule remarkable for its hardness (*indurated papule*) develops, and often ulcerates superficially (*hard chancre, indurated* or *infecting sore*). These are apparently due to local irritation of the virus. But some of this passes on into the lymphatics, and some again has entered the blood; the former causes swelling and induration of the nearest glands, the latter multiplies in the blood, and produces, in the course of a few weeks, a number of inflammations of skin, mucous membranes, and other tissues, known as *secondary* symptoms, and many of which are frequent means of propagating the disease. These continue to appear for one or two years, or longer; and are succeeded, often after a pause of many years, by characteristic inflammations (*gummata, syphilomata*) of the deeper connective tissues. This disease is, therefore, absolutely distinct from the above. Difficulties in diagnosis do, however, occur, as will be pointed out. It may be mentioned here that much confusion arises from the not infrequent inoculation at the same time of the poisons of both soft and hard chancres.

Gonorrhœa and Urethritis.

Gonorrhœa is an infective inflammation of the mucous membrane of the urethra in the male or of the external organs in the female; thence it may spread widely by continuity of tissue. It occasionally excites suppuration in the nearest lymphatic glands; sometimes it is complicated by secondary inflammation of joints and fibrous tissues.

Cause.—Contact of the mucous membrane with gonorrhœal pus almost certainly produces the disease. In gonorrhœal pus large cocci are found upon the surface of epithelial cells, placed at a distance equal to the diameter of a coccus from each other. These are constantly present, and are not found in non-gonorrhœal discharges; they are found also in pus from gonorrhœal conjunctivitis, in conjunctivitis of newborn children, and in fluid from gonorrhœal arthritis. Vaginal and urethral secretions not containing *gonococci*, produced no urethritis when inoculated upon men, but secretions containing them caused urethritis after a short incubation in the same men (Welander, *Gaz. Méd. de Paris*, No. 23, 1884). The cocci have been cultivated and successfully inoculated by Bockhardt and Bókai.

Urethritis in the male may be caused also by mechanical violence (*e. g.*, introduction of instruments), cantharides, turpentine, and other drugs; irritation of worms in the rectum of an unhealthy child; acid and irritating urine, especially in gout; other chemical irritants, many of which may be met with in menstrual, leucorrhœal, and other discharges from the female organs. It is these cases of urethritis, when contracted from sources beyond suspicion, that have given rise to the belief that gonorrhœa is not a specific disease. But these are distinguished from gonorrhœa by their milder course, by the absence of incubation, by the absence of gonococci from the discharge, by their slight tendency to spread, whilst they never infect distant parts. It is possible, however, that there may be organisms other than the gonorrhœal capable of exciting urethritis. The author has seen violent urethritis and abscess of the navicular fossa traced to connection with a chaste wife wearing a intrauterine pessary.

The symptoms of simple urethritis will be gathered from the description of gonorrhœa, and common sense will suggest the modifications of treatment required.

SYMPTOMS OF GONORRHŒA IN MAN.—After an incubation of two to eight days, usually three or four, the symptoms begin. The inflammation starts in the fossa navicularis and travels backward. In the *first stage*, the patient notices a little itching at the orifice of the urethra, which is rather swollen and red, with a slight serous or thin whitish discharge. If the disease is not checked, it passes after a few days into a second, or *acute inflammatory stage*. The discharge becomes thick and purulent, often greenish, or tinged with blood. The penis swells; the glans red, tender, and often excoriated. In consequence of the tumefied tender state of the urethra, the stream of urine is small and forked, and passed with much straining, pain, and scalding. The groins, thighs, perineum, and testicles ache and feel tender; and the patient's rest is disturbed by long-continued and painful erections, and by *chordee*—that is, a painful crooked state of the penis during erection. This arises from infiltration of the *corpus spongiosum urethræ*, which glues together the cells, so that when the penis is turgid with blood, it is bent downward, producing much pain. In London, the symptoms of gonorrhœa are not often so acute as above described. After seven to fourteen days, a *third stage* sets in, the above symptoms abate, and in another week have almost disappeared, but a diminishing rather thin discharge remains for two or three weeks longer, and then it disappears. It may, however, persist for months or years, and is then called a *gleet*. This is a serious thing, for in the great majority of cases it is due to a granulating patch in the urethra—*i. e.*, to a chronic inflammation which sooner or later will end in stricture. Such a discharge may be due also to chronic folliculitis, warts within the urethral orifice, a concealed chancre, chronic prostatitis, or the irritation of a stricture. A short speculum will show the warts or chancre; an olive-headed sound will, as it is withdrawn, detect tender patches or slight narrowings.

COMPLICATIONS.— These are inflammations of portions of the genito-urinary tract affected by extension; less often, of parts at a distance.

Retention of urine from swelling of the mucous membrane and spasm of the periurethral muscles is not uncommon in the *second stage* or at any period from exposure, drink, or sexual indulgence; it will be treated of later.

BALANO-POSTHITIS.—Acute suppurative inflammation of the surfaces of the glans and prepuce from irritation of the discharge, often coupled with *phimosis* from swelling of the foreskin, or *paraphimosis* should this be forcibly retracted.

Hemorrhage from the urethra during chordee is rarely severe, and often gives relief.

ABSCESS.—This may begin in a urethral follicle. A tender submucous knot forms and usually bursts externally, but may do so into the urethra, or both ways, leaving a troublesome fistula. Or it may begin with brawny swelling and pain about the bulb, fluctuation being late to appear. Or suppuration may start round about an inflamed Cowper's gland, the abscess then lying on one side of the bulb. The two latter kinds tend to burrow widely before pointing, and may cause retention by pressure. They may burst into the urethra, discharge by that channel, and heal; but there is danger of extravasation of urine.

PROSTATITIS.—Acute or chronic. (See "Diseases of Prostate.") Sometimes with grave general symptoms an abscess forms round the prostate and between it and the rectum. After some days it generally comes toward the perineum.

With the above, symptoms of *cystitis* and great irritability referred to the neck of the bladder are usual. Very rarely inflammation extends up the ureters and all the symptoms of single or double *pyelitis* occur. This is almost always fatal, though the case may be a long one. Curiously, it may arise from a very slight urethral discharge.

Epididymitis and orchitis by extension down the vas from the prostatic urethra. (See "Diseases of Testis.") It is common after the second week, especially in third and fourth.

Inflammation of the inguinal glands, rarely running on to abscess (bubo), with the usual signs, though fluctuation may be slow in developing. Lymphangitis of the dorsal lymphatics of the penis, with considerable swelling of the skin, may be present.

Gonorrhœal rheumatism is apparently due to the entry of the gonorrhœal poison into the blood and to its settlement in one or several joints and fibrous tissues. It may begin at any time, but it is most common late in the disease, and especially in young men of fair complexion and strumous or delicate constitution. It is characterized by irregular and not very high fever, with swelling and pain of one or more joints of the lower, more often than of the upper limb; at the same time pain in one or several aponeuroses is complained of. There may be free effusion, or little fluid and much swelling of the synovial membrane of the joints. Usually one or two joints only are affected, but almost all the larger articulations may be, one after the other; commonly in such cases the disease settles and persists in one joint. Occasionally suppuration occurs, and there may then be superficial abscesses as in pyemia; more often movement of the joint is much impaired by cicatricial contraction of the capsule. Among the fibrous tissues affected may be mentioned the sclerotic, and the plantar and lumbar aponeuroses, and the outer part of the fascia lata. Free sour sweating does not occur.

The disease is very obstinate, crippling patients for months by pain and for life by ankylosis. It is liable to recur with each attack of gonorrhœa.

By inoculation from the urethra other mucous membranes may be infected—*e. g.*, that of the rectum, nose, and eye.

Gonorrhœal conjunctivitis is most serious, and if not properly managed may end in sloughing of one or both corneæ, and total blindness. This is owing to the rapid and intense swelling of the conjunctiva (*chemosis*), by which the cornea is deprived of its nourishment. Haziness of the cornea is the sign of danger.

TREATMENT OF THE FIRST STAGE.—In the first stage the plan of treatment found most efficacious is the use, six times daily, of a mild sedative injection such as the lotio plumbi diacetatis (F. 232). A narrow strip of lint should then be well soaked in the lotion, rolled round the penis, and covered by a piece of thin oilskin; or, better, the penis may hang in a waterproof bag having a little salicylic wool at the bottom to catch the discharge, which should always be allowed to run away freely. The bowels should be freely opened by some saline aperient, and a mild sedative (F. 81, 83, 88, etc.) should be taken every night. Rest, if possible. A milk, fish, and soup diet, and *abstinence from all alcoholic liquors*, from strong coffee or tea, and from highly seasoned food of every kind, should be enjoined: and diluents, such as soda- or barley-water, linseed tea, milk, and cocoa, should be freely used.

The manner of injecting is important, as the efficacy of the lotion depends entirely on its free and repeated application to the whole of the diseased surface. Before any injection the urethra should be washed out by micturition or a syringeful of lukewarm water. The patient should use a three-drachm glass syringe, with a small bulbous extremity, and having filled it, should introduce it for half an inch with his right hand. Then, holding upright the penis with his left forefinger and thumb, so as to compress the urethra against the syringe and prevent any of the fluid from escaping, he should push down the piston, letting the fluid pass freely into the urethra. The syringe should now be withdrawn, but the orifice should still be compressed laterally, as near the end as possible, and the fluid be retained for two or three minutes; after which, on removing the finger and thumb, it will be thrown out by the elasticity of the urethra. It is always worth the surgeon's while to *see* that the injection is properly used.

Of the Second Stage.—In a first attack in a young irritable subject, the patient should be confined to the house. Walking and horse exercise should be prohibited. The scrotum should be supported by a suspensory bandage. Diet as above. The scalding will be relieved by sod. bicarb. gr. xxx, tr. hyosc. ʒss, aq. ad ℥j, 6tis hor., and a general bath of the temperature of 90° to 95°; but the bath should not be too warm, or it will excite the circulation and bring on erections. The bowels should be kept open rather freely, and sleep be procured by Dover's powder or other anodyne, every night, whilst there is much pain and chordee (F. 81, 83, etc.). When there are much pain and scalding, injections are harmful, unless it be one of extr. bellad. gr. ij ad ℥j, very gently used. As the symptoms subside zinci sulph. gr. j–ij, may be added and the belladonna soon omitted. The sulphate of zinc generally suffices to cure; the strength may be increased to four or six grains. In very acute cases treatment by diet, alkalies, anodynes, baths, and rest, without injections, is best for the time being. So also during acute epididymitis.

Of the Third Stage.—When scalding is gone and the discharge is getting thin, copaiba, cubebs, and sandal-wood oil (♏x–xxx thrice daily) are very useful. They are eliminated by the kidneys, though not as such, and act locally on the mucous membrane (F. 336). Copaiba and cubebs are very nauseous, and sometimes cause vomiting, purging, and a papular rash. The sulphate of zinc injection may be strengthened, or others tried (F. 254, etc.). Tonics of every kind, bark, zinc, and steel, are all of service (F. 16, 18, 26, 27). The patient must live a most regular life, and avoid late hours and stimulating living. If he wants to make water oftener than natural, and there is an uneasy sensation in the urethra afterward, and the urine deposits a mucous cloud, Pareira brava, buchu, and uva ursi will be advisable. If the urine is preternaturally acid or alkaline, or the digestive organs deranged, the case should be treated as directed in the section on urinary deposits. If the health is materially enfeebled, affusion of cold water on the genitals, cold sea-bathing, blisters to the perineum, bark and steel, good living, and perfect chastity of body and mind, are the necessary remedies. If the discharge continue, the cause of the gleet must be carefully sought. It will generally be a patch of granular urethritis and perhaps slight narrowing of the canal. This is best treated by the passage, every other day, of the largest sized steel bougie that the urethra will take; some grease it with a stimulant ointment—*e. g.*, ung. hydr. rub., cold. If this fail, apply a little solution of argent. nit. (gr. x ad ℥j) to the granular surface by a special syringe, make the patient wash out the urethra immediately after, and confine him to bed for a few days. Then use ordinary injections and the bougie. Internal urethrotomy is the final remedy.

Treatment of some kind should continue so long as the meatus is occasionally sealed of a morning—for granular urethritis surely leads to stricture. Besides, it is impossible to say when the discharge ceases to be infective.

TREATMENT OF COMPLICATIONS.—Painful erections and chordee may be relieved by avoiding sexual excitement, by moderate diet, and lying on a hard mattress, by a bag of cold water, Dover's powder gr. x, and a suppository containing camphor gr. v–x, at night. Balanitis and phimosis must be treated by frequent washing under the prepuce. Abscesses should be opened as soon as possible to prevent their bursting into the urethra. Cellulitis from extravasation must be treated as usual. Hemorrhage may be checked by cold water or ice and pressure on the urethra. Swelling of the glands in the groin may generally be removed by rest, and, if necessary, a few leeches.

For *gonorrhœal rheumatism* the patient should be confined to bed, and have warm baths. The bowels should be cleared by an aperient, and then ammonia with lemon juice, every four or five hours, and a dose of Dover's powder at bedtime. For treatment of joints, see "Diseases of Joints." In the chronic stage: Iodide of potassium, bark, volatile tincture of guaiacum, and warm sea-bathing are the remedies.

In *gonorrhœal conjunctivitis* protect the sound eye with a watch-glass fixed on with India-rubber plaster, carefully stuck down toward the nose, but with an opening left externally for ventilation. Caution every one as to the infectiveness of the discharge. Wash away the discharge every hour with a gentle stream of water or boracic lotion. Grease the lids with vaseline to prevent their adhering. If seen early, cold or iced compresses may be used, but in most cases boracic fomentations (changed every hour) will be found more comforting and efficacious. Four to six times a day, having washed away the discharge, put a few drops of nitrate of silver lotion (gr. ij to ℥j) into the eye. In the most severe cases evert the lids and brush them with a lotion containing arg. nit. gr. xx ad ℥j, neutralizing it with salt solution in fifteen seconds, and make radial cuts through the swollen conjunctiva. Chloroform may be required: repeat when the discharge becomes again profuse, but not oftener than once a day. Continue treatment till discharge has quite ceased, and thickening of lids gone. Use no nitrate of silver till the discharge is free.

GONORRHŒA IN WOMAN.

It begins at the opening of the vagina, and may extend to the uterus and Fallopian tubes, to the ovaries, and even cause fatal peritonitis; the urethra is affected, and extension to the kidneys may occur as in man.

SYMPTOMS.—Swelling and redness of the mucosa, tenderness, pain in walking, ardor urinæ, and discharge soon becoming purulent. In ten to fourteen days acute symptoms are gone, but a good deal of discharge from the posterior cul de-sac or cervix remains. Also a little can be pressed from the urethra, where it long remains. It may last years, its presence being so little evident that "latent gonorrhœa" has been described; but presence of the disease is proved by communicating infection, by ophthalmia of a child born, or by sudden extension to the pelvic peritoneum.

DIAGNOSIS.—Unless gonococci are to be regarded as proof, it is often impossible to distinguish between simple and specific vaginitis. Pus in the urethra generally means specific.

TREATMENT.—Diet and habits must be regulated as above directed. At first rest in bed, warm baths, fomentations, mild purges, and injections of warm water, belladonna lotion or astringents, according to the amount of irritation. The woman should lie on her back, pass a long tube to the top of the vagina and inject with a Higginson's syringe or from an irrigator.

All pus should first be washed out with warm water. Then gr. lx of sulphate of zinc or alum should be dissolved in a quart of water and the whole slowly injected; to be repeated thrice daily. A plug of wool soaked in glycerin of tannin may then be packed round the cervix. Terebinthinate drugs (copaiba etc.) are of use only in checking urethral discharge, when astringent injections also should be used. In any obstinate case insert a speculum and apply powdered alum in some quantity to the deeper parts of the canal, especially the posterior cul-de-sac; if copious mucopurulent discharge is issuing from the os, touch the cervical canal with nitrate of silver. Treatment should be persisted in till all symptoms and discharge have disappeared; also gonococci. It is very difficult to tell when a cure is perfect; power of infecting may remain for years.

Abscess in Bartholin's gland is common; it forms a large, red, very tender swelling on one side of the vaginal orifice. It must be freely opened on the vaginal aspect, the part kept clean by frequent use of boracic lotion. A bit of lint steeped in the lotion may be worn and frequently changed.

Gonorrhœal ovaritis, characterized by pelvic hypogastric pain and tenderness, with some fever and perhaps vomiting, must be treated by rest in bed, frequent hypogastric fomentations, belladonna injections, and light diet.

For *uterine complications*, refer to manuals on "Diseases of Women." Dangerous ones are rare.

Soft Chancre, Chancroid, Non-infecting Sore, and Sloughing and Phagedænic Sore.

The *soft chancre* is a highly contagious ulcer, communicable only by the direct or mediate inoculation of chancrous pus upon some breach of surface. This pus contains a virus which has not yet been isolated, which obviously multiplies largely at the site of inoculation, which frequently finds its way to the nearest lymphatic glands, exciting suppuration; but it apparently does not enter the blood, and it never causes general symptoms; nor does the disease confer any immunity against itself, the pus of a chancre which is not healing being inoculable upon the bearer almost indefinitely.

Symptoms and Course.—These may be studied when this sore is produced by inoculation. During the first twenty-four hours the puncture reddens, on the second and third days it swells slightly, and becomes a pimple, surrounded by a red areola; from the third to the fourth day, the cuticle is raised by a turbid fluid into a vesicle, which displays a black spot on its summit, consisting of the dried blood of the puncture; from the fourth to the fifth day, the morbid secretion increases and becomes purulent, and the vesicle becomes a pustule with a depressed summit. At this period the areola, which had increased, begins to fade, but the subjacent tissues become infiltrated. It generally bursts on the fifth or sixth, leaving a *soft chancre*. This is a circular ulcer with sharply cut, slightly irregular, perhaps undermined edge, surrounded by a ring of inflammation; it usually involves the whole thickness of the skin or mucous membrane; and its base looks worm-eaten, spongy, and is of gray or yellow color; there is no induration or thickening of its base or edge, so that the sore is hardly detected by grasping it between the fingers; the discharge is yellow-white, opaque, and watery; the part is tender and often painful. The discharge being inoculable on the bearer, soft chancres are frequently multiple.

After increasing for seven to ten days, the ulcer becomes stationary for two or three weeks if nothing is done; it then granulates, its discharge loses its infective power and becomes healthy pus, and the sore changes to a healing ulcer.

SEAT.—Almost always the genitals—on the inner surface of the prepuce, in the furrow round the glans, or by the frænum in man; just within the posterior commissure or on the nymphæ in woman. The uninjured skin is impervious to the poison, but a scratch on the finger may be infected. Extra-genital hard chancres are generally due to inoculation from secondary lesions of lips, nipple, etc., none of which exist in soft sores. Chancres occur in the male urethra and on the cervix uteri: these seats are liable to be forgotten.

VARIETIES.—The sore may be quite superficial, the edges not at all undermined; this variety may heal in a few days. The base may become decidedly indurated, but the thickening has not the circumscribed character of a typical hard sore. It may, however, be impossible at once to make a diagnosis between the two. It must be remembered that the syphilitic poison may have been inoculated with that of the soft sore, in which case the sore or its scar will surely indurate in three to four weeks' time.

COMPLICATIONS. PHAGEDÆNA.—Soft sores are occasionally affected by an intense inflammation leading to necrosis of the surrounding parts and rapid spread of the ulcer. Sometimes this complication is obviously due to the accumulation and putrefaction of discharges beneath a long foreskin; in other cases it sets in in spite of every attention to cleanliness, the sore possibly having been contracted from a similar case. Almost always the general health has been lowered by privation, intemperance, etc. Thus the celebrated "Black Tim," which affected the English troops in Portugal in the Peninsular War, seems to have been a sloughing of the penis from acutely inflamed chancres, with a good deal of general disturbance. A good many phagedænic sores are not soft, but syphilitic, and are followed by secondary symptoms (B. Hill).

Every stage may be met with between an ulcer which slowly spreads and one which extends so rapidly that its surface remains covered with dead tissue of color varying from ashy-white to black. Some ulcers (*serpiginous*) extend at one side and heal on the other, thus covering large surfaces. A hole may form in the prepuce through which the glans protrudes, much of the glans and penis may be destroyed, the urethra may be opened and a permanent fistula left, or free hemorrhage may occur from eroded vessels.

BUBO.—About thirty per cent. of all chancres are complicated with abscess in or around the inguinal glands on one or both sides—generally on that at which the sore is situate? It is of two kinds, *simple* and *virulent*. The *simple* is analogous to the suppuration which follows the absorption of irritant stuff from simple sores; the pus formed is not inoculable. But in the *virulent* the abscess cavity is sloughy, the pus produces soft sores when inoculated, and the resulting sore may spread with all the characters of a soft chancre. Sometimes on opening a bubo a swollen gland containing pus is found in it; this is infective, that around it is not. A chancrous bubo may, like the soft chancre, be *serpiginous*, extending over the abdomen or groin; or *phagedænic*, perhaps laying bare the great vessels and endangering their integrity.

Bubon d'emblée is the name given to a bubo supposed to arise from the absorption of chancrous poison without any breach of surface having occurred, It is very doubtful whether this can happen, as buboes certainly occur after very slight chancres have healed.

SYMPTOMS OF BUBO.—At first one or more glands become swollen, tender, and painful; then their outline is lost and the tissues round about them become infiltrated and more or less quickly the skin reddens over them. Sooner or later the brawny mass softens, the skin thins, and the abscess bursts or is opened. It is then often found that the cavity is much larger than the area of softening would lead one to expect.

Lymphangitis, perhaps with abscess, along the penile lymphatics, may occasionally occur.

Phimosis.—Not uncommonly the irritation of a chancre leads to phimosis, or this may be congenital. The patient comes with the foreskin reddish and swollen, and a free discharge from the orifice. Is it simple balano-posthitis, gonorrhœa, or chancre? The situation of the pain in micturition is of much help; if the orifice of the urethra can be seen, redness, and swelling of the meatus and discharge issuing point to clap; often localized pain and some induration about a sore can be felt through the prepuce.

Treatment of Chancre.—Finely powdered crystals of iodoform should be dusted on the sore night and morning, the part being washed with boracic lotion at each dressing; a bit of rag spread with boracic ointment should be placed on the sore, between it and any adjacent part. This often cures in ten to fourteen days.

Now that local anæsthesia can be induced by cocaine, treatment by cauterization will probably again come into use—either by the actual cautery or strong nitric acid to the dried ulcer. The whole surface must be thoroughly destroyed. Any simple antiseptic dressing may then be used. The slough is quickly cast, and the sore granulates and heals.

If phimosis be present, but discharge and swelling only moderate, frequent syringing with lotio plumbi or 1 in 40 carbolic may subdue the inflammation; the foreskin should be distended with the lotion. Should discharge or swelling increase, or should the nature of the case be doubtful, circumcision should be done, chancres, if found, being well scrubbed with lint soaked in chloride of zinc (1 in 12) or sublimate lotion (1 in 500) after the foreskin has been slit up. If the sore cannot be entirely removed, cauterize the part left freely with the thermocautery.

Phagedœna is treated at the Lock Hospital on Hebra's plan, viz., immersion in a bath at 98° F. for ten hours daily, or constantly in the most severe cases. When out of the bath, iodoform and boracic fomentations should be applied. The treatment given under hospital gangrene may be used if the above cannot be carried out.

Ammonia and bark, iron, cod-liver oil, and good food must be given; also small doses of mercury may be tried if there is reason to think that the sore is syphilitic. Morphia or cocaine may be required to relieve pain.

Buboes must be opened as early as possible and great care paid to drainage. A gland surrounded by pus should be removed. Long sinuses are frequent, and should be carefully sought for, drained or slit up. Blue edges in old cases must be cut away. The virulent forms must be treated like the corresponding states of chancre. Fixation of the hip on a Thomas's splint may be necessary, and is always useful to cause sinuses to heal; pressure by a truss may be valuable. The preventive treatment is that of abscess.

Venereal Warts.—These are common, from the irritation of gonorrhœal or chancrous discharge, on the inner surface of the prepuce, on the glans, on the labia, and round the anus. They may be few or very numerous. They are bright red, pedunculated, very vascular bodies; on the labia they may form cauliflower-like masses as large as the fist. They may be cut off with scissors and touched with solid perchloride, or, if large, removed with the thermocautery. Recurrence is frequent and much favored by moisture, so keep the parts very dry and clean. Many small warts may be got rid of by rubbing them thrice daily with a powder composed of equal parts of savine and verdigris.

Syphilis.

Syphilis may be defined as a chronic general infective disease, the virus of which is capable of inoculation at any breach of surface. The disease may likewise be transmitted hereditarily. The clinical history of the disease must be considered under two headings, that of *acquired* syphilis and that of *congenital* syphilis.

I. ACQUIRED SYPHILIS.

Inoculation.—The poison of syphilis gains access at some point or abrasion of the surface. The abrasion speedily heals, provided no other irritant have been present along with the syphilitic virus. Now follows a period of latency or *incubation*, which may last from ten days to between six and seven weeks, but averages three to four weeks.

Primary Stage.—At the end of this time the initial or primary lesion appears at the point of inoculation. It may take the form of a hard, reddish, desquamating papule, from one-eighth to one-half inch across, especially upon dry parts exposed to little irritation. Much more commonly the papule ulcerates superficially; we then have a sharply cut, shallow excoriation with a smooth pale red base secreting a little watery fluid and surrounded in all directions by much firm infiltration. The excoriation rests upon a small, well-defined mound, as it were, which feels like a piece of gristle, and has round, sloping margins. Naturally it lasts weeks or months. Sometimes the ulceration is more free than above described. There is little or no pain.

Induration and superficial indolent ulceration are the chief characteristics. Induration may be slight, but is rarely found absent if the base of the sore is fairly taken between the finger and thumb. When only a thin, firm layer exists (frequent on body of penis), it is called *parchment* induration. Induration may persist for months after the healing of the sore. From mechanical or chemical irritation or inoculation with the soft chancre poison, free ulceration and formation of pus which is inoculable upon the bearer results. It is not uncommon to see a sore (*mixed sore*) exactly like a soft sore in incubation and appearance, indurate in the course of three or four weeks, and secondaries appear a little later.

Seats.—May be anywhere; most commonly the genital organs. Urethral chancres in men and those on the cervix in women are apt to be overlooked, especially the latter, as the inguinal glands are unaffected. The lips, the nipple, the finger, are the commoner seats of extragenital sores.

Number.—The secretion of the sore not being inoculable upon the bearer, the sore is generally single, thus contrasting with the soft sore. But not very rarely there are two or more, from inoculation at several points simultaneously, or at all events before the development of a typical hard chancre.

Seven to fourteen days after the appearance of the hard sore, the nearest *lymphatic glands* almost invariably enlarge and form hard, perhaps slightly tender, swellings of characteristic shape; usually they reach no great size, and remain distinct from each other.

In the first instance the enlargement is limited to the nearest lymphatic gland group, but within a few days it may become general. Suppuration is rare, but in states of lowered health, and when the sore is ulcerating at all freely from soft chancre poison or some septic irritant, the nearest glands may suppurate. The lymphatic vessels leading from the sore to the glands are not infrequently enlarged and to be felt as a hard cord.

Secondary Stage.—Thus far we have had evidence of nothing beyond a local disease. Nothing more than a thorn in the flesh would give rise to—

inflammation immediately around the thorn and swelling of the next lymphatic glands; but in syphilis other manifestations now arise. After a period of about four to six weeks from the first appearance of the hard sore, a *rash* breaks out on the surface of the body. This interval between the times of appearance of the sore and the rash is sometimes called the "second incubation." It is a period of quiescence for the most part, but not uncommonly, toward the end, certain symptoms are observed—*e. g.*, the patient becomes markedly anæmic and feels out of sorts—nothing perhaps beyond this; or, in addition, the symptoms which usher in a mild fever may be present—malaise, anorexia, pains in the limbs, etc., and the temperature will be found slightly raised. In some cases the constitutional disturbance may be very marked, severe headache, etc. The fever generally lasts one to five days, is remittent, and falls when the rash is fully out.

Characters of the Rash.—The form usually noted is that of *roseola*—pale rose-red or bluish-red spots, from the size of a lentil to that of a finger-nail, little or not at all raised above the surface, fading away at the edge and darkest in the centre, at first disappearing on pressure. The rash does not itch. The trunk (chest and abdomen) and the flexor aspects of the limbs are chiefly selected. The intensity of the rash varies greatly. In some cases a few faint spots alone are present, in others the rash simulates that of measles. The duration of the rash may be days, weeks, or even two or three months. It disappears without desquamation, but pigmentation may mark the site for some time longer. Roseola sometimes relapses during the first year.

Occasionally papules appear with the roseolous blotches (a maculo-papular form), or as these fade; but the earliest rash may be *papular*. A coarse and a fine variety are described, according to the size of the individual papules. The color of the spots is bright red at first, yielding to a "raw ham" or "copper" hue. Scales commonly form on the papules (*papulo-squamous rash*), but are neither so plentiful nor so silvery-white as the scales of true psoriasis. Separate patches may enlarge to the size of a florin, but lesions larger than this usually show by their outline that they have been formed by blending of smaller ones. As the patches enlarge, they often heal centrally, and thus present an annular form which is very characteristic; portions of rings too are frequent. Brown stains remain. Ulceration and formation of bloody crusts on these papules may occur in severe cases, especially in those of feeble constitution. Pigmented or white scars may result.

Papules in all stages of advance and decline are frequently present at the same time (*polymorphism*).

This rash may occur anywhere, and its distribution may be partial or general. It is quite as common on the flexor as on the extensor aspects, and is usually absent from the points of the elbows and knees. A circlet of papules across the forehead just below the hair (*corona Veneris*) is very common.

The papular rash seems very different when it affects the palms or soles. At first bluish-red spots, one-eighth inch or more across, are seen through the cuticle, which thickens and soon conceals the spots. It becomes hard and brittle, scales off, leaving pale red, tender, sunken patches covered by epidermis; or it cracks along lines of flexion, and the fissures extend into the corium, causing much pain. This disease has been badly named *palmar* or *plantar psoriasis*. It begins in the centre of the palm or sole, and is limited to these parts; whereas simple eruptions invade the palm from the margins, and occur elsewhere than on the hand or foot. It may occur in the first few months, but usually not till the second or third year. It is very obstinate, and may last many years.

Other forms of rash occasionally occur in this early stage—*e. g.*, vesicular, pustular, tubercular; there is no simple rash which the syphilides may not simulate.

The several characters of these less common eruptions cannot be described in detail—it must suffice to mention certain group characteristics of the whole class of syphilitic skin eruptions. These are:

1. The *raw ham* color, which develops in the later stages of the rash, and may later on give way to a *coppery* tint.

2. The frequent presence of more than one form of eruption—*e. g.*, scaling here, pustulation and scabbing there, papulation simply at another spot—polymorphism.

3. The syphilide does not affect the seats of election of the non-specific rash which it simulates. Thus, the papulo-squamous syphilide does not specially affect the extensor surfaces, and frequently does not occupy the elbows and knees—the peculiar seats of simple psoriasis. In other respects also the simulation of a simple by a syphilitic rash is never exact.

4. Itching and irritation are usually absent in syphilides.

To the affections of the skin belong the affections of the hair and nails. The hair in this stage frequently comes out in large quantity, causing patches of baldness or great thinning; the hair itself is very dry. The nails are liable to an inflammation of the matrix (onychia syphilitica); more often they are barred, opaque, and brittle.

The *mucous membranes* not infrequently suffer in common with the external surface; the mouth and fauces nearly always; hence the sore throat complained of during this stage. On examination, redness and often shallow gray-based ulcers may be discovered on the arches of the palate or tonsils. Small, recurring ulcers of the cheeks and tongue are frequent, and laryngeal catarrh, with hoarseness or loss of voice, is fairly common early in the second stage. A little later, *mucous tubercles* and *condylomata* appear. These are pathologically the same as the papulo-squamous patch on the skin, but being kept constantly moist, and irritated by decomposing secretions, the papillæ become more swollen and the epithelium remains thick on the surface. Under suitable circumstances—*e. g.*, on the female genitals—the primary lesion may assume the form of a mucous tubercle. The mucous tubercle is a flat, slightly raised patch of pale red color and irregular on the surface, varying in size from a florin downward, and often blending with neighboring lesions. It is always moist, and a good deal of watery fluid flows from it which infects the parts over which it runs; it is the commonest means by which syphilis is spread. Condylomata are simply very prominent, wart-like mucous tubercles. These lesions occur chiefly on muco-cutaneous surfaces—on the vulva and round the anus (where they are very common), the scrotum, angles of mouth or nostrils, on tongue or cheeks, or orifice of larynx; less commonly in the fold of the groin, beneath the breast, and other places kept moist by perspiration.

Pains in muscles, fibrous tissues, bones, and joints may occur during this stage; also periosteal swellings (nodes), and effusion into the joints occasionally. When joint pains and effusion are accompanied by fever, the diagnosis from acute rheumatism must be made; by the general remittency of syphilitic fever, by the less marked sweating, absence of sour smell, and speedy effect of mercury in reducing the temperature.

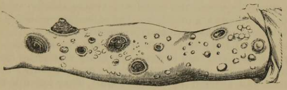
Iritis may come on, and generally in the first six months; also choroiditis and retinitis. Frequently with the above manifestations there are noted anæmia and general falling off in health—a dull, earthy complexion resulting.

The second stage just described may last from six to eighteen months, and the disease then disappears. In other cases, at the end of the second stage there may be an interval of months or years, and then the symptoms of the third stage appear—or symptoms intermediate in character between those of the second and third stages may occupy this interval.

TERTIARY STAGE.—The lesions of this stage are characterized by absence of the symmetry seen in secondary lesions, and by being less general; but, expressed in the phraseology of logicians, what they lose in extension they gain in intension—*i. e.*, there is deeper invasion of the tissues at the part affected.

Amongst the forms of rash observed now we have *rupia*, a pustular rash which shows curious conical, limpet-shaped or flat, oyster-shell-like scabs (Fig. 14), beneath which are ulcerated surfaces. The ulcers start from

FIG. 14.



Crusts of rupia. From a cast in the King's College Museum.

ecthyma-like bullæ, and spread beneath scabs formed by drying of the bullæ and growing by successive additions—whence the form.

We have also a *tubercular* syphilide of the skin which presents great resemblance to lupus. It consists of groups of broad, reddish-brown tubercles, found most frequently on the alæ of the nose or on the cheeks. They may break down, and are succeeded by spreading irregular ulcers, which cause destruction of the alæ nasi, cartilages, etc., and terminate in puckered cicatrices.

When a disease like lupus begins in adult life, always suspect syphilis.

In the subcutaneous tissue, usually without obvious cause, rather indefinite elastic swellings form and cause more or less pain. They may become very soft and remain long without exciting inflammation, but unless they are treated or disappear spontaneously, they sooner or later excite irritation and the swelling breaks down. Some thin puriform fluid escapes, and leaves a ragged, soft-edged cavity, often containing a slough which has been aptly compared to wet wash-leather. If connected with the deep fascia, the slough may be many weeks in separating. The history just sketched is that of a *gumma* or *syphiloma*.

Syphilitic ulcers of the skin are very common, especially upon the leg; but they may occur almost anywhere. They may form early from breaking down of a secondary rash, or later from softening of gummata. They generally appear without obvious cause, but may follow an injury; they commonly occur over the soft parts and back of the leg, rather than over the bone, and in the upper rather than in the lower half of the part; the region of the knee is a favorite one; they are often multiple, and at first usually small and circular. When untreated they often remain for long periods, but they generally heal quickly under pot. iodid. internally and iodoform locally. The resulting scars are generally raw-ham-colored, then brown.

Gummata are frequent also in the submucous tissue, especially of the tongue, larynx, and pharynx, and rectum of women; the ulcers left by them may cause great destruction and danger to life, as also do the scars, should they heal.

Of internal organs, the liver, the testis, the uterus, the brain, and spinal cord, are most commonly affected, but other organs also suffer—*e. g.*, the heart, the lungs, the kidneys, the stomach and intestines. Syphilis of these organs has been less worked at. The whole department of visceral syphilis belongs rather to medicine than surgery, with the exception of disease of the testis, *q. v.* Disease of the uterus, however, deserves mention here, for in the form of a chronic endometritis it may lead to such changes in the mucous membrane, that should conception obtain the uterus will abort. In such cases the maternal placenta is frequently found the seat of round-celled infiltration and fibroid change. The fœtal placenta will suffer in like manner.

Severe cachexia, with sallow, earthy tint of skin often marks the third stage of syphilis.

Syphilitic Disease of Bones. — Syphilitic inflammation may affect bones. In the early stages the periosteum suffers chiefly, in the later the deeper parts of the bone are invaded. The subcutaneous bones—tibia, ulna, cranium, clavicle, and ribs—are most frequently attacked.

The bone pains of secondary syphilis are very characteristic; often slight or absent in the daytime, they increase markedly at night. Soon low, oval, tender swellings, called *nodes*, appear on the painful bones; they are tense, slightly elastic, and covered by normal skin. They are due to infiltration of the periosteum, raising it from the bone, and if not speedily absorbed the exudation ossifies into a plaque of open structure, quite distinct and easily shelled off from the old bone. If still not absorbed, this distinction disappears and the outline of the bone is permanently altered—*e. g.*, crest of tibia is thickened.

A syphilitic infiltration may invade the whole thickness of a bone (ostitis) and gradually ossify; at the same time new bone forms beneath the periosteum. The whole bone becomes thicker and denser (sclerosis); ultimately even the medullary canal may be obliterated. More or less constant aching accompanies the process, which may affect one or several bones.

It is thought that this *sclerosis* may go so far as to shut off all nutrition from the bone and cause necrosis of a piece, especially in the skull. Usually *syphilitic necrosis*, which is specially common in the skull, is due to the more or less sudden death of an infiltration which is frequently eating the bone away rather than causing thickening of it. With the infiltration the bone of course dies, and in the course of months or years is thrown off as a more or less wormeaten plate, embracing perhaps the whole thickness of the skull, but more often only the outer table. In these cases a swelling (gumma) forms on the head, and, if not removed by treatment, it runs the course of an abscess and bursts, leaving the bone bare at the bottom. Not uncommonly a coronet of these lesions forms round the head. The hard palate and bones of the nasal cavity frequently necrose.

Subperiosteal gummata are common; they cause erosin of the bone with which they are in contact, and frequently actual perforation (*syphilitic caries*). Even the skull may be thus pierced; the palate commonly is, and the nasal bones sink in from erosion; other bones of the nasal fossæ may ulcerate or necrose. The sternum, spine, and other spongy bones may be affected. If the gumma bursts, a probe strikes soft granular bone.

Sometimes gummata form on the deep surface of the skull and cause symptoms by pressure on the brain.

Syphilis is generally a disease of moderate intensity, but in some cases it pursues so rapid a course as to justify the name "galloping" or "malignant."

The *duration* of the disease varies greatly, the variation depending upon the susceptibility of the patient to the poison and on the treatment adopted. Of ninety-three cases treated without specifics the disease was severe and prolonged, with early tertiary symptoms in only four. Seven showed only one rash, fifty-three had eruptions during the first year, and twenty-nine had eruptions, periostitis, iritis, and other secondary symptoms for two years (Diday). Should tertiary symptoms arise, it will probably be about five years from inoculation; it may be much earlier, in strumous or feeble patients, or much later (ten to twenty years); they may last an indefinite time.

Morbid Anatomy.—The lesions of syphilis are to the naked eye very manifold, but great simplicity underlies apparent diversity. The essential element is a granulation tissue which may either diffusely invade the tissues of a part or collect in circumscribed foci, or the diffuse and circumscribed forms may occur together. In almost every organ or tissue these two forms may be witnessed, but it is the circumscribed mass which is especially characteristic. It goes by the name of *gumma*, and it may occur in very minute form (miliary), or in nodules the size of a horse-chestnut or larger. In all the above points the lesions of syphilis resemble those of *tubercle* (p. 93), and other infective granulomata. The miliary variety does not form such distinctly circumscribed nodules as in the case of tubercle, nor is the larger mass so distinctly built up by the aggregation of smaller masses. It is the coarse variety of gumma which is so specially characteristic. Its appearance varies according to the stage. In the early stage the typical gumma presents a grayish-red appearance; from the periphery, which is often sharply defined, radiating bands of similar appearance invade the surrounding tissues. In the later stages organization and degenerative changes appear, the latter in the central parts. The gumma in this stage shows a more or less thick capsule of dense fibrous tissue, and embedded in this a dry yellow core of caseous consistence which is darker and tougher than the caseous stuff of tubercle.

The microscope in the early stage discovers a dense clustering of round cells embedded in the connective-tissue reticulum of the parts. In addition, collections of epithelioid and giant cells occur here and there, but not so commonly as in tubercle, for vessels do penetrate this granulation mass; but they, especially the arteries, become chronically inflamed, the intima thickens greatly, and the lumen is proportionately diminished. In the later stages the microscope shows a dense fibrous tissue in the outer parts of the tumor, and in the caseous core fatty detritus, shrunken cells, and the remains of a fibrous tissue. Calcification is rare.

This degeneration of the granulation tissue is due in great measure to imperfect blood supply, owing to the above-mentioned narrowing of the arteries. But doubtless the specific and constant action of the syphilitic virus has a large share in producing it. In superficial lesions the degeneration leads to ulceration; and subcutaneous and cutaneous gummata frequently soften, irritate, and slough out, instead of becoming caseous and encapsuled as in the deeper organs.

Syphilis indirectly, by means of the chronic suppurating bone-diseases to which it gives rise, is a cause of albuminoid disease (p. 83).

Etiology and Pathology.—Syphilis is acquired by infection of the healthy with a specific poison from the diseased. It is assumed that there must be some breach of surface to insure inoculation. Susceptibility to the disease appears to vary very greatly with the individual. The period during which the syphilitic are contagious to others appears to extend over the first and second stages. Once acquired, the disease may be passed on to the offspring. The period during which this power to transmit to the offspring exists is an indefinite one, but it appears to be greater the more recent the date of the infection of the parent. A second attack of syphilis is rare one attack, as a rule, conferring immunity for the remainder of life.

The fact of contact with the diseased being essential is evidence of the disease being due to the *entry of some poison.* The poison exists in the (*pathological*) secretions of:

1. The initial lesion.
2. The moist surface lesions of the secondary stage.
3. It exists also in the blood during the same stage; but it does not appear to be present in the *physiological* secretions of the same stage, therefore neither in the saliva, sweat, tears, semen, nor milk. Nor, should a patient be simultaneously suffering from another disease, will the lesions of that disease—*e. g.*, the vaccine vesicle—necessarily be infective.

The discharges from lesions of the third stage do not appear to be infective.

The poison may be conveyed by articles, such as spoons, drinking-vessels, pipes—which have been in contact with mucous tubercles of the mouth, etc. It is important to bear in mind that *anything* used by the syphilitic may possibly be contaminated. Such communication of the poison is spoken of as *mediate* in contradistinction to the *direct* or *immediate* communication of the disease from person to person. Direct communication is most common during sexual intercourse, but other possible modes must be remembered—*e. g.*, infection of the child through the nurse, or *vice versâ*, in the act of suckling. Also the attendance on women in labor may endanger the midwife or the medical man,

The facts relating to hereditary transmission are complicated, but the following may be remembered:

1. The danger to the offspring is greater the more recent the infection of the parents—*i. e.*, the earlier children generally suffer most.
2. That either parent, being *apparently* alone infected, may transmit the disease to the child, but that; of the two,
3. The infection of the mother is the more dangerous to the child.
4. It is doubtful whether a woman can bear a syphilitic child without herself contracting the disease.
5. That the child does not, of necessity, become infected by the parents.
6. Should the mother become syphilitic during pregnancy, the child will usually suffer provided the infection of the mother have occurred early. About the seventh month the escape of the child will be more common. Syphilis may then be acquired by the child in its passage through the vagina.

The complication in the facts of hereditary syphilis arises in part from the influence of treatment—a child born during treatment of the mother possibly escaping, while one born later, after premature discontinuance of the treatment, may suffer, in part also because periods of quiescence appear to arise in syphilis independent of treatment. Complication also arises from the difficulty of ascertaining with certainty the presence of infection on the side of the parent.

Disregarding these points of obscurity, the existence of a special poison is quite clear, and the fact that inoculation of the poison at one spot leads to contamination of all the tissues of the body, shows clearly that the poison is one which multiplies in the system. Joining these facts to those derived from the clinical history, in which we note a period of incubation, the appearance of general symptoms, and of a rash, and subsequent protection of the organism, it is difficult to escape from the conclusion that syphilis is a disease like smallpox, the chief difference being that the stages are relatively very long, and that its cause is similar in nature to the causes of the acute infectious fevers. But these, we have every reason to believe, result from the entrance of a specific organism into the system. Several authors have described organisms in syphilitic lesions, and Birch-Hirschfeld[1] has found them even in growing parts of gummata; cultivations of organisms have been made, and, it is said, animals successfully inoculated. But even the presence of a specific organism is not satisfactorily established.

A point of considerable interest in the pathology of syphilis concerns the relationship of the initial lesion to the general disease. Does the indurated sore represent a local infection only, and does the general infection take place from the local source? Many points in the clinical course would favor an affirmative answer, but the results of early excision of the hard sore certainly negative such a view, for this fails to prevent the general disease.[2]

II. INHERITED SYPHILIS.

Syphilis may cause abortion (p. 116), usually about the fifth or sixth month. Should the mother go to the full time, the child may be born dead, or alive and obviously diseased, or alive and apparently healthy. In the last case, the child may remain healthy, but very often signs of disease appear, and almost always within the first three months. The earliest signs are wasting without obvious cause, and snuffles and hoarse cry from catarrh of the nasal and laryngeal mucosæ. Thrush often appears in the mouth as a complication, eruptions appear on the skin, which becomes wrinkled, inelastic, and of pale yellow tint (*café au lait*); the face assumes a puny, aged appearance. The spleen may often be felt enlarged. It is worth remembering that a mother who steadily denies that her child had a sore anus, will often admit that it suffered badly from thrush, which "went right through it."

The Eruptions.—The skin is the tissue most frequently affected by congenital syphilis. The most common rashes are *erythematous* and *papular*, very similar to those of the acquired disease. They may be general, but much more often they are localized to the region of the anus, where the patches develop into mucous tubercles, or ulcerate. A diffuse dermatitis of the buttocks, scrotum, penis, and thighs is a common manifestation. A similar rash often appears on the lips and chin, accompanied by mucous tubercles at the angles of the mouth and less often at the apertures of the nostrils; from these points fissures (*rhagades*) radiate on to the surrounding skin, and leave when healed characteristic, tell-tale, radiating scars. Mucous tubercles occur also between fingers and toes, at the navel, behind the ears, and in folds of the skin in fat children.

A *bullous* eruption is much rarer; it is generally not present at birth, but may appear later. There may be many or few bullæ, and they are most common in the soles and limbs. They break, leaving a dirty ulcer slow to heal. The prognosis is bad.

Bones.—Of all organs and parts, the bones are affected most frequently, next to the skin. The chief difficulty in the matter is to decide whether certain lesions are due to syphilis or to rickets. Parrot gets over this easily by stating that rickets is a form of congenital syphilis. Here syphilis is regarded as a possible factor in the production of rickets, as are all conditions lowering the general health.

Certain lesions appear to be surely syphilitic, and they are of much importance in the diagnosis of the inherited disease. They are of two kinds, *periostitis*, and *epiphysitis* or *chondro-osteitis*.

[1] Lehrbuch d. path. Anatomie, 1883.

[2] Syphilis and Local Contagious Disorders, Berkeley Hill and A. Cooper. Second edition, pp. 75 et seq.

1. Periostitis.—This is by far the most common. Parrot makes two subdivisions, the osteoid and the rachitic—the latter is simply rickets.

The *ossifying periostitis* of congenital syphilis may begin *in utero*, and is common in the first two years. It produces upon the surfaces of long and flat bones, tubes or lenticular plaques, in fact, rapidly ossifying nodes. Its chief *seats* are the bones of the cranial vault, and the humerus and tibia among long bones; less often the femur and ulna. The whole skeleton may suffer.

The cranial osteophytes are of great interest. They begin after birth. They generally form swellings on all four sides of the anterior fontanelle, separated by a cruciform depression, so as to give the appearance, and even the feel of a small hot-cross-burn. They often look bluish through the delicate skin; post-mortem they are of deep maroon color. Not uncommonly they run back on each side of the sagittal suture, which lies in a groove. Rarely the temporals, and very rarely the occipital, is affected. The parietal and frontal eminences are the parts last involved. The whole skull may be thickened, reaching in parts a thickness of even one inch, and premature ossification of sutures, especially sagittal, induced—leading, it is said, to idiocy. The bosses often remain as evidences of the disease. Of the humerus, the lower part is affected; the thickening increasing down to the epiphysis, dies away above and is most marked posteriorly. The tibia thickens chiefly or alone on its inner aspect about the middle, and the femur antero-externally. On other long bones the seats vary, but are generally near to that epiphysis which grows least. (Parrot.)

Symptoms.—But little pain accompanies these lesions, which are overlooked unless very marked or specially looked for.

2. Chondro-osteitis, or Epiphysitis.—The principal change is generally above and not at the epiphyseal line. In a healthy bone a regular line of calcification, one millimetre wide, lies between the zone of multiplying cartilage cells and the spongy new bone. This band of infiltrated cartilage widens greatly and appears as a markedly irregular white or whitish-red line, the layer of cartilage in contact with it is jelly-like and swells up on section, and the calcareous layer, with the epiphysis, is separated from the spongy bone by an irregular, soft, grayish-yellow mass of granulation tissue which eats away the already formed bone and thus loosens the epiphysis. Rarely, this granulation tissue may invade a good deal of the shaft. In bad cases it undergoes mucoid degeneration, leaving a mesh-work of vascular fibrous tissue containing watery fluid. Fractures easily occur in this state, and always just above the *epiphysis*. From friction of fragments and other unascertained causes, suppuration sometimes occurs at the seat of fracture or in the neighboring joint. The above description, chiefly from Wegner, comprises Parrot's *chondro-calcareous* and *gelatiniform atrophy*.

Symptoms.—Powerlessness to move, in proportion as the atrophy is advanced, is the chief. In severe cases the arms lie pronated by the sides, the legs extended (instead of flexed), and when the child is raised they dangle like a doll's. There is little pain. Parrot calls the state *pseudo-paralysis*. It is often taken for paralysis, but the muscles react as usual to electricity, and on trying to move the epiphyses of the inert limb on their shafts, a fracture may be discovered, or a fine grating indicative of looseness obtained.

Syphilitic chondro-osteitis, like rickets, probably produces its dwarfs.

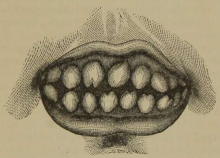
Craniotabes, formerly regarded as due to rickets, has recently been ascribed to syphilis. At about the fifth or sixth month pressure with a finger on the occipital or posterior inferior parietal regions may cause the bone to cave in and spring out again when pressure is removed, very much like the top of a tin-box. The side on which the child lies is generally most affected, constant pressure between brain and pillow being the immediate cause of the thinning.

Among syphilitic affections of the first two or three years of life must be classed some of the cases of *dactylitis*—inflammations sometimes periosteal, sometimes of the bone substance, which lead to an apparent or real enlargement ("expansion") of the phalanges of fingers and toes. In many cases mercury has no effect, and they seem to be tubercular.

From infancy on even to adult age periostitis and ostitis of long bones,[1] especially the tibia, occur, and are most intractable. Gummata, too, form in connection with bones.

Next in order comes the evidence of the *permanent teeth.* The central upper incisors (one or both) are conical or "pegged," being wider at the alveolar than at the free border, which often presents a central semilunar notch (Fig. 15). The upper lateral and lower incisors may less commonly be

FIG. 15.



Pegged and notched teeth in congenital syphilis (Hutchinson).

malformed, and the teeth generally are irregularly set. ("Clinical Memoirs on Diseases of the Eye and Ear consequent on Inherited Syphilis," Hutchinson).

Lastly, from eight to ten years onward, later in proportion to the slightness of taint and to the robustness of the patient, comes *interstitial keratitis.* Spots of haze begin in one cornea and run together till the whole cornea except a ring at the margin looks like ground glass; and meanwhile the other is running the same course. The sclerotic is congested, there is some photophobia, and the patient is almost blind. In twelve or eighteen months, or sooner under treatment, the haziness almost or quite disappears, but changes in the corneal curve almost always result.

For visceral affections of syphilitic infants, see works on Medicine.

DURATION AND PROGNOSIS.—If the child shows signs of syphilis at birth, it generally dies; if it escape for the first few weeks it will probably recover under treatment. Late bone-inflammations may be very intractable.

TREATMENT OF SYPHILIS, ESPECIALLY BY MERCURY.

There are several methods of treating syphilis: 1. By mercury. 2. By iodide of potassium and other salts. 3. By sudorifics and vegetable remedies, and restricted diet. 4. By expectancy—that is, by doing nothing beyond ordinary hygiene. 5. By syphilization.

Modern experience has shown that syphilis, primary or secondary may

[1] Mansell Moullin, Brit. Med. Journ., 1884, vol. i. p. 52.

get well of itself (p. 117). This is most likely to happen to robust persons who lead regular lives, take outdoor exercise, and perspire freely. Universal experience has also proved the efficacy of mercury in curing syphilitic symptoms, promoting the healing of primary ulcers, and removing the exudations which characterize constitutional syphilis. But unluckily mercury is a dangerous drug, producing most depressing effects when given in excess. The object of the practitioner is to secure its curative, and avoid its toxic effect; for mercury, as Dr. Wilks observes, is a foe to syphilis, but a friend to the ulcerations, suppuration, and cachexia which constitute the tertiary symptoms. The feeble, albuminuric, and scrofulous are the most prone to suffer the worst forms of syphilis, and are also the most liable to be injured by any incautious use of the remedy. Hence the first point is to maintain the *highest state of health* and strength by *general* treatment; secondly, to use mercury discreetly. If mercury be deemed unfit, we fall back upon iodide of potassium and general treatment.

1. The syphilitic patient should dress warmly, live well but wisely, avoid all things likely to disorder the bowels, and keep good hours. If there be any indication of anæmia or debility, iron, bark, quinine, or cod-liver oil should be freely given.

2. Then induce gentle mercurial action, and keep it up *long enough.* There are four modes of effecting this—fumigation, internal administration, inunction, and subcutaneous injection.

Fumigation is the oldest mode of applying mercurial vapor to local disease, and to impregnate the whole system; its administration was improved by the methods of Parker and Lee.[1] Lee prescribes 10–30 grains of calomel for each fumigation. The instrument-makers sell an apparatus consisting of a lamp so arranged as to evaporate both the calomel and some water, and an India-rubber cloak to confine the vapor. The object is to get the patient's skin thoroughly moist, and if possible sweating, before the calomel vapor reaches it. In the absence of special apparatus, place the patient on a cane-bottomed chair with a thick blanket round him, and place beneath him on the ground a small vessel containing one ounce of boiling water, with a spirit-lamp beneath it; give a little hot coffee to drink. In a few minutes introduce another lamp having over it a plate on which is the dose of calomel. The bath should last fifteen to twenty minutes, be repeated nightly, and continued till the symptoms subside; three to five weeks is generally long enough for the course. The treatment is specially useful for lesions of the skin.

Internal administration is generally preferred in England. Five grains of blue pill, given every night and morning, produce a rapid effect, and such might be desirable—*e. g.*, in iritis; but if this be not indicated, it is best given in smaller doses, say one grain *three times* a day. Calomel in dose of a grain night and morning, with half a grain of opium, takes effect very quickly. Hyd. c. cret., and pulv. ipecac. co., of each gr. j, made into pill and taken thrice daily, acts very well; the dose may be pushed to five or six pills daily. The green iodide is an uncertain remedy, being liable to decomposition. It should therefore be avoided. In most cases the author prefers the *corrosive sublimate* (F. 162, etc.).

Mercurial ointment is not so likely to disorder the bowels as the blue pill, but it is a little more troublesome. The dose is gr. xx–lx: to be rubbed in daily upon the inside of the thighs or arms till it disappears. The morning is the best time for doing it, as the skin is then softer. It should be rubbed

[1] H. Lee, Med. Chir. Trans., vol. xxxix.; Langston Parker, Modern Treatment of Syphilitic Disease, Lond., 1854.

on different limbs successively, the patient wearing the same drawers both by day and night. If the skin becomes irritated, it should be well washed and bathed. If the patient cannot rub in the ointment himself, it may be done by an attendant, whose hands should be protected by a pig's bladder, well softened in oil and tied round his wrist.

Subcutaneous injection of mercurial solutions is used by some; the best are Sigmund's (hydrarg. perchlor., gr. iv; sodii chloridi, gr. lxxx; aq., ℥j: dose 10–20 ♏), and Ragazzoni's (hyd. biniodid., gr. iv; sodii iodid., enough to dissolve the mercury, 4 grains or less; ♏ aq. 256: dose ♏ x). This method produces a rapid effect, but should rarely be used, as it is painful and causes abscesses and inflammation at the punctures. Rest after the injection, which is best made into the subcutaneous tissue of the flank (Hill), should be insisted on.

The Ill Effects of Mercury.—1. *Irritation of the bowels*, with dysenteric symptoms, straining and tenesmus. To be treated by opium with chalk mixture and opiate enema; omitting the mercury for a few days, and combining it afterward with opium; and using double precaution against cold and damp.

2. *Salivation.* It is common to meet with persons who are salivated by very small quantities, and every practitioner should make a point of ascertaining this before he prescribes large doses of mercury for a new patient. Mercury is imperfectly eliminated in Bright's disease, and salivation is consequently easy. The symptoms of severe salivation are, swelling and inflammation of the salivary glands, cheeks, tongue, and fauces, with a flow of peculiarly fetid saliva, foul breath, and sloughing of the surface of the gums and of the inside of the cheeks. The earliest symptoms are the most important: metallic taste in the mouth, tenderness of the teeth, a red line on the gums where they touch the teeth, and some swelling of them, and increased flow of saliva. The occurrence of any of these symptoms should lead to diminution of the dose, unless the evidences of syphilis will not yield to smaller quantities of the drug.

Salivation is treated by withholding mercury; by employing strong gargles of alum or chlorate of potash, or tincture of myrrh and tannin, Turkish baths thrice a week if the patient can bear them, and the cautious administration of pot. iodid. with bark. Keep the bowels open and give a liberal diet. Change of air and removal from hospital wards are indispensable.

3. *General cachexia.* A condition of malnutrition marked by great anæmia, emaciation, loss of strength, and disordered state of the secretions generally. The condition may resemble scurvy.

4. As the result of the local application of mercury as an inunction, considerable irritation may ensue. This must be guarded against by diminishing the vigor of the friction and varying the place of inunction. A hairy surface is to be avoided, as inflammation is more easily started there—hence the inner side of the arms must not be taken to mean armpits. The inflammation once excited must be treated on the ordinary lines.

In whatever way mercury is administered, it is good, if the patient be at all feeble, to give iron or quinine, or both, at the same time.

In secondary symptoms, if ushered in with febrile symptoms, it will be necessary temporarily to give saline medicines and warm baths, and confine the patient to the house.

In the later stages of syphilis, mercury must be used with great caution, especially if the health be broken down and the aspect flabby and anæmic. In all cases in which the health is impaired, and it is desired to get the greatest benefit from the smallest doses of mercury, and to continue it a long time, the *corrosive sublimate*, in doses of one-sixth or one-eighth of a grain daily, is the best form (F. 162). It may be combined with bark or steel. Plummer's pill, and the biniodide with iron, and Donovan's solution, deserve respectful mention. Where it is borne, it is recommended that mercury be given for eighteen months to two years after contagion, with occasional short intermissions—and it must be continued beyond this if symptoms be still present. On the theory that syphilis is a bacterial disease, and that mercury destroys the bacterium, the indication would be to keep the largest possible percentage of the drug in the blood short of injuring the health.

Whether mercury cures syphilis or not is still doubtful. It acts upon the primary and superficial secondary lesions admirably, but in affections of the deeper connective tissues it does not give such effectual and speedy relief as iodide of potassium. Frequently a lesion will yield rapidly to a mercurial lotion or ointment, when mercury by mouth alone has failed; local application should therefore never be neglected.

The *iodide of potassium* is especially useful in the later stages, when the deeper connective tissues are affected, and in all cases in which mercury is undesirable, or has been given so far as is thought prudent without relieving the symptoms. (See F. 159 *et seq.*) The chloride and carbonate of ammonia are often combined with the iodide and bromide of potassium (F. 167, 178). The bromide of potassium in scruple doses at night is good for nocturnal pain and sleeplessness. Sarsaparilla has the reputation of healing irritable ulcers and adding to the patient's nutrition. The sudorific decoctions of guaiacum, drunk hot in large quantities, are perhaps not so worthless as they have been deemed. The surgeon will need great variety of remedies in protracted tertiary cases. The main object should be to improve the general look and condition of the patient; to relieve pain; to treat symptoms; to give short courses of alteratives in succession, continuing each so long as it does good; never to push a remedy, if it does manifest harm, under the vague idea that it is specific; and to cure the disease with as little harm to the constitution as possible.

Local Treatment.—For syphilitic eruptions, warm, vapor, and Turkish baths are very useful, if comfortable. The removal of obstinate papular eruptions may sometimes be hastened by ung. hydr. nitratis, diluted, and itching eruptions by a weak lotion of corrosive sublimate. Ulcers must be treated according to their condition, whether inflamed, irritable, or indolent. In general, weak mercurial applications, such as black-wash, or weak red precipitate ointment, answer best as local applications. Iodoform powdered on, or applied as iodovaseline, is an excellent application. On mucous membranes, ulcers may be touched twice daily with a lotion of hyd. bicyanid. or perchlor., gr. ij ad aq. ℥j.

For loss of hair a pomade containing a very small proportion of ung. hyd. nitr. scented, is useful; or a wash containing cantharides.

For the common excoriated sore throat, the best application is a solution of the nitrate of silver of the strength of ten grains to the ounce, or of a finely pointed stick lightly applied. When there are ulcers, gargles of corrosive sublimate (F. 207); and when the ulcers are indolent they may be touched with the *linimentum æruginis*, or *mercurial fumigation* may be used to the part affected. For ulceration of the larynx with necrosis of the cartilages, tracheotomy may ultimately be needed.

For palmar and plantar psoriasis soak the part nightly in hot water, and rub and scrape away as much epidermis as possible without drawing blood. Then rub ung. hydrarg., gr. x–xv, thoroughly into the exposed patches, holding the part in front of the fire during the inunction. In this way many cases may be cured in a few months.

Mucous tubercles about the genitals should be washed with solution of alum or sulphate of zinc, and then be sprinkled with dry calomel. A rag wrung out of black wash should be kept constantly between the labia. The yellow wash is also good (F. 244).

The pain of nodes is often relieved by blisters. Acute inflammation of the periosteum is best treated by iodide of potassium, in doses of three grains every four hours, and Dover's powder. When nodes are very tense and painful, it may be necessary to puncture them by *subcutaneous* incision. It is to be noted that the opening here is subcutaneous. It is a golden rule also never to open gummata if this may be avoided. The subcutaneous injection of gr. ¼ of morphia is often useful for nocturnal pains.

Before concluding the subject of the treatment of acquired syphilis, we must mention syphilization.

Syphilization signifies the repeated inoculation of matter from a venereal sore, upon the same patient, either to render him insusceptible to fresh attacks, or to relieve existing symptoms. It was first devised by Auzias Turenne, and Sperino, of Turin, about 1850, and since has been carried out on a very large scale by Professors Boeck, Faye, and Bidenkap at Christiania, and by Dr. P. H. Watson, of Edinburgh.[1]

The *theory* on which syphilization is defended, is that it does by art for syphilis, quickly, what is done in smallpox by eruption—that is, it exhausts the material capable of producing syphilitic disease, and thus renders the patient insusceptible to it. The material employed is the matter of any active venereal ulcer.

It is quite certain that some patients suffering under obstinate constitutional syphilis have got well whilst subjected to this most disgusting treatment. Yet the more it is analyzed the more unsatisfactory it appears, and, in the author's opinion, no English surgeon is justified in adopting it. It were far better to trust to *hygienic treatment* only, remembering that the virulence of syphilis varies inversely as the general health of the sufferer.

The *treatment of congenital syphilis* presents nothing very special. Infants bear mercury very well. The best form for internal administration is gray powder, which may be given in doses of one-half grain three times a day, or of one grain twice a day. Treatment by the inunction of blue ointment is equally efficacious and some hold preferable. All that is needed is to smear about ten grains of blue ointment every night on the soles of the feet, and let the child wear socks day and night. Cod-liver oil may be given internally as well. Treatment should be continued for at least six months.

The later forms of congenital syphilis are best treated with iodide of potassium.

Local lesions will require local treatment—*e. g.*, boracic ointment smeared over inflamed skin about the anus, scrotum, and thighs, whilst mercury acts.

As to diet; the infant should be suckled by the mother if this be possible. If this cannot be, and a wet-nurse be employed, and this is recommended, she must be syphilitic.

FITNESS FOR MARRIAGE.—The surgeon is often asked on this point by men who are just recovering from a syphilitic attack; and the most prudent advice is to wait *a year after the disappearance of the symptoms*. The shortest time between contagion and marriage should be *three years*.

On the whole subject see Hill and Cooper, *Syphilis and Local Contagious Diseases;* and Bäumler's article in Ziemssen's *Encyclopædia of Medicine.*

[1] See Aperçu des différentes méthodes de traitement employées à Hôpital de Christiania contre la Syphilis constitutionnelle. Par J. L. Bidenkap. Christiania, 1863. And a very exhaustive paper by J. R. Lane and G. Gascoyen, in Med. Chir. Trans., vol. i.

CHAPTER X.

TUMORS.

Definition.—No satisfactory positive definition has yet been given. The difficulty is to draw a line between tumors, on the one hand, and new formations due to hypertrophy and inflammations, on the other. Clinically, the distinction between tumors and inflammatory products is of great importance.

A tumor is a more or less circumscribed swelling, consisting of newly formed tissue, the development of which is a departure from the normal type of the part; for the mass disturbs its form and the relations of its elements, and almost always differs more or less in minute structure from the tissue in which it arises. This excludes all swellings, such as hæmatomata, retention and dilatation cysts, which are not neoplasms; also general hypertrophies which adhere to the type of a part, merely enlarging it; but it does not exclude localized hypertrophies and outgrowths, nor masses of inflammatory tissue. Circumscribed hypertrophies are generally spoken of as tumors. With regard to inflammatory neoplasms, taken as a whole, they differ in many ways from tumors—even sarcomata. They are obviously the result of irritation, a factor which seems to play but a mild part in the evolution of tumors; and their constant tendency is to develop into fibrous tissue, though perhaps after suppuration. For the infective granulomata, however, we knew nothing until lately of irritant causes; the tumor-like products of these diseases have no very strong inclination to form fibrous tissues; and their power of infection causes them to resemble malignant growths. Still, the tendency of each granuloma is certainly to break down and leave a scar, not to continue to grow like a tumor or even to remain stationary. We do not know the immediate causes of tumors, and it has been suggested that malignant growths may be due to the action of an organism, but it is hardly likely that a bacterium capable of producing an epithelial cell in a bone will be discovered.

Pathologists, therefore, being unable to insert the cause of tumors in their definition, to separate them etiologically from inflammations, adopt the negative method, and say that the new tissue of which a tumor consists is not the result of an inflammatory process.

Clinical Course.—For the patient the most important division of tumors is into *simple* and *malignant*.

A *simple* tumor is circumscribed, generally encapsuled, and movable among the surrounding tissues; it generally grows painlessly, slowly, and never by invasion or infiltration of neighboring parts; it is but slightly vascular; it may reach a great size and produce serious and even fatal symptoms by pressure on important parts, or make life a burden by its size and weight, or inflame and ulcerate or slough; but, except from some such accidental circumstance, it produces no effect upon the general health; if removed with common care, it does not recur; and it shows no tendency to infect lymphatic glands or distant parts. Histologically simple growths usually consist of well-formed adult tissue.

A *malignant* tumor, on the contrary, does not feel circumscribed, is not encapsuled, and is more or less adherent to surrounding parts; it generally grows rapidly, and chiefly by infiltrating the tissues around; it is often very painful, and always much more vascular than a simple tumor. When springing from bone or other deep part it may reach an enormous size, but when superficial it often ulcerates whilst small; during its growth the patient becomes markedly anæmic and loses flesh and strength rapidly—*i. e.*, it causes *cachexia;* if removed by incisions which apparently go quite clear of its edge, it often recurs *in loco*, and either before or after removal of the primary growth secondary tumors appear in the nearest lymphatic glands, or in distant parts of the body, or in both situations. The minute structure of a malignant growth is usually embryonic and most atypical.

Upon the above points the *differential diagnosis* rests; assistance may sometimes be given by age and heredity.

Owing to the way in which they infiltrate, the apparent is not the real margin of malignant growths, and cells swept from them by the lymph stream may stick here and there in the neighboring tissues. *Recurrence in loco* is certainly due to the leaving behind and continued growth of some of these germs. *Infection of lymphatic glands* is due to the carriage to them of cells from the growth by the lymph stream; it is extraordinary how many months sometimes elapse before enlargement of the glands is evident. Again, tumor cells and small masses frequently migrate or grow into bloodvessels, and are carried by the blood stream to *distant parts*. Most commonly they stick in the first set of capillaries reached (lungs or liver), but they may pass through these and settle elsewhere. The secondary growths may be few or very numerous, and vary greatly in size; usually they are smaller than the primary. *Cachexia* is always secondary to the growth of the tumor and often to its ulceration or generalization. Pain, anxiety, discharge, septic absorption, the breathing of putrid gases, etc., aid in its production; but malignant growths seem to have a special effect behind all this.

The *causes of malignancy* are unknown. It is generally associated with an embryonic or very atypical structure, but not always, for highly developed cylindrical epitheliomata, tumors having exactly the structure of the thyroid body, nay, even fatty and other simple tumors, occasionally generalize. This, together with the fact that artificial emboli of lining periosteum grow for a few weeks and are then absorbed by the healthy tissues around them, led Cohnheim to suggest that depression of that physiological resistance which keeps contiguous tissues from invading each other's limits may have more to do with malignancy than the structure of the tumor. He believes that this weakness of tissue may be produced by irritation and inflammation or by senile decay, or that it may be inherited. He does not explain why it so constantly accompanies cancers and sarcomata, so rarely fibromata, lipomata, etc.; tumors consisting entirely of actively growing and probably mobile cells, perhaps lying in lymph spaces, and richly supplied with thin-walled vessels, are apparently more likely to generalize than growths made up of fibres, fat, or cartilage, and possessing few vessels of any kind.

CAUSES.—Very little is known. Owing to their greater clinical interest most attention has been paid to the etiology of malignant growths.

It is said that *dark races* and inhabitants of *hot climates* are more liable to tumors than dwellers in northern climes. *Certain districts* of England, and even parishes of London, show a much larger cancer mortality than others. *Men* are probably more often affected than *women*, much oftener if tumors of the mamma and uterus are excluded. No *age* is exempt; some tumors are congenital. Cancer is very rare under thirty-five, and attains its maximum between forty and fifty. Sarcoma is the malignant tumor of early life, but it also attains its maximum in mid-life. Cancer, especially of the breast and uterus, and multiple simple growths, are often *hereditary*.

Irritation and injury are given as causes in 7.14 per cent. of the cases. In many of these it is just as probable that the tumor existed before the injury. The skin is most exposed to irritation, and warts and epitheliomata most often attributed to it—*e. g.*, warts and epitheliomata of workers in mineral oils or tar, of the lower lip from clay pipes, of the tongue from sharp teeth, of the scrotum from soot, of scars exposed to irritation. Phimosis is said to predispose to cancer of the penis. Points of constriction, and, therefore, of friction along the alimentary tract (back of cricoid, crossing of left bronchus, cardia, pylorus, ileocæcal valve, hepatic and splenic flexures, junction of sigmoid and rectum), are the commonest seats of disease. But there must be something else to account for the selection of the few who suffer. Many have maintained that malignant growths are the local expression of general or blood diseases, saying that if one growth was removed the disease returned *in loco* or burst out elsewhere, and referring to heredity and the cachexia in support of their view. But local abnormal tendencies may be inherited just as certainly as normal tendencies, and the phenomena of recurrence are easily explicable (p. 127) from the point of view of a local infecting growth. The general view would render treatment hopeless; the local tells the surgeon that recurrence occurs because he has not operated sufficiently early or freely.

Development.—Under the influence of the above, and other much more important though unknown causes, it has been supposed that the adult cells of the affected part begin to multiply. To form a sarcoma the adult cells must become embryonic. This does not seem very likely. Cohnheim has suggested another explanation—viz., that tumors develop from small masses of embryonic tissue left among the mature elements—that they are, in fact, due to developmental errors, like certain hypertrophies or supernumerary digits. At present the idea is simply a theory which explains many observed facts—*e. g.*, the occurrence of a large proportion of tumors at points where complicated developmental changes occur (orifices of body, many of the constricted points in alimentary canal, etc.); the independence of tumors of the part in which they lie, and the lack of control exercised over them by the regulating machinery of the body ; the extraordinary growth of some tumors accords better with the properties of embryonic than with those of adult tissue. Such growths as epitheliomata of scars or from pure irritation are excluded by Cohnheim from among true tumors; the same pathological changes are produced by another cause.

The effect of irritation, on Cohnheim's theory, is to increase the blood supply and excite the embryonic germ to growth.

Classification.—Tumors are best classified according to their anatomical structure. Embryology teaches that the cells of the segmented human ovum very early arrange themselves in three layers: an outer, *epiblast*, from which the hair, spinal cord, nerves, epithelium of the skin, mouth, and lower end of rectum, are developed; an inner, *hypoblast*, which gives origin to the epithelium of air-passages, of the alimentary tract, of the ducts and glands (liver and pancreas) opening on it, and of the bladder; and a middle one, *mesoblast*, from which are formed all the tissues and organs contained between the two epithelial layers, viz., all connective tissues, all muscle, blood-vessels, and lymphatics. It is believed that neither *in utero* nor later does a mesoblastic tissue arise from epi- or hypo-blast, or *vice versâ*. Once the embryonic layers are differentiated the tendencies of their cells are absolutely distinct. The only way in which epithelium can seem to arise from mesoblast is by means of some errors of development leading to the inclusion of hypoblastic or epiblastic cells by mesoblast.

Now, tumors contain no new elements; they spring from the tissue cells, or from similar rudiments, and every kind of adult tissue cell may be the characteristic element of a tumor. There is also a large group of cases resembling embryonic connective tissue.

So there is the same wide gulf fixed between tumors as between tissues of mesoblastic origin, on the one hand, and of epi- or hypo-blastic on the other. We shall, therefore, adopt the following classification:

Mesoblastic.

1. *Type of fully developed Connective Tissues:*	
Type of fibrous tissue	Fibroma.
" fatty tissue	Lipoma.
" cartilage	Chondroma.
" bone	Osteoma.
" lymphoid	Lymphadenoma.
2. *Type of Higher Tissues:*	
Type of muscle	Myoma.
" nerve	Neuroma.
" bloodvessels	Angioma.
3. *Type of Embryonic Connective Tissues*	Sarcoma.

Epi- and Hypo-blastic.

4. *Type of Epithelial Tissues:*

Papilloma   Adenoma   Carcinoma.

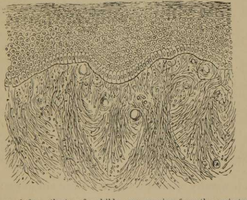
For convenience, Cysts will be taken at the end of Tumors.

A. Mesoblastic Tumors. Adult Types.

THE FIBROUS TUMOR.

The fibrous tumor consists of fibrous tissue; sometimes white, glistening, and hard, resembling tendon; at other times soft, loose, and yellowish from a little fat in its meshes. Thus there are two chief varieties, the *hard* and

Fig. 16.



Fibrous tumor. Removed from the toe of a child; was growing from the periosteum. Surface covered with epithelium. Tumor consists of interlacing bundles of connective tissue, containing nuclei. One or two vessels in cross-section.

the *soft*. The *hard* are mostly found in connection with the periosteum, especially of the jaws, nasal bones, external base of skull, and front of cervical vertebræ, the fasciæ, and the nerve-sheaths; the soft—the *fibrocellular,* or *connective-tissue* tumor—in the subcutaneous, submucous, and intermuscular tissue. They are most frequent in the scrotum, labium, peri-vaginal tissue, and the deep intermuscular spaces of the thigh. The superficial often become pendulous and pedunculated. Their naked-eye appearance is that of loose fibrous tissue.

Microscopically these tumors consist of bundles of white fibrous tissue, interlacing in all directions, often wound round vessels, and more or less studded with nuclei according to the rapidity of their growth. The annexed figure (Fig. 16) is taken from a small fibrous tumor of the periosteum of the little toe.

They are subject to *degenerations.* Cysts filled with serous or mucous fluid may form in the interstices. Such tumors may inflame, soften, suppurate, and slough out entirely or by degrees, or may adhere to the skin, and cause it to ulcerate by distention, and may then throw out bleeding fungous protrusions.

These tumors are hard or soft, elastic, free from tenderness, smooth, oval or pyriform; encapsuled; of slow growth, lasting any number of years, and attaining to almost any size; generally single, or, if multiple, affecting but one and the same organ, as the skin (Fig. 17).

FIG. 17.

Fibroma molluscum multiplex. From a patient under the care of Mr. Jonathan Hutchinson.

Their origin is usually spontaneous, and cause unknown; sometimes they follow an injury.

Extirpation is the only *treatment;* after which the patient may be comforted with the probability that there will be no return of the disease in the same place or elsewhere.

Virchow has described a fairly common variety under the term *Fibroma molluscum*, in which there is an immense production of growths from the subcutaneous tissue. Sometimes a single tumor will develop which may attain gigantic proportions, but in the more common form a large number of small tumors occur over the whole body (Fig. 17).

The common mucous polypus of the nose is a loose fibroma, of which the stroma contains a good deal of albuminous fluid.

Two other varieties of fibrous tumors require notice; one, commonly called *neuroma*, which is not a nerve tumor, as its name would imply, but a fibrous tumor developed in the sheath of a nerve; they are often multiple and hereditary. The other is the *painful subcutaneous tumor* of Wood (*Edin. Med. Chir. Trans.*, vol. iii.); a small body, rather larger than a pea, or coffee-berry, composed of fibrous tissue, situated under the skin, generally single, generally affecting women, accompanied by fits of most excruciating neuralgic pain, and often by hysteric and spasmodic affections. Hitherto anatomists have failed to detect, on dissection, any connection between these tumors and the nerves. Extirpation is the remedy.

FATTY TUMOR, OR LIPOMA.

The fatty tumor consists of fat tissue intersected with meshes of fibrous bands, and contained in a fibrous capsule. When the fibrous element is in excess, the tumor is sometimes called *fibro-fatty*. It is often combined with nævoid tissue (*nævo-lipoma*); and sometimes with much round-celled growth (*lipo-sarcoma*). In these latter cases the cells of a sarcoma have become infiltrated with fat, and the peculiarity recurs in secondary growths.

It is not very liable to *secondary changes*. Cysts may form from mucous softening, and the fibrous tissue may calcify or even ossify. Rarely it inflames and ulcerates from irritation.

Causes.—The most important known is heredity. Dr. Murchison reported (*Edin. Med. Journ.*, June, 1857) the history of a family in which father and two daughters had a fatty tumor in almost identical positions. More commonly the growths are multiple, often very numerous, in hereditary cases.

Fatty tumors, for the most part, occur at that time of life (35–50) when people tend to become fat. It has been said that they sometimes follow local irritation; seeing the frequency with which they occur about the shoulders, nape of the neck, and back, it seems not improbable that local pressure long continued, or other irritation, may be a cause.

Seats.—The subcutaneous tissue of the trunk, especially about the back of the neck and shoulders, but they may extend between and under the fasciæ, deep amongst the muscles of the neck, trunk, or limbs, or amongst the viscera. They may be found even where no fat exists naturally, as in the scrotum or eyelids. Uncircumscribed masses of fat, often symmetrical, occasionally develop about the neck.

Clinical Characters.—The fatty tumor is generally single; its growth is slow. It may attain enormous bulk, even seventy pounds, but causes no inconvenience, save what arises from its weight and situation. It is soft, often semifluctuating, but solid when taken between the fingers; lobulation can be felt and often seen; it is movable over deep structures freely, but may cause slight dimpling by adhesion to the skin; not painful or tender. A finger pressed upon its edge feels that this is thick and round as the tumor slides away, which, together with lobulation and perhaps exploratory puncture, distinguishes it from cold abscess and sebaceous cyst.

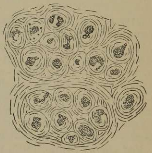
Treatment.—Removal by the knife, if the patient wish it and his health is satisfactory. Cut right into the tumor so as to open the capsule; the growth then "shells out" as a rule. Sometimes, especially on the back, it requires careful dissection, the septa passing to the capsule (which is left behind) being stout. If completely removed it will not recur, unless it be a *lipo-sarcoma*. Large uncircumscribed masses are best left alone.

CARTILAGINOUS TUMOR, CHONDROMA, OR ENCHONDROMA.

This consists for the most part of cartilage (Fig. 18) identical with normal cartilage, either hyaline or fibrous; rarely the matrix is mucous and the cells spindle-shaped or branched. Such tumors are often intersected by strands of slightly vascular connective tissue, or they may consist of distinct round nodules like peas or marbles, held together by connective tissue. They are well encapsuled, and do not recur after complete removal.

The varieties depend mainly upon the nature of the intercellular matrix. Tumors originating from bone are of the hyaline variety, while those from connective tissue in other parts of the body are more frequently fibrous.

Fig. 18.

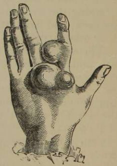


Microscopic characters of chondroma; nuclei granular. From nature.

Fig. 19.

Bony skeleton of chondroma (chondro-sarcoma?). From the King's College Museum.

Fig. 20.



Chondromata of the hand. From a cast in King's College Hospital Museum.

Some of these growths (*chondro-sarcomata*), especially in glands and the medulla of bones, consist of well-developed hyaline cartilage with much spindle-celled tissue; there is no capsule, and round cells infiltrate the neighboring tissues. These growths behave with all the malignancy of sarcomata.

Secondary changes are common: *calcification*, especially in chondromata of fingers; *ossification*, especially in subperiosteal specimens which may (?) show a skeleton of light papery plates (Fig. 19); *mucoid softening* leading to formation of cysts. Rarely these ulcerate.

Causes.—Chondromata are often hereditary, especially when multiple. Those growing from medulla of long bones are believed to start from islets of cartilage left unossified (Virchow); Cohnheim suggests that those of the parotid and testes may begin from misplaced bits of the cartilage whence the jaw or vertebræ grow. They sometimes follow injuries and are most common in early life.

Seats.—Bones most commonly, especially the phalanges and metacarpals, and the shafts of the long bones; sometimes from the ribs and pelvic bones. They occur also in the parotids and testes, but almost always mixed with mucous or gland tissue; rarely in subcutaneous tissue, rarely also from cartilage, as of larynx or ribs (*ecchondroses*).

In bones they may be of medullary or subperiosteal origin; in the former case, as the old bone is absorbed a thin shell of new is laid down by the periosteum, and the bone "expands;" in the latter the growth may envelop the bone—*e. g.*, tibia or femur.

Clinical Characters.—As occurring on the fingers (Fig. 20), they are firm, smooth, rounded masses of slow growth, and rarely larger than a good Tangerine orange; the skin is unaffected for a long time, but may redden over very large, soft, and degenerate growths; they are usually multiple. On the long bones they cannot be diagnosed with certainty. From a cyst an aspirator may draw off recognizable cartilage cells. Rarely these growths reach a great size; one of femur, three feet round, in five years (Frogley, *Med. Chir. Trans.*, vol. xxvi.). When soft, but not from mucous softening, and of rapid growth, chondrosarcoma must be thought of. The presence of cartilage in gland tumors can be told on inspection only.

Treatment.—Removal from connective tissue or parotid; castration, if in the testis; amputation when on a long bone, complete removal otherwise being rarely possible; but it may be attempted, especially in the fingers. Amputation of a finger is required only to remove a deformity, unless the growth is in the way.

BONY TUMOR, OR OSTEOMA.

These consist of compact or spongy bone; hence the two varieties: *compact* or *ivory*, and *cancellous* or *spongy exostosis*. The *ivory exostosis* consists of extremely dense, white, ivory-like bone, Haversian canals being scarce; it grows from periosteum, especially of the bones of the calvaria, orbit, face, and the bony part of the external auditory canal. It forms a low, smooth, rounded swelling, absolutely sessile and fixed, and of very slow growth.

The *spongy exostosis*, much the commoner, is really an ossifying chondroma which grows from the shafts of long bones near their epiphyses, most commonly from the lower end of the femur, and the upper of the tibia or humerus. On section they show spongy bone continuous with that of the parent bone; and, so long as they are growing, are capped by cartilage. Often pedunculated and clubbed, they may have broad attachments and very irregular surfaces; one above each inner condyle of the femur is not uncommon. Their position on and fixation to bone, and their occurrence before manhood, are the characteristic points.

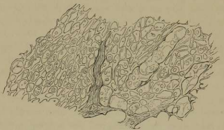
Osteomata are often hereditary and multiple. They rarely occur as primary growths, except in relation with bones. They are innocent; but sarcomata may ossify all but their growing edges. Osteomata may become carious or necrose and exfoliate, especially the ivory form, the result being a cure.

Treatment.—Removal, if pressure symptoms, deformity, or other inconvenience requires it.

LYMPH GLAND TUMOR, LYMPHADENOMA ; HODGKIN'S DISEASE.

This tumor consists of lymphoid tissue which has a very general distribution in the body. It is made up of a network of homogeneous fibrils, with nuclei here and there at points of junction (Fig. 21) ; in the meshes lie cells

FIG. 21.

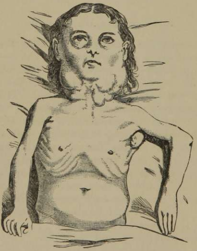


Lymphoma. Delicate reticulum : the corpuscles have been pencilled out. From a cervical gland in Fig. 22.

exactly like white blood-cells. The network may be very fine or very dense, the tumor being correspondingly *soft* or *hard;* the fibrous septa of the gland remain and may thicken greatly. Firmness generally goes with age and slow growth. A soft gland is yellowish or pinkish-gray, uniform, pulpy, and yields milky juice on scraping; a hard one is obviously more or less fibroid. Fatty degeneration, caseation, and suppuration are rare.

Lymphadenomata start in lymphatic glands: only one gland may be affected, and the health be unimpaired ; or every gland in the body may be

FIG. 22.



Lymphadenoma. Showing the enlarged glands on both sides of the neck, and in each axilla. The child was greatly emaciated, and died very shortly after this sketch was made.

involved, the spleen enlarged, the lymphoid tissue everywhere—tonsils, alimentary canal, liver, kidneys, testes, marrow of bones, etc.—overgrown, whilst anæmia progresses with the disease. This is *Hodgkin's disease.* In some cases, otherwise apparently similar, *leucocythæmia* occurs, the white corpuscles being smaller than normal.

Enlargement of the first gland or group of glands may start without obvious cause or from absorption of some irritant; it is impossible in this stage to say the disease will not become general, and this may occur after a single group of glands has been enlarged and stationary for years. The diagnosis from scrofulous glands may be very difficult.

SYMPTOMS.—The groups of glands are affected in the following order of frequency; cervical, axillary, inguinal, retroperitoneal, bronchial, mediastinal, mesenteric. Smooth, painless, and, at first, freely movable, the glands ultimately blend into an irregular lobulated mass by bursting of the capsules and blending of the contents. The swelling may increase rapidly or slowly, other glands may enlarge simultaneously or not for years. Symptoms arise from pressure on nerves, veins, œsophagus, bronchi, thoracic duct, bile-duct, etc.; also from lack of red corpuscles. The patient may die of marasmus, starved, or comatose after convulsions and delirium. Remittent fever (2°–6°) is frequent, and generally indicates a rapid course. Fig. 22 shows a child with Hodgkin's disease, formerly under Mr. Haward at the Hospital for Sick Children.

TREATMENT.—When only one group of glands is diseased, removal may delay advance or even prevent it, but diagnosis at this stage is doubtful. When all the glands cannot be removed or the spleen is enlarged, operation does no good. None should be undertaken with less than sixty per cent. of red corpuscles. Arsenic in the largest possible doses is the only drug of much value. Cod-liver oil, iron and tonics, and change of air are always useful. (See article by W. R. Gowers, M.D., in Reynolds's *System of Medicine.*)

THE MUSCULAR TUMOR, OR MYOMA.

Muscular tissue includes two varieties—the striped and the unstriped. Tumors may occur in either kind. The *striped* are exceedingly rare, but have been found in the heart and tongue of newborn infants. Tumors of *unstriped* muscle occur chiefly in the uterus. They are found also in the œsophagus, stomach, and prostate gland; in the scrotum in man, and in the labia majora of women.

Mixed with much fibrous tissue they constitute what is known as the "fibrous tumor" or *fibro-myoma* of the uterus. They may be subperitoneal, submucous, or intramural—*i. e.*, in the substance of the uterine wall. On either surface they tend to become pedunculated.

They are generally enclosed in a capsule; do not invade other structures; and, histologically speaking, are perfectly innocent growths.

NERVE TUMOR, NEUROMA.

This name has been given to fibromata, myxomata, etc., growing from the fibrous tissue of nerves. Tumors of nerve tissue are very rare. The bulbous ends of nerves in a stump are sometimes called *amputation-neuromata.* They may contain rolled-up nerve fibres from regenerative attempts of the nerve fibres; often they consist of fibrous tissue only. When a nerve is divided and does not unite, the central end may become similarly bulbous.

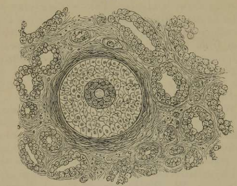
VASCULAR TUMOR, ANGIOMA OR NÆVUS.

This consists of bloodvessels, some of new formation, many apparently formed by dilatation of preëxisting ones. Increase takes place by budding from the vessels of the growth, and can be followed best in fatty tissue.

There are two kinds: 1. The *simple* or *capillary*, which consists of very large capillaries with thick walls lined with cells, one to three deep, very much like those lining gland-ducts (Fig. 23). 2. The *cavernous*, which resembles erectile tissue, consisting of freely anastomosing irregular spaces, separated by fibrous septa lined by venous endothelium.

Capillary nævi occur in the skin and subcutaneous tissue. On the skin they form the mother's "marks" and "port wine stains" which are so common—bright red or purple patches sometimes a little raised above the skin and sometimes covered with long coarse hair. They are probably always

FIG. 23.



Horizontal section of a rapidly growing nævus of the back. The centre is an enlarged hair follicle ; round it are the hypertrophied bloodvessels, probably the plexus greatly enlarged, which is normally found round each hair-sheath.

congenital, and may grow rapidly and cover a very large surface. When subcutaneous they form soft, rather ill-defined roundish swellings, emptied by compression, filling when pressure is removed, swelling up when the child cries or strains (erectile), and often having a bluish color through the skin. These are the clinical signs of cavernous nævi of the subcutaneous tissue, which occur also in bones, muscles, liver, kidney, and very rarely in the rectum. Often a nævus is both cutaneous and subcutaneous. (See "Diseases of Bloodvessels.")

B. Mesoblastic Tumors, Embryonic Types. Sarcomata.

The tumors hitherto described have all been formed of fully developed tissue; we now pass on to consider those which consist of embryonic tissue —the sarcomata.

Embryonic connective tissue is well represented by granulation tissue, described at p. 59. Sarcomata have the structure of granulation tissue-cells (round, spindle, branched, or giant) in a matrix which may be homogeneous, mucous, fibrous, calcified or ossified. Much stress is laid upon the presence of matrix between sarcoma cells, as distinguishing these growths from epithelial ones, in which the cells touch: it is doubtful whether the distinction holds. Microscopically, sarcoma tissue often cannot be diagnosed from granulation tissue; but the tendency of the sarcoma to grow without ceasing distinguishes them. All sarcomata are very liable to fatty degeneration and to hemorrhage into their substance, sometimes destroying all but a capsule of new growth (*blood-cyst*). The chief varieties of sarcoma are named according to the dominant shape of their cells, but all varieties may be found in one specimen. Other names spring from changes in the matrix and secondary changes in the cells—*e. g.*, pigmentation.

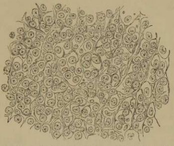
Sarcomata always spring from connective tissue, and may occur wherever this is found. They are common in skin and subcutaneous tissue, fasciæ, muscles, bones.

1. *The round-celled sarcoma* consists of a very delicate intercellular substance, in the meshes of which are contained small round cells; many of them are indistinguishable from lymph cells; they vary in size, and contain nuclei and nucleoli.

The intercellular substance also varies, being either homogeneous, granular, or fibrillated. Fig. 24 represents a typical round-celled sarcoma.

2. *Spindle-celled sarcoma*, formerly called "fibroplastic." The cells are

FIG. 24.

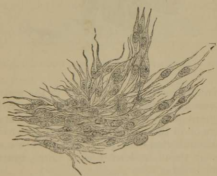


Round-celled sarcoma. Showing large round cells, and a very delicate network of connective tissue stroma.

fusiform, long and narrow, terminating in "tails," and contain oval nuclei and nucleoli. They are arranged more or less compactly, and parallel to each other in bands and whorls. When closely packed they resemble fibrous tissue (Fig. 25). *Recurrent fibroid* tumors were small spindle-celled sarcomata, often springing from fascia.

3. *Giant-celled or myeloid sarcoma*, so called because of the presence of a

FIG. 25.

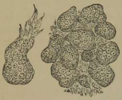


Spindle-celled sarcoma.

number of large, many-nucleated cells (Fig. 26), resembling those of embryonic marrow. On section they are often of decided maroon tint (Paget). They are more especially found in the osteo-sarcomata springing from the interior of bones, especially the jaws, and are the least malignant of sarcomata.

4. *Glioma.*—Virchow has described a peculiar form of sarcoma, which is found in nerve structures—chiefly in the retina and brain—as *glioma.* It occurs in the connective tissue framework which supports the nerve tubes, and is characterized by the presence of a number of small round cells, embedded in a very faint homogeneous intercellular substance. Though locally malignant, they rarely generalize.

FIG. 26.



Myeloid cells from a myeloid tumor of the upper jaw, removed by Sir W. Fergusson, Nov. 24, 1855. In color and consistence it exactly resembled human kidney.

FIG. 27.

Glioma.

5. *Alveolar sarcoma* resembles cancer in having a well-marked alveolar stroma; the microscopic distinction rests upon the discovery of some intercellular substance between the individual cells. These are much more closely related to the stroma than in cancer.

6. *Melanotic Sarcoma.*—This (Fig. 28) as it occurs in man is a very malignant kind of sarcoma; the cells are usually spindle, but may be round;

FIG. 28.

Nodule of melanotic sarcoma in the true skin, King's College Museum.

dark brown pigment is seen in them and also in the matrix, but many cells escape. White horses are extremely liable to pigmented fibrous tumors, but possessing no malignant quality. Melanosis in man is very serious, generally beginning in the eye or in the skin, exceedingly liable to return after extirpation, and to be disseminated over the body; thus in a certain case it was found in skin, areolar tissue, muscles, pleura, lungs, heart, liver, mesentery, spleen, kidneys, and womb.

7. *Myxoma.*—In this, by some error of original development, or subsequent degeneration, that which should have become fat or connective tissue, becomes a soft gelatinous stuff like the umbilical cord, mixed with more or less sarcomatous growth. Probably the majority of myxomata are innocent; they are often classed with the fibromata.

Mixed-celled sarcomata, in which no form of cell predominates, are common.

Peculiarities which are reproduced in secondary growth constitute varieties —*e. g.*, *lipo-sarcoma*, fatty infiltration of sarcoma cells; *calcifying* and *ossifying* sarcoma. The latter changes occur in connection with bones, subperiosteal sarcomata frequently having a bony skeleton like that in Fig. 19, said to have belonged to a chondroma; these are most malignant growths.

Mixed forms occur—*e. g.*, chondro-, adeno-, myo-sarcoma. The latter are tumors of early life containing striated and non-striated cells, and occurring in the kidney or testis.

As regards *clinical characters*, the sarcomata are *malignant* growths. They occur for the most part in early and middle life, seldom (except in bone) in later life. They are rapid in growth, and infiltrate neighboring tissues widely; they therefore are very liable to recur *in loco* after extirpation. Their vessels having very thin walls into which tumor cells easily pass, they generalize usually by the blood rather than by the lymph stream; and secondary growths are, naturally, most frequent in the lungs. But, strange to say, sarcomata of the tonsil, testis, lymphatic glands, and some fasciæ generally infect lymphatic glands (Butlin). The degree of malignancy varies: it is most pronounced in the melanotic, and least so in the myeloid variety. Sarcomata may be extirpated completely and never recur, or may return *in loco* several times after operation, as the name *recurrent fibroid* indicates, and finally become disseminated in distant parts of the body.

C. Epi- and Hypo-blastic Tumors. Epithelial Growths.

Warts. Papillomata.—These hardly merit a class to themselves; they seem to be fibromata which have become papillary by the accident that they are on a free surface. They consist of a connective tissue basis which sends vascular papillæ toward the surface, each covered by more or less epithelium. Warts may spring from cutaneous, mucous, or serous surfaces. They are generally pedunculated and "papillary" on the surface, but dense epithelium may fill in the irregularities. On mucous surfaces the papillæ may be very long, delicate, and branching, covered by little epithelium and easily torn; they then bleed profusely—*e. g.*, villous tumors of bladder and rectum. They are often due to irritation, as seen in soot-warts on the scrotum, venereal warts on the genitals, and warts on the hands of workers in paraffin.

Papillomata are innocent, though they are very troublesome to get rid of, even by excision. Their epithelium is all on the surface; in epithelioma it has invaded the connective tissue. Warts may be starting-points of epithelioma; development or irritation of one after forty is ground for uneasiness and watchfulness.

GLAND TUMORS, ADENOMATA.

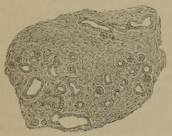
Adenomata are new growths of gland tissue, in structure more or less unlike that of the gland they spring from. Some appear to be mere hypertrophies of preëxisting structures.

Probably all glands give rise more or less commonly to a tumor of glandular nature, but some do so very rarely.

Adenomata are of two kinds: *racemose* and *tubular*. Of *racemose adenomata*, the common chronic mammary tumor may be taken as the type. It consists of acini lined by epithelium embedded in a fibrous stroma; slit-like spaces (ducts) also are seen (Figs. 29 and 30), but there is no efferent duct from the tumor and no evidence that it performs any function. The stroma may be largely infiltrated with round and spindle-cells (*adeno-sarcoma*), or consist of mucous tissue (*myxo-adenoma*).

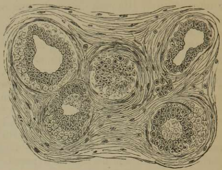
Dilatation of acini and ducts into cysts, which may be large and contain yellow or brown mucous fluid, is common, especially in oldish women. Into these spaces papillary growths may project from the walls. For clinical characters of these growths, see "Diseases of Breast."

FIG. 29



Adenoma, from a girl of sixteen. Showing arrangement of gland structure in fibrous matrix. × 50.

FIG 30.

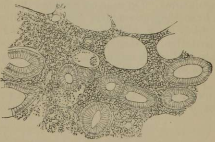


Adenoma. × 240 Cross-sections of acini, showing epithelial lining and nuclei of stroma.

Mucous glands (*e. g.*, of the soft palate) and the parotid may give rise to acinous adenomata; in the latter, the gland tissue is usually mixed with mucous, sarcomatous, or cartilaginous.

TUBULAR ADENOMATA.—As type of these may be taken the glandular polypus of the rectum seen in children (Fig. 31). The drawing shows

FIG. 31.



Polypus of rectum.

hypertrophied tubules, cut across, lined with columnar cells in a loose connective tissue stroma. Microscopically, it is impossible to distinguish between these growths and columnar epithelium.

Many ovarian tumors are of this type; also some mixed tumors of the testis.

CANCER, CARCINOMA.

Cancer may be defined as a new growth consisting of epithelial cells in the alveoli of a fibrous stroma: the latter being of secondary importance.

It invariably originates from epi- or hypo-blastic structures, and is characterized by the tendency of its epithelial cells progressively to force their way into neighboring connective tissue along the paths of least resistance (lymph-channels). As a rule, they infect the nearest lymphatic glands, and frequently distant organs also, by means of the blood-path.

Cancers are divided into groups according as they spring from the epithelium of skin or mucous membranes (*epithelioma*), or from that of glandular organs (*acinous cancer*). The cells of any cancer may undergo colloid degeneration, producing *colloid cancer*.

STRUCTURE. CELLS.—Any of the different types of epithelium (except ciliated) may be found in cancer, varying according to the source whence they spring: from the skin squamous, from intestinal mucous membrane cylindrical, from acinous glands more or less cubical. From the form of the cells, epithelioma is divided into *squamous* and *cylindrical*. Epithelial cells vary greatly in shape and size, and cannot thus be distinguished from mesoblastic elements, but they lie in immediate contact, separated by no matrix, their relation to the fibrous stroma is loose, and vessels never pass between them. There is usually a well-marked line between cells and stroma; but it may be obscured by a cloud of leucocytes which precede the advancing epithelial cells, and from which the epithelial cells have been supposed to spring. The epithelial cells grow in irregularly swollen branching and intercommunicating cylinders, the swellings forming probably at points of least resistance; hence the variety in shape of the alveoli.

The *stroma* is formed of connective tissue and bears the supplying blood-vessels. It consists of the original connective tissue of the part, generally much thickened by fibroid tissue apparently of inflammatory nature, derived from the round-celled infiltration which precedes the spreading edge of a cancer, and seems due to the irritation of the epithelial cells forcing their way along the lymph-paths. Two varieties of acinous cancer are based on the amount of stroma: *scirrhus* or *hard* cancer, when the stroma is dense and in considerable or large amount; *encephaloid* or *soft* cancer when there is but little stroma, and that loose.

Sooner or later the cells of all cancers undergo fatty degeneration, forming yellow areas on the surface of section: this may be from pressure of the multiplying cells upon the vessels, or from contraction of the stroma, or from an inherent peculiarity of the cells. In superficial cancers this necrosis leads to ulceration (p. 67).

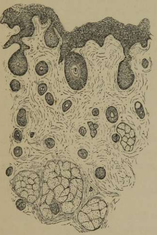
SQUAMOUS OR PAVEMENT EPITHELIOMA.

This form starts from skin or mucous membranes with squamous coverings. It may occur at any part of the skin, but is especially frequent at points of union of skin and mucous membranes, such as the lower lip, prepuce, vulva, anus; it is found also on the tongue, gums, cheeks, tonsil, œsophagus; on the vaginal surface of the os uteri, and in the bladder.

Epithelioma usually begins as a hard pimple or knot in the skin which soon ulcerates; or a fissure may be first noticed. It soon presents itself as an oval or roundish ulcer, with thick, hard, raised, irregular edge, a pale red or grayish warty base, which bleeds easily and discharges a thin, opaque, yellowish, foul, and often sanious fluid containing epithelial cells and débris. The surrounding parts are red, more or less swollen, and indurated for a considerable but very variable distance. The early ulceration, warty appearance, and induration are the special points in diagnosis; and to these must be added early involvement of lymphatic glands.

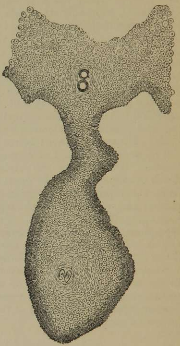
The very characteristic structure of epithelioma is well shown in Fig. 32, which represents a section through the lower lip. From the epithelium above the interpapillary portions are growing down into the connective tissue, and the cylinders can be followed for a short distance as such. Then their ramifications take them from the plane of section, or they cease, single cells are swept on, and fresh rods start; below they are frequently cut across, and show as dark circles, some with white centres. In the latter, epithelial evolution has gone on to cornification and the production of a "nest" of squamous cells. One of these, but not very typical, is shown in Fig. 33. In some squamous epitheliomata no nests form. The stroma is

FIG. 32.



Epithelial cancer. × 40. Columns of epithelium cut across at various levels in the corium. Mucous glands below.

FIG. 33.



Epithelial cancer. × 250. An ingrowing cylinder showing rudimentary nest.

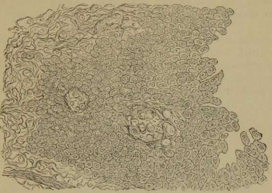
plentiful, and contains leucocytes in proportion to the rate of growth and ulceration. Fig. 34 is from a case of primary epithelioma of the tonsil, and shows invasion of the deeper structures by epithelial cells. The tonsil throughout contained similar ingrowths. Its gland structure was much altered and its stroma enormously hypertrophid (R. W. Parker).

To the naked eye an epithelioma presents a grayish-white granular surface on section dotted with yellow points which start out, like the contents of sebaceous follicles, when pressure is applied; the little cylinders consist of fatty epithelium.

Sometimes epitheliomata of mucous surfaces become markedly papillary, ulceration being slight; induration at their base distinguishes them from simple warts. Fig. 35 shows a papilla from the bladder, and Fig. 36 separated cells.

Rodent ulcer is a variety of epithelioma, occurs almost always upon the skin of the face—especially nose and eyelid—and usually as a pimple which is often scratched. It may begin between thirty and forty, but about fifty is more usual; is more common in men than women, and is characterized clinically by its very chronic course (even twenty to thirty years) and slight tendency to infect lymphatic glands. It spreads by slow invasion of neighboring tissues, and ulceration follows so closely upon infiltration, that the

Fig. 34.



Cancer of tonsil. × 240. Shows the great proliferation of epithelium and its invasion of the deeper structures.

edge is not much thickened. It destroys everything—bone, cartilage, eyeball—that it comes to, till the orbits and nose may form one cavity, with the brain pulsating at the bottom. Yet no gland will be involved, no internal organ affected, and the general health remains good for many years.

Fig. 35.

A representation of a papilla, or the apex of a granulation, found in the urine, in the case of epithelioma of the bladder. Internally it contained a loop of vessel; outwardly it was clothed with scales of exuberant epithelium. About 200 diameters.

Fig. 36.

Epithelial cells infiltrating the deep tissues of the lip.

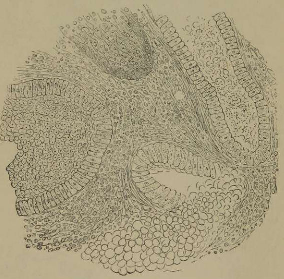
Microscopically the growth differs from squamous epithelioma in the small size of its cells, and the slight tendency to formation of nests. But some tumors on the face having the above history are, microscopically, typical squamous epitheliomata.

Columnar or Cylindrical Epithelioma.

This springs from mucous membranes covered with columnar epithelium and provided with tubular glands. It is by ingrowth of the latter into the connective tissue that the cancer originates. The rectum, large intestine, and uterus are its seats, but it may occur in the stomach, and very rarely in the small gut.

It forms prominent vascular growths which break down in the centre and present ulcers with firm, thick, irregular edges which overlap the surrounding mucous membrane. It is soft, pinkish-gray, and semitranslucent in section, and often striated vertically to the surface. It consists of tubules lined by columnar epithelium, just like crypts of Lieberkühn, but often much larger (Fig. 37). The stroma is soft and round-celled. In tumors of rapid

FIG. 37.



Cylindrical epithelioma of the rectum. × 350.

growth the tubules are imperfectly formed and the cells small. The lumina in some growths become completely filled up, and a section then resembles one of acinous cancer.

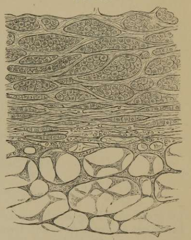
These epitheliomata are very liable to colloid degeneration, infiltrate surrounding parts, do not affect glands very early, and rarely generalize widely. Secondary growths in the liver are not uncommon.

Scirrhus and Encephaloid as seen in the Breast

Cancer of the breast will next be considered. The epithelium of its ducts is directly continuous with that of the skin, but it changes its character as it passes from the lactiferous tubes into the interior of the gland substance. Cancer, according to Billroth, begins in the acini of the gland by multiplication of the small round epithelial cells which line them, and by an infiltration of the surrounding connective tissue with leucocytes. The chief varieties are the *hard* and *soft* cancers, and, as before said, these variations depend on the relative amounts of stroma and cellular elements.

Scirrhus is characterized by the large amount of its stroma, which increases with the age of the tumor. It was to this variety that the word cancer was first applied, on account of a supposed analogy between the long fibrous prolongations of the stroma and the outspread claws of a crab. It occurs, for the most part, in the breast, but is found also in the alimentary canal, uterus, prostate, and elsewhere. Comparatively slow in growth, it is nevertheless malignant in all its tendencies—*i. e.*, it invades all structures with which it comes in contact, affects the lymphatic glands, and is carried by the blood to distant parts of the body.

Fig. 38.



Scirrhus of breast. × 240. Showing the alveoli filled with epithelial cells, and the commencing infiltration of the fat with leucocytes.

Fig. 38 represents an average scirrhus of the breast. It consists of a fibrous stroma, the alveoli of which are filled with very granular epithelial cells, many undergoing fatty degeneration. The drawing shows also the spreading edge of cancer, preceded by irritative round-celled infiltration of the fat and fibrous tissue, which it is invading (p. 141). Cancers are not encapsuled; though fairly defined to the naked eye, the microscope shows the true state of matters.

Scirrhus cuts crisply like potato or cartilage. Its surface of section is often slightly cupped, and has been likened to that of an unripe pear, being gray, slightly tinged with pinkish-yellow, and marked with streaks and patches of distinct yellow from fatty degeneration. The section yields, on gentle pressure, a copious juice of a milky character, readily miscible with water. This contains abundance of cancer cells (Fig. 39), which, like the epithelium of

Fig. 39.

Cancer cells traced with the camera ; magnified 200 diameters. *a*, nuclei ; scale of 0.001 inch.

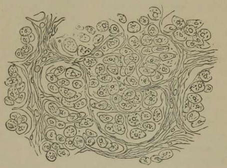
the bladder, present great variety of form and size, and usually contain a very large oval nucleus, with one or two nucleoli. The largest are found in old slowly growing scirrhus, smaller and less perfect ones in the more rapidly growing encephaloid.

The cupping is due to the contraction of the newly formed fibrous tissue, as also, most probably, is the fatty degeneration of cells. This shrinking leads to important clinical signs—*e. g.*, *retraction of the nipple*, by fibrous tissue developed along the ducts. Chronic inflammations may obviously produce the same effect. *Puckering of the skin* wherever invaded by cancer is another result.

10

CANCER "EN CUIRASSE."—This is so called because it converts the skin of the chest into a hard and rigid mass inflexible as a breast-plate. It begins in the form of small nodules in the skin, which spread round about the primary focus, enlarge, and coalesce. Generally it occurs after extirpation of the breast. Internal organs are not very frequently affected. In consequence of its tendency to spread and to contract, the breathing becomes much interfered with, and death may result from this cause. The disease is chronic; it is allied to those forms known as *atrophic scirrhus*, characterized

FIG. 40.

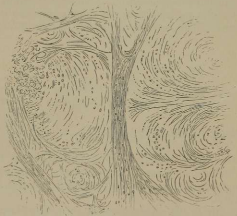


Medullary cancer.

by great shrinking of the breast and long course—eight to twelve years being not uncommon. Both forms give rise to crater-like ulcers which discharge a very fetid ichor.

Encephaloid, or *soft acinous cancer*, differs from scirrhus chiefly in the rapidity of its growth, and the consequent preponderance of its cellular

FIG. 41.



Colloid cancer of stomach and omentum. × 240.

elements. Indeed, it is often made up entirely of cells, the amount of stroma being almost inappreciable. Fig. 40 represents a typical case; the large size of the cells, their number and arrangement, and the small amount of stroma, contrast with the scirrhus shown in Fig. 38. It must not, however, be supposed that they are radically distinct; the differences between them are simply due to the rapidity of growth, perhaps also to the age of the patient attacked. Many cases present intermediate stages between the two forms, and the deposits which are found in internal organs, secondary to primary scirrhus of the breast, are often of the encephaloid variety.

When cut into, degenerate parts resemble brain-matter, and hence their name; but the growing parts are pinkish-gray and translucent. Hemorrhages into their substance are frequent. Fibrous bands are rare or absent in the section, which is probably convex and soft.

Colloid Cancer.—Cancers are very liable to retrograde changes, of which the most frequent is fatty degeneration. Few are free from this. Another form, not unfrequently met with, is colloid or gelatiniform degeneration. In this form the protoplasm of the cancer cells becomes converted into a substance called colloid (glue-like).

Fig. 41 represents alveoli containing the colloid substance. The individual cells have been converted into colloid masses, which have coalesced, and the intercellular substance has atrophied and formed cyst-like dilatations, in which the colloid has collected. Colloid cancer is most frequently found in the stomach (pylorus) and rectum, occasionally in the breast. It is generally rapid in growth.

Sarcomata also may undergo this degeneration.

TREATMENT OF MALIGNANT GROWTHS.

The only treatment that holds out any chance of success is *early and complete removal of every abnormal cell*—one left behind probably means recurrence. This statement shows implicit faith in the local origin of malignant tumors (p. 126), and is justified by the results which surgeons have of late years obtained in the treatment of such cases by earlier and more radical operations. These have been planned in the belief that it is necessary in all cases of cancer, and in those special ones of sarcoma (p. 136) which generally involve glands, to remove not only the whole primary growth, but also all the glands which receive lymph from the affected part, whether they can be felt enlarged or not. These operations are more difficult and much more extensive than the older kind, and the immediate mortality from shock has risen in consequence; but in disease of this kind it seems right to advise a patient to undergo an operation of greater, rather than one of less, danger, when the former holds out the chance of cure against the palliation of the latter.

But palliative operations also are required when cases have gone too far for cure to be thought of. A patient's last days may be rendered easy by the removal of an extremely painful or foully ulcerating growth, death from recurrence in internal organs being often comparatively easy.

Caustics are employed in the treatment of malignant disease only under special circumstances, as when, after clearing out an orbit, it is thought well to cause exfoliation of the bones lest they be infiltrated by growth. Sometimes, too, they are used to destroy extensive growths, like rodent ulcer, which are known not to be very thick. But they are very uncertain weapons and intensely painful, the pain lasting even for days.

The acid nitrate of mercury, F. 333, arsenic, and chloride of zinc, are the most useful. Arsenic is generally employed in the form of *Mance's paste*, composed of fifteen grains of white arsenic, seventy-five of cinnabar, and thirty-five of burnt sponge, made into a thick paste with a few drops of water. There is danger of arsenical poisoning, especially if the paste is used timidly. Chloride of zinc is made into a paste with three or four parts of flour and a few drops of water. Sometimes a mass of cancerous tissue may be destroyed by inserting into it small lozenges or *stilets* composed of chloride of zinc, oxide of zinc, and flour make into a putty with water and baked till hard. Sir J. Y. Simpson recommended dried and powdered sulphate of zinc made into a paste with a few drops of glycerine. Whichever is employed should be thinly spread on the surface to be destroyed, and covered with cotton-wool. We may observe that the *skin* should never be attacked with these caustics, only an ulcerated surface.

Other remedies to check the growth of cancerous tumors—congelation, firm compression, powerful astringents, and tonics—have been tried repeatedly, but in vain. A good but light diet and light tonics, and especially the preparations of iron and quinine, may be used at the surgeon's discretion to keep up the appetite and combat the cachexia. F. 8, 10, 25, 153.

The smell of most malignant ulcers can now be kept within bounds by the use of antiseptic powders, lotions, and wool dressings. Pain may be relieved, sometimes by the section of sensory nerves, sometimes by the application of anodynes (F. 238–240), including lead lotion, sometimes only by opium given freely by mouth or subcutaneously.

It is a singular fact, that with some patients certain preparations of opium disagree violently without relieving pain, whilst other preparations relieve the pain and agree perfectly. Many patients can take only morphia, others find the solid opium or the purified extract best. Battley's sedative solution of opium, Squire's meconate of morphia, the black-drop, and other special preparations may have to be tried in turn.

As *local applications*, before ulceration, fine cotton-wool, belladonna plaster, and chloroform liniment, relieve the neuralgic pain.

CYSTIC TUMORS AND CYSTS.

Cystic tumors are such as contain cysts; and a cyst is a cavity containing fluid or semifluid stuff. These structures vary greatly in pathology, and are grouped simply for convenience.

They may be grouped into the following groups:

1. *Cysts from dilatation of spaces*, preëxisting or newly formed, on account of irritation and excessive secretion. Such are enlarged bursæ, ganglia, hydrocele, and that form of ovarian cyst due to dilatation of the Graafian follicles. Hemorrhage may occur into these, rendering the fluid red, brown, or treacly.

2. *Cysts from retention* of the secretion of a gland from obstruction of its duct. Such are sebaceous cysts, mucous cysts, galactocele, encysted hydrocele.

3. *Cysts of New Formation.*—1. *Serous cysts* formed by effusion into areolar spaces, often at points of irritation and gradual blending of the spaces into one—*e. g.*, false bursæ. 2. *Blood cysts* (*a*) from extravasation into healthy or morbid tissues, formation of fibrous tissue round the collection and absorption of more or less of the coloring matter and fibrin; these are common in brain and in malignant growths. (*b*) Rare tumors occur in the neck containing fluid blood; when this is drawn off they refill rapidly; some communicate with large veins, in others the pathology is obscure. 3. *Degenerative cysts.* Generally from mucous softening occurring in cartilage and fibrous tissue. 4. *Cystic tumors.* Such as ordinary ovarian tumors, and cystic growths of the breast and testis. The warty growths which often project into and even fill or burst out of the cavities of such growths have been mentioned.

4. *Cysts Due to Developmental Errors.*—The chief are *Dermoid cysts,* due to inclusion of a portion of epiblast which goes on to develop skin, with its glands and dermoid appendages, as hair and even teeth. *Unobliterated fœtal structures* may become distended with fluid—*e. g.,* the funicular process of peritoneum, and the remains of the Wolffian body in the broad ligament (parovarium).

5 *Parasitic Cysts.*—The chief forms round the echinococcus, described in Chapter XIX.

The cysts of each part and organ will be referred to in part III.

CHAPTER XI.

SEPTIC DISEASES OF WOUNDS.

We have already pointed out the reason of the great difference in results which exists between simple and compound injuries; it is that the latter are open to infection by organisms from the air, dressings, hands, etc. Of these organisms certain, and especially those of putrefaction, are non-pathogenic; but these flourish in the wound discharges, and produce many phlogogenous and pyrogenous bodies. Others again, apparently less commonly present than the organisms of putrefaction, are pathogenic, and excite local or general infective diseases. Our knowledge at present is insufficient to decide positively to which class certain diseases belong. The present chapter will deal with a group of diseases of wounds due either to putrefaction of the discharges (non-infective), or to the entry into the body of pathogenic organisms (infective).

Diseases due to the irritation or absorption of *septic products* are—ordinary inflammation, already considered; septic traumatic or wound fever; hectic fever; septic intoxication. These three varieties of fever are believed to be due to the absorption of poisonous bodies produced by the growth of septic organisms *in the wound discharges,* and, consequently, *external to the tissues.* In the two former the quantity absorbed is small or moderate, and the absorption continues for some time; in the latter a large quantity is rapidly taken into the system, and often the absorption continues until death is produced. They all require an absorbing surface of considerable extent, and are greatly favored by accumulation of the decomposing discharges under pressure. Healthy granulations seem to prevent the absorption of septic poisons, the temperature in wound fever falling so soon as granulation and suppuration set in—*i. e.,* usually the fourth to the sixth day; but this action of granulation tissue is not understood, for it certainly absorbs soluble putrid poisons, and even charcoal powder laid upon its surface. Clinically, however, the coincidence of granulation and fall of temperature in spreading inflammations and septic traumatic fever is marked.

There are apparently several *infective diseases* of wounds, judging from their clinical course, which is that of an infection of neighboring or distant parts, or of the blood from a wound; from the fact that some of them are very infectious, and all are probably communicable from man to man; and also from their resemblance to infective processes experimentally produced in animals. Organisms have been found in all, but in only one (erysipelas) have they as yet been proved to be the cause of the disease.

Infective diseases which are apparently *local* are erysipelas, wound diphtheria, hospital gangrene, spreading traumatic gangrene.

Lymphangitis and spreading traumatic phlebitis, diseases showing that the poison is passing from the wound along the lymphatics or veins, intervene between the local and the *general* infective diseases—septic infection and pyæmia.

Erysipelas, hospital gangrene, pyæmia, and septicæmia were formerly spoken of as *hospital diseases*, the belief being that they were engendered by hospital atmosphere, or air rendered noxious by the overcrowding of patients with septic wounds, and that, with the exception of erysipelas, they arose in this way only.

The effect of crowding more than a certain number of patients with wounds into a place of any given ventilation capacity has been again and again proved to be the generation of pyæmia, septicæmia, and hospital gangrene. These actually originate under such circumstances, as shown in military hospitals in time of war. It cannot be doubted that conditions which will produce disease will tend to maintain it; consequently every attention must be paid to ordinary hygiene, and especially to free ventilation, with a view to the prevention of these maladies.

Erysipelas is probably as common out of hospitals as in them; the other three are much commoner in hospitals, and hospital gangrene is very rarely met with elsewhere. All these diseases are probably communicable from patient to patient, two of them very markedly so; and probably they are also infectious or communicable, without contact or inoculation, through the air. Now, the conditions in hospitals where patients are massed together, attended by a few people, are obviously most favorable to carriage of disease from one to another; and when, as formerly was the case, no precautions were taken against this (*e. g.*, by purifying the hands), or against spread of infectious disease by isolation of an affected patient and thorough disinfection of the ward and furniture about him, it is easily conceivable that, once introduced, the causes of these diseases should be ever present, ready to act whenever conditions were sufficiently favorable. It is impossible to apportion to these two factors their proper share in the generation of "hospital" disease. The more perfect the antiseptic system of a hospital, the less possible will it be for infective diseases of wounds to appear. But in time of war, asepsis is very difficult to attain and maintain, and in civil practice many wounds are necessarily septic, so sporadic cases will continue to occur.

Prevention of Septic Disease.—The first point is attention to *general hygiene*. Every wounded man should have a space of two thousand cubic feet to himself; the measurement in height in this calculation must not exceed twelve feet. The air in this space must be changed from two to three times in the hour, so that four thousand to six thousand cubic feet are supplied for each patient. Every precaution should be taken to prevent the accumulation of excreta and other refuse in the ward or in the vicinity of the hospital. The maintenance of the strength of the patients by proper diet is most important.

Next comes the *hygiene of the wound*, the object being, as far as possible, to prevent fermentative processes in the discharges by antiseptic treatment.

And, lastly, every precaution should be taken to prevent the carriage of any infection from one patient to another. Before passing from one case to the next, the hands of any dresser or surgeon should be thoroughly purified in sublimate solution; and nothing capable of carrying infection should be used for two patients without proper disinfection. Sponges should not be used in wards, but rags or wool steeped in antiseptic lotions; these should be burnt after use.

Directly a case of infective disease occurs, the patient, with all his belongings, should be isolated. Bed furniture should be removed with the patient, and the floor and walls, if possible, round about the patient be scrubbed with sublimate solution or carbolic. Before the patient can return to the general ward, after recovery from the disease, he should be well washed with soap and water, and then sponged with sublimate solution or carbolic—one part being finished and dried and then another taken up. His mattress (straw) should be destroyed, the bedding disinfected by boiling for two hours or by steam superheated to 105° C., and the bedstead and furniture thoroughly washed with sublimate.

Erysipelas (Cutaneous).

Definition.—An infective febrile capillary lymphangitis due to the presence in the lymphatics of certain micrococci.

Causes.—Fehleisen (D. Ætiologie d. Erysipels, 1883) purified superficially and excised bits of erysipelatous skin and placed them on peptonized gelatine; he obtained a growth of micrococci (*M. erysipelatis*), which he cultivated through thirty generations in two months; he then inoculated eight patients, and seven developed typical erysipelas; he also inoculated successfully a number of rabbits.

With regard to predisposing causes, erysipelas is certainly favored by unhygienic conditions, such as the crowding together of patients with septic wounds; but it may occur under the most favorable circumstances. It hangs about particular beds in hospitals, and this has sometimes been found to be due to the proximity of a foul closet or an ash-bin. Weather, *per se*, has little influence. It is occasionally epidemic, and frequently endemic in old hospitals.

Pathology.—Micrococci in chains occupy the superficial lymphatics of the skin where the rash is spreading; inflammatory œdema, with more or less corpuscular infiltration, is also present. It is doubtful whether the coccus can enter otherwise than by a wound.

The *period of incubation* is fifteen to sixty hours or less; and an attack probably confers no *immunity*.

Symptoms, General.—The *onset* is sudden, marked by a rapid rise of temperature to 102° to 104°, with chills, or, less often, a rigor, nausea, or even vomiting, and all other signs of fever. The *fever* is, as a rule, continuous, but sometimes remittent, and occasionally of inverted type; it may be high, with little rash, and *vice versâ*, but generally rises when the rash spreads. Delirium, either violent or muttering, may be due to fever and idiosyncrasy or to meningitis. In some cases and in some epidemics typhoid symptoms occur; diarrhœa sometimes; albuminuria occasionally.

Local.—The *rash* spreads from a wound, which may be a mere crack in the skin, or may even have healed when the case is seen. It is often not characteristic at first. When spreading, the rash is bright red, disappears momentarily on pressure, has an edge which is well defined to the eye and slightly elevated above the surrounding skin; the part is distinctly tender, and the seat of burning or smarting pain; the nearest glands are swollen and tender, and, upon the limb, often connected to the rash by streaks of lymphangitis. The rash may be bluish, or so pale, in cachectic patients, as to be difficult of recognition. It often skips points where the skin is tightly bound to subjacent bones. Where the skin is loose, great œdema is produced, and the part becomes pale. Not uncommonly the œdema fluid raises the cuticle in vesicles or large bullæ, which dry and peel off; they may leave superficial ulcers. Desquamation follows subsidence of the rash. Abscesses are uncommon, but may be numerous in the affected area and glands. Sloughing of skin is rare. The rash may spread on to mucous membranes. Arthritis, meningitis, pleurisy, and peritonitis are rare complications, and generally of erysipelas of the skin over the membrane affected. Pyæmic symptoms and lesions may occur with erysipelas.

The rash may last two days to three or four weeks; generally six to ten days; relapses are common. It may spread but little (E. fixum), or wander extensively (E. migrans), or spring from part to part.

PROGNOSIS.—See "Fever." Young children and the aged, weak, and intemperate, bear erysipelas badly; so also patients with albuminuria. The above complications and involvement of the fauces are very grave. The return of suppuration in wounds is a favorable sign.

TREATMENT, GENERAL.—See "Fever."

LOCAL.—At the very onset, some have obtained good results by injecting three per cent. carbolic solution round the patch at intervals of two inches. One gramme is injected at each spot, and the patch should be small enough to be surrounded by six to eight injections. Repeat in twelve to twenty-four hours.

The skin may be rubbed with oil of turpentine, or fomented with one in twenty carbolic (cold). La Valette recommends rubbing in *well* twice daily a thirty per cent. solution of perchloride of iron after all grease has been removed by soap and water from the skin. Bromine applied in vapor or solution acted well in the American war; also creasote upon a cloth. Assiduous fomentation and the use of glycerine and belladonna are useful. In slight cases the part may be covered with cotton-wool and oil-silk.

Puncture with a lancet may be necessary if the œdema is great and tends to cause sloughing.

Solid œdema of a limb, left by the rash, may be relieved by bandaging; but in the face it is hard to remove.

CELLULO-CUTANEOUS OR PHLEGMONOUS ERYSIPELAS.

This is the name given to a diffuse inflammation of the subcutaneous tissue tending to run on to suppuration and sloughing. The skin is involved secondarily, and does not present the true erysipelatous rash. Micrococci are found in the tissues, as they are in most intense inflammations. There is no evidence to show that they are *M. erysipelatis*. The disease is not infectious like true erysipelas; but it is almost certainly inoculable, and against this every precaution must be taken.

The inflammation commonly follows quickly upon injuries, especially contusions with slight abrasion, such as are common from falls on the elbow, or wounds of the fingers or hand; it may arise without obvious cause, or from the injection of some irritant, as urine, among the tissues.

SYMPTOMS.—A part, generally a limb, swells rapidly with considerable fever, and all the signs of a severe inflammation. The skin is deep red, dying away at the margin; the part, at first markedly œdematous, becomes firm, tense, brawny, and the seat of pain corresponding to the tension. Bullæ containing serous or sanious fluid are common. If the disease runs on, the skin becomes darker or bluer at one or more spots, and here the hardness and tension change into *bogginess* or *doughiness*, fluctuation being scarcely apparent because the pus is rarely well circumscribed, but infiltrates the subcutaneous tissue, which frequently sloughs in large pieces. If the fascia is opened by the original injury, suppuration and sloughing may affect the intermuscular planes, and the presence of pus is then still more difficult to detect. Sloughing of skin, fascia, and large shreds of areolar tissue are common; occasionally joints are opened and suppurate, or bones necrose. Cases of this kind are very prolonged, the discharge often profuse; the fever, high at first, becomes hectic after opening of abscesses, and the prognosis as to usefulness of the limb may be so bad, that amputation may be required. Death may occur early from septicæmia, later from pyæmia or hectic.

Treatment.—In the earliest stage good results will be obtained by washing the wound, if there be one, with sublimate solution, powdering it with iodoform, and applying Gamgee's compression treatment (p. 64); and this may be used if a single abscess is present. It should be opened freely and salicylic wool applied over it.

But in the more serious cases where frequent examination is necessary to detect boggy softening as early as possible, assiduous fomentation (boracic if there is a wound), the use of glycerine and belladonna, and frequent local warm boracic baths are most to be relied on. Of course any wound must be disinfected and thoroughly drained, openings through deep fascia especially being enlarged.

Incisions are frequently necessary in phlegmonous erysipelas. When the swelling is great, hard, tense, resisting, and increases rapidly; when the pain is severe and throbbing; when there is the least sensation of local softening and bogginess; or when the skin is becoming livid or dusky, or covered with livid vesicles, they are imperatively demanded. They are absolutely necessary for the discharge of pus and sloughs; for, as James observes, these matters are neither brought to the surface by pointing, nor walled in by adhesion. And they are not merely apertures for the discharge of matter, but a very effectual means of cutting short the inflammation, by relieving the tension. They are requisite in diffuse cellulitis of the neck (*angina Ludovici*), also when great swelling threatens suffocation by pressure on the trachea. They should be made of moderate length, one or two inches, in as many places as required; they should be carried down to the deep fascia ordinarily, through it if there is much deep swelling, and should be repeated as often as necessary. Several short incisions (one to two inches) heal sooner and are more efficacious than fewer long ones. They should be carefully placed to relieve tension; an anæsthetic should be given, a tourniquet applied, and vessels tied or general bleeding controlled by finger-pressure, otherwise much blood may be lost. Antiseptic fomentation should then be continued.

When spread is checked, attention must be given to drainage and to keeping the discharge as sweet as possible. Wool dressings are very useful in maintaining rest; but so far as is possible regular passive movements of all joints concerned should be practised after granulation has begun, to limit that matting of muscle and tendon which is so difficult to undo.

Spreading Traumatic Gangrene (G. Foudroyante).

This is the most intense form of cellulitis known. It runs on rapidly to gangrene, and the parts putrefy as rapidly as they die, the gas accumulating in the tissues. Passing from above down in the limb, all the stages of inflammation from simple œdema to a markedly hemorrhagic exudation will be met with.

Causes.—This form of inflammation develops within two or three days of a compound injury, before granulation is established. The injury is generally contused, and often fractures bones or opens joints, especially of the foot;

it may be only a prick. Within a very few hours the blood in the wound may be most offensive, and imperfect drainage has doubtless much to answer for. Active bacteria in great numbers are found in the fluids of the part, and sometimes also in the urine, but their relation to the process is unknown. The disease is not infectious in the ordinary sense, and does not arise specially under circumstances of overcrowding. It is obviously due to the entry of some virus, which multiplies and spreads very rapidly in the tissues, but only by continuity; putrefactive organisms enter also.

The *symptoms* are those of cellulitis, but the swelling is greater and spreads more rapidly than in any form yet described, involving the whole length of a limb in perhaps twenty-four to forty-eight hours; it advances most rapidly in the loose tissue around the great vessels of the limb, and when not too tense is characterized by emphysematous crackling. Redness is not marked on account of tension; but, before gangrene, a dusky, brown-red color, due to staining by extravasated hæmoglobin, appears upon the skin and marks out the lines of vessels. The part below the injury, whence the swelling extends upward, is pale and but slightly swollen. Pain is not great. Soon the red-brown color above the injury becomes purplish, the cuticle rises, the part becomes softer, moist gangrene is established and follows in the wake of the hemorrhagic inflammation.

General symptoms vary greatly; sometimes they are slight till near the end, and there is little fever; this is not uncommon at first. Strength is often well preserved even after gangrene has set in. In other cases there is severe fever, and the patient dies with all the symptoms of acute septicæmia. The urine is frequently albuminous.

Treatment.—If seen quite early, treat like severe phlegmonous erysipelas (p. 153). The incisions must be very free, going through the deep fascia, and carefully washed with chloride of zinc (1 in 12), boracic fomentations and baths of 1 in 40 carbolic may then be used. But should these measures fail, amputation should be done at the shoulder in the upper, high in the thigh in the lower limb. The flaps should be no longer than is absolutely necessary, the longest being from the outer part of the limb. Every endeavor should be made to get flaps free of œdema, as the chief danger is recurrence of gangrene in the stump, which is especially frequent in the lower limb.

Remove with scissors as much œdematous tissue as possible; rub the raw surface well with chloride of zinc (1 in 12), or sublimate lotion; and dust with crystals of iodoform; leave the flaps widely open for drainage and further application of antiseptics, and apply a light antiseptic dressing.

The *prognosis* is always very grave.

Croup of Granulations—Wound Diphtheria.

This term is very loosely applied to all cases in which a false membrane forms upon a granulating surface.

When granulations are acted on by a strong irritant, such as a blister, putrid discharge from a sinus, or urine, they become covered with a gray-white, tough membrane which is peeled off with difficulty and soon reforms. The wound does not heal, but, otherwise, the membrane does no harm. This is often spoken of as *croup* of granulations, the membrane being formed by coagulation of the superficial cells of the tissue and of the serum of the discharge. Antiseptic dressings, or caustic to the surface, generally cure.

In other cases, granulations here and there become pale and swollen, and, shortly after, hemorrhages form at these spots; further swelling follows, and a yellow patch dotted with hemorrhages forms. This soon bursts, a pulpy material comes away, and leaves a yellow-based, sharp-edged ulcer in the granulation tissue. Similar ulcers develop round about, destroying the granulation tissue and healing edges; if very numerous the patient becomes slightly febrile. This form is communicable from patient to patient, but not easily. If milder antiseptics fail, rub the surface with chloride of zinc (1 in 12). The ulcerous form of hospital gangrene begins as above sketched, and König thinks the two processes may be the same in spite of the mild course of the above disease.

Then in rare cases wounds are inoculated with the poison of *pharyngeal diphtheria*. The wounds become painful, discharge offensive serum freely, and are quickly covered by a flabby grayish membrane of variable thickness. The edges swell and become violet-red (Trousseau). The case resembles one of hospital gangrene, and many think that this is diphtheria of wounds. But in great epidemics of hospital gangrene, pharyngeal diphtheria does not occur with unusual frequency, and the attendants do not catch it; a wound inoculated from pharyngeal diphtheria does not tend to spread; diphtheritic paralysis has several times resulted in such cases, but this has never followed upon hospital gangrene. König therefore believes that, though very similar, the diseases will be found due to different organisms. The treatment is that of hospital gangrene.

Hospital Gangrene—Sloughing Phagedæna.

A local infective disease of granulating wounds which leads to gangrene of the granulation tissue and surrounding parts.

The *cause* is quite unknown; a wound is essential. The virus has been supposed to be that of true diphtheria; the reasons for doubting this are given above. Micrococci in chains and groups are found in the sloughs and even the living tissues, and in the former bacteria of putrefaction are more or less plentiful. Its name indicates its former prevalence in hospitals; in the Hôtel Dieu for two centuries so many of the patients with wounds suffered from it, that the surgeons were afraid to mention its true name, and christened it "pourriture." Much of this prevalence was due to contagion, for it is intensely contagious; possibly infection also acted. But many undoubted cases have originated quite unconnected with hospitals, especially during epidemics in these institutions. Its occurrence in any civil hospital nowadays would be regarded as condemnatory of its hygiene.

Pathology.—The virus seems to cause inflammation which very rapidly ends in death of the tissues; these in dying undergo coagulation, and thus form a homogeneous mass. Hemorrhages are common, large and small. Microscopically will be found, in typical cases, on the surface a homogeneous layer full of fine granules, many being cocci; then leucocytes often full of cocci appear, and then a fibrinous network. Leucocytes become more numerous, ultimately forming a dense layer, on the near side of which tissues become recognizable with leucocytes stretching away along the lines of least resistance. Even here cocci are seen in and among the cells. Sometimes the slough undergoes rapid putrid decomposition, when ordinary bacteria in numbers will also be present. The dead parts soften and come away with greater or less rapidity, and the amount of hemorrhage varies much, accounting for differences in the appearance of cases.

The disease is purely local at first, general symptoms being secondary, for, as a rule, the latter distinctly follow the local lesion. The progress of the gangrene is that of a local infective disease; if a patient has two or more wounds, only one shows the disease at first, and the others may be successfully protected against inoculation from it.

SYMPTOMS.—Three forms are described: *croupous* and *diphtheritic, ulcerous,* and *pulpous;* they pass into each other. In the first form adherent membranes form on or in the surface granulations, the edges at the time becoming red and painful; the ulcer does not as a rule increase in size, granulations either appear through the membranes in a few days, or the membranes soften and come away. But the membrane may extend to the edges, and deeply into the base, and be cast off in shreds, whilst the wound secretes a thin ichor.

The *ulcerous* form is more common, and begins as above described. The yellow foci with hemorrhages in them multiply and coalesce till the whole surface becomes covered by a raised, tough, pulpy, and firmly adherent mass of gray or yellow-red color; the slough has been compared to blanc mange, but is much tougher. It comes away, leaving an ulcer generally of circular form, with undermined, deep red, painful edges, looking as if they had been bitten. It may extend both superficially and deeply. The secretion is thin, free, and foul.

The *pulpous* form is characterized by rapid progress of gangrene, free hemorrhage into the tissues, and early putrefaction, causing further swelling up by gas of the slough, which projects from the wound, is soft, offensive, and grayish-red or red like softened spleen, or putrid fœtal brain (König).

In lax tissues rapidly progressing gangrene is more common than in dense parts. The necrosis may extend superficially or deeply. In the latter case it destroys the deep fascia, and extends along intermuscular planes, destroying them, so that in a few days in some cases a hand might be placed between any two muscles of the limb. At first, large vessels, like muscles, are spared; but ultimately they are eaten into or die, and profuse hemorrhage results. Bones necrose, joints are opened, and occasionally even body cavities.

At any time the sloughs may separate, the wound granulate floridly and heal rapidly, with contraction proportionate to its size; but spontaneous recovery is rare.

GENERAL SYMPTOMS.—There is fever of septic type, sometimes beginning with a rigor and temperature of 104° to 106°, at first continuous, then remittent. It is accompanied by the usual symptoms, and is most marked in the pulpous form. Pyæmia or erysipelas may supervene.

TREATMENT.—Look first to the safety of the healthy, by taking every precaution against spread of the disease.

Place the patient under the best possible hygienic conditions, and feed him generously and carefully.

The only reliable local treatment is to anæsthetize the patient, slit up every burrow and pocket into which gangrene has extended, so as to see clearly *all* the disease; if necessary to this end, almost anything may be cut through. Scrape and cut away all sloughs and inflammatory exudation. The affected surface must now be completely and deeply destroyed by Paquelin's cautery, or chloride of zinc used as follows: Cleanse the part thoroughly with sublimate solution; then stuff into the wound a layer of wool *wrung dry* out of chloride of zinc rendered just oily by addition of water. The wool is one cm. thick, or less, and remains in from five to twenty minutes, according to the depth to which it is wished to cauterize. An antiseptic dressing is applied, and pain relieved by morphia. The slough separates in three to ten days, and is followed by healthy granulations; or if gangrene reappear the treatment must at once be repeated. (König.)

Slight forms are treated by simply painting with the chloride of zinc.

Hemorrhage is specially dangerous when from small vessels; chloride of zinc will often arrest it. Ligature at the spot is very difficult, and generally fails from further sloughing, non-formation or destruction of clot, etc.

Ligature above is also very uncertain. Amputation may therefore be necessary; and if undertaken with the most stringent antiseptic precaution, the chance of recovery will certainly be much greater than formerly.

Septicæmia and Pyæmia.

Our knowledge of the essential nature of the diseases of man classed under these headings is as yet most imperfect; it is based entirely upon the results of experimental pathology. The diseases generally arise in connection with a septic wound; certain of them are characterized by the occurrence of *secondary suppurations*, whilst in others *no such complications* result. *Pyœmia* is now used to designate the former class, *Septicœmia* to designate the latter.

SEPTICÆMIA.

Definition.—*Septicœmia* is a general term for febrile diseases due to the absorption, from a wound, either of products of putrefaction or of micro-organisms which excite fermentative changes in the blood and tissues without causing secondary inflammations.

Experimenting with putrid fluids, Koch (*Infective Diseases of Wounds*, Sydenham Soc.) found that the injection of ♏v to ♏x beneath the skin of mice caused immediate illness and death in four to eight hours, or even less time, the earlier the larger the dose, whilst with small doses many recovered. Mice *inoculated* from the blood of an animal thus killed were in no way affected; and no organisms were found in the blood. The disease produced was evidently analogous to that due to injection of any poisonous chemical—*e. g.*, morphia; it was a simple chemical poisoning by the products of putrefaction, and consequently receives the name of *septic intoxication*. When the dose sank to ♏ ij, the symptoms of septic intoxication were absent; but after twenty-four hours about one-third of the mice sickened characteristically and died in forty to sixty hours. A mouse inoculated with a scalpel, the point of which had just touched the subcutaneous tissue of one dead of this disease, sickened similarly and invariably, and died in about fifty hours. Here we have a general infective disease; the infinitesimal quantity of poison introduced has multiplied enormously and penetrated all vascular parts. Microscopic examination showed the presence of immense numbers of small bacilli in the blood, and it was demonstrated that these were the cause and contagion of the disease, which is a *septic infection*. Similar diseases have been produced in many animals, and with regard to septic infection it has been found that a disease of this kind is produced by a different organism in different animals, and that similar symptoms may be produced by different organisms in the same animal—*e. g.*, the rabbit, in which three or four kinds have been described.

Examination of putrid fluids shows that the *bacterium termo*, a non-pathogenic fungus, is always present, and with it many other forms. These forms doubtless vary with the locality, certain ones being present in the air of some places but not of others; they vary in different stages of the process, some dying out and new ones appearing as the composition of the soil changes from the bacterial action which has gone on in it. The bodies formed are very numerous, and many of them are fever-exciting, others are phlogogenous, and others again possess both properties: the original composition of the fluid no doubt has its effect here. From various putrid fluids chemists have extracted bodies resembling alkaloids which are intensely poisonous, and which are called *septic alkaloids* or *ptomaïnes*—*e. g.*, Panum's *putrid poison*, Bergmann's crystalline *sepsin*, supposed to be *the* poison of septic intoxication, and compounds having physiological actions like those of curare, morphia, atropine, or strychnine. Very little is yet known of these bodies; but the above search instead of revealing a specific poison, has shown how complex and how variable the intoxication must be. The organisms present in putrid fluids are also very imperfectly known in their relation to man, and it is possible that several may be pathogenic, and capable of exciting a general poisoning without producing secondary inflammations.

The terms "putrefaction" and "putrefactive organisms" are, as the above shows, vague. Putrefactive or septic organisms apparently mean those capable of growing in fluids containing the offensive products which characterize putrefaction, and which seem due chiefly to the growth of *bacterium termo;* they do not themselves necessarily produce foul-smelling bodies. Cultivations of the organisms of septicæmia in animals show this. The bacterium termo, which is the cause of offensive decomposition, takes part in the production of septic intoxication but not septic infection.

Lastly, many organisms produce *unformed ferments,* like pepsin or diastase, which act without themselves multiplying and in the absence of living cells ; these may be factors in septicæmia.

We may summarize from the above, that there are two distinct processes included under septicæmia: *septic intoxication,* in which poisons manufactured by organisms *outside the body* are absorbed and produce disease; and *septic infection,* in which pathogenic *organisms enter the blood* and multiply, producing *in that fluid* and *in the tissues* the poisons which are the immediate cause of disease. Experimentally one or other of these can be produced ; but frequently mixed cases arise from absorption from wounds.

There can be no doubt that similar processes occur in man, judging from circumstances connected with their causation, and the resemblance of their symptoms and post-mortem signs to those of intoxication and infection in animals. But the etiology of cases of septic disease in man has not yet been worked out, and mixed forms are common. *Septic intoxication* may, however, be suspected when the fluids in a large body cavity, joint, abscess, or wound putrefy, and especially if they do so early, before the cavity is surrounded by dense fibroid or healthy granulation tissue. Imperfect drainage and accumulation of the decomposing fluid under pressure greatly favor its occurrence. Experimental intoxication runs a much more rapid course than infection, the poison being injected in one big dose; but in man the absorption, though often rapid, is somewhat prolonged, and the case is proportionately drawn out. *Septic infection* is certain when the disease arises from inoculation of a minimal dose of poison, as from scratches and small wounds during operations in septic cases, post-mortems in cases of peritonitis, etc. But the possibility of the entry of bacteria through a large wound, also, is obvious.

In surgery we need concern ourselves only with cases arising from wounds; but very rarely the poisons do enter through mucous membranes. We know nothing of how, after absorption, they produce the nutritive disturbances which result in fever and other symptoms. Hüter, from microscopic observation of the human lip, says that widespread capillary stasis occurs in these cases, the corpuscles running into clumps; perhaps half the capillaries in an area may be thus affected, and the circulation in the small veins is slow. The stasis varies much, affecting now these vessels, now those.

It is stated (Bergmann) that in both forms of disease white corpuscles are broken up; thus the tendency of the blood to coagulate is heightened, and actual thickening may result. It is believed that this, together with cardiac weakness, accounts for the above circulatory phenomena and for ecchymoses, etc., found post-mortem.

MORBID APPEARANCES.—The bodies putrefy early, the superficial veins becoming marked out by purple staining and offensive gas collecting in the body cavities and connective tissue. The blood is often dark and thick, and very shortly after death the lining membrane of the heart and great vessels will be found deeply stained by pigment of broken-down corpuscles. Subserous ecchymoses are common, especially on the back of the heart and on the lungs. Small, more or less deeply blood-tinged effusions into serous cavities, especially pleuræ, are frequent; also œdema and hypostatic congestion of the lungs.

All solid organs show "cloudy swelling." The intense catarrh of the intestinal mucous membrane, swelling of Peyer's patches, and even ulceration, common in animals, the submucous ecchymoses and blood-stained mucus in the bowel, are rare in man. The spleen is large, firm at first, but soon flabby and diffluent. The other abdominal organs may be swollen and full of blood. Sometimes yellow dots may be seen beneath the capsule of the kidney, due to degenerating round organisms in glomeruli. Organisms may be found everywhere; almost always cocci. The above in varying combinations make up the post-mortem appearances of septicæmia. No one point is constantly found.

SYMPTOMS.—The most important is *fever*. The onset may be gradual, but is generally sudden, perhaps ushered in by a rigor, which does not necessarily indicate unusual severity. The fever is usually continued, but may be remittent; it is sometimes interrupted by rigors, especially in the infective form. It is often very high, and may rise up to death, and even after; or it may sink rapidly, and be subnormal for a day or two before the end, being accompanied by all the signs of cardiac failure. All the symptoms of severe fever (p. 58) are present, and the tendency is toward the typhoid state. In the most severe cases, the temperature may be subnormal throughout the then very short course of the disease. At first there is often headache, but this is soon replaced by stupor which may pass into complete unconsciousness. In early stages the delirium may be violent, even homicidal, but it soon becomes quiet. Bilious vomiting is not uncommon; constipation is much more usual than diarrhœa; in rare cases choleraic symptoms have occurred. Albuminuria may occur. The skin is muddy, perhaps slightly jaundiced (hæmatogenous). Erythematous rashes may appear, some having the closest resemblance to that of scarlatina; perhaps they are sometimes scarlatinal, the disease having been contracted before operation.

The state of the wound at the onset of septicæmia varies greatly. In some cases it has been inflicted only a few hours, shows no inflammatory changes, and is not offensive. It may be very offensive, surrounded by spreading inflammation of all degrees of intensity; it generally shows signs of irritation, and lymphangitis is not uncommon. For septic infection the existence of offensive decomposition would certainly seem to be unnecessary.

The *prognosis* varies with *age*, being much more favorable in youth, bad after forty. Feeble individuals with degenerate hearts or nephritis are very bad subjects. The effect of the disease must be estimated as for any fever (p. 58).

TREATMENT.—Place the patient under the best hygienic conditions possible. Drain and disinfect the wound thoroughly. When the disease is connected with spreading inflammation, treat this by incisions or amputation, as before advised. The prognosis after amputation is always bad, but recoveries have been reported even when patients have been comatose at the time of operation. Septic intoxication, from fissured fractures into joints, and injuries which cannot be thoroughly exposed, is probably best suited for this treatment; but even with septic infection, the removal of the source of infection may have a good effect.

The internal administration of antiseptics (quinine, sulphites, benzoate of soda, salicylic acid) is of little value. Fever should be treated by the ice-cap or cold bath (p. 66). Starch and opium enemata control diarrhœa best.

Stimulants may be given freely to prolong a rapidly ebbing life, and perhaps to give other treatment a chance of acting. For diet, see p. 66.

PYÆMIA.

Definition.—A febrile disease starting almost always in connection with a suppurating focus, and characterized chiefly by a very irregular temperature of intermittent type, by more or less frequent rigors, and by the occurrence of secondary suppurations. The evidence of the last fifteen years goes to show that it is a general infective disease.

Etiology.—The origin and epidemic spread of pyæmia in overcrowded hospitals; its endemicity in old hospitals, where sanitation and asepsis have been little regarded; the large share that actual inoculation of one patient from another plays in producing epidemics and in rendering the disease endemic in beds, rooms, or hospitals, have been referred to (p. 150). A country practitioner may acquire a large operative experience without seeing a single case of pyæmia; but typical cases do occur sporadically, having no connection with a hospital, and in the open country.

To produce the essential phenomena of the disease we apparently require: 1. Some general poison (chemical) which shall excite increased tissue-change with its result—fever. 2. Some particular virus which, entering the circulation from the wound, is carried to, and arrested at, various spots, and there excites suppuration. The irregular rises of temperature are probably due to entry of fresh doses of poison or to their production in the blood; the falls to elimination of the poison.

Koch twice induced in rabbits a disease like pyæmia, by subcutaneously injecting a putrid infusion of mouse-skin. Post-mortem, diffuse suppuration spread round the puncture, and inflammation had extended to the peritoneum; the spleen was much swollen; the liver showed gray wedge-shaped patches; the lungs small, dark red, airless areæ. Animals inoculated from this one died of the same disease. Cocci were found everywhere, especially in obvious lesions; they formed colonies to which red corpuscles adhered apparently by coagulation, and these microscopic thrombi formed emboli.

No organism has been proved to be etiologically related to pyæmia in man. Attempts to produce the disease in animals by injection of pyæmic pus or blood have failed. But micrococci have been traced from wounds into the circulation, along both the lymphatic and venous paths, and they are constantly found in secondary suppurations. It is not known whether they are identical with the cocci of ordinary suppuration; if so, their sudden virulence remains to be accounted for. It is likely that more organisms than one fulfil the above acquirements—*e. g.*, those of acute necrosis, endocarditis maligna, erysipelas, and gonorrhœa.

Perhaps emboli of putrid clot, containing chemical irritants and non-pathogenic organisms, might excite secondary suppurations, giving rise to a pyæmia which would not be infective (Beck).

Pyæmia is said to affect weakly individuals less severely than robust; and children, in whom it is uncommon (excepting the umbilical pyæmia of the newborn), less severely than adults. It almost always starts from a suppurating lesion, but may arise before suppuration sets in. It begins usually in the second or third week, but may occur so long as the wound is open. The chronic inflammatory infiltration about strumous joints, ulcers, etc., seems to oppose entry of the virus, so pyæmia is rare in these cases.

Injuries of certain parts are exceptionally liable to be followed by pyæmia —*e. g.*, severe injuries of the bones of the head and limbs, large amputations, wounds of large joints, wounds and ligatures of large veins. The larger the number of large veins involved in an injury, and the less perfect the drainage, the more likely is it to lead to pyæmia should antiseptic treatment fail (see "Pathology").

Pathology.—There is no special tendency to decomposition. The body may be jaundiced. The blood is normal to the naked eye; it contains leucocytes in excess, and sometimes cocci are found, free or in white corpuscles. It does not stain the endocardium and large vessels.

Veins.—One or more veins in immediate relation with the wound are usually thrombosed for a greater or less distance; the clot is undergoing *puriform softening* and breaking down at its central end, particles of it having been swept away in the venous current. Around the vein there is often a good deal of septic inflammation; from this focus cocci pass into the thrombus, causing it to soften and extend. The particles detached pass through the right heart into the lungs, and are arrested when they reach arteries or capillaries too small to permit their passage. If the artery is an *end artery*, infarction (p. 42) may follow; in the area deprived of circulation the cocci from the clot probably multiply and induce suppuration. Single cocci and small groups may pass through the lungs into the general circulation. Increasing in size and perhaps causing adherence of red corpuscles (Koch's experiments, above), the colonies may become arrested in small systemic vessels exciting the formation of miliary and larger abscesses; or they may be eliminated by the kidneys, in which greenish or yellowish streaks of cocci stretching from the pyramids into the cortex are frequent. The cocci lie in urinary tubules, also in vessels. They may excite suppuration before they can be eliminated. Similar streaks and dots may be found in other organs —*e. g.*, the heart.

In some cases the veins at the seat of infection are quite normal; the abscesses in the lungs must then be due to bacterial emboli, but evidence is wanting as to the exact mode of entry of the organisms.

It is not rare to find softening thrombi in veins removed from the seat of infection; these are probably excited by the pyæmic organisms.

Abscesses may occur in any of the viscera, in the subcutaneous, intra- and inter-muscular connective tissue; suppuration is frequent in joints and serous cavities. Only one organ may be affected, or several; the abscesses may be all visceral or all superficial. When the focus of infection is in the area of the portal system, the first abscesses are likely to be in the liver.

Visceral abscesses vary in size from a walnut downward. The larger are generally found on the surface of organs, the smaller are often scattered through its substance. Their mode of origin has been given. The larger abscesses are generally wedge-shaped on section, and form pale, firm, slight elevations on the surface, of yellow color, often surrounded by a ring of deep red. The contents may be thin or thick, gelatinous or shreddy pus.

Abscesses in connective tissue are often very imperfectly bounded, and accompanied by but slight signs of surrounding inflammation; they are often of large size.

Effusions into serous membranes and joints present all stages between serous and purulent. Joints filled with thin pus may look practically normal when this is washed away; in other cases the ordinary appearances of acute synovial arthritis with ulceration or necrosis of cartilage at points of pressure are found.

Visceral abscesses are very much more common in the lungs than elsewhere; next in the liver, and almost as often in the spleen; next in the kidneys, and occasionally in brain, eye, pancreas, parotid, etc. Subcutaneous abscesses frequently form at points of pressure or of injury. Any joints may be affected, those of the knee, shoulder, and ankle being the most common. It is said that serous membranes are affected in the following order: pleura, 4; meninges, 3; pericardium, 2; peritoneum, 1. ("Report of Committee," *Path. Soc. Trans.*, 1879.)

The spleen is swollen more constantly than in septicæmia, and is soft and pulpy.

Cloudy swelling of parenchymatous organs is constant.

Symptoms.—The onset of the disease is generally sudden and begins with a severe rigor. The temperature runs up to 104°–106°, the rise being the more astonishing if the patient was previously suffering from little or no fever. In the course of a few hours the temperature has fallen with profuse sweating, almost to normal, perhaps even to below normal. But it quickly rises again and becomes very irregular, the chart representing a series of sharp ascents and falls, having no definite relation to time and obliterating the normal diurnal variation. Every now and again the ascents are higher than usual, a rigor having occurred. This goes on till death; or before this the temperature may become subnormal, or it may rise to and even after death. As a rule, the temperature and rigors are very irregular; but the former sometimes forms curves which extend over two or three days, and are repeated again and again, and the rigors may recur as regularly as in malaria. Rigors may be entirely absent, the irregular temperature persisting; there may be only one (initial) or they may be very numerous. Sometimes after the initial rigor an almost apyrexial period of some days follows, leading to the hope that nothing serious is to happen; but another occurs followed by the typical temperature.

The pulse varies with the temperature, and becomes progressively smaller and more frequent as strength is lost. Respiration may be affected not only by the fever but by affections of pleura, lung, pericardium, or peritoneum. The breath often has a distinctly sweet odor.

The mental state of a pyæmic patient is clear and fully appreciative of danger, herein differing much from that of the septicæmic subject; nocturnal delirium occurs with exhaustion.

Digestive troubles would be expected from the fever; vomiting may occur, especially with rigors; diarrhœa is uncommon. The tongue shows a much less tendency than in septicæmia to become dry and brown; ultimately it generally does so, and sordes accumulate.

Albuminuria is common.

The skin becomes dull, muddy, and lax, as loss of flesh is rapid; often it is distinctly jaundiced, the color appearing first in the conjunctivæ. This may be due to the pressure of an abscess on a main duct, to catarrh of the bile duct, or it may be non-obstructive. Transient erythematous patches may appear here and there; or there may be an outbreak of vesicles or pustules.

Lastly, *secondary suppurations* develop. Many of the visceral abscesses cannot be diagnosed. In the lung, they are almost always too small to cause physical signs. A pleuritic stitch renders it likely that one exists; the preliminary infarction may cause a little blood-spitting, and rarely one has burst into a bronchus and been expectorated. In the liver they are often accompanied by jaundice; the organ may be swollen and tender, and irregular swellings have been felt. Tenderness is the only sign to go upon in the spleen and kidney, unless hæmaturia occur. The symptoms in abscess of the brain might permit of its localization. Inflammation of serous membranes may be recognized by the ordinary symptoms and signs; but these are often masked by the septic state in mixed cases.

Abscesses deep in limbs generally cause acute pain at first; so also does suppuration in joints, but some of these are found quite by accident. Subcutaneous abscesses are easily recognized, and often form without symptoms, especially at points of pressure or other injury.

The wound meanwhile has ceased to heal, and its discharge has become watery; parts that have healed may necrose, and clots closing vessels break down, leading to secondary hemorrhage.

Varieties.—*Acute pyœmia* is the common form, running its course in four to fourteen days; the chief symptoms, especially embolic abscesses, being well marked. It is almost always fatal; a very few cases of recovery are recorded.

Chronic pyœmia generally arises in connection with injuries of soft parts only, of the urethra, during gonorrhœa, or after parturition. The rigors are generally few, and long periods of slight fever come between the marked ascents. The abscesses are generally limited to the subcutaneous tissue and joints. From this form recovery is not uncommon, though the health is often ruined and joints destroyed.

Spontaneous Pyæmia.—In very rare cases an accurate search has revealed no breach of either a mucous or cutaneous surface by which the virus could have entered; it is still impossible to be certain that none existed.

As before mentioned, all the symptoms and pathological lesions of pyæmia may occur during acute infective inflammations like acute necrosis and endocarditis maligna. The virus in these diseases is capable of exciting suppuration and being distributed in particles by the blood stream; secondary abscesses result.

Newborn children suffer a kind of pyæmia which Roloff has named *umbilical*, believing that the virus enters by the umbilicus. The children are generally two to four weeks old, and there may be a history of sore and discharging navel; the fever is slight, but wasting and loss of strength rapid. The abscesses usually affect the subcutaneous tissue and joints; the joints lose their cartilage early. Pustules may appear on the skin. Frequently pus fills the portal vein from its trunk to the finest branches, though the umbilical may show nothing abnormal; in such cases an icteric tint is usual. Peritonitis may occur. The disease is very fatal. It has been suggested that some cases are due to inoculation of the navel with gonorrhœa at the time of birth.

Septicopyæmia.—It is rare to meet a case of pure pyæmia. As a rule, septic poison is absorbed also, and symptoms of both diseases result, rendering the diagnosis difficult or impossible.

Erysipelas and *pyœmia* may occur together; or erysipelas may present a pyæmic temperature and no secondary suppuration be found; or the erythemata of pyæmia may resemble erysipelas closely. Erysipelas may cause suppuration not only of joints and serous membranes over which it passes, but also metastatically. Cultivations of M. erysipelas, *injected into the circulation* of animals, caused suppuration of joints.

Prognosis.—In acute pyæmia, practically fatal. In chronic cases, in which the abscesses are superficial or in joints, there is hope in proportion to the strength of the patient, lowness of fever, absence of rigors, etc.

Diagnosis.—Has to be made from *ague* and *rheumatism*. Irregularity of temperature and rigors and the occurrence of secondary abscesses will clear up matters where there is any doubt.

TREATMENT.—This is the same as for septicæmia in general points. As to the secondary abscesses, the subcutaneous, glandular, and intermuscular should be opened freely as soon as possible, and a reliable antiseptic applied to their interior. In swollen joints without acute symptoms the fluid is often not regular pus, especially in puerperal cases (catarrhal suppuration); aspiration and injection with five per cent. carbolic will often cure, though the aspiration may require repetition. Should it fail, and in all more acute cases, free incision and antiseptic washing out with subsequent drainage must be practised.

Very rarely a deep abscess points through the skin; as a rule, it is amenable to no treatment.

Amputation has been successfully performed in cases arising in connection with osteomyelitis.

On the subject of septic diseases, consult—Koch, *Wundinfections-Krankheiten*, translated by W. W. Cheyne (Sydenham Society); Erichsen, *Science and Art of Surgery*, 8th edit., by Marcus Beck; König, *Lehrbuch der allgemeinen Chirurgie*; Hüter, *Grundriss der Chirurgie, allgemeiner Theil;* "Report of Committee on Pyæmia," *Path. Soc. Trans.*, 1879.

PART II.

INJURIES.

CHAPTER XII.

GENERAL EFFECTS OF INJURIES.

Injuries, besides local damage, produce general symptoms through the nervous system; also in many cases by loss of blood. Thus *shock* or *collapse*, which closely resembles ordinary *syncope*, is frequent. Indeed, there is one pathological condition sublying these states, viz., more or less complete loss of vascular tone leading to accumulation of the blood in the vessels and chiefly the great abdominal veins. The patient in these conditions "bleeds into his own veins." Under these circumstances the heart receives little blood from the veins—in the upright position perhaps none; further, influences which bring about the above loss of tone often depress the heart-action directly or indirectly, and perhaps stop it in diastole. The result of all is failure of blood-supply to the brain, most marked in syncope.

Causes.—Excessive stimulation of sensory nerves, such as occurs from major operations, or severe or extensive injuries, and especially from blows on the abdomen stimulating the centripetal fibres of the splanchnics, as in Goltz's Klopfversuch; injuries of the testis produce a specially powerful effect. Mental impressions—*e. g.*, fear of an operation, may cause even fatal syncope. Then we have the sudden removal of pressure external to vessels, as by emptying an abdomen distended by a full bladder, large tumor, fluid, etc.; the action of certain drugs, especially chloroform; and the effect of direct injury of the brain, as in concussion.

Delicate, nervous people, with over-wrought brains, are, as it were, predisposed to shock; the physically strong and healthy resist it. The very young and very old suffer severely, as also do the intemperate.

Symptoms.—These vary from momentary pallor, giddiness, and tendency to fall, up to death from arrest of the heart.

In well-marked shock the patient lies with his eyes closed, breathing lightly, but occasionally sighing deeply; questions are answered slowly but rationally, if at all, power of thought being slight; the muscular system is relaxed; the surface is pale, cold, and clammy, the extremities bluish; often the patient shivers, and complains of cold; there is nausea and perhaps vomiting: the pulse is quick and feeble, irregular or intermittent, perhaps imperceptible at the wrist, the heart-sounds weak and distant. The temperature in recto is commonly 96°–97° F., and may sink even 4° in cases that recover. Shock may not appear immediately after an injury, and it always deepens for some time, perhaps passing into insensibility and death.

Shock may last many hours without signs of *reaction*. Whilst it is severe no operation should be done beyond such as may be absolutely necessary for the arrest of hemorrhage and the prevention of sepsis of the wound. Chloroform is inadmissible in such cases; ether will probably strengthen the pulse.

TREATMENT.—Lay the patient down with no pillow, or a very thin one, beneath the head, and the feet somewhat raised; cover him lightly but warmly; place hot bricks or bottles close to him in the bed; rub the limbs with warm hands and stimulate the skin of the trunk strongly by sinapisms, turpentine stupes, or electricity; give hot coffee or brandy by mouth if the patient can swallow, and inject thirty drops of ether under the skin every half-hour; enemata containing brandy may be given. Later, if vomiting is troublesome, strong coffee, ice, iced champagne, or brandy and soda-water are the best remedies. The greatest skill, care, and patience are necessary in managing cases of severe shock.

DELIRIUM TRAUMATICUM.—Three kinds of delirium may follow injuries, independently of the light-headedness which may occur during the subsequent fever.

(1) *Delirium tremens;* this affects persons of intemperate habits and usually young or middle-aged adults.

The tongue is moist and tremulous, as also are all the muscles; the patient is totally sleepless, irritable, and answers questions in a peculiar sharp manner; is often anxious to call himself perfectly well; and, as the malady increases, becomes restless, impatient, and talkative; wishes perhaps to get out of bed, or attempts to injure his attendants, or becomes furiously maniacal. Often the delirium is mild; the patient is haunted by extravagant ideas and spectral illusions, especially of insects, etc., crawling about; or he is suspicious of every one; or fancies himself busied in his ordinary avocations, and talks perpetually about them. The pulse is rapid, face flushed, skin moist, tongue foul, breathing quick, and there are most signs of excitement without force.

The *treatment* consists chiefly in promoting sleep and administering plenty of fluid nourishment. There is no need for alcohol on the score of delirium tremens; but if in old or feeble patients the pulse fails rapidly, an endeavor may be made by free stimulation to keep the patient alive. At the commencement a purge is useful. Give bromide of potassium or sodium, gr. 20–30, every two hours, till sleep is induced, during violent, early delirium; smaller doses answer later; opium or morphia in frequent small doses, carefully watched, or belladonna, hyoscyamus, cannabis indica may be useful. Chloral is uncertain and dangerous in large doses.

Violence is better allayed by one or two kind, but firm attendants, than by straps and strait-waistcoats. The head should be frequently bathed with tepid water, the bowels be opened by mild aperients. If coma supervenes, counter-irritation by means of sinapisms or blisters to the scalp, feet, or calves of the legs, may be tried.

(2) The second form is the ordinary *mania,* of a mild cast. There are some persons of advanced life predisposed to insanity in whom the pain and excitement of any operation or injury, or even of any painful disease, are quite sufficient to upset the mental balance.

(3) The third kind is *hysterical excitement,* which the practitioner must be on his guard against, and will probably detect through observing the exaggerations and inconsistencies peculiar to that disease.

Lastly, there is one caution we must give the young practitioner who is called in to a patient with alarming symptoms following injury, or accompanying a sudden attack of disease. It is possible that the patient may have had too much brandy, and that some of the most alarming symptoms may be due to this alone. But though very drunk, he may also be hurt; and the surgeon's reputation is injured if a fractured skull is overlooked.

CHAPTER XIII.

SUBCUTANEOUS INJURIES—CONTUSIONS.

Injuries are divided into two great classes—(1) those without, *subcutaneous*, and (2) those with a wound of skin or mucous membrane, *compound*, by which they communicate more or less freely with the air. The importance of the difference has been shown.

Subcutaneous injuries are all such as are unattended by wound of the skin; or if there be a wound, it is slight and quickly healed. This definition includes *contusions* or *bruises; strains* and *sprains*—*i. e.*, rupture of ligamentous fibres by overstretching; *rupture* of *tendons* and *muscles; simple fractures* and *dislocations;* and such *wounds* as are made in tenotomy through small openings in the skin.

Of these, *contusions* and *bruises* are by far the most frequent. They are due to striking a part with or against some hard blunt object, the soft parts being squeezed between the latter and a bone, generally; less often the soft parts are pinched.

The soft parts resist such violence unequally. Skin is so tough, elastic, and movable over deeper parts, that it may suffer no rupture when all the parts beneath it are crushed and bones broken, as seen in buffer accidents. Connective tissue with its finer vessels are most easily torn; large healthy vessels escape by their toughness and elasticity; nerves, fasciæ, and tendons resist strongly.

Contusions vary from a slight bruise of the skin to complete smash of everything contained within it. In the slightest forms the smaller vessels only and the loose tissue round them are injured; the hemorrhage is slight and limited, but spreads for a short time. Next, a large number of small vessels and some larger are torn, and of course lesions of the tissues are evident. Lastly, all the soft parts may be crushed and the hard splintered. Gussenbauer finds that the tissue-cells escape injury largely in contusions. The number and size of the vessels torn are the most important points clinically. When a moderate number of fine vessels suffer, many hemorrhages form in the injured area; if very many are torn, circulation ceases at once, and hemorrhages form only at its periphery. Necrosis usually results.

Symptoms.—Extravasation of blood is the most important. Its amount varies with the driving force and the resistance offered to it. Bleeding continues until clotting closes the vessels, or until tension in the tissues equals the blood-pressure.

When blood is extravasated into the skin it may be seen as red, purple, or bluish points, or uniform *discolorations.* But in deeper parts its only sign is the more or less rapid formation of an elastic swelling, which may be very large and tense. A circumscribed swelling in connective tissue is called a *hæmatoma;* it fluctuates distinctly, and after a time has a firm margin from clotting. In *cephalhæmatoma* blood collects beneath the periosteum, usually of the parietal, and ossification goes on at the margin, forming a hard rim. A hæmatoma may pulsate either from communication or contact with an artery. In diffuse subcutaneous extravasations, soft crepitation is frequently felt on palpation.

Pain varies with the sensitiveness of part and patient. Main trunks of nerves may be bruised and anæsthesia or numbness produced; or pain radiating along their branches and into neighboring areas. A violent blow on a nerve may, reflexly, render a limb absolutely powerless. Motor paralysis may be due directly to nerve-injury or to bruise of muscles; it will be temporary or permanent according to degree of injury.

Shock.—Naturally varies greatly.

Aseptic traumatic fever (p. 57) frequently occurs with large extravasations; it is slight, usually continued, and over in a few days.

In subcutaneous and deep extravasations the coloring matter comes to the surface, perhaps after days, and soaks into the connective tissue widely. It undergoes very characteristic changes. In a superficial lesion the color on the third day is violet, and the margin, at first well defined, is faint and indistinct. About the fifth or sixth day the color becomes green; on the seventh or eighth, yellow; and it gradually disappears about the tenth or twelfth—sooner or later, according to the vigor of the individual, and the quantity of blood effused.

FATE OF THE EFFUSION.—*Absorption* is the most common, fluid and some corpuscles passing rapidly into the lymphatics, other cells breaking up and undergoing fatty degeneration previous to removal. The coloring matter is extravasated.

Large effusions are not uncommonly *encapsuled* by inflammatory tissue and organized clot. Most of color disappears, and a cyst of clear fluid may result, rarely the contents dry and calcify.

Bits of necrosed soft parts break down and are absorbed; so also some bits of dead bone are removed by granulation tissue, or they may become encapsuled.

Occasionally a subcutaneous effusion *suppurates*. Then commonly infection from without has occurred through excoriated and bruised skin, through a surface on which a bulla has risen, or through a necrosed patch; in other cases a septic wound exists elsewhere; but sometimes no such mode of infection is found, and we must suppose infection to occur through mucous membranes. The patient is usually unhealthy.

TREATMENT.—Rest and elevation in painful cases with increasing extravasation; in the latter case uniform compression over a quantity of wool acts well, or ice or cold compresses closely packed round the part.

To promote absorption, massage is highly spoken of; it distributes the extravasated material and forces it into lymphatics. Afterwards, stimulating liniments or evaporating lotions may be applied to the skin. For slight bruises on the face, such as a black eye, the application, by a brush or piece of lint, of brandy, spirits of wine, or the tincture of matico; or a solution of alum or tannin will often prevent the effusion of blood. If there is any injury of the skin likely to lead to formation of bullæ, or necrosis, disinfect it thoroughly and put the part up in an antiseptic dressing. With these precautions suppuration will not occur. In cases of effusions so tense as to threaten sloughing, or of others pressing on vital parts, the blood may be withdrawn by aspiration or evacuated antiseptically; and thus are to be treated cases of persistent non-absorption and of suppuration.

Subcutaneous division of large arteries will be treated under "Traumatic Aneurism."

If it is evident from the amount of damage to the deep tissues that circulation in the part beyond a contusion cannot be carried on, primary amputation must be done just above the bruise. If there is any doubt as to whether a part can live or not, give the patient the benefit of it; render the whole surface aseptic, wrap it up in a dressing and wait.

CHAPTER XIV.

WOUNDS.

Different Kinds of Wounds.

Definition.—A wound is a solution of continuity or separation of continuous parts, by violence, usually directed from the cutaneous or mucous surfaces, but sometimes from within the body, as by broken bones.

Varieties.—*Incised* wounds—made with sharp, clean-cutting instruments; *punctured*—made by instruments whose length greatly exceeds their breadth, including stabs and pricks of all sorts; *lacerated*—in which parts are torn; *contused*—made by blunt instruments and accompanied by bruising of the edges; and *poisoned*—in which some infective virus is inoculated upon the raw surface, are the chief varieties.

Incised Wounds.—In these the injury done to the tissues is most limited; only a microscopic layer of tissue on each side of the wound dies, so the edges may be regarded as living and ready to unite should nothing prevent. The symptoms of these, and of most wounds are—*pain*, *bleeding*, and *gaping* of the edges; the latter, in incised wounds, being sharp and regular. Each of these symptoms varies much. Any tissue or organ may be divided by wounds which extend through the body in all directions. Elastic or contractile parts, skin, artery, or muscle, retract strongly when divided; fasciæ, ligaments, and tendons not at all. The different parts divided are clearly recognizable when the blood is wiped from a recent incised wound.

Treatment.—The object of this is to secure the conditions favorable to healing—viz., close and permanent contact of the raw surfaces, and absence of all irritation. The general indications will therefore be: 1, to check bleeding *absolutely;* 2, to remove foreign bodies; 3, to bring the raw surfaces into contact and to keep them so; 4, to guard against all sources of irritation, mechanical, chemical, and—by far the most important—putrefactive and infective.

1. The *natural and artificial arrest of bleeding* will be described under wounds of arteries and veins. Here it need only be said that all bleeding should, if possible, have stopped before the wound is brought together, or its surfaces will probably be forced apart by clot, which may putrefy.

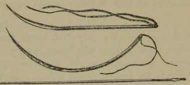
2. The *removal of foreign bodies—e. g.*, dirt, gravel glass—should be thoroughly effected by fingers, forceps, sponging, or irrigation with some antiseptic lotion.

3. To *bring the raw surfaces into contact and keep them so.* The parts must be so placed that the edges of the wound lie naturally in contact, or come as near together as they will; of course, they may gape widely from loss of substance. Supposing them to come together, they are brought into and kept in apposition by *sutures*. For rapid union it is most important that the edges be free from irritation, and consequently from tension; if, therefore, there is any possibility of this from weight or shortness of the flaps or from subsequent accumulation of discharges it is well to use two kinds of sutures—those of *support* (Fig. 44, *s.s.* 1, 2), of stout material widely set and put in half to one inch from the edges, and causing them just to meet; those of *apposition* (Fig. 44, *s.a*, *b*, *d*), finer, more numerous, and inserted close to the edges, so as to bring them into the most accurate apposition. The surgeon cannot be too careful in sewing up wounds if he wishes for quick healing. Experience must teach how much tension may be put upon a

stitch; if there be too much, it simply cuts out and no union occurs; bu with skilful use of sutures of support, widely gaping aseptic wounds may often be much diminished by immediate union at their angles.

Sutures are introduced by means of *needles*, straight, half curved, or semicircular (Fig. 42), the size being proportioned to the thickness of the thread;

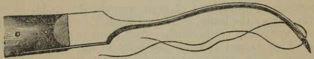
FIG. 42.



1. Curved surgical needles; 2. Fine steel pin for twisted suture.

the straight are the most generally useful. Sometimes needles (Liston's) of various curves and set in handles (Fig. 43) are needed. The *materials* for sutures are silver or iron wire, silk, catgut, and horsehair.

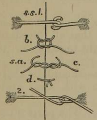
FIG. 43.



Liston's needle.

The chief *forms of suture* are: 1. *The interrupted suture.* A needle armed with a single thread is passed from the skin into the wound on one side of a cut and from the wound to a corresponding point of skin on the other. The edges are then drawn together, and a reef knot (Fig. 44, *b*) tied, without strain, on one side of the line of wound. The stitches are close in proportion to the accuracy of apposition required—perhaps only one-eighth of an inch apart.

FIG. 44.



Sutures. *s.s.* 1. Suture of support (the hooks of the wire are too widely open). 2. The mode of twisting the ends after beginning an ordinary knot. *s.a.* Suture of apposition: *b.* silver wire (fine) or silk, tied in reef knot. *c.* horsehair with double twist in first stage. *d.* Suture tied.

2. The *continuous* or *Glover's suture* is simply the stitch used by seamstresses for sewing two edges together. It is the easiest means by which to obtain accurate apposition, as of the edges in plastic operations. Its disadvantage is that a single stitch cannot be removed to relieve tension or give exit to discharge without letting all loose.

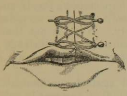
3. The *twisted suture.* The edges of the wound are placed accurately in contact, and a sufficient number of fine steel, lancet-pointed pins (Fig. 42, 2) passed through both of them at convenient distances. In the lip, the first pin should be placed close to the free border to insure accuracy of fit there. When all have been introduced, and the parts accurately adjusted, the middle of a long silk ligature is twisted twice or thrice round the uppermost in a figure of 8. Then the two ends are brought down and twisted round each of the other pins successively in like manner; and, lastly, they are to be secured by a knot. Many surgeons use a thread to each pin, lest by carrying one on they should approximate the pins. Lastly, cut off

the pin-points with pliers, and slip bits of plaster or lint beneath the ends (Fig. 45).

The *harelip* suture is chiefly one of support, and interrupted continuous sutures of apposition are generally used with it. In plastic operations many surgeons after introduction of the sutures dry the part, push the edges closely together, and brush the surface round the cut with *contractile collodion;* this takes strain off the sutures and protects the wound.

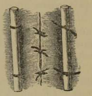
4. The *quill suture* (Fig. 46), a suture of support, is performed by passing a sufficient number of threads with a Liston's needle (Fig. 43). The loops

Fig. 45.



Twisted suture.

Fig. 46.



Quill suture, and suture of apposition.

are retained on one side, and through them a bit of bougie is passed, the free ends being drawn on, to approximate the edges, and tied round another bit. The bougie interferes too much with the circulation in the edges, so most surgeons use Lister's *button sutures*—stout wire passed at each end through a lead button, and twisted round lateral projections. These are the most valuable sutures of support.

But in order that a wound of any size may be accurately sewn up, as above described, throughout the greater part of its length, it is generally thought necessary to *drain* the wound—*i. e.*, to provide apertures at certain points for the escape of blood and discharges. Neuber and Esmarch have, however, of late been using *buried sutures* of catgut; beginning at the bottom of a wound they sew bone to bone, periosteum to periosteum, muscle to muscle, fascia to fascia, and skin to skin, with interrupted stitches, the object being to leave no space in which fluid can accumulate. They and others have reported most favorably of the plan. It answers best when the spray is not used, irritation of the wound being less; but the wound must be aseptic. The perfection of healing obtained in animals when serious wounds are at once sealed with collodion would lead us to hope that some approach to the same may be made in man. At present, English teaching is to drain most carefully.

Having then brought the wound together by superficial sutures, carefully and without dangerous tension, its surfaces must be kept in undisturbed contact by *drainage, fixation of the part* in a well-chosen position, and the application of *uniform elastic compression.* Of these measures drainage is the most important, and is usually effected by the red rubber tubes shown in Fig. 4. One or more of these must be so placed as to run off any blood which may escape after application of the dressing, and all the discharge which runs from the raw surfaces irritated intensely by knives, chemicals, etc.; otherwise the surfaces will be forced apart, and tension very likely induced. The lumen of the tubes must be proportioned to the amount of discharge expected, and their number to the number of pockets and recesses in which fluid might accumulate. Sometimes a tube at one or either end of a linear wound will suffice. Often it is best to make a small opening through the skin at the most dependent point, *in the position which the patient will* *usually occupy*, introduce a tube through it, and sew the wound up closely. Short wide tubes become plugged less easily than longer or narrower ones. All tubes should be level with the surface, lest pressure close them. Small wounds are drained by a strand of horsehair or fine catgut. Drains prevent entire healing by first intention; but they enable almost the whole wound to do so, and their tracks soon close. They are to be removed or diminished in size and length as the discharge diminishes and the sinuses close up. When there is but little discharge they should be removed tentatively, for they often keep open channels which are little inclined to close. The removal of a tube is often an experiment, and the surgeon must watch carefully for signs of consequent bagging.

In septic cases good drainage is of vital importance; for, if no fluid can collect in wounds there is nothing to putrefy—there is no nidus wherein septic and infective organisms can multiply. Were it not that infective organisms can be inoculated upon living tissues, perfect drainage would do away with the need for antiseptics; but *perfect* drainage can rarely be assured.

In the last paragraph we have provided against mechanical irritation of wounds. Chemical irritants (antiseptics) often necessarily come in contact with wounds; all unnecessary irritations of this kind—*e. g.*, syringing of aseptic wounds—must be avoided. But the importance of these irritants is as nothing when compared with that of *septic and infective organisms* (p. 49), as shown by even our present knowledge of inflammation and accidental wound diseases. Our object is to cause a wound to heal like a subcutaneous injury of equal gravity; ordinarily it does not do so, because, through the broken skin, organisms enter, excite irritant decomposition of the wound-fluids, and often invade the living tissues.

Garengeot, Hunter, and others taught that decomposition of discharges was the great enemy to "adhesion," and many excellent antiseptics were used empirically in the treatment of wounds. But it was Lister who grasped the analogy between a wound with its albuminous discharges and a flask of putrescible fluid; it was he who conceived the possibility of preventing infection of a wound, just as Pasteur had prevented infection of his flasks, and who enunciated as the guiding principle of surgery—"Prevent putrefaction in wounds," and insisted that the causes of decomposition enter wounds from without. By years of scientific labor Lister elaborated a method of carrying out the above principle with very great success; it has its inconveniences and its weak points, and many different modes of carrying out the principle of antiseptic surgery have been suggested and are practised.

The following must be the articles of the creed of every surgeon desirous of keeping wounds aseptic:

1. The causes of wound-diseases come from external to the body.
2. These causes are microörganisms, and it is possible that an unpurified finger, instrument, sponge, suture, or anything else brought into contact with a wound may inoculate it with the most deadly bacterium.
3. Failures to maintain asepsis mean that the precautions are not sufficiently stringent, and demand increased care in the carrying out of the method; or they may be due to insufficiency in the antiseptic employed.

Two classes of cases present themselves for treatment: in one the surgeon makes the wound and takes precautions to keep it aseptic; in the other, the wound is in existence, and almost certainly infected before he sees it.

The Conduct of an Operation (Infliction of a Wound) under Lister's Method.

The smaller the number of assistants at an operation the better; only one should be allowed to touch the wound. No one should be concerned who is attending post-mortems or infectious cases without changing his clothes. It is best to work with arms bare to the elbow, thoroughly cleansed with soap and water, and then carbolized (1 in 20); special attention must be paid to dirt about the nails. A clean white macintosh apron should be worn. The patient's clothes should be well away from the wound covered by macintoshes. A clean towel wrung out of 1 in 20 should be placed between the wound and the operating table; on this instruments may rest in the spray during the operation.

Purify the seat of operation like the surgeon's hands; scrub it well. Hairy parts should always be shaved, and are very difficult to disinfect thoroughly; all grease having been removed, a towel wet in carbolic (1 in 20) may be laid on the part for an hour before operation. All *instruments* should be most carefully cleaned and laid in a flat dish of carbolic (1 in 20). *Sponges* are kept in 1 in 20 carbolic. During an operation they are simply squeezed dry and then wrung out of 1 in 40 lotion. Some surgeons use bits of wet carbolic gauze or salicylic wool instead.

The *spray* is now turned on and kept playing on the part throughout the operation; its reservoir is filled with 1 in 20 carbolic, and this, when mixed with the steam, forms a solution of 1 in 30 strength. No one must pass between the spray and the wound.

(For all the above purposes corrosive sublimate (1 in 1000 or 1 in 500) is more certain than the carbolic; but the latter must be used for instruments and spray.)

The operation is performed, care being taken that nothing not freshly carbolized approaches the wound; the hands of surgeon and assistant should be cleansed of blood occasionally during a long operation.

If for any reason the spray be stopped during an operation, cover the wound with a "guard"—two or three layers of close muslin squeezed out of 1 in 40.

Hemorrhage having been checked in some non-infecting way, the wound is drained and closed. Then a bit of *protective* is laid over the wound, and over this *two or three layers* of gauze (deep dressing), wrung *as dry as possible* out of carbolic; over this more or less "loose gauze" is placed, most in those directions in which drainage will probably take place lastly, the "dressing," consisting of eight layers of gauze, between the outermost two of which is a piece of thin macintosh, is applied, its size being proportionate to the amount of discharge expected, unless limited by proximity to one of the orifices of the body. The dressing is kept in place by the gauze bandage, or, better, by one of the thin white muslin in which butter is wrapped; this should be firmly applied. Every precaution should be taken to prevent the dressing from slipping, and its own adhesiveness does much towards this. Round the edge of the dressing a bit of elastic webbing is coiled, and to it the *edge* of the dressing is fastened by safety-pins going through the macintosh; the prick of a pin elsewhere should cause the macintosh to be discarded. If much discharge is expected, it is well to lay over the dependent edge of the dressing a large pad of salicylic wool, and to include it in the bandage.

Change of Dressings.—After any large operation the dressing should be changed in twenty-four hours, or earlier if the discharge is very free. Subsequent changes are indicated: (1) by the appearance of discharge at the edge of the dressing, and this should be carefully looked for four times in twenty-four hours; (2) by the dressing having been on seven days, after which time it probably contains too little carbolic to be efficient; (3) by rise of temperature lasting more than twenty-four hours, or by any sudden and considerable rise; (4) by pain or other symptoms at the wound likely to be relieved; (5) by the necessity of shortening tubes, removing sutures, etc.

A wound which is doing well shows no signs of inflammation nor of retention of discharge—no redness of the edges, no pain, surprisingly little tenderness, and the skin lies well down upon the deep parts. The protective shows no brown or black staining, the discharge is almost odorless, and after blood has disappeared, serous, scarcely changing the color of the gauze.

At the first dressing, unless a wound is obviously not draining, the tubes are often best left alone; subsequently, when their tracks are marked out, they should be removed and cleaned in carbolic. The wound and its immediate neighborhood should be gently wiped with a guard, and covered at once with protective and deep dressing. *Then* all the parts beneath the dressing, especially those over which discharge has run to the edge, must be similarly washed, and the dressing completed as above. Stitches may be left in so long as they cause no irritation and hold parts together, until union is complete. For management of the tubes see p. 171.

The objections to Lister's system are the smell of the carbolic; its effect upon the skin causing the surgeon's hands to peel, and often producing some eczema on the patient; the large quantity of discharge which it excites; delayed healing from irritation; the necessity for somewhat frequent change of dressings and therefore disturbance of the wound; but chiefly its poisonous properties, which rarely affect the surgeon, more often the patient. The symptoms of poisoning are said to be: mental dulness, or even unconsciousness, headache, slowly reacting or fixed pupils, depressed temperature, small, frequent pulse, loss of appetite, persistent vomiting. After almost all large operations the urine becomes olive-green or deep brown on standing; color rarely altered till after exposure to light. All the symptoms are increased by the application of a fresh dressing; young children chiefly suffer, adults rarely, except after long abdominal operations under the spray, or after energetic attempts to disinfect a septic cavity. A chronic poisoning may result from use of daily carbolic injections.

For carbolic eczema paint the part with salicylic cream, or cover it with protective. Poisoning necessitates replacement of carbolic dressings by others; and the administration of Glauber's salt freely diluted is recommended. Dark urine alone generally passes off in a few days.

Severe symptoms and death are certainly very rare, but they do occur, and would require the abandonment of carbolic acid had we anything to replace it. In efficiency it has as yet but one rival: corrosive sublimate, probably the most efficient antiseptic which can be employed upon living tissues; but it also, when freely used, causes poisoning with dysenteric symptoms.

It is to the spray, and to unnecessarily free use of carbolic lotion, that most of the objections to Lister's method are attributable. Knowing that septic organisms are comparatively infrequent in the air, a large number of the best surgeons have abandoned the spray, trusting only to the most conscientious disinfection of anything that comes in contact with the wound; and they have shown that as good results may be obtained without as with it. Nevertheless, there are certain cases in which we should be sorry to be without the spray, especially in operations opening the pleura, in which large volumes of air are sucked in and the drainage is often imperfect; also when compelled to operate in close, crowded districts, the air must be regarded with more dread.

Sublimate Dressings.—Lister himself has lately had a few failures which led him to investigate the relative efficiency of various gauze dressings, with the result that sublimate guaze stood first, carbolic came close behind, and eucalyptus distinctly third. Koch has shown the sublimate (1 per thousand) to be the only surgical antiseptic which will destroy resting spores by short contact, such as washing the hands in it. This body is accordingly being used largely as lotion of 1–500, 1–1000, 1–5000, and also in gauze and wool dressings: either no spray or the carbolic is used. It is the antiseptic preferred by many surgeons (v. Bruns, MacCormac); but severe poisoning has occurred, and complaints of irritation of the skin are frequent.

Eucalyptus gauze is a fragrant and good substitute for carbolic, but a little dearer.

Having gone far toward extinguishing sepsis, surgeons of late years have striven to obtain also complete rest for wounds by means of *permanent dressings*. These consist of highly absorbent materials, such as absorbent cotton-wool, wood-wool, jute, peat, moss—impregnated with a non-volatile antiseptic—salicylic acid, iodoform, sublimate; in large quantities of these the part is enveloped far on all sides of the wound, and provision for drainage having been made, a bandage is applied so as to keep up uniform moderate pressure on the wound. Oozing is checked, the parts are kept closely in contact at a uniform temperature, and such discharge as escapes is rapidly dried up and kept sweet whilst moist. These dressings, except the sublimated, are not to be relied upon when the discharge is necessarily very free; one of the previous dressings should then be used until the discharge is less.

The work of every dressing—*i. e.*, the amount of discharge it has to keep sweet, is rendered lighter by the rubbing of a little *iodoform* in fine crystals upon the raw surfaces. This drug is by no means powerful as an antiseptic, moving organisms being found in discharges distinctly colored by it: but it greatly reduces the quantity of discharge from fresh and other wounds, and, with a little help from the dressing, will prevent putrefaction by rendering the fluids too inspissated. A gauze and a wool are prepared. It is an insidious poison, causing loss of appetite, nausea, vomiting—perhaps severe, restlessness, sleeplessness, delirium, rapid wasting, and a small frequent pulse; iodine is usually found in the urine. More rarely, especially in the young and old, symptoms of cerebral meningitis appear running on, after a short stage of irritation, to general or local paralysis. Nothing nervous is found post-mortem; but often the heart, liver, and kidneys are fattily degenerated. To prevent such symptoms, not more than ʒj should be applied in children, not more than ʒij in adults. It is *very* slowly dissolved, so care must be taken in repeating the dose.

Iodoform is of especial value in tubercular cases after sharp spooning, resection, etc., appearing to exercise a specific influence; the operations are done with all antiseptic precautions, and iodoform applied when bleeding is stopped. Nothing compares with it in its power of keeping sweet wounds about the mouth, vagina, and rectum, usually so disgustingly offensive. As a permanent dressing, iodoform wool is much dearer than salicylic acid, and no more efficient.

Should symptoms of poisoning arise, wash away all iodoform with some mild antiseptic lotion, and they will generally subside.

Salicylic acid in lotion (1–300), in powder, in wool, or in ointment of varying strength, up to ʒj ad ℥j, is very useful—the lotion for irrigation, the powder for foul sores, the wool as a permanent dressing, the ointment for ulcers, especially lupus. Poisoning may be produced.

Boracic acid in saturated lotion, in powder, in lint or wool, is an excellent unirritating antiseptic for slight cases, which can easily be kept dry; or, frequently changed, it acts well in severe cases, as a cold compress or hot fomentation. Boracic ointment is very useful as a dressing, and for smearing parts near orifices—*e. g.*, in circumcision, when it prevents wetting of the wound; also in burns. It does not cause poisoning.

These are the chief antiseptics used at present, but many other bodies are being tried. The desideratum is a perfectly unirritating, non-poisonous body, which instantly destroys all organisms, which is free from unpleasant properties, and is usable in all the forms required for surgical purposes.

INFECTED WOUNDS.—When a wound, abscess cavity, etc., is infected before the surgeon sees it, attempts may be made to disinfect it: if only an hour or two old, such a wound as a compound fracture (*q. v.*) may generally be rendered quite sweet, but after days success is very doubtful.

In cases of spreading septic suppuration and gangrene seen early, the success of attempts to disinfect depends entirely upon the possibility of opening up the whole diseased area and applying strong antiseptics to it. The agents generally used are chloride of zinc (see p. 154), 1 in 20; carbolic, or sublimate, 1 in 500. All necrosed and putrid tissue, clots and discharge, must first be cut and washed away by a mild lotion, and then the strong application thoroughly made. Such cases should be dressed antiseptically every day, and left gaping widely till all chance of recurrence is over. A little iodoform may be rubbed on the most suspicious parts. In some cases of putrid discharge which cannot be drained freely, constant irrigation with permanganate of potash, strong in proportion to the stench, or other mild antiseptic —iodine, boracic acid, thymol, salicylic acid—may be tried.

CASES OF COMPLETE DISUNION.—If a small part—*e. g.*, a last phalanx or tip of the nose, be cleanly cut off—fix it on again as soon as possible, with a continuous fine suture, and keep up its temperature with wool. Even after separation for some time, it may reunite if well washed with warm boracic lotion and applied closely to a perfectly clean surface. A case is related of firm union of the last phalanx of the middle finger after one and a half hour's separation. (Bailey, *Ed. Med. and Surg. Journ.*, July, 1815.)

OPEN WOUNDS.—Wounds with loss of substance, or which cannot for any reason be brought together, are to be treated upon the lines laid down above, some antiseptic dressing being applied, and a portion of it laid between the flaps if it is desirable to prevent their union. They heal by granulation; but if carefully covered with protective, kept sweet, and not irritated by chemicals, the granulating surface will yield no pus.

CONTUSED WOUNDS.—Add a wound to the degree of contusions described in Chapter XIII., and we have contused wounds varying from a bruise and an abrasion to the crushing off of a part. Such wounds have torn, irregular edges, limp, little retracted, and often obviously ecchymosed; they bleed little. Usually the edges are not in a condition to unite by first intention.

To the danger of gangrene from primary injury to vessels, we now have also the danger of septic inflammation, greatly increasing the difficulty of circulation and the probability of gangrene; for the parts being much damaged and infiltrated with blood and fluid for long distances prove a most suitable nidus for the causes of spreading inflammations.

TREATMENT.—If gangrene must occur from injury to vessels, or if the soft parts are so extensively destroyed that the wound could not heal, or would not leave a useful limb if it did, amputate as in simple contusion.

Otherwise disinfect, make free counter-openings, drain, bring the wound together carefully, and try to save.

If seen when diffuse cellulitis or spreading gangrene has set in, see pp. 152, 153 for treatment.

LACERATED WOUNDS are very like the above, but are caused by tearing instead of crushing. Treat similarly.

PUNCTURED WOUNDS.—The whole danger of these, apart from danger due to structures injured, depends upon decomposition of retained discharges which are forced by tension into the areolar planes, etc., exciting diffuse inflammation.

TREATMENT.—Gently pass a tube to the bottom of the wound and disinfect thoroughly: put in a drainage tube almost to the bottom for twenty-four to thirty-six hours, when almost all discharge should have ceased. But if it become purulent the tube must be retained. Treat cellulitis as usual.

POISONED WOUNDS are dealt with in separate articles.

In the treatment of wounds of all kinds the general principles laid down under incised must be acted upon. If no antiseptics are at hand, perfect drainage, complete rest, uniform pressure, and dryness must be aimed at: and in large wounds, the surgeon will often do well to employ the "open method." Introduce sutures at the time of operation, but leave the wound open for several hours to "glaze;" close when most discharge has ceased, use no dressing, but with a dry rag occasionally wipe away any oozing from gaps purposely left at the angles or between sutures.

GENERAL TREATMENT.—A patient with a severe wound should be kept in bed under the best hygienic conditions obtainable. His diet should be simple and nutritious; so long as he is afebrile he may take fish or meat. Stimulants are unnecessary except in cases of collapse.

The temperature should be recorded two to six times a day.

THE HEALING OF WOUNDS.

In almost all parts this is effected by the formation of vascular connective tissue; the reproduction of special tissues, as muscle or nerve which may have been divided, is a secondary phenomenon.

There are two sources of connective tissue—the preëxisting connective tissue corpuscles, and leucocytes. Adult connective tissue cells do not proliferate because the stimuli to growth—especially food-supply—are sufficient only to maintain them *in statu quo;* in other words, the tendency to grow in the prime of life is just balanced by the hindrances to grow, such as pressure of the cells against each other. In wounds, the injured vessels permit free escape of fluid and leucocytes, whilst pressure in the tissues is lessened.

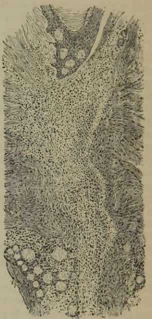
There are really only two ways in which wounds heal—by the *first intention* and by the *second intention* or *granulation.* These modes differ only in the amount of the round-celled exudation by which they are characterized; when irritation of the wound-surfaces is reduced to a minimum, both as regards its intensity and duration, the amount of inflammatory exudation is microscopic; but when irritation is prolonged, and perhaps also intense, as when wounds gape or cannot be brought together, round-celled exudation is very free, granulation tissue being produced in macroscopic quantity.

A knife producing a wound irritates intensely the tissues through which it passes, and probably kills a microscopic layer on each side. Bleeding from small vessels and capillaries is soon stopped by their being thrombosed up to the first collateral branch; but in large wounds from slight oozing, escape of red corpuscles through vessel walls, or expression of them from clots, the discharge continues bloody for some hours. In smaller wounds it soon becomes reddish-yellow. At first, if the wound is left open, the cut tissues can be distinctly seen, but in an hour or two these become indistinct owing to the formation over them of a thin layer of lymph which *glazes* the surface and is of reddish-gray color. It consists, of course, of closely packed leucocytes in scarcely perceptible fibrin, both of which continue to escape from the vessels so long as irritation continues. If now the surfaces be accurately brought together, the lymph on them blends and glues the two sides to each other. Living tissue is now in contact with living tissue, irritation soon dies away, and exudation ceases. This is the first stage of *union by the first intention;* with proper precautions the wound may be brought together at once, instead

FIG. 47.

Section of a herniotomy wound on fourth day; healing by first intention, death from double pneumonia. The wound is torn open above; elsewhere it is easily traced, the edges being somewhat displaced so that fat on the left lies against cutis on the right. Note how little exudation there is. *e*, epidermis; *f*, fat; *v*, vein; *s.g.*, sweat-gland; *n.c.*, red corpuscles.

FIG. 48.



Section of a breast wound on thirteenth day; death from septicæmia. Union of granulating surfaces. The uniting mass is not sufficiently cellular.

of being left open to glaze. The very small portions of tissue killed in incised wounds are absorbed. This temporary union is now replaced by the permanent, which is simply new connective tissue developed from leucocytes and from the fixed cells of the tissue, this being preceded by development of vessels which speedily meet across the incision (p. 60). It is these rapidly developed vessels which maintain the vitality of small, completely separated parts (finger-tip, point of nose) when they are replaced. In cases of union by first intention it is often difficult to see what holds the cut surfaces together (Fig. 47); small clumps of cells lie here and there, in loose or vascular parts of the tissues on each side of the cut, which is marked by a narrow line of fibrin, red corpuscles, and leucocytes. The epithelium soon grows across the narrow gap on the surface, whilst development of fibroblasts and connective tissue (p. 60), together with absorption of fibrin and blood, go on in deeper parts. It is cases like these probably which have been described as cases of *immediate union*, in which the tissues are supposed to unite directly without any intermediate substance; probably this never occurs.

In union by first intention, the first stage is complete in twenty-four hours, the second in one to two weeks.

When it occurs aseptically, absolutely no clinical signs of inflammation are present; under other circumstances there may be slight redness and swelling of the edges. Inflammation running beyond this prevents union.

Healing by Granulation (Second Intention).—If instead of closing the wound we allow it to gape, it will be exposed to constant, though it may be slight, irritation from dressings, discharges, etc. The surface becomes infiltrated with small round cells, capillary loops spring from the vessels of the part, and grow towards and at right angles to the surface. The cells become massed round them and form granulations (p. 68); and the cells eat up or cast off any sloughs which may exist. The wound is now a healing ulcer (p. 69). The nature of the discharge—purulent or serous—varies with the irritation to which the surface is subjected. A wound may heal by granulation without forming any pus.

Healing Beneath a Scab.—Sometimes when the discharge from a wound with loss of substance is slight, it dries and forms a scab, which, in uninfected wounds, is non-irritating and protects the wound from irritation from without. The processes of granulation and skinning over go on beneath it, and all is complete when the scab falls off or is removed. Very rarely large wounds heal thus in man.

Healing of Two Granulating Surfaces.—When two such surfaces are brought into close contact, they grow together; the tissue develops into *scar-tissue*, as usual. Frequently, when union by first intention has failed, parts are held together by sutures, etc., and ultimately granulate and unite as above said (Fig. 48). No line can be drawn between union by first intention and union of granulating surfaces.

The smaller the amount of inflammatory tissue, the more, probably, do the fixed cells of the part do towards repair; also the scar is smaller and the contraction less under these circumstances. Union by first intention is therefore aimed at in almost all cases.

A *scar* differs from the surrounding connective tissue in being denser, less vascular, free from lymphatics, and also from elastic fibres. The epithelium over it is often thinner than elsewhere, and no papillæ, hair bulbs, or glands are developed. Its surface is therefore smooth and dull white as a rule, and its substance is firm and unyielding. A few weeks after union by first intention, however, it may be quite impossible, even with the microscope, to trace the course of an incision through connective tissue; and the tendency of all scars in the course of many years is to become more and more like normal tissue. On the surface, however, the naked eye will probably never fail to discover the scar left by a wound which has fairly penetrated the skin, relative pallor being most important.

Diseases of Scars.—Most scars are tender for some time after their formation; but this may be acute and enduring and accompanied by spontaneous pain. Perhaps, a nerve is pressed upon and irritated by the scar tissue. Excision is the treatment.

Scars are weak points, and break down under slight irritation into ulcers which are slow in healing. Rest is very important.

In their early stages there is excess of tissue in scars; this shrinks and depression results. But sometimes, instead of this, scar tissue grows into prominent rounded ridges of pale reddish color, which are very disfiguring. This state of scars is called *false cheloid*, and is specially common after burns. Its cause is not known. The scar may sometimes be excised, and an endeavor made to procure union by first intention.

Scars are not very uncommon seats of epithelioma.

CHAPTER XV.

GUNSHOT WOUNDS.

General Description.

Definition.—Under the term *gunshot wounds* are included all injuries caused by shot and other substances discharged from firearms, by fragments of stone or splinters of wood struck thereby, and by the bursting of firearms and of shells.

A cannon-shot for the first twelve or fourteen hundred yards destroys everything that opposes its course. If it strikes a limb it either carries away or completely smashes it, pulpifying all tissues with which it comes into contact. The shock in such cases is always very severe, and often fatal of itself. The hemorrhage is usually slight: a gush of blood escapes at the moment the injury is inflicted, but the torn vessels soon retract, and the bleeding for a time is stopped. There were a few instances during the Crimean campaign in which fatal hemorrhage from the femoral artery was caused by cannon-shot injuries.

When the shot has lost a portion of its impetus, the injury which it inflicts is often even greater. Instead of going right through, or carrying away, the part struck, it will allow its course to be changed by objects which it may meet in its way, and thus give rise to wider and more serious injuries.

This happened in the case of a private in the 1st Royals, working in the trenches before Sebastopol. He was in the act of shovelling up some earth, with his body bent, and his right hand holding the handle of the shovel, low down in front of the space between his legs. In this position he was struck by a round shot. It shattered his arm, leaving it hanging only by the integuments, and, passing between the thighs, tore away from each of them a large mass of the integuments and muscles, and laid bare the femoral artery on one side. It carried in front of it the penis, scrotum, and anus, and a large portion of the glutæi of one side.

Cannon-shot when nearly *spent* may produce severe injury without breaking the skin, just as happens in buffer-accidents (p. 167). Bones may be broken, or the deep tissues so contused as to lead to severe sloughing. However near the end of its career a round shot may be, it still carries destruction with it; and many a soldier's foot has been knocked off, when put out to stop a shot slowly ricochetting along like a cricket-ball.

A round shot rarely lodges, yet after Balaklava a six-pounder was found in a man's ham, with but little distortion of the limb.

Wind-contusion.—No one now believes that injuries can be produced by the commotion of the air caused by the passage of balls which go near without touching. The injuries in question were generally subcutaneous and often very severe—viscera, soft parts, and bones being often crushed and torn. They were due to actual contact with a spent ball.

It must be added that cannon-shot are seldom fired on the battle-field in modern warfare.

Shells.—If a shell strikes anything before its explosion, it produces effects similar to those of round shot. After it has burst, the wounds inflicted by its fragments are not so severe as those of cannon-shot, although they certainly rank next in the amount of damage they produce. The large irregular masses of iron often cause the most fearful contusions and lacerations of the tissues, and comminution of the bones. In the Crimea, the bursting of one howitzer shell caused ten admissions into hospital, and of the men so admitted seven lost an arm or leg. The English artillery fire "Shrapnel shells," which burst on touching the ground, and vomit forth a number of bullets with which they are loaded.

Rifle-bullets.—The largest number of wounds in any engagement is from bullets. Until the Crimean war, the round leaden ball, fired from a plain or rifled barrel, was the only one in common use. Now, however, its place has been supplied by conical balls which, being projected with much greater force, are capable of passing through one or two men, and lodging in the body of a third. They do not deviate from their course to the extent that the round balls sometimes did. What they strike they usually per-

Fig. 49.

Fig. 50.

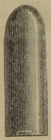


Fig. 51.

Fig. 52.

Fig. 49.—Bullet with which the Shrapnel shell is charged, weight 510 grains.

Fig. 50.—Martini-Henry rifle bullet used in England, weight 480 grains.

Fig. 51.—Chassepot bullet used by the French, weight 380 grains.

Fig. 52.—Prussian needle-gun bullet, weight 500 grains. The mitrailleuse bullet weighs 765 grains. MacCormac says that no cases of wounds from a mitrailleuse bullet came under his notice at Sedan, hence that the mitrailleuse either failed to hit, or else was fatal on the spot. On the other hand, an account is given of one (German) soldier, struck by thirty-two mitrailleuse balls and surviving (Woodman and Tidy, "Forensic Medicine," London, 1877). In civil life the surgeon will probably have to attend to revolver wounds.

forate, in some cases drilling through bones, in others producing severe comminuted fractures. They lodge much less frequently than the round ones. Again, the ball may, if the force is nearly expended, lodge in the cancellous tissue of a bone, and form for itself a space in which it may be easily moved, but from which it is with great difficulty extracted. Sometimes a ball will strike a bone longitudinally, and channel a long groove without fracturing the bone.

Small shot, discharged from a fowling-piece or pistol, produce different effects, according to the distance at which they strike. If the distance is great, they will be scattered and fall singly; *peppering* the victim smartly, but not penetrating beyond the subcutaneous tissue, nor doing much harm unless one of them strikes the eye. But if the distance is small, so that they strike *en masse*, their effects are far more destructive than those of a bullet, for they spread *in* the flesh, and so cause greater laceration, besides the mischief arising from their lodgement in the tissues.

Though there may be no *ball* in a gun or pistol, yet the *wadding* may act as one, if the piece is discharged close to the body. The surgeon in civil practice who examines a gunshot wound perhaps inflicted with intent to murder, should always save the wadding if he finds any, as it may afford a clew to the perpetrator of the deed. All gunshot injuries at close quarters may be complicated with severe burns from the explosion of gunpowder.

Occasionally portions of clothing or accoutrements, money from the pockets, or even pieces of bone from other soldier's bodies, are carried by the shot into the wound and lodged.

COURSE OF BALLS.—Any trifling obliquity of surface, or difference of density in the part which it traverses, may cause a *round* ball to take a most circuitous route. An officer in the Crimea was struck on the abdomen by a musket ball. It impinged against a button of his trousers, which it bent double. This served to change its direction, and instead of passing into the cavity of the abdomen, it travelled downward between the abdominal muscles, and lodged deeply in the upper part of the thigh.

A round ball may enter on one side of the head, chest, or abdomen, and pass out at a point exactly opposite, just as if it had gone entirely through the cavity. In such instances, it is generally deflected by bone, and guided round the part by the elastic resistance of the obliquely placed skin. Sometimes it makes a complete circuit, as in the case of a friend of Dr. Hennen, who was struck about the *pomum Adami* by a bullet, which passed completely round the neck, and was found lying in the very orifice at which it entered. Similarly, balls will pass along concave surfaces, being constantly slightly deflected by them; thus a soldier may be struck on the wrist, when

FIG. 53.

This figure, due to R. W. Parker, represents a round bullet, so altered in shape and increased in area on passing out, that it naturally made a larger and more jagged exit hole. It traversed the thigh, struck against the femur, which it furrowed but did not break, and was found in the man's boot. The arrest of the motion of bullets probably heats them sufficiently to soften the metal. (C. A. Gordon, *Lessons from the Franco-Prussian War*, London, 1873, p. 105.)

the arm is bent in the act of firing, and the ball may graze along the arm, and fly off at the shoulder; or a ball may glide along the inner surface of the peritoneum or pleura, and pass out or lodge near the spine. But *conical* balls are rarely turned aside.

If a ball has passed through a part, an orifice of entrance and one of exit are usually found. With the old round bullet it commonly happened that the *orifice of entrance* was smaller, with its edge *inverted*. That of *exit* was larger and more ragged, with its edge somewhat *everted*. But the new rifle balls are propelled with such velocity that, if they pass clean through the soft parts, it is impossible to tell one orifice from the other. If, however, the speed of the ball be diminished, we may have the classical appearances of its ingress and egress well marked, or if the bullet in its course through the limb has struck against the bone, and become misshapen.

The ball in its passage through a part leaves a track which is often indicated by a bluish or dusky red line or wheal on the skin, or sometimes by a peculiar emphysematous crackling. Along this track the tissues are bruised and broken down, and their vitality greatly impaired, and lying in different parts of it are the fragments of foreign bodies which the bullet may have carried before it. A ball of soft lead like the Enfield, which flattens considerably on striking bone, seems to cause more extensive splitting than the harder Martini-Henry ball.

Lodgement and Extraction of Balls.

Lodgement of Balls.—Shot do not always penetrate. A ball may produce a furrowed wound, or if nearly spent a contused wound only. Most wounds are, however, penetrating, and the bullet may or may not lodge. It is always important, and usually easy, to ascertain this point.

If there is but one hole, the bullet has probably lodged, but not always; very rarely it may have escaped by the hole at which it entered (p. 182); or it may have struck a firm substance and recoiled, or it may have penetrated and have fallen out later; thus a ball drove a piece of bone into the brain, and fell out of the wound afterward. In some cases, from lack of resistance behind it, a ball has not perforated a fold of linen, or silk handkerchief, but has carried it three or four inches into the wound; on drawing the pocket out, the ball comes with it. The explosion of the powder alone may make a hole.

But if there are two holes, it must be considered whether they are produced by the *entrance* and *exit of one*, or by the *entrance of two* distinct balls. Thus a soldier presented himself with two shot-holes, one on the outside of the ankle, the other near the trochanter; but both were caused by the same ball, which entered at the ankle when the foot was raised in running. Again, a soldier ascending a scaling-ladder, was wounded in the right arm, and the ball was found under the skin of the opposite thigh.

Sometimes a ball splits from defect in casting, or from striking some sharp bony ridge, as the shin, vomer, or edge of a fractured bone, and the pieces may escape by distinct openings; or though one bit may have been extracted, another may be lodged, and may have injured important vessels or nerves. This must ever be borne in mind; for frequently large masses of metal are impacted in the substance of a part without much external sign of their presence.

Detection and Extraction of Balls and Foreign Bodies.—It is of the greatest importance for the future well doing of the patient, that any ball or foreign body which may have lodged should be removed. A most careful examination should be made as soon as after the injury as possible, before swelling and œdema have come on. It should include (1) a most careful *palpation* of the part, and (2) *exploration* with the right forefinger, aided by counter-pressure with the other hand, the wound being enlarged, if need be. The examination should be made thoroughly and once for all, and the patient should always be *placed as nearly as possible in the position in which he was struck.*

Where the finger is too short, use a 12-inch probe.

Often a hard body is felt by the probe, but no clear evidence may be thus obtained as to whether it is exposed bone or a leaden ball. The famous case of Garibaldi gave rise to great difference of opinion as to whether a ball were lodged or not in the tibia near the ankle-joint. Nélaton discovered the ball by means of a probe, the point of which carried a bit of unglazed porcelain (Fig. 54). The rough surface of this brought away stains of lead when it

FIG. 54.

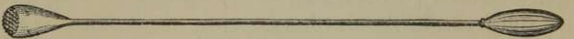
Nélaton's probe.

had been rubbed upon the bullet for a short time, and their nature was chemically demonstrated. This is not infallible. T. Holmes (*Treatise on Surgery*, London, 1875, p. 304) shows that the bullet, in passing over a bone, may leave a streak of lead upon it, which may be taken up by the porcelain and so lead to the mistaking bone for bullet.

On the same occasion a magnetic probe was suggested by Dr. Miller, of King's College, London; contact of its point with metal caused deflection of a magnetic needle connected with it.

Kress's probe (Fig. 55), used in the American army, rasps off and retains particles of metal when its file-like end is rotated on a bullet.

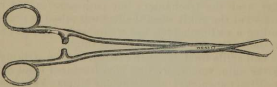
FIG. 55.



Kress's probe.

When found, the ball or fragment must be removed through the wound by forceps (Fig. 56), or, if it be difficult to do this, and the ball can be reached

FIG. 56.



Forceps for extracting bullets; hooks too long.

more easily from some other point, it must be cut down upon, the new opening being always useful for drainage. When the ball is lodged in a bone, even though movable, great tact is often required to get hold of it; all such attempts failing, or the ball being firmly fixed, cut down upon it, enlarge the opening with a gouge, and remove.

The rule with regard to the extraction of lodged balls may be stated thus: always extract them as soon as possible when this can be done without inflicting dangerous injury upon the patient by the procedure necessary; thus it is not advisable to pass a probe in various directions through the brain in the endeavor to find a ball.

Gunshot wounds are like punctured wounds in that their orifice bears but a small proportion to the raw surface from which it must drain away the discharge; but they are contused or lacerated, being inflicted by a blunt instrument. Consequently, they usually bleed but little, do not heal readily, but inflame, suppurate, and slough, whilst diffuse cellulitis may extend widely from the wound. Things are somewhat different with conical balls, which travel so rapidly that they really *cut* their way through flesh, leaving a wound that not infrequently heals by first intention; they may even pass through cancellous bone without fissuring it. The nature of the wound depends upon the relation between the momentum of the shot and the resistance it meets. But neither round nor conical shot causes suppuration and spreading inflammation; these are due to the irritation of retained septic fluids.

The immediate symptoms of gunshot wounds are pain, some bleeding from the apertures, and shock. The last two require special mention.

HEMORRHAGE.—*Primary* or *immediate* hemorrhage to a dangerous extent, following severe gunshot wounds, is comparatively rare. In the majority of cases in which limbs are torn off by shot or shell, or left hanging merely by skin, the lacerated vessels yield no alarming hemorrhage. But if travelling at full speed, a modern ball cuts an artery like a knife, rapidly fatal bleeding resulting in the case of the larger arteries of the trunk and limbs. Patients so wounded generally die on the field before help can reach them, unless either the patient or a comrade has sufficient presence of mind to tie a handkerchief round the limb above the wound and twist it tight with a bayonet passed through it, or, if the vessel wounded be in the trunk or neck, to thrust a finger into the wound as far as it will go.

Large arteries and veins seem often to be pushed aside by balls, being saved from wound by their toughness and elasticity. But too often they are bruised, and become thrombosed, perhaps leading to gangrene, as in a case of Guthrie's, in which a ball passed between the femoral artery and vein. Later, though probably only in septic wounds, the injured portion of the vessel may slough, the clot break down, and secondary hemorrhage result.

Intermediary hemorrhage, during recovery from collapse, is not uncommon.

Secondary hemorrhage is especially common in military surgery, owing to the haste with which cases have to be treated; the impossibility of keeping many of the wounds aseptic, and the diffuse suppuration which surrounds the ends of vessels; the necessity for moving the patients long distances from hospital to hospital—often in rough conveyances over rough roads—and consequent mechanical disturbances of clots; and the often unhealthy, even scorbutic state of the patients, from exposure, privation, and septic inhalations. "Secondary hemorrhage," says MacCormac, "is often the first symptom of pyæmia." The most anxious time is during the second and third weeks, when sloughs are separating. Every cause of this form of hemorrhage met with in civil is still more common in military practice. A vessel may be wounded at almost any period after an injury by a sharp fragment of bone, perhaps during an attempt at its removal, or during a change of splints, or simply from constant pressure against the artery, but though occurring late, there is nothing "secondary" about this hemorrhage.[1]

The *treatment* will, of course, vary with the severity of the bleeding. When it is serious, no pains should be spared to stop it by ligature or cautery at the bleeding point; only when this *is impossible* is ligature at a distance permissible. Amputation is a last resource in the limbs, plugging on the trunk.

[1] "A case of this kind," says R. W. Parker, "came under my own observation. I was attempting to save a gunshot fracture of the middle third of the thigh, and one morning while changing the splint the femoral artery was cut by a sharp piece of loose bone which had escaped our notice. Amputation was immediately resorted to. The patient died of pyæmia."

The preventive treatment of secondary hemorrhage consists of good food and hygiene; the employment of care in, and easy means of, transport, such as stretchers borne by men, or litters on the backs of animals, rather than wheeled conveyances; but above all, by keeping the wound drained and aseptic, and drainage must be free in proportion as asepsis is doubtful, the wounds being much enlarged and tubes introduced.

Collapse from Gunshot Wounds.

Gunshot wounds, like other severe injuries, are followed by more or less shock, characterized by the usual symptoms, and proportionate to the severity of the injury, the loss of blood, etc. As usual, injuries involving the thorax and abdomen (especially the region of the solar plexus) are productive of the most serious results. Shock alone may be fatal, loss of blood being slight. In the Crimea as many as 160 wounded men died within 24 hours and 149 more within 48 hours, a very large majority of these deaths being due to shock and collapse. The only special point about wounds in battle is that they are often received during great excitement, sufficient in some cases to prevent a man from feeling even that both his legs have been shot away; nervous exhaustion necessarily follows, and is much increased by the knowledge of having received a serious injury. It is in these cases chiefly that the onset of symptoms of shock may be postponed for a little time. Surprising differences are, however, met with in individuals.

The *treatment* is that usual for shock (p. 166), but caution against hasty rallying of a patient must be observed when there is danger of internal bleeding. Here, unless something more radical can be done, safety lies in a long period of rest with a feeble pulse, and is best secured by opium, ergotin subcutaneously, and just sufficient warmth and stimulant to keep the patient from sinking.

Gunshot Injuries of the Limbs.

Gunshot wounds are met with more frequently in the arms and legs than in any other part. MacCormac says that the left side of the body is injured much more frequently than the right, in the proportion of not less than three to two. The left lung is traversed nearly twice as often as the right, and the same is true of the arms and legs. The attitude of soldiers in the act of firing accounts for the difference. Of these wounds some are—

1. *Flesh wounds*, caused by the passage of balls, without fracture or injury to any important vessels or nerves.

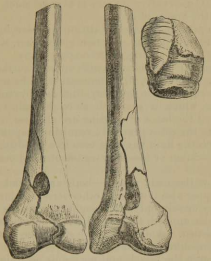
The damage, however, which results from fragments of shell, often ends in severe sloughing, producing, if the patient survive, great deformity from the cicatrization and contraction of the tissues which have been involved; for example, after wounds of the calf of the leg, in which there has been loss of a large portion of the gastrocnemius.

2. *Simple fractures*, usually caused by spent balls; and although, in such cases, the integument may not have been broken, sloughing often follows from the contusion.

3. *Fractures with wound of the integument* are produced by balls penetrating the limb and striking the bone, or by fragments of shell producing severe contusion and laceration of the integuments and muscles, as well as fracturing the bone; sometimes by large stones, which have been struck and set in motion by shot or shell. Such fractures may be (*a*) mere *perforation*, the ball going through the bone or perhaps lodging in it, without splitting it. The author saw at Madras an artilleryman, under the care of Dr. Corbett

at the Mount, in whom a rifle ball had passed through both condyles of the femur, immediately above the joint, without further mischief; the patient recovered. (*b*) Or the bone may be merely broken clean across *transversely*, without comminution, as in some cases related by MacCormac; (*c*) but far more frequently the fracture is extensively *comminuted*, as in Fig. 57, from

FIG. 57.



The author is indebted to Mr. MacCormac for the preparation depicted above, and for the following description of it. "Perforating (*Lochschuss*) gunshot fracture of lower end of femur. The bullet entered the centre of ham, divided the popliteal artery and vein, traversed the femur, causing extensive fissuring both upward and into the knee-joint. The appearances presented by the bone at the orifices of entrance and exit of the ball are typical of gunshot injury produced by a rifle bullet travelling at a high velocity: the former nearly circular, with defined, very sharp margins; the latter irregular, larger, and showing a larger amount of splintering, owing to the diminished speed. The ball, which is shown of the natural size, was split in its progress and considerably altered in shape. Immense extravasation followed the injury, and gangrene of the leg. I performed amputation of the limb forty-eight hours afterward, in a Russian ambulance near Alexinatz. The patient perfectly recovered, and is now alive, walking on an artificial limb.

the wedge action of conical balls, especially when they are soft and flatten on impaction against the bone. (*d*) Gunshot *contusion* of a large bone, without fracture, is highly dangerous. (*e*) Large *vessels* or *nerves* may be divided. (*f*) The whole limb may be *torn away* by a round shot or shell, and left hanging merely by the integuments, with fearful collapse, from which the patient seldom rallies.

4. *Injuries of joints*, which may be (*a*) severely *contused* by spent shot or fragment of shell.

(*b*) They are often implicated by *fissures* of the shaft extending into the articular ends.

(*c*) Fragments of shell or bullets may lay open a joint, causing, at the same time, severe destruction of the soft tissues, and fracturing or splintering the bones.

(*d*) A ball may lodge in the extremity of one of the long bones with a fissure into the joint.

(*e*) A bullet may pass through a joint *en séton*, grooving, perhaps, the articular cartilage. Cases of this nature are quite as dangerous as those in which the joint has been more fully exposed.

TREATMENT.—The first thing the surgeon has to determine is, *Can the limb be saved or not?* and most surgeons agree with MacCormac, " that radical and not conservative surgery is the best for severe gunshot wounds," especially if transport to a distance is immediately necessary.

This question must be decided partly by the nature and extent of the wound, and by experience gained from statistics of the results of treatment of similar wounds, but still more must it depend on the means at the surgeon's command. Conservative surgery is always much more successful in the upper than in the lower limb.

The object of operations is to substitute a lesser injury for a greater. Amputation is more suited than resection or excision, when the patient has to be carried with an advancing or retreating army. A man with a well-dressed stump will suffer less than one with opposed surfaces of bone rubbing against each other. Moreover, after amputation, if the wound become septic, danger of profuse suppuration, osteomyelitis, and pyæmia is less than in a compound fracture, which is so much more difficult to drain. The time under treatment and the labor of dressing are also less.[1]

The following are the cases generally requiring amputation:

1. Those in which the limb has been torn away bodily.
2. Extensive laceration or loss of integuments and deeper soft parts, the bones being sound.
3. Laceration of the main vessels—both artery and vein—of the lower limb, and of the upper also if there is other serious injury. When cases of wound of the artery or vein only are brought in, which is rare, an Esmarch's tourniquet should be applied, the wound freely opened up, and the ends of the wounded vessel tied. A divided nerve should be sutured.
4. Extensive compound comminuted fractures with much destruction of soft parts, even though the vessels and nerves be not injured.
5. Compound comminuted fracture into the knee-joint, unless antiseptic treatment is possible.

PRIMARY OR SECONDARY AMPUTATION.—Whether the surgeon determine to amputate or to save the limb, with or without excision of an injured joint or resection of fragments, he must make up his mind at once. If he is to amputate, he should do so as soon as the patient is sufficiently recovered from the shock of the injury. The experience of every war has shown that *primary* amputation, performed before fever and inflammation have set in, is much safer than the *secondary*, or that which is delayed until suppuration is established.

In the Peninsular war, Mr. Guthrie found that the loss after secondary amputation was three times as great as after primary.

In the second period of the Crimean war, the rate of mortality per cent. was 25.3 after primary amputation of all kinds, and 42.7 after secondary.

In the American war, of the amputations of the thigh 54 per cent. of the primary were fatal, and 74 of the intermediate and secondary.

MacCormac gives a table of 138 operations of all kinds: 79 primary, of which 23 were fatal, or less than a fourth; 59 secondary, of which 38 were fatal, or nearly two-thirds.

If the primary period has, however, been missed, it seems to be better to amputate during traumatic fever rather than to wait for the secondary period, with the many chances of death before it arrives.

In gunshot fractures of the *upper extremity*, conservation should be the rule where the condition of the soft parts permits.

[1] Surgeon-General Gordon thus sums up the conditions requisite for conservative treatment: The cases few; the surgeon with little work; the attendance good and numerous; accommodation, food, and extras all good and abundant. (Op. cit., p. 108.)

In gunshot fractures of the shoulder-joint, excision of the head of the humerus may be performed if the bone is comminuted; as much as six inches of the bone have been removed with good result. Excision of the elbow-joint also is the rule, instead of amputation, unless the bones are so much injured that a flail-like joint would result from extensive resection. These operations are quite informal, the existing wounds being enlarged, all loose and slightly attached fragments picked out, and sharp points cut off.

In the American war, 575 excisions of the shoulder-joint are recorded—252 primary, 323 secondary; 165 were fatal, 343 recovered. During the Russian war, out of 13 cases of primary excision of the elbow-joint, only 3 patients died; and of 8 cases of primary excision of the head of the humerus only 1 died.

In wounds of the hand, which frequently happened from the explosion of flasks, every endeavor should be made to save as much of the part as possible. The arm is capable of recovering from injuries which would prove fatal or require amputation in the leg. The humerus or bones of the forearm may be comminuted; but unless the integument is either severely lacerated, or extensively torn away, or large vessels or nerves injured, the surgeon should endeavor to save the limb either without or with resection, the case being treated as an ordinary compound fracture. Frequently, after severe comminution of the bones, a large portion will suffer necrosis, but this may either come away of itself or be removed by the surgeon, and a useful arm be preserved.

In the lower extremity the tendency is to amputate rather than to endeavor to preserve the limb, in cases in which the line of treatment is at all doubtful. The limb is much larger than the upper, and much less easy to immobilize; wounds of it are much larger, deeper, and more difficult to drain, to render and to keep aseptic; the shock from them is much greater, the general vitality of the part is less, and the limb becomes useless if weak or greatly shortened. Of course, the danger increases the nearer the injury approaches the trunk; and the same applies to amputation. Consequently we find that the mortality after gunshot fracture of the upper end of the femur extending into the hip-joint, and, indeed, of all fractures in the upper two-thirds of the femur, has always been exceedingly high whatever mode of treatment has been adopted. The most generally supported view is that excision should be done in injuries of the *upper third* of the thigh, the mortality after which operation has been, according to Gurlt, about 87 per cent.; that in the *middle third*, the choice between amputation and conservation shall depend largely upon the necessity for and means of transport; whilst in the *lower third*, especially if the knee-joint is involved, primary amputation gives a much better result than resection or simple expectation, the results of which are extremely bad. Of course, one might easily be forced to amputate primarily even at the hip by laceration of soft parts and injury to vessels.

In the leg very extensive comminution, splintering into the knee-joint or from a distance into the ankle-joint, necessitate amputation; wounds of the lower end of the tibia into the ankle or of the joint itself may often be treated by excision.

The *general treatment* of gunshot fractures, in which the surgeon thinks he can save life and limb without amputation, is that of compound fractures; splints, especially Smith's or Hodgen's splint for the leg, or plaster-of-Paris casing with an aperture for the wound, drainage tubes to prevent bagging of matter, the freest use of antiseptics with the syringe, and free incisions if necessary to let out matter. (See "Fractures.")

In all operations for gunshot injuries, *chloroform* will be found a most useful adjunct. It not only protects the patient from pain during the search for balls and foreign bodies, which is often a most tedious proceeding, but it serves to remove the mental anxiety which is generally present. The patients awaken refreshed from a sound sleep, free from injurious excitement, and animated with a hope that what has been done for them will lead to their ultimate recovery.

Simple flesh wounds, if not severe, require but little surgical aid.

Foreign bodies, including the bullet if lodged, fragments of clothing, etc., should be carefully removed; the wound syringed with weak carbolic lotion, and some of the same applied on lint as a water dressing, and secured with a few turns of bandage.

In the subsequent treatment cleanliness should be the great aim, and be secured by antiseptics. Surgeon-General Gordon speaks highly of the soothing effect of warmth, after every kind of gunshot wound, slight or severe.

The above rules for the treatment of gunshot injuries, especially fractures, will almost certainly be considerably modified by the use of some reliable form of antiseptic dressing, if we may judge from the remarkable results obtained in the Russo-Turkish War by Reyher and Bergmann, and elsewhere by other surgeons. The great object of discussion among military surgeons of the day is how best to carry out in the field the principles of antiseptic surgery ; for, as has already been mentioned, septic diseases are seen at their worst in military hospitals, and the advantage of an aseptic course in such serious injuries as those often inflicted by gunshot is inestimable.

There are many difficulties in the practice of antiseptic surgery under the conditions of active warfare, the chief of which are that the soldier when wounded is often filthy from sweat and dust; that, after he is wounded, he must often lie for many hours on the field before he is carried to the dressing place; that pieces of clothing and other dirty things may be carried into the wound, though this happens much less often with conical than with round balls (Esmarch) ; that officious people may finger the wound—a most fertile source of infection ; that the number of patients is too great ; that the dressings become displaced during transport ; and, lastly, that the dressings are too bulky. As to the latter, there can be little doubt that means will be found for compressing them within reasonable limits; it is admitted on all hands that irrigation during and through disinfection after operations, etc., may take the place of the spray in military surgery ; and many of the other difficulties can be got over frequently, if not always.

According to Reyher, there are two plans of treatment which may be employed in cases in which amputation is not obviously necessary: (1) *Occlusion* by an absorbent antiseptic dressing ; (2) *Débridement*, or opening up freely, and thorough cleansing of the depths of the wound. He read a paper[1] based upon 376 cases of gunshot fractures and wounds of joints, before the International Congress of 1881, from which the following remarks are taken :

Some surgeons (Esmarch), believing that a large number of gunshot wounds remain pure for some time unless directly infected by dirty fingers or instruments, recommend the occlusion treatment primarily in all cases after disinfection of the surface only, débridement must be done immediately if inflammation arises. Others (Gurlt, Volkmann), on the other hand, regard all gunshot wounds as probably infected, and consequently open them up freely, remove all clot, disinfect the cavity thoroughly, drain and dress as often as may be necessary. This is a long process, and could not possibly be generally practised after a great battle. The occlusion method is quickly carried out and is brilliantly successful in suitable cases, thus

[1] Ueber primäres Débridement der Schusswunden.

apparently proving the truth of Esmarch's view; it will, therefore, be a great relief to ambulance surgeons, if properly employed. Neither method is perfect. If the attempt to obtain healing under a scab fail, the wound may at once be opened up and the endeavor to disinfect it made; but the results will not be very good. On the other hand, if a fracture of the thigh, which would have got well under a scab, is opened up, it may become septic and the patient die. It is, therefore, of great importance at once to select well the cases for treatment by each method. The following were the points by which Reyher was guided. There is nothing very exact about them, but his statistics show that they were tolerably trustworthy; the rules must be readily applicable, for but few minutes can be given to consideration.

The *indications for primary opening up* of the wounds and drainage, removal of fragments, or even excision, were the following: gaping of the wound such that fragments of bone or portions of joint surfaces could be seen, emphysema, and obvious infection of the wound by fingering, shreds of clothes, straw, etc,

The *occlusion method* was proper when the wound openings were small and looked clean; or, if they were large, when the wound-canal was not gaping, but run through muscular layers in which there were no emphysema and no infecting material visible or perceptible to touch—when, in fact, the injury resembled an uncomplicated punctured wound—treatment by scabbing was indicated.

Of course, Reyher's own hands and instruments were aseptic during the examination of each patient; and he issued the strictest orders that no one was to finger the wounds. He divided his cases into "befingerte" and "unbefingerte," and the results of the former were very different from those of the latter. The following are some of his statistics:

Of 376 cases (105 gunshot fractures, 271 wounds of joints), including injuries of all parts of the limbs, 180 recovered, and 196 died (52.1 per cent.). Of these 376, 232 cases were deemed suitable for conservative surgery. Of these 57 were treated by occlusion with a carbolic gauze dressing, after superficial disinfection; 47 healed soundly (⅛th of all cases), 39 under a scab or with superficial suppuration, 4 with suppuration not extending to the point or fracture, 2 with suppuration involving the fracture or joint, and in 3 after late suppuration and elimination of a sequestrum; 10 died (15.7 per cent.) of spreading suppuration, pyæmia, etc. Among these cases were 13 fractures of the thigh, of which 11 recovered—10 under a scab and 1 with slight suppuration; and 18 wounds of the knee, of which 17 recovered, 15 under a scab, 1 with slight suppuration, and 1 with suppuration extending to joint. Of 175 cases treated by opening up, drainage, and in 67 cases complete or partial resection, 55 were seen early, and of them 42 healed, 13 died (23.6 per cent.); 93 were seen in the intermediary stage, and of these 42 healed, and 51 died (53.7 per cent.); and 27 were seen in the secondary stage, of whom 9 healed, and 11 died (55 per cent.). Of 14 fractures of the thigh, 2 came under notice at once, 8 in the intermediate, and 4 in the secondary stage; only 2 of the latter lived. Of 40 wounds of the knee, 7 were treated in the primary, 30 in the intermediary, and 3 in the secondary period; the mortality for each period was 57.1 per cent., 72.7 per cent., and 100 per cent. In future wars Reyher would amputate more frequently for this injury. All cases of wound of the hip-joint died, 8 under occlusion, and 7 under débridement (3 with resection); 7 primary excision of the shoulder, all recovered, and of 9 excisions of the elbow only 1 died.

Bergmann treated 15 recent gunshot wounds of the knee, using salicylic wool and plaster; they were then sent a very rough four days' journey 8 healed without suppuration, 2 with slight suppuration, and 5 suppurated deeply; of the latter 1 died of pyæmia, 2 were amputated, and 2 ultimately recovered.

It is obvious from the above results that the sooner a patient is treated, the better. The line of treatment should be determined and carried out as far as possible at the dressing place. The opinion is gaining ground that the most experienced surgeons should be here to decide upon and carry out the immediate treatment, rather than waiting at the field hospital. If transport thither is necessary, all wounds must be made as secure as possible, and for this purpose wool dressing in large quantities and bandaged tightly is the best; or in fractures and wounds of joints, a large antiseptic dressing having been applied, splints or plaster of Paris may be used outside it. In cases treated by opening up the wound, the bones should be sutured when fractured.[1]

Arrow Wounds.

Bows and arrows are by no means obsolete in warfare. In the hands of the Indians, in Western America, they are very formidable to the United States soldiers; and in the hands of the South Sea Islanders they have wrought considerable havoc amongst English naval officers and men. Nor are they by any means despicable weapons. They are noiseless, and adapted for many kinds of service. They may be aimed with the greatest accuracy, and their penetrating force is very considerable. Cases are recorded in the United States Reports, in which arrows have transfixed bones, penetrating both tables of the skull as cleanly as any bullet, so that it is estimated that their initial velocity may nearly equal that of a musket-ball.

Of course, if impacted, an arrow must be cut out as speedily as possible, in the same manner as a bullet; but there are two circumstances which require attention—one is, the construction of the arrow-head, which may not only be barbed to render extraction difficult, but the arrow-head may be only glued on to the shaft, so that when the glue is softened by the blood and warmth of a wound, the shaft is easily detached and comes out, leaving the arrow-head in the wound. The natives of the South Sea Islands tip their arrows with bone, often a human bone, such as the fibula or ulna, ground down very thin, and so arranged that it easily breaks off on entering the body.

The next point is, that from time immemorial savage and half-civilized people have been in the habit of poisoning their arrows. For this purpose several plans have been adopted: one is to dip the arrow-heads in the blood and gore of a dead and putrid animal; a second, is to use for this purpose

[1] For the Surgery of the Peninsular War, the student may consult the works of Guthrie, Larrey, Hennen, and Ballingall. Medical History of the British Legion in Spain, by Rutherford Alcock, Lond. 1838. Battle of Navarino, Lizars's Practical Surgery. Canadian Rebellion in 1838, Home, Edin. Med. and Surg. Journal, July, 1840. Indian Wars of 1848-49, Cole, Military Surgery, Lond. 1852. Crimean War, Duigan, Med. Times, Sept. 1855; Lyons's Pathology of Army in the East; Williamson, Military Surgery, 1863; Medical and Surgical History of the British Army during the War against Russia, 1854-56, 2 vols. folio, Lond. 1858; Longmore, in Holmes's Surgery; Baudens, La guerre de Crimée, Paris, 1858. War of the American Rebellion, 1861-65, History of prep. by Surg.-Gen. Joseph K. Barnes, Washington, 1876; Moses, op. cit.; Brinton, op. cit.; G. A. Otis, Circ. Nos. 2 and 7. On the Confederate side, J. Julian Chisolm, Manual of Military Surgery, for the use of the Surgeons in the Confederate States Army, 3d edition, Columbia, 1864. Of the Franco-Prussian War, Gordon, op. cit., MacCormac, op. cit. Stromeyer, Erfahrungen über Schusswunden im Jahre, 1866, von Dr. L. Stromeyer, Hannover, 1867. L. Legouest, Traité de Chirurgie d'Armée, deuxième édition, Paris, 1872. Socin and Klebs, Chirurgische und pathologisch-anatomische Beiträge zur Kriegsheilkunde, Leipzig, 1872. The United States official reports are admirable.

some poisonous vegetable, especially such as tend to produce tetanus; besides these, the rattlesnake venom and other poisons are no doubt used. But whatever the intentions of those who dip their arrows in poison, accurate observation has shown that they fail in fact. Staff-Surgeon Dr. Messer proves this very clearly in his account of the case of Commodore Goodenough and six others, who were wounded with arrows by the natives of the Santa Cruz Islands, in August, 1875. Three out of seven persons wounded died within eight days; but they did not die of pyæmia, as might have been expected, had the arrow been poisoned by some putrid animal matter, nor were there any symptoms of strychnine poison. But they died of tetanus, which came on four or five days after the injury, in the way in which it only too often follows wounds received in hot climates. Though there was no poison, the dread of it acted most injuriously on the wounded persons.[1]

CHAPTER XVI.

EFFECTS OF HEAT—BURNS AND SCALDS.

Burns and scalds are divided into six "degrees" according as they produce: 1. Hyperæmia, probably followed by desquamation. 2. Vesication. 3. Superficial, and 4. Complete destruction of the skin. 5. Destruction of deeper soft parts. 6. Complete charring.

A recently burnt or scalded part, then, may be simply red, or studded with vesicles containing clear yellow coagulable fluid; in the centre there may be a moist white patch of dead skin, which in burns from the action of higher temperature, may be brown or black and dry. Up to 100° C. heat causes only coagulation of the tissues and such change in the vessels that no blood enters.

We have already shown (p. 48) that the irritation of a severe burn alone excites only hyperæmia and some exudation round about the eschar, and this is absorbed or thrown off by granulation tissue due to constant slight irritation, which the presence of the eschar excites. But ordinarily burns from the second degree onward become septic, and the result is free suppuration, death of parts which would have recovered, traumatic and suppurative fever, and perhaps some infective process during or after the separation of the sloughs. Should all go well, the ulcers left granulate, and often become too luxuriant; sometimes they are exquisitely tender, the removal of dressings causing extreme pain. Before granulation, burns causing exposure of the nerve-endings in the papillæ are very painful. Healing is usually slow, and, when the whole thickness of the skin is destroyed, accompanied by great scar-contraction. Some ulcers are so extensive that healing ceases entirely. Eschars may extend into joints or body cavities.

[1] See Report on Surgical Cases in the Army of the United States, 1865–71, Circular No. 3, issued by the War Department, Surgeon-General's Office, 4to. Washington, 1871. An Inquiry into the Reputed Poisonous Nature of the Arrows of the South Sea Islanders, in Relation to the Occurrence of Three Fatal Cases of Tetanus after Wounds by Them on board H.M.S. "Pearl" in 1875, by Staff-Surgeon A. B. Messer, M.D., R.N. Published by the Admiralty.

A singular accompaniment of severe burns was pointed out by Mr. Curling, *Med. Chir. Trans.*, vol. xxv., that they are liable to be followed, about the tenth to fourteenth day, by acute ulceration of the duodenum beginning in a Brunner's gland. It may end fatally by perforating the intestine and causing peritonitis, or by opening some large artery and causing bloody vomiting and purging. Mr. Humphrey has observed ulceration of the lower part of the œsophagus. The bleeding usually comes quite suddenly and without warning.

The constitutional symptoms of severe burns may be divided into three stages, each with its special dangers:

1. Immediately after the burn there is more or less intense *collapse*, which may pass into coma and death within a few hours. It is due to excessive stimulation of sensory nerves; hence the *danger* of burns is in proportion to their superficial extent rather than their depth; and it is greater when they are on the trunk than on the extremities.

2. *Traumatic* fever, not uncommonly passing into fatal septicæmia, occurs until granulation is established; and

3. *Hectic*, from profuse suppuration, or pyæmia may destroy the patient later. Death from perforating ulcer occurs early in this, or at the end of the last, stage.

TREATMENT: GENERAL.—Take care in removing the clothes not to tear off the cuticle; if the warm bath is to be used—and the warm bath is very valuable in burns—let them float off in it. Treat shock by coffee and stimulants. The treatment of fever presents nothing special; in the later stages support of every kind must be given. Pain often requires opium, which may be given, with the necessary caution, even to children. To them it is often right to administer a small quantity of chloroform at each dressing.

LOCAL.—The object of this is to prevent decomposition and all its consequences. Vesicles may be pricked and allowed to collapse. Then wash the injured surfaces with some warm unirritating antiseptic lotion, wrap the part in a quantity of salicylic wool, and bandage carefully. Do not remove the dressing unless it comes through or smells offensively, or the patient becomes febrile; changes should be as infrequent as possible. More limited burns may be treated with carbolic or mercuric gauze dressings, if they are preferred. Boracic fomentations facilitate the separation of sloughs; ultimately these may often be freed by careful use of scissors.

Old established remedies are—for superficial burns, carron oil (ol. olivæ, aq. calcis, āā; for deeper, a liniment of ung. resinæ, ℥j, and ol. terebinth., ℥ss, freely applied on lint, the part being then wrapped in wool and as little disturbed as may be. A still simpler plan is to endeavor to keep the part dry by dusting it thickly with flour and leaving the crusts undisturbed.

In case of complete charring, or great destruction of soft parts, *amputation*, when possible, and when shock has been tided over, must be done at the lowest point at which skin is obtainable. During time of doubt carefully render aseptic and wait. With free drainage and antiseptics, even without perfect asepticity, the extension of an eschar into the knee-joint does not necessarily require amputation.

There is nothing special in the treatment of the ulcers left by separation of sloughs. Choose as permanent a form of antiseptic dressing as possible; salicylic wool covered by macintosh cloth is very good. Iodoform must be cautiously used, if at all. Ointments of boracic or salicylic acid or thymol are often employed, but they require daily changing. Luxuriant granulations at the edge must be kept down by caustic and nicely adapted pressure. Skin-grafting is of some assistance in healing large sores. When these have become stationary, it would be well to try transplantation of skin as done by Wolfe for ectropion. He cuts a bit of skin, say two by one inch, from some other part (or a just amputated limb), and dissects off *every particle of fat;* he then applies it to a raw surface from which bleeding has quite ceased, covers it with a moist boracic dressing, and this again may be covered by salicylic wool. By the third day adhesion should have occurred. The raw surface might be prepared by scraping away granulations, and a smaller bit of skin than the above would probably have a better chance of living.

Prevention of Contraction, and Treatment of the Scar.—The scars of severe burns are excessively dense and thick, and contract so as to occasion the most serious deformities. Thus the eyelids or mouth may be rendered incapable of closing; the chin may be fixed to the breast, or a limb be rigidly flexed or extended. This contraction may be sometimes successfully opposed by a suitable splint, or, if the neck is the part burned, by making the patient wear a stiff collar; and by frequently stretching the part during cicatrization. Hebra used the permanent water bath for extensive burns; healing occupied some months, and took place with less contraction, and less general disturbance. If the fingers are severely burned, place lint between them, and keep them apart as much as possible; it may be very difficult to prevent them from adhering. When an orifice of the body is involved, keep it dilated with a canula or plug of oiled lint till cicatrization is complete. But if, notwithstanding every precaution, the cicatrix contracts, and produces deformity, or prevents any necessary motion, the knife should be resorted to. Sometimes a narrow band may be extirpated, and the parts on each side being dissected up, slid in and united; or simple transverse division of a scar at one or more spots may be done, and extension made by apparatus during healing; or it may be divided thoroughly by one or more V cuts, the flaps dissected up and pushed up, whilst the raw angles left are closed by approximation of their borders. None of these is very successful. Some excellent operations are performed by dissecting up two large flaps, with long convex borders at right angles to, and meeting in the line of, greatest contraction. The displaced part can be considerably pushed up, the flaps sewn together for a short distance, and then, by a *slight* stretching of their free borders, they may be attached all along to the skin whence they were cut. This is the principle upon which Syme's operation for replacing an extroverted lower lip is planned; the more the lip has to be raised, the longer must be the convex edges of the flaps. In other cases, after complete division or excision of a scar and remedying of the deformity, a flap, cut from some neighboring part in such a way as to leave no serious deformity, is twisted upon a stalk which contains its vessels, laid in the wound, and sewn to its margins; or the gap may be filled in by small bits of skin transplanted according to Wolfe's method; or by a granulating piece of skin still adhering by a stalk to some distant part, which can be approximated or rigidly fixed close to the defect; when the flap is adherent to the latter its stalk is cut through (method of Tagliacozzi).

General Points about Plastic Operations.—Flaps in plastic operations should contain a good deal of subcutaneous tissue; the knife should always be turned away from them in dissecting them up; they should be cut according to a pattern in paper or lint of the flap required, but one-quarter to one-third larger to allow for elastic shrinking and scar contraction. The pedicle should contain the chief vessels, and be sufficiently long and narrow to permit twisting without obstructing them. The stalk should be laid in a groove, not stretched over a bridge of sound skin. The edge of a flap must be most carefully attached to the raw edge of the gap; often the line of union is coated with collodion, but there is no better dressing than a pad of salicylic wool. The skin chosen to replace a defect should be as like that lost as possible. Scar tissue should never be included in a flap if it can be avoided, being very liable to slough.

CHAPTER XVII.

THE EFFECTS OF COLD.

I. General Effects of Severe Cold.—When a person is exposed to severe cold, especially if accompanied by wind,—or during the night,—or if he have been exhausted by hunger, watching, and fatigue—he feels an almost irresistible impulse to sleep, which, if yielded to, is soon succeeded by coma and death. During the state of coma, the body is very pale and cold, respiration and pulse almost imperceptible, pupils dilated; but the limbs are flexible so long as life remains, unless the cold be very intense. Post-mortem—the chief morbid appearances are great venous congestion and serous effusion in the head.

II. Frost-bite.—If the cold affect some exposed part only, such as the nose, ears, or extremities, frost-bite may follow. Sudden intense cold, like the ether spray, causes pallor and shrinking of the part; if this state continue, the part may be pale and tallowy even when dead. Ordinarily, the first sign is a dull purplish-red color, from stagnation of blood in the veins, the arterioles being strongly contracted, and the blood passing into the skin lacking driving force. If this state continues bullæ may rise, which often contain red corpuscles. Finally, the part becomes dark blue or brown, studded with vesicles, perfectly insensible and motionless. When in this condition it is said to be *frost-bitten*. The patient may be quite unconscious of the accident that has befallen him until told of it by some other person; especially if it be his nose or ear that is affected, or some other part that he does not move.

Starvation predisposes people strongly to suffer gangrene of extremities from cold.

As the part thaws, blood rushes into it; the vessels have undergone the molecular change (p. 53) from anæmia and cold, they leak, and the phenomena of inflammation, intense in proportion to the duration of the freezing, ensue. These may soon lead to *moist gangrene* of parts not directly killed by cold.

Treatment.—The temperature of the body and of the part must be *very* gradually raised, that the vessels may have time to recover and resist the arterial pressure. Place the patient in a cold room in a cold bed if suffering from the general effects of cold, and use friction of the whole surface and artificial respiration if the breathing fails; ammonia may be held to the nostrils, the temperature of the room gradually raised, and tepid coffee given; then warm milk and fluid food. As the extremities recover they may be acutely painful, and the above symptoms set in; usually some parts die.

A slightly frost-bitten part should be rubbed with snow, then with cold water, and finally with the hand. But if there are vesicles present it is best to disinfect the part with sublimate solution, to wrap it in an antiseptic dressing, and employ suspension more or less approaching the vertical (Bergmann), attending meanwhile to the general condition. This is the treatment also in cases of doubtful gangrene; if the color becomes dark cherry-red, there is little hope. So soon as it is certain where gangrene ceases, amputate.

The *contact of any intensely cold body* (such as frozen mercury) causes severe burning pain, followed by vesication or sloughing. Treat antiseptically.

III. Chilblains may present themselves in three degrees. In the *first*, the skin is red in patches and slightly swelled, with more or less itching. In the *second*, there are vesications—the skin around being bluish or purple. In the *third* degree there is ulceration or sloughing.

Treatment.—Friction, with stimulating liniments, such as F. 266; turpentine, or camphorated spirit; iodine paint or ointment, or other local stimulant, will be useful in the first stage. Always look to the general health; advise active exercise, bathing—as cold as can be borne—warm covering for the extremities.

If there are *ulcers*, or *sloughs*, attended with much heat, pain, and irritation, boracic fomentations are required. Later, stimulating ointments or lotions (F. 304 and 307) should be preferred.

CHAPTER XVIII.

EFFECTS OF THE POISONS OF HEALTHY ANIMALS.

Snake Bite.

All snakes are well furnished with teeth; but whilst the *innocent* snakes have on each side of the upper jaw a row of palatine teeth and a row of maxillary teeth outside them, the *venomous* have the outer or maxillary row suppressed, except one long poison-fang at the anterior extremity. In the latter, there is a gland in the temporal region, the duct of which opens into a pouch formed of the mucous membrane of the mouth, enveloping the root of the poison-fang. Thus the poison can readily escape between the fang and the gum; moreover, there is a canal in the fang through which it passes when the snake bites.

The fang is longest, most perfectly developed, and erectile in the rattlesnake and viper tribe; in them it is furnished with a perfect canal, while in some less perfectly developed poisonous snakes there is only a groove on the anterior surface of the fang.

The poison is a clear, slightly viscid, faintly acid liquid. It contains an active principle named *echinidine, viperine*, or *crotaline*. In composition this appears to be allied to albumen. When injected into the flesh or blood of any animal whatever, save its own species, the saliva of every poisonous snake threatens to destroy life. Warm-blooded animals, such as birds, suffer most quickly; but snakes and cold-blooded animals die with equal certainty, though more slowly. The bite of the cobra or of the rattlesnake will kill any other snake, but these creatures have been made to bite themselves or others of their own species with impunity. The action of snake poison on *mucous* membranes is surprisingly small; "fine particles of the dried poison have a pungent action on the nostrils, the taste is slightly bitter, and causes a flow of frothy saliva," says Mr. Nicholson, who has never found any ill effects from tasting it, or from the action on the nostrils; but if any gets into the eye it causes a painful inflammation, which, however, soon passes off. Weir Mitchell says that the poison of the rattlesnake may be applied with entire immunity to the mucous membrane of the stomach of pigeons; for instance, if a pigeon's crop is opened and a few drops of rattlesnake poison poured into one of the lateral pouches away from the wound, "an hour passes and the pigeon remains unaffected." "With a fine needle," says Dr. Mitchell, "I twice puncture the mucous membrane on which the venom lies, in five minutes the pigeon's head falls, in a quarter of an hour it is dead." Fayrer, however, denies that snake poison is harmless when applied to the mucous membranes; for cobra poison applied to the conjunctiva of chickens is absorbed and produces its usual effect. Mitchell has shown by experiments on the mesentery of the frog that rattlesnake-poison passes through the *serous* membranes instantly, producing hemorrhage from the vessels beneath.

The only poisonous snake met with in the British Isles in the viper, which very seldom kills human beings, although it may do so. In the United States the *rattlesnake* and *copperhead*, in Australia the *tiger snake*, are the chief varieties to be dreaded; in Southern India the commonest poisonous snakes are four—namely, the *Cobra*, or *Naja tripudians;* the *Krait*, or *Bungarus arcuatus; Russell's viper*, or *Daboia elegans;* and the *Carpet viper*, or *Echis carinata.*

The *symptoms* produced in living animals are of three orders: first, those relating to the nervous system; secondly, those depending on the state of the blood; and thirdly, local symptoms at the bitten part.

(1) NERVOUS SYMPTOMS.—These are the most prominent and remarkable symptoms of every kind of snake bite. The man or animal bitten is first conscious of more or less pain at the injured part, then gradually becomes drowsy, comatose, and probably convulsed. A European patient, whose case is amongst Fayrer's valuable records, first complained of hot pain, then headache, drowsiness, and vomiting. There is no limit to the variety of possible nervous symptoms, but extreme torpor and convulsions are the commonest. In the case of a keeper at the Zoölogical Gardens, who was bitten on the root of the nose by a cobra, on the 20th of October, 1852, there was no swelling; a slightly pinkish hue of the eyelids, dyspnœa, stupor, paralysis of the extremities, and coma came on, and the patient died in 95 minutes. The chief points of interest in the post-mortem examination were a dark, alkaline, and fluid state of the blood, which emitted a peculiar sour and sickly smell; and intense congestion of the lungs, spleen, and other internal organs.

(2) The *state of the blood* is remarkably altered by the action of the viperine poisons. In experiments shown to the author by Dr. Shortt, the poison of a daboia was mixed with blood from a living dog; this blood did not coagulate—as did the blood of a dog bitten by a cobra, a colubrine snake—but degenerated into a slimy liquid of arterial color; and the blood from the cobra-bitten dog displayed its red globules in a natural condition, whilst that mixed with the daboia poison showed them shrunk up and collapsed, yet there was remarkably little difference between the symptoms of poisoning by one snake and the other. Weir Mitchell has taught us the solvent power of the rattlesnake poison (viperine) on the blood: hence it is no wonder that hemorrhage is a frequent after-symptom of poisoning by viperine snakes. Blood oozes from the mouth, eyes, nose, and bowels, and with the urine; and, as in other cases of dissolution of blood, the patient is jaundiced. However, there seems to be nothing intrinsically dangerous in this bleeding, which, of course, is noticed in those patients who live through the primary nervous symptoms.

(3) The *local symptoms* consist of severe swelling, ecchymosis, and probably suppuration of the bitten part, when the patient survives the more perilous early symptoms. Hence it is commonly said that the cobra poison is the more narcotic, because it is early fatal, and the daboia and echis more irritating locally, because the patient survives till swelling and abscess form. The time within which death may occur is very short, generally under two hours; but a case is recorded by Fayrer in which, after the patient recovered his consciousness, and seemed doing well, the coma returned and ended in death in sixty-three hours.

DIAGNOSIS.—There is often great doubt whether a patient has been really bitten by a snake, but if he shows two punctures about half an inch apart bleeding pretty freely the case is clear. A few innocent snakes have the anterior maxillary teeth developed like poison fangs, but bites from them are not very likely to occur (Fayrer). When a full-sized cobra or daboia has inflicted a thorough bite—and it must be remembered that a snake bites with a will, and holds on like a dog—so that it has injected a full dose of poison, we believe the case is inevitably fatal. But this is very much a matter of quantity, the smaller the animal bitten and the larger the quantity of venom injected, the greater the danger. In short, there are many loopholes of escape: the snake may have been sickly, its poison used up, and its bite a mere scratch with a very slight injection of venom, if any; and nervous symptoms may be simulated by fright.

TREATMENT.—The only rational measures are these: first tie a ligature tightly above the bitten part, if on a limb; then cut out or deeply cauterize by the actual cautery or by caustic the wounded part, and encourage bleeding by hot water. In addition, the part should be emptied of blood by the use of the dry cupping glass, or else the wound should be vigorously sucked, the saliva being quickly spat out, as the proceeding is else not free from danger (Fayrer). Then the condition of the patient must be carefully attended to; hot spirits and water may be given in small quantities to keep up the circulation, or the liq. ammoniæ well diluted; or the patient may be kept up by enemata of brandy, ammonia, and coffee. Artificial respiration may be tried if the breathing flags. Professor G. B. Halford, of Melbourne, has shown that the injection into a vein toward the heart by a hypodermic syringe of 30 minims of the liq. ammonia (B. P. sp. gr. 0.959) is efficacious in the case of bites from the Australian snakes. Of other antidotes there is arsenic in half-grain doses, and liq. potassæ, recommended by Dr. Shortt. But the surgeon will take care rather to do nothing than to do mischief. Dr. Weir Mitchell believes that some of the symptoms attributed to rattlesnake poison have been caused by the misuse of whiskey in poisonous doses as a remedy.

It is customary to keep the patient awake by walking him about, just as after poisoning by opium. Sir Joseph Fayrer warns against exhausting the patient by this proceeding.[1]

[1] The author must express his great obligation to that accomplished naturalist, Dr. John Shortt, of Madras, whose courage, dexterity, and ingenuity in handling snakes, and experimenting on the nature of their poisons and the remedies, are above all praise. Dr. Shortt's writings are in the Madras Monthly Journal of Medical Science, and the author would refer to his "Letters from Madras" in the Medical Times and Gazette for August 23, 1873, September 30, 1873, and January 31, 1874. He is also under obligation to Surgeon-Major Edward Nicholson, author of the Elementary Treatise on Ophiology, 2d ed., Madras, 1874; Fayrer's magnificent work on the Thanatophidia of India; S. Weir Mitchell, Med. Times and Gazettte, vol. i., 1869. Sir Everard Home, Case of Rattlesnake Bite, Phil. Trans., vol. c.; Case of Keeper in Zoölogical Gardens bitten by a Cobra, Lancet, October 30, 1852; Chevalier, Med. Chir. Trans., 1813, on Use of Arsenic in Snake Bite; on Rattlesnake Poison, Phil. Trans., vols. xxx. and xliv.

Poisonous Insects.

The bites or stings of mosquitoes, wasps, bees, spiders, and scorpions may produce a good deal of pain or itching and swelling. The number of remedies in vogue shows that none of them is reliable. Some apply carbonate of soda, or chalk, or spirit of ammonia; others vinegar; perhaps a weak solution of carbolic acid in water, or carbolized oil (1 in 20) or compound camphor liniment, is the best; some preparation of carbolic acid is thought to be efficient for keeping mosquitoes at bay. Some of the essential oils—*e. g.*, pennyroyal, peppermint—are useful both as local sedatives and also for the purpose of keeping off insects. In the case of bee or wasp sting, if the sting is seen to be left in the wound it should be extracted with a fine forceps. Children or even adults may be so severely stung by a swarm of insects as to suffer severely from collapse, and require brandy and ammonia. A wasp or bee sting in the throat may cause imminent danger of suffocation from swelling of the glottis; gargling with warm salt and water is recommended, and it may be necessary to perform tracheotomy.

CHAPTER XIX.

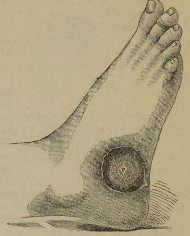
ANIMAL PARASITES—ENTOZOA—VEGETABLE PARASITES.

I. The Guinea-worm. — *Dracunculus* or *Filaria Medinensis* is a very common pest, especially on the coast of Africa and in the East Indies. The female only is known. It infests the subcutaneous areolar tissue, especially of the feet and legs. It attains a length of from one to six feet, and has the thickness and appearance of vermicelli, or of a common wax match. It is calculated that it takes nine months to develop and mature its young, and then it comes out; usually in the summer, from May to September. During its growth it causes gradually increasing pain, stiffness, and swelling; in ordinary cases there next follows the appearance of a huge circular bleb or blister filled with a seropurulent fluid: the surgeon cuts off the raised cuticle all round its margin; then is seen the rounded head of the worm with one or two inches of its body protruding from the centre of the denuded cutis (Fig. 58). The surgeon now makes a small quill-like roll of adhesive plaster, rolls the worm round it, and gently draws out as much as will come *without risk of breaking.* Rupture of the parasite has caused severe local and even constitutional symptoms, probably owing to the escape of the young filariæ. This process of drawing out and rolling upon the plaster is repeated every day, till at last the tail, which is pointed and turned up like a small hook, comes wriggling out, and the case is at an end. The worm, if examined, is found to be full of young filariæ, which have been developed whilst the parent was in the body of the human "host."

Sometimes the worm forms a subcutaneous abscess, instead of a bleb; in this case the abscess must be opened, when a loop of the worm will probably protrude, and must be got out as above described. There may be more than one worm; the author saw a case at Madras in which nineteen had been extracted from different parts of the legs. The patient had been seven months in the hospital, and had been in great danger from tetanus. If near a joint the worm may cause synovitis. This malady is so common in Madras during the summer as to fill from five to ten per cent. of the beds in the General Hospital.

The life history of the guinea-worm is not complete; the young filariæ on escaping from the body of the parent worm are sexually immature. It is believed that they then enter the tissues of minute fresh-water crustacea, and in a further stage of development gain access to the alimentary tract of man. The notion of direct penetration of the skin by the worm has been abandoned.

Fig. 58.

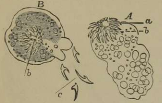


This figure represents the guinea-worm bleb just cut off, and the head of the protruding worm rolled round a small quill of plaster. From a patient of Dr. Paul's, who caused a life-like drawing to be made by Moonesawmy, and gave it to the author. See author's "Letters from Madras," *Med. Times and Gazette*, Jan. 3, 1874.

II. The Chigoe or Sand-flea (*Pulex penetrans*) is a minute insect, abundant in the West Indies and northern parts of South America, in dry and sandy situations. The insects attack the feet chiefly beneath the nails and between the toes, the impregnated females penetrating the skin. The abdomen of the parasite then swells and forms a small cyst. When the cyst is fully formed it may be of the size of a pea, and is of a bluish color. The symptoms are a violent itching. The treatment consists in extracting the creature and its eggs, which operation is dexterously enough performed by the negroes with the point of a needle, and the cavity left is filled with tobacco ashes. If the bag is broken in the extraction, so that the young chigoes escape, violent inflammation is the result. On the other hand, if left in the tissues the insect may excite violent inflammation, suppuration, and, maybe, extensive ulceration. Should such inflammation have resulted, the wounds must be frequently washed with 1 in 20 carbolic or other strong antiseptic, to destroy the larvæ.

III. The Echinococcus (*Hydatid*).—This is the cystic or larval condition of a minute tapeworm, infesting the dog tribe, the ova of which find their way into water and so gain access to the alimentary tract of man. The embryos, set free from the ova, burrow into the tissues, and, having lodged in some one organ or tissue, develop into sacs or cysts, which are filled with fluid. The echinococcus cyst may be of any size, from that of a small nut to that of a man's head. The structure shows an outer fibrous capsule, which is of inflammatory origin and belongs to the tissues of the host; within this a characteristic translucent gray-white gelatinous membrane of variable thickness, very loosely connected to the capsule; under the microscope this shows in cross-section very beautiful, fine lamination; the inner surface of the gelatinous membrane appears somewhat granular, and small, opaque, white granules may be visible on it. Each granule consists of an encapsuled group of small echinococcus heads (*scolices*). Filling the cyst is a clear, very thin fluid which does not contain albumen (no coagulation with heat or acids). We have thus a single fertile cyst. In other cases the small, white, granular echinococcus heads may be absent—the cyst is then sterile. In yet other cases—this is the most frequent variety in man—secondary or daughter cysts form within the primary cysts, and within these tertiary cysts. These cysts are structurally quite like the parent cyst; they vary greatly in size, and float as gelatinous spheres in the hydatid fluid. These secondary or tertiary cysts may be fertile or sterile.

Fig. 59.



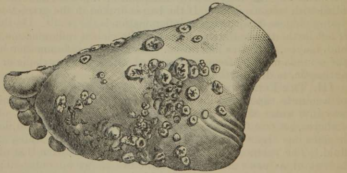
Two scolices from a cluster. *A*, scolex with head extruded; *B*, with head invaginated in the hinder part of the body; *a*, rostellum; *b*, crown of booklets; *c*, individual hooklets. (From a hydatid of the liver.)

The most common *seats* of the hydatid are—the *liver;* then, but far less frequently, the *peritoneum;* but it may occur in the lungs, kidneys, brain, bones, subcutaneous tissue—in fact, in almost any organ or tissue.

The surgeon will be consulted for a slow-growing, non-inflammatory, encysted, fluctuating tumor, yielding a peculiar thrill to percussion—*hydatid fremitus*—which, if punctured, gives exit to a clear serous or purulent fluid (for the fibroid sac containing the hydatids may suppurate); and the hydatid cysts themselves, or portions of them, will shortly protrude. The diagnosis in doubtful cases will be determined by examination of the fluid, by finding teeth under the microscope, or fragments of laminated membrane.

Treatment.—Free incision if the cyst be superficial. If deep-seated, a puncture with a very fine trocar and canula, and simply drawing off the fluid, is the most successful practice—often causing death of the parasite. Everything used should be rendered perfectly pure. If in the liver, the puncture should be made over the most prominent part of the tumor; part only of the fluid should be removed. The patient should be kept at perfect rest afterward, with a flannel bandage firmly applied round the seat of

Fig. 60.



Fungus foot, drawn, by permission of Dr. Furnell, from a specimen in the Madras Museum; shows the little pea-like elevations of the skin which mark the orifices of sinuses, with which the flesh and bones of the foot are riddled.

puncture to guard against escape of hydatid fluid into the peritoneal cavity, which may occur even through a very fine puncture. Should tapping fail, an incision under antiseptic precautions may be carried down to the surface of the tumor; should this be adherent to the abdominal wall, a free opening may be made and the cyst evacuated and drained; should it not be adherent, the peritoneum must be opened, and the tumor left presenting in the gaping wound till it have contracted adhesions (Volkmann). Then the tumor may be opened. This operation should not be lightly undertaken.

IV. Vegetable Parasites.—Of these we can here refer only to the *Fungus Disease* of India, described by Professor H. V. Carter, of Bombay.[1] In this curious disease, the sporules of some fungus find their way beneath the cuticle of the foot, increase, and form tumors, then abscesses, and at last invade the bones, which they excavate and fill with rounded black masses. The fungus has been named Chionyphe Carteri; but it is by no means certain that the disease is due to the fungus, for a form of the disease exists in which no black masses are present and no fungus elements discoverable. The disease affects natives of India, and seems to be irremediable except by amputation.

CHAPTER XX.

DISSECTION OR POST-MORTEM WOUNDS.

When a prick or other breach of surface is brought in contact with the tissues of a dead body, poisoning, which may be local or local and general, is liable to result from inoculation of a virus. The nature of the poison is not known; it is probably different in different cases. It is most virulent in fresh bodies, and in the bodies of those who have died of some infective disease—*e. g.*, erysipelas, septic infection, pyæmia, puerperal fever, and peritonitis; it diminishes as putrefaction advances. That poisons present during life in the organism may retain their powers after death is shown by the fact that glanders and splenic fever may be inoculated from the dead body.

The poison enters almost always through some breach of surface; but it sometimes appears to do so through a hair follicle in unbroken skin. The resisting power of the tissues is an important element in the case, for it is in depressed states of health that poisoning is most likely to occur. Probably, other things being equal, a person constantly exposed to the poison will be less susceptible than one only occasionally exposed.

Forms of post-mortem poisoning:

1. The *dissecting-porter's wart.* This is the result of continued irritation of the surface by putrid material; it is analogous to the warty growths caused by the irritation of gonorrhœal discharges. There is no entry of the poison in this case. The warty growths affect the back of the hand, over the knuckles and joints of the fingers. An ichthyotic appearance is sometimes present, with cracks and fissures of the surface, but no true ulceration, which, with the fact that the growths are multiple, distinguishes the disease from epithelioma.

2. The *dissecting-room pustule.* Here there is local infection. The chief point calling for note is that the pustule, if opened but otherwise untreated, scabs and persists as an unhealthy ulcerating surface beneath this scab.

[1] "On Mycetoma or Fungus Disease," Trans. Med. and Phys. Soc., Bombay, No. vii., 1862. See also Quain's Dictionary of Medicine, article by Cunningham and Lewis.

Suppuration of the hair follicles of the hand and wrist, boils, whitlow, may be mentioned as occasional effects of post-mortem poison.

3. *Suppuration of the matrix of the nail*, generally at its root, results also from infection. The tissues immediately adjoining are inflamed and very tender. The condition is very chronic on account of the difficulty of getting at the disease beneath the nail.

TREATMENT.—The wart may sometimes be cured by the constant application of ext. belladonnæ. If this fails, caustics may be used; but it would be proferable to scrape away the growth, disinfect its base, and treat antiseptically. Collections of pus must be opened, washed with an antiseptic, the cavities dusted with iodoform, and moist boracic dressings applied. Remove a nail if its base cannot be cut away sufficiently to expose an ulcer completely.

4. The poison may spread widely from the point of inoculation, and this most readily occurs in loose cellular tissue. A *diffuse cellulitis* results, starting from the point of inoculation, and *lymphangitis* also is commonly present. For the signs, symptoms, and possible terminations and treatment of diffuse cellulitis, see p. 153. Among these terminations must be mentioned *spreading gangrene* (p. 153).

5. *Acute lymphangitis and lymphadenitis* sometimes occur even in cases with scarcely any change at the site of inoculation; sharp fever, with red lines, extremely tender, leading to swollen and painful glands, characterizes the affection. The termination may be suppuration in the glands or along the inflamed vessels.

TREATMENT.—Disinfect any wound; hot fomentations, with free application of glycerine and belladonna along the lymphatics; early evacuation of pus. As the disease generally signifies depressed health, it may be essential to support the patient by milk, strong beef-tea, eggs, and quinine.

6. *Cellulitis of the axilla* sometimes arises as in the preceding cases, with but trifling local signs at the site of inoculation. Symptoms of an intense on-coming pyrexia (rigor, vomiting, headache) may precede the axillary affection, the temperature perhaps reaching 105°. Then with much pain and tenderness brawny swelling of the axilla sets in, spreading beneath the pectorals inward toward the mid line. The swelling may advance to the front of the chest, and spread upward to the clavicle, and downward along the side. Typhoid symptoms (p. 58) set in early, perhaps with diarrhœa, and the patient dies comatose. Throughout there may be no distinct fluctuation in the axilla.

TREATMENT.—*Early* and *free* incision by Hilton's method, opening the deep axillary fascia and the subpectoral tissue; then frequently changed boracic fomentations. There must be no waiting for fluctuation. The constitutional treatment is essentially supporting; milk, eggs, beef-tea, and, maybe, the free use of stimulants and quinine in full doses.

7, The symptoms of *acute septicæmia* or *pyæmia* may rarely follow on post-mortem wounds.[1]

[1] Cf. Marcus Beck, article in Quain's Dictionary.

CHAPTER XXI.

EFFECTS OF POISON GENERATED BY DISEASED ANIMALS.

I. Hydrophobia.

Definition.—Hydrophobia is an acute disease caused by the inoculation of the saliva of a rabid animal, and characterized by mental excitement and spasms induced by the attempts to swallow fluids. The disease is almost invariably fatal.

Symptoms in the Dog.—The earliest, according to Mr. Youatt, are "unusual sulliness, fidgeting, and continual shifting of posture." The dog retreats to his bed, where he lies curled up, with his head buried between his paws. Then he becomes fidgety, continually changing his resting-place. Delirium is also an early symptom; the dog perhaps springing up and giving an angry bark at some imaginary object.

With the delirium a variable amount of *ferocity* is displayed by rabid dogs. Some there are who, if loose, rush out, biting every man and beast in their way. Others, on the contrary, in the very earliest stage of the disease, show an *increased fondness*, and are perpetually trying to lick their owners' hands and face.

Another early symptom is *change of voice*. There is said to be a most peculiar and characteristic combination of a perfect bark ending abruptly and very singularly in a howl, a fifth, sixth, or eighth higher than the commencement,

Other symptoms, observed at the commencement of the disease, are, loss or perversion of appetite, propensity to lick cold surfaces, such as stones or iron, and to devour straws, litter, and similar rubbish. There is no *dread of water;* on the contrary, an insatiable thirst, which the dog endeavors to allay by lapping as long as he has power over his jaws. The mouth is dry, and the saliva exceedingly viscid; so that the dog may be seen fighting with his paws at the corners of his mouth to get rid of it; hence the *scratch* of a rabid animal may be as dangerous as its bite.

In some cases paralysis of the muscles of the mouth and jaws is a very early symptom, the mouth being open and the tongue protruding. A dog in this condition will plunge his muzzle into water up to the very eyes in order that he may get one drop into the back part of his mouth. This is generally called *dumb madness*.

As the disease approaches its termination, general paralysis comes on and the animal dies exhausted. There seems to be perfect insensibility to pain throughout.

The usual *duration* is from four to six days.

The post-mortem appearances show merely the *effects* of this malady, in various degrees of congestion of the mucous membrane of the respiratory and alimentary surfaces. Perhaps one of the most characteristic is the presence of a peculiarly mingled mass of hay, hair, straw, earth, and excrement in the stomach, or in the fauces, where it may have lodged from defect in the power of deglutition.[1]

[1] See The Dog, by W. Youatt, Lond. 1845.

Causes.—No cause is known except a bite from another animal already diseased. The disease is not known to arise spontaneously.

Besides the dog, rabies infests the wolf, jackal, badger, cat, and many other mammiferous animals, and there is no doubt that every animal capable of taking the disease can also propagate it. This is equally true with regard to human beings. MM. Magendie and Breschet produced rabies in dogs by inoculation with the saliva of a hydrophobic man.[1] The disease has been communicated to man by pigs and horses. Breschet repeatedly infected dogs with the saliva of rabid dogs and asses. When rabbits or other rodentia, and birds are inoculated they very soon die, but without exhibiting any of the ordinary symptoms.[2]

Many authorities believe that it may be communicated by contact of the dog's saliva with the skin, or mucous membrane, without any wound or abrasion. In a case narrated by Watson,[3] the dog's tooth merely indented the skin of the back of the hand, but made no wound. Lastly, it is stated that the bite of an animal in health, or of one merely enraged, may cause the disease. Both these statements are very doubtful.

The blood of rabid animals is probably infective—certain it is that post-mortem inoculation may take place through a dissection wound. During life, the only secretion known to contain the poison is the saliva, and in this the vitality of the virus is probably long maintained. Though the usual mode of inoculation is by the bite of a rabid animal, yet there are instances of inoculation by other means.

If the bite take place through clothing the danger is less; but, given inoculation, there appears to be great difference in susceptibility among individuals, and even when no treatment is applied to the wound only about one-third of the cases take the disease.

Symptoms in Man.—About five weeks to three months after a bite (rarely less, sometimes much longer, possibly even one or two years), the patient feels pain in the wounded part of a rheumatic character, or a stiffness or numbness. In some rare cases the wound long healed has inflamed and suppurated afresh. In many these premonitory symptoms have not appeared at all. The real symptoms of hydrophobia begin with low spirits, feverishness, headache, stiffness of the neck, soreness of the throat, and some trouble in swallowing, especially liquids, which from the first is often associated with embarrassed breathing; but their nature is not usually suspected for a day or two, till, on a sudden, on attempting to drink, the patient is seized with a fit of suffocating spasm, and manifests extreme horror at the sight of fluids.

The most prominent symptoms that henceforth present themselves are three: viz., difficulty of breathing and swallowing, extreme irritability of the nervous system, and disorder of the mind.

(*a*) The *difficulty of breathing and swallowing* depends on spasm of the muscles of the pharynx and larynx. Sometimes the patient can swallow neither solids nor liquids; but more frequently the disability extends to liquids only, because they require a greater exertion of these muscles, and are consequently more liable to excite spasms. It is this circumstance that

[1] Breschet, Sur quelques Recherches expérimentales sur la Rage. L'Expérience, Oct. 8, 1840.

[2] For rabies in the horse, see Blaine's Outlines of the Veterinary Art, 2d ed., Lond., 1816. For rabies in the sheep, see Lancet, 1829–30, vol. ii. p. 511. Two ewes were bitten by a mad dog, and died of rabies. One had two lambs, the other one; all three of which were seized with the disease a week afterward, although they had not been bitten by the dog, nor, as was supposed, by the mothers. Steele, Med. Gaz., Oct. 25, 1839.

[3] Lecture, London, 1843, vol. i. p. 577.

causes the aversion to fluids and the alarm at the sight of them which so generally characterize the disease. At first the spasms are excited only by attempts to swallow fluids; then by the sight or thought of them, or by the motions of spontaneous deglutition; but as the malady advances, they recur in frequent paroxysms, which cause the most frightful struggles for breath. The spasm, from being limited to the muscles of respiration, may become general and tetanic in character.

(*b*) *Irritability of the Nervous System.*—A look, or a sound; the opening and shutting of a door; a movement of the attendant; the reflection of lights from a mirror; the least impression on the skin; the touch of a feather, or the gentlest current of air, is sufficient to bring on the convulsive fits.

(*c*) The *State of Mind*—Sometimes there are great restlessness and talkativeness; sometimes maniacal fury; more rarely entire composure and tranquillity.

Progress and Termination.—The sufferings are aggravated by extreme thirst, and by a peculiar viscid secretion from the fauces, the irritation of which brings on the convulsive fits, and causes a perpetual *hawking* and spitting. The convulsions increase in frequency and violence; till at length one fit lasts long enough to release the patient from his misery. A period of calm sometimes occurs shortly before death.[1] The temperature is usually raised two or three degrees during the course of the disease. Albumen is often found in the urine—sometimes sugar.

Morbid Anatomy.—The morbid appearances most frequently found are: general fluidity of the blood (*cf.* "The Blood in Septic Diseases"), injection of the fauces and pharynx, sometimes of the salivary glands, and occasionally also evidence of congestion of the brain and spinal cord with their membranes. The microscope shows in the nerve centres round-celled infiltration around the small vessels. This is most marked in the lower half of the medulla—*i. e.*, in the neighborhood of the respiratory and deglutition centres. There is little or no change in the upper half of the medulla oblongata, the corpora quadrigemina, basal ganglia, and cerebellum. The cortex cerebri may be slightly affected in the same way as the medulla; also, maybe, in the gray matter of the spinal cord (Gowers). The ganglion-cells of the parts affected show granular degeneration. Similar round-celled infiltration is described by Coats in the salivary glands, mucous glands of larynx, and kidneys.

Pathology.—The disease results, as we have seen, from the inoculation of a special poison, and it shows itself by an exalted sensibility of the central nervous system, and in particular of that portion which adjoins the respiratory centre. Here the morbid action starts, and here it culminates, in intensity. In nature the morbid action is simply inflammatory.

The nature of the poison is unknown at present: it is assumed by many to be a specific germ. Recently some very interesting experiments have been made by Pasteur with a view to determining whether by transmission through other animals the virus might be modified so that if used to inoculate other animals it would without endangering them protect them from the influence of the unmodified poison. The source whence Pasteur obtained the poison was the medulla oblongata of a rabid dog. With this poison a series of monkeys were inoculated—the first monkey from the dog, the second monkey from the first monkey after the disease had developed, the third from the second, and so on. In this transmission the poison became less and less violent, and taken at a certain point in the series it was found

[1] Bardsley, Cycl. Pract. Med., Art. Hydrophobia.

so far attenuated as to be safely inoculable on dogs, and to protect these completely.

Transmission through rabbits and guinea-pigs did not mitigate the virus. A government commission in France has examined and confirmed Pasteur's results; the subject is still under investigation by Pasteur.[1]

DIAGNOSIS.—The most valuable element is the respiratory spasm caused by the attempt to swallow fluids. If this be absent the diagnosis may be very difficult, and must rest chiefly on the history of a bite, the onset of convulsive symptoms with salivation, etc. From tetanus it is to be distinguished by the absence of trismus and continuous spasm.[2]

PREVENTIVE TREATMENT.—A tight ligature must be applied at once above the part, the wound washed, and then encouraged to bleed freely, or well sucked; if this latter, the mouth should be rinsed with water, or with vinegar and water, after each act; it is not a safe proceeding if there be any abrasion of the mucous membrane. Free cauterization by lunar caustic, nitric acid, liquid carbolic acid, or the actual cautery should be then employed. Excision is a still wiser plan.

The *treatment of the disease*, once it has developed, consists in removing all exciting causes of spasm. The patient must be kept perfectly quiet and in the dark, and draughts of air and the sight and sounds of fluids excluded (if these excite). Food must be administered by the rectum if swallowing cause spasm.

Of direct antidotes there is no certain knowledge. Sedatives are naturally indicated, and of these chloral and morphia used subcutaneously are chiefly recommended; they are best given together.[3]

II. SPLENIC FEVER; MALIGNANT PUSTULE; INTERNAL AND EXTERNAL ANTHRAX.

Splenic fever is the name given to an acute infective disease common among horned cattle, horses, sheep, and other herbivorous animals, and characterized among other things by a swollen brittle spleen. It is rare in Great Britain, but a dreadful scourge in many parts of the Continent, Asia, and Africa. The disease is due to the growth within the animal of the *bacillus anthracis*, one of the largest and best known of the vegetable parasites. These organisms are straight, motionless rods varying in length from $\frac{1}{2500}$ to $\frac{1}{1250}$ inch, and in width from $\frac{1}{25000}$ to $\frac{1}{18000}$ inch, with perfectly square-cut ends; they are easily found in serum by a power of 500 diameters, even without staining. In the living body they multiply rapidly by simple transverse division; but in suitable soils, such as the blood of a dead animal, with a free supply of oxygen, and an appropriate temperature (15° to 42°),

[1] See Med. Times and Gaz., Aug. 23, 1884; Gazette des Hôpitaux, Aug. 9, 1884.

[2] Consult Gowers's Art. Hydrophobia, Quain's Dictionary of Medicine; also, Ross's Dis. of Nervous System, 2d edition, vol. ii. pp. 818 et seq.

[3] There are three errors often refuted, but which revive from time to time. One is the notion that there is no such disease as hydrophobia, but that all the symptoms and consequences depend on the fright and worry of the patient. This is refuted by the Account of the Effects of the Bite of a Wild Jackal in a Rabid State, as the same occurred at Kattywar, in the East Indies, in 1822, by Mr. Hewitt, Surgeon in the Bombay Medical Establishment. Several native soldiers and others who were bitten died of hydrophobia, although entirely ignorant that there was such a disease. Med. Chir. Trans., vol. xiii., 1825. The second error, which is well called a hoax in Sir Thomas Watson's Lectures, is that certain vesicles are found under the tongue, and that if these are cauterized, hydrophobia is prevented. The third is the notion of relieving the spasm by tracheotomy. This was proposed by Mr. Herbert Mayo, forty years ago, and later by Dr. Marshall Hall; but death from laryngeal spasm is too rare to justify the measure.

the rods grow into long filaments, and in these numbers of oval spores form. Whilst the bacilli are easily destroyed, these spores possess wonderful powers of resistance; and it is chiefly by them that the disease is spread. It must be remembered that immediate burial of an animal, dead of this disease, at a depth of more than one metre prevents development of spores by lack of oxygen and of warmth.

VARIETIES.—There are two chief varieties, resulting apparently from the mode of inoculation. If the poison enters through the pulmonary or alimentary mucous membrane, *internal anthrax* or *woolsorters' disease* results. It occurs chiefly among those who are engaged picking and sorting wool and fur imported from countries where splenic fever prevails, but has been known to arise from eating the flesh or butter, or drinking the milk of diseased animals. It is characterized by symptoms of acute blood-poisoning, usually ending in early death; the stress falls sometimes upon the pulmonary, sometimes on the gastro-intestinal tract, and during its course diffuse or carbuncular inflammations may appear upon the skin. This form belongs to internal medicine. When the poison finds entry through some cut or abrasion of the surface, especially of the face, neck, hands, or forearms, a *malignant pustule* or *anthrax œdema* will probably result. This accident is most common among butchers, tanners, and laborers employed in carrying hides at the docks and factories.

SYMPTOMS OF MALIGNANT PUSTULE.—After an incubation period, which varies from a few hours to twelve days, and which is most often two or three days, some burning and itching are felt at the seat of inoculation, and a small pimple, upon the apex of which a vesicle soon rises, develops. Both pimple and vesicle increase with much itching, and the contents of the latter become red and then purple. Finally it bursts or is burst, and leaves a dry brown or black eschar depressed somewhat below a swollen, brawny, red or purplish areola which usually rises abruptly to one-eighth to one-sixth inch from the surrounding parts. Upon this areola, close round the slough, is a ring of small vesicles. All these parts increase, the central slough attaining perhaps a diameter of one inch, the ring of vesicles behaving like the primary one. Around it there is much and increasing swelling, which in two or three days may involve the whole side of the head and neck, or the greater part of a limb; red streaks of lymphangitis often run up to the nearest glands, which swell early. Much pain in the part is suffered. The appearance of the pustule is, as a rule, very characteristic; but sometimes we find no eschar, only one or more vesicles, on an inflamed base; or both eschar and vesicles may be absent, and there is only a pale yellow œdematous swelling —*anthrax œdema*. In case of doubt, examine microscopically a drop of serum from a vesicle or of blood. A history of exposure to contagion is a very important aid. In this form there are at first no general symptoms. Such may appear and kill within forty-eight hours, but do not as a rule come on for two days or even longer. Up to this time fever has been slight or absent; but now the temperature usually runs up suddenly, perhaps with shivering, general pains, vomiting, and sense of great weakness and illness; diarrhœa comes on, cramps occur, dyspnœa becomes very marked, the patient gets delirious, and dies comatose, almost always before the seventh day. Sometimes there are few symptoms, and the patient dies rapidly with signs of cardiac failure, the mind remaining clear.

Sometimes the "pustule" ceases to spread, the slough is cast off, the ulcer heals, and the patient recovers spontaneously. Greenfield says that the mortality is probably one in three. The disease is most dangerous in the head and neck, least so on the limbs.

Morbid Anatomy.—Much like that of septic disease; blood dark and liquid, subserous and submucous ecchymoses, hemorrhages into the skin and viscera, blood-stained effusions into serous cavities, hypostatic congestion of the lungs, patches of simple œdema, especially of the submucous tissue of the intestine, and sloughing ulcers of the gastrointestinal mucous membrane may occur (Mahomed, *Trans. Path. Soc.*, 1883); the spleen is often swollen and friable or diffluent.

The malignant pustule shows all stages of inflammation up to the hemorrhagic in its centre; it extends into the subcutaneous tissue; the surrounding swelling is due to a serofibrinous, often hemorrhagic infiltration. Bacilli anthracis are found in the blood everywhere, and chiefly in the capillaries, where the circulation is slowest.

Treatment.—This consists in complete excision of the pustule, with subsequent free application of sublimate lotion (1 in 1000), or 1 in 20 carbolic, to the raw surface. On the face, injections of 1 in 40 all round the swelling have been successfully used; but excision is preferable, and should always be practised unless the patient is absolutely moribund. Davies-Colley on the third day excised a pustule on a man who was voiding numbers of bacilli in sputum, urine, sweat, and feces. The patient recovered slowly, and a month later the urine still contained a few bacilli (*Trans. Path. Soc.*, 1883). It would seem, therefore, that it is never too late to try excision, but that its success will be greater the earlier it is practised. Reliance should never be placed on the possibility of cure without operation.

In all cases liberal diet must be allowed. When general symptoms are marked, quinine has been recommended, and also corrosive sublimate (p. 38). Charters Symonds reports a case (*Brit. Med. Journ.*, vol. i., 1885) in which the latter treatment failed. When the inflammation is not circumscribed, and in arthrax œdema, long free cuts should be made into the subcutaneous tissue and a sublimated fomentation applied.

The results of early excision are very good. The analogy is obvious between malignant pustule with secondary general symptoms and all general infective processes starting from a focus of local infective disease—such as syphilis and the general infective diseases of wounds; and the success of excision in malignant pustule shows the reasonableness of thorough disinfection or removal of primary foci of disease.

PART III.

INJURIES AND SURGICAL DISEASES OF VARIOUS TISSUES, ORGANS, AND REGIONS.

CHAPTER XXII.

SURGICAL DISEASES OF THE SKIN.

Hypertrophy of the entire skin of a part, so that it hangs in pendulous flaps, or projects in folds, is sometimes congenital, sometimes appears later without obvious cause. The masses thus formed may be very large and the area involved extensive. The subcutaneous tissue shares largely in the process. If inconvenient, the knife is the remedy; the masses are very vascular.

Hypertrophy of skin from congestion with blood or lymph, as seen in cases of varicose veins, or of true elephantiasis, and that which frequently results from chronic or repeated inflammation, has been described.

Boil (furunculus).—A circumscribed, round, hard swelling depending on inflammation of one spot of the true skin, almost always around a hair, and most common on hairy parts; usually attended with acute pain and tenderness; and ending in suppuration, and the discharge of a small sloughy shred of areolar tissue, which forms what is called a *core*. Sometimes no suppuration or sloughing occurs, but the boil dies away and is said to be *blind*.

Hard swelling may cover several square inches around a bad boil. Sometimes quickly, sometimes not for several days, the most prominent central point becomes bluish, thins and bursts, leaving a yellow adherent slough exposed. This is slowly thrown off and the cavity then heals. Usually the nearest lymphatic glands are swollen and painful, but do not often suppurate; lymphangitis is not uncommon. All symptoms quickly subside once the boil is fairly open. Frequently boils keep coming out, fresh ones appearing as the older heal (*furunculosis*). They are especially common in spring, and are sometimes almost epidemic.

They are evidently due to some strong irritant, but this probably varies in its nature. Sometimes the general state seems potent in their production, as when they occur after acute fever, after a period of dyspepsia, in the half starved, diabetic, or albuminuric, or in the over-fed and bloated. In other cases the patients are in robust health ; they frequently form on the buttocks of men training for boat races. Here friction probably has some influence. In other cases they seem to be due to the entry of septic material into the hair follicles.

Treatment.—In cases accompanied by much pain and swelling, a moderately free incision with a lancet will give much relief, and should be employed especially when lymphangitis and lymphadenitis have arisen. Nothing is more soothing or hastens the course of a boil so much as the free use of glycerine and belladonna, and frequent hot fomentations; but moist applications sometimes bring out a crop of pustules. When this treatment cannot be followed out, keep constantly applied the glycerine and belladonna and some cotton-wool.

Look carefully for any indication for general treatment and endeavor to meet it; starvation, over-feeding, and want of exercise, anæmia, dyspepsia, and constipation frequently require attention. For furunculosis in people apparently in good health, change of air and a critical examination of the diet and habits of life suggest themselves. It is said that sewer gas poisoning is a cause.

Sulphide of calcium, $\frac{1}{10}$ gr. every two or three hours, sometimes cuts an attack of boils short; tinct. arnicæ and tinct. belladonnæ are also recommended; whilst as a general tonic ammonia or acids and bark act well.

Carbuncle is an exaggerated boil. The inflammation is more widely spread, and ends in the production of a much larger slough of subcutaneous tissue and cutis, which is discharged in shreds through *multiple* openings. There is no line clinically between boils and carbuncles.

A more or less oval patch of skin and subcutaneous tissue becomes infiltrated, forming a hard, characteristically brawny dull red swelling, very tender, with heavy aching pain. After a few days of gradual increase, softening and suppuration occur at several points which become bluish, more prominent, fluctuate obscurely, and ultimately burst. The openings ulcerate, forming round sharp-edged holes, from which a thin ichor escapes; but a thick glutinous matter may often be squeezed out. The apertures coalesce, large white sloughs slowly separate, and a large gaping cavity is left which granulates and heals. The patient may suffer much or little pain; he is generally a good deal pulled down in appearance. Carbuncles appear in much the same constitutional conditions as boils; some people suffer repeatedly from them. They are most common upon the back of the neck and upon the shoulders, but may occur anywhere.

There is a disease, by some called *facial carbuncle,* though by others the correctness of the name is called in question, which appears on the lips or other parts of the face, causing much swelling, quickly followed by multiple points of suppuration, and complicated from an early date with septic symptoms. It is extremely fatal. So also are carbuncles of the head. Elsewhere, the *prognosis* varies with the strength and age of the patient. Death from septic disease may occur.

TREATMENT.—Attend to any defect of health that admits of remedy; a very nutritious, easily digestible diet should be prescribed, alcohol being given if required to aid digestion or whip up appetite; or a bitter tonic may do this. Pain must be allayed by local applications or opium; of the former, belladonna and fomentations are the best. A free incision right through the brawny tissue in one or two directions should be made when there is much tensive pain and spreading; often none is needed, or not until suppuration has set in—to let out the pus and insure free drainage. Separation of the slough is hastened by resin or creasote ointment, which may be plastered into the cavity.

LUPUS VULGARIS.—Lupus affects chiefly the skin of the face, especially the cheeks and alæ nasi, whence it may spread to the adjacent mucous membranes, which may also be primarily involved. The disease may, however, attack any part of the skin. It begins in childhood, but by relapses often lasts into adult life; women are rather more often attacked than men, and the scrofulous are especially liable.

The disease begins by the appearance of minute nodules, deep in the corium, the red color of which is seen through the cuticle. They slowly enlarge, project as reddish-brown tubercles a line or so across, and blend into larger slightly raised patches. These may long remain unchanged and finally disappear, without ulceration, but with a little scaling or crusting of the surface, leaving a thin, smooth, white scar. More often ulceration occurs and is very chronic, spreading superficially by the development and breaking down of fresh tubercles round the margin, and in depth by a similar process. Thus all the soft parts, including cartilages of the nose, may be destroyed; or parts of the lip or ear may disappear. When healing occurs, the scar may cause ectropion or other deformity. Healing at one spot and spreading at others is common. Even when a scar seems to have covered the whole surface, tubercles appear beneath it and break down, and thus the disease lasts for years

In very scrofulous subjects distinct nodules may not form, but from the beginning a diffuse infiltration which spreads and breaks down more rapidly than usual (*Scrofuloderma*).

Pathology and Etiology.—The nodules and infiltrations consist of granulation tissue, in which are often seen bodies having the structure of miliary tubercles (p. 93). On this ground Friedländer regarded lupus as tuberculosis of the skin; a view strongly supported by Hüter and Schüller, who inoculated animals with lupus tissue and produced a disease like tuberculosis. Finally, Koch ("Aetiologie der Tuberkulose," p. 68) demonstrated tubercle bacilli in the giant cells of the nodules, but in small numbers only. In each of seven cases examined, however, Koch produced tuberculosis by inoculation, and from one he obtained a pure cultivation, with which he inoculated successfully.

The tuberculous nature of lupus is denied by Kaposi, because he believes that phthisis is very rare in patients with lupus. Besides its very slight tendency to produce general infection, it is more vascular than ordinary tubercular infiltrations, and has little tendency to caseate or to infect glands. But Koch's results are too strong to be shaken by such difficulties (see *Proceedings of International Congress*, Copenhagen, 1884; *Brit. Med. Journ.*, vol. ii. p. 419).

Treatment.—When lupus is getting well, iodovaseline on rag should be constantly applied. The course may be hastened by destruction of the tubercles by scraping, cautery, caustics, or excision, and one or other should always be used in ulcerating cases. It is then best to destroy thoroughly with a small sharp spoon every tubercle and patch of soft tissue, and to repeat the process as fresh nodules appear. Chloride of zinc (1 in 2) may be applied freely to the raw surface, which is to be dressed with powdered iodoform and boracic ointment, or with iodovaseline. No operation to remedy deformity due to lupus should be undertaken till the parts have remained sound for two years.

The Scrofulide or Tubercular Nodule.—This is frequent in young children. It begins as a small hard painless nodule in the skin, which slowly reddens and breaks, giving exit to a thin discharge, which often continues for months, or perhaps the sore heals and breaks out again.

Treatment.—If seen quite early, when small, excision would probably give the best result. Later, incision, if necessary, and the free use of the sharp spoon and iodoform, together with general treatment, are the proper measures.

Callosities are hypertrophies of the horny layer of the cuticle due to frequent intermittent pressure; they are semi-transparent, yellowish white, lens-shaped swellings lying in the cutis, slightly concave on their deep aspect, or moderately convex, as on the surface. Callosities occur chiefly on the hand

and fingers, often showing by their site the nature of the possessor's employment.

Corns differ from callosities only in the presence of a tongue-like process on their deep aspect, which is driven by pressure into the skin, producing pain and atrophy of the subjacent papillæ. They form usually over the first joints of the toes from pressure of boots or of other toes. Sometimes they appear between the toes, and are then *soft* because kept moist; they are found also upon the sole, and often without obvious cause.

TREATMENT.—Removal of pressure and all irritation is the first point; boots should be made upon a new last. Radical cure can be obtained only by softening the epidermis with potash solution, soft soap, or some such substance, and scraping the mass away completely, which will probably induce some bleeding. This proceeding is dangerous in patients with degenerate arteries. Palliative measures are; bathing in warm water and frequent paring with a knife to keep the horny layer thin and supple, and the wearing of a perforated corn plaster.

If the corn is on the sole of the foot, a piece of felt or small fold of flannel may be arranged so as to relieve it from pressure. For the soft corns between the toes, and for very irritable corns, the nitrate of silver is the best application. When a corn inflames it should be poulticed. If matter forms beneath it, there will be œdema and redness round about; the pain is most excruciating, and to be relieved only by paring down the corn and letting out the fluid.

These thickenings may slowly disappear if all irritation is stopped.

Horns (*cornu cutaneum*) in look closely resemble those of animals; they may grow almost anywhere, reach a length of several inches, and last for several years, or, if they are knocked off, grow again. Elongated papillæ penetrate their base for a varying distance; the horns are therefore closely analogous to warts, the papillæ being bound together by a dense covering oı epithelium. Sometimes they lie in a hollow, again on level skin, and they are often connected with a sebaceous follicle or cyst. They may be removed by two elliptical cuts; if springing from a cyst, its wall must be removed also. Epithelioma has developed from the base of a horn.

Warts (*verrucæ*) consist of hypertrophied papillæ covered by more or less dense epidermis. A good number are *congenital*, are then often darkly pigmented, covered with long hair, sometimes nævoid, and of very various form and extent. Most warts appear later, and chiefly in young people. *V. vulgaris* is most common on the hands and faces of children; it is flat or hemispherical, usually smaller than a pea, dry, firm, with a surface which may be fairly smooth or much cleft. Their cause is unknown, and there is no ground for the common belief that they are infective. If necessary to interfere, warts may be snipped off, tied, or touched with caustic; but they often return obstinately, in spite of treatment, and disappear of themselves after months or years when let alone. Perhaps the best plan is to divest them as much as possible of cuticle by soaking them in soda and water, and then to paint them with ethereal tincture of tannin. F. 335.

Small, dirty brown warts not unfrequently appear on the face of old people.

Venereal warts form another variety. They are most frequent after gonorrhœa, but may grow on the site of a healed chancre, and are obviously the result of irritation; mucous tubercles and condylomata again are the result of syphilitic irritation. The latter are wide based, whilst the former are pedunculated. These warts occur on the glans and inner aspect of the prepuce, at the orifice of the vagina, round the anus, on the perineum, and on the thighs. They may bleed easily or be pale and indolent; they discharge a thin ichor. There is no evidence that gonorrhœal warts can of themselves produce warts on another person; but syphilitic warts are highly infective.

The treatment of this variety should consist in frequent washing with some astringent lotion, careful drying of the part, and the application of the acetate of lead, alum, savin powder, and verdigris in equal parts, or other strong astringent. If the masses are very large, snip them off and touch the bases with carbolic acid or nitrate of silver.

Other warts from irritation are the soot-wart, the tar-wart, the warty tumor of cicatrices (C. Hawkins, *Med.-Chir. Trans.*, vol. xiv.). These are the beginning of epitheliomata, and should be removed completely with the knife.

Wens are most common on the head, face, and shoulders, and are *sebaceous cysts* due to obstruction of sebaceous glands, or are erratically developed cutaneous cysts. They occur most commonly after mid-life, and are often numerous upon the scalp. The matter contained is a collection of epidermic scales with oil-globules and crystals of cholesterine, and has received the name of *atheroma* or *steatoma*, from its resemblance to gruel or suet. These cysts commonly vary from the size of a hen's egg downward; they are round or ovoid toward the surface, tense, elastic, quite smooth, as a rule, adherent to the skin, but not to deeper parts, and their ducts may often be found as a black spot or crust; the skin over them long remains of normal appearance; and when pressure is made upon their edge, no thick mass is felt to slip away. These points will usually enable the *diagnosis* from chronic abscess and fatty tumor to be made. Suppuration, ulceration, and fungous granulation of the interior of the cyst sometimes occur.

Treatment.—On the face the duct may be enlarged, or a very small opening made, the contents expressed, and a fine sharp spoon freely used over the interior; a cure without a scar may thus be obtained, but it is uncertain. Elsewhere, it is best to extirpate the cyst by freely transfixing it, seizing its base or edge with forceps, and gently tearing it out. On the back, the adhesions may be so tough as to require careful dissection. A pad of salicylic or other antiseptic wool is the best dressing, the edges of the wound being in no way united. Suppurating and fungating cysts must be dissected or scraped out.

Molluscum Contagiosum.—This consists of one or very many tumors, from the size of a pin's head to that of a pea, hemispherical or spherical and pedunculated, of a white, pearly, translucent appearance, the larger presenting a slight umbilication superficially; firm and solid to the touch. When squeezed between the thumb nails the little body is torn off and leaves a bleeding furface. They may be scratched off, disappear spontaneously, or remain for years if uninjured. They are most common in children and chiefly on the face. Kaposi, "Hautkrankheiten" (p. 177), regards them as distended and hypertrophied sebaceous follicles; but other views are held. They are by some thought to be contagious because they frequently occur in several of a number of children thrown much together; but others regard contagiousness as non-proven. I have seen it on the foot of a sucking child and on the mother's breast. Squeeze off the little growths with the thumb nails, and touch the base with the nitrate of silver.

Keloid.—The true keloid tumor of Addison consists of dense fibrous tissue, and presents itself in the form of one or more projecting tumors, or thickened reddish patches, in the substance of the skin. It occurs without obvious cause, and usually on the chest near the sternum, sending out processes between the ribs. It is very rare. False keloid tumors having their seat in scars are much more frequent; they are most common in people of color, and soldiers after flogging, but may be developed in any scar—even on leech bites, or on the ear that has been pierced for earrings. They are extremely liable to return after extirpation. Iodine and arsenic should be cautiously tried.

Moles.—Oblong patches of imperfectly developed pigmented skin, small vascular patches, and other congenital imperfections, should be extirpated if at any time they seem inclined to spread and become irritable, because it is possible that they might become the starting-point of melanotic sarcoma (see p. 138), or of cancer. Some moles have a most malignant structure under the microscope, though clinically quite innocent.

The *malignant growths of the skin* may be primary or secondary. Primary cancer is always squamous epithelioma (p. 141); but any other kind may occur secondarily, either by extension or by embolism. Round or spindle-celled, alveolar, or melanotic sarcoma may be primary or secondary.

CHAPTER XXIII.

INJURIES AND DISEASES OF BURSÆ, TENDON SHEATHS, MUSCLES AND TENDONS.

Injuries and Diseases of Bursæ.

The diagnosis of injury or disease of a bursa depends so largely upon knowledge of the fact that a bursa is present at the affected spot, that the student will do well to acquaint himself with the position of the chief bursæ, and to remember that bursæ frequently develop at usual points of pressure, and are liable to disease.

Contusions may cause a bursa to fill with blood; sometimes suppuration follows, especially if the skin is in any way injured. *Wounds*, if diagnosed, require no special treatment.

The diseases of bursæ are all inflammatory, acute, or chronic. The bursa patellæ serves as a type.

Acute Bursitis.—Often there is no discoverable cause; but injury and extension of inflammation from surrounding parts not uncommonly act. Its usual seats are: the bursa patellæ, that over the olecranon, and, much less often, those beneath the ligamentum patellæ and over the great trochanter.

Symptoms.—These vary in degree according as the disease is *serous* or *purulent*. They are: redness, heat, swelling with more or less fluctuation, and pain, all localized to the seat of a bursa or radiating from it; more or less fever, reaching 102°–104° in cases of suppuration.

If pus forms and is not let out, it may burst through the skin; but there is much danger that this will prove too resistant, and that a subcutaneous or subfascial rupture will occur, and diffuse cellulitis, with sloughing of connective tissue, result; the bursa beneath the ligamentum patellæ may burst into the knee. It is not very uncommon for ulceration to extend from an open, septic, suppurating bursa to a bone on which it lies.

Treatment.—Rest on a splint and ice, or belladonna and fomentations. So soon as it is probable that pus has formed, incise antiseptically and drain. If subcutaneous rupture and cellulitis have occurred, many incisions will be required for drainage. If the case is septic when seen, boracic fomentations are most useful.

Chronic bursitis may cause simply serous effusion into the cavity, with slight thickening of the wall; or marked thickening, with little or no effusion, until the cavity is all but obliterated and the bursa a solid mass which rarely calcifies; commonly warty growths and bridle-like structures project into the cavity from a slightly thickened wall; rarely, loose bodies—chiefly fibrinous "melon-seeds"—occur in the cavity.

The cause is chronic irritation, generally friction or contusion; and the common seats are: the bursa patellæ (housemaid's knee) and those over the olecranon (miner's, student's bursa), the tuber ischii (weaver's bottom), and the two malleoli (tailor's bursa). Of the deep bursæ, that between the semimembranosus and gastrocnemius is most often affected, and usually by simple effusion only.

The *symptoms* vary much, as is evident from the pathological varieties. The bursal swelling may be soft or extremely hard, fluid, lax or tense, or solid; the skin over it may be normal, thickened or stretched till translucent; warty growths may be felt on pressing the walls into contact, or loose bodies may yield a soft crepitus though they often escape detection.

Treatment.—In early cases strong counter-irritation with tinct. iodi or blisters may do good. Later, aspirate, repeatedly if necessary, and keep up firm pressure against a splint. This failing, try *very firm* compression with a flannel roller against a splint on the opposite side of the limb (Volkmann), reabsorption takes two to eight days; or, use antiseptic drainage or dissect the bursa out.

When loose bodies are present, they should be completely evacuated through an antiseptic incision; and warty growths, or marked thickening of the sac, must be treated by excision of the latter, if relief is needed.

The deep bursæ which may open into joints are the most difficult to treat, especially those in the popliteal space. If counter-irritation, aspiration, pressure, and rest fail, and something must be done, antiseptic drainage is that something.

Diseases of Tendon Sheaths.

These are so similar to the diseases of mucous bursæ that they will be next described.

Acute teno-synovitis is usually serous or fibrinous, rarely suppurative except from wound. It presents along the line of a tendon the signs of an acute inflammation. The surfaces of the sheath are often coated with lymph, so that when they move upon each other a soft crepitus (*teno-synovitis sicca* or *crepitans*), felt both by patient and surgeon, occurs. In many cases the surfaces are separated by effusion. Movement is painful.

Wound, strain, and over-use are the chief causes. The tendons most affected are the extensors of the fingers, thumb, and toes, and the peronei.

Treat like acute bursitis, immobilizing the affected tendons.

Chronic Teno-synovitis.—There are several forms: 1, distention of the sheath with serous fluid or gelatinous stuff; 2, dropsy with loose bodies, generally fibrinous "melon seeds;" but sometimes cartilaginous, calcifying or ossifying nodules occur, having separated from synovial fringes; 3, fungous teno-synovitis, in which the sheath is lined by granulation tissue, and in which the contents may turn out quite unexpectedly to be (4) pus. The two latter forms are very chronic, and often cause disease of bones or joints by extension. They all impair movement considerably.

The causes are the same as for the acute disease, but less intense. Fournier describes a syphilitic form. All the long tendon sheaths may suffer. When the sheaths are crossed by annular ligaments, as in front of and behind the wrist, so that a bilobed swelling forms, it is called a *compound ganglion*. This is most common in front of the wrist, and loose bodies may almost fill the sac.

FIG. 61.

Dropsy of the sheath of a flexor tendon of a finger.

TREATMENT. — Counter-irritation and pressure are of little value. Injection of iodine, after the contents of the sac have been well washed out, is much used abroad in dropsy, simple or with loose bodies. Antiseptic incision and horsehair drainage are preferable. Should the cavities become septic, suppuration will probably lead to sloughing of the tendon or tendons; very free slitting up of the sheath gives the best chance. Dense adhesions will almost certainly form. The involvement of bones and joints will usually require excision or amputation.

PARATENDINOUS CYSTS OR SIMPLE GANGLIA.—These are bursa-like cysts frequently found in the immediate vicinity of tendon sheaths; they are generally believed to be hernial protrusions from the sheath, but their contents are very rarely reducible into the sheath, and upon dissection their connection with the sheath is generally very slight. But their constant association with tendon sheaths is almost proof of an original connection. Paget regards them as due to cystic dilatation of synovial fringes. The similar cysts due to protrusions of the synovial membranes of joints, especially the wrist and knee, cannot in many cases be diagnosed from these tendinous cysts. The treatment of ganglia must therefore be conducted with great care, lest a communication with a joint exist.

Ganglia are infinitely most common upon the dorsal surface of the wrist, but may occur in connection with any tendon sheath. They contain generally a yellow colloid material varying somewhat in consistence and depth of color.

The *causes* are unknown.

SYMPTOMS.—A rounded swelling, varying in size from a pigeon's egg downward, tense and elastic, not tender, and covered by normal integuments; when so small as to require full flexion of the wrist to render them prominent, they seem of almost bony hardness, and resemble the head of the os magnum. Some weakness of the wrist may be complained of; often they cause inconvenience only by their appearance and size, or from slight pain owing to pressure on nerves. The appearance of such swellings may be the first sign of chronic arthritis.

TREATMENT.—The simplest method is rupture by strong pressure with the thumb; the contents must be squeezed out into the subcutaneous tissue, and spread through it as far as possible. A flat piece of lead wrapped in washleather must then be firmly strapped over the bursa, and several times a day for the next week the patient should firmly squeeze and rub the part, with the idea of irritating the bursal wall, and keeping open the tear in it for a little time. The plan is not very effective; often it is impossible to rupture the sac by such pressure. A fine tenotomy-knife should then be passed through the skin at a little distance from and along one side of the swelling, and a sweeping cut made into the cavity through the whole of one side; the contents must next be squeezed out, partly along the blade; and finally, the whole inner surface should be scored and scraped with the point and end of the blade. The after-treatment is that before given. The results of this method are much better than those of rupture.

Should it, however, fail, and further treatment be necessary, the ganglia may be laid open freely, under antiseptics, and a bit of gauze placed in the cavity to prevent superficial union; or the whole or greater part of the cyst may be excised. For fear of accidents, these operations should not be inconsiderately undertaken.

COMPOUND GANGLION.—The situation and form of the swelling, bulging above and below an annular ligament, fluctuation beneath this band and perhaps soft crepitus from loose bodies, and the limitation of movement of the tendons affected render the diagnosis easy from everything except the rare *lipoma arborescens* (Müller), due to overgrowth of synovial processes. Treat by antiseptic incision, removal of loose bodies, and drainage for seven to ten days.

INJURIES AND DISEASES OF MUSCLES AND TENDONS.

Contusions of muscles cause more or less effusion of blood with pain, tenderness, and inability to use the part. Complete absorption generally occurs, though it may be slow. Rarely suppuration, the skin having usually been damaged by the injury or leeches, follows; it is diffuse and difficult to treat with good result.

Sometimes *progressive atrophy*, said by Volkmann to be inflammatory, results from even slight contusions, or even from not very prolonged pressure —*e. g.*, lying on arm for half an hour. It occurs chiefly in the deltoid and rectus femoris, and must be met by the constant current.

The result of a blow may be to cause rupture of the sheath of a muscle and *hernia of the muscular substance*. The swelling is often taken for a cyst or tumor, and is most common in the thigh and belly wall. No symptoms result.

Dislocation of muscles and tendons rarely occurs; the peronei behind the outer ankle and the biceps from its groove are most frequent. The displacement is caused by some violent movement, and may be permanent, or occur with only certain movements. Prolonged rest may do some good for the peronei, but dislocation of the long head of the biceps is irremediable.

RUPTURE OF MUSCLES AND TENDONS.—This is frequently caused by violent muscular contraction, especially if, after illness or long inactivity, the muscles are subjected to sudden and severe exertion; also by contusing force, the skin often escaping. The muscles which are most frequently ruptured are, the *gastrocnemius*, the *rectus femoris*, which sometimes is entirely detached from the patella, and the *biceps flexor cubiti;* but more frequently the tendons give way, especially the *tendo Achillis* and flexor tendons of the wrist.

The *symptoms* of this accident are sudden pain, and sometimes an audible snap; hence the French term *coup de fouet*. The patient cannot extend the tendon as he can in the opposite limb. A depression may be felt with the fingers at the ruptured part.

Repair takes place by the development into fibrous tissue of a round-celled exudation from the divided ends and surrounding soft parts. A splice of varying length is inserted in the muscle or tendon; in cases of this kind, the shorter it is, the better. The latest results show that in muscle a new formation of muscle-cells from the preëxisting ones occurs, so that ultimately a short scar in muscle may be obliterated. At first the new bond is adherent to surrounding parts; it works free as the muscle contracts. Usually when the thickness of a muscle is torn, the ends remain at some distance apart, and can be felt ultimately as rounded swellings.

TREATMENT.—The main point is to keep the injured part in a state of constant rest and relaxation, to bring the severed ends into close approximation, and to prevent any extension till union is firm. When the *tendo Achillis* or the *gastrocnemius* muscle is ruptured, the knee may be kept bent by a string passing from the heel of a slipper to a bandage round the thigh. For ruptures of the extensors of the thigh, the limb must be placed in the same position as in fracture of the patella. If the *biceps* is ruptured, the elbow must be kept bent to its utmost; if the tendons about the wrist or fingers, the forearm must be confined by a splint with the fingers extended or bent as the rupture is on the extensor or flexor side of the limb. The even pressure of a roller over the part is also beneficial. After three or four weeks of rest the surgeon may use *passive motion*—*i. e.*, to bend and extend the joints of the injured limb with his hands several times successively. But the patient must be cautious in using the muscle for a long time; and, if it be the *tendo-Achillis*, must walk with a high-heeled shoe for two or three months; so that the recent callus may not be stretched and lengthened, which would cause permanent weakness.

Sometimes no position will approximate the torn ends; nothing can be done for muscles, as sutures will not hold in them when freshly torn; but important tendons should be sutured at once.

In old cases of rupture, with long union and much loss of power, an attempt to bring the ends together by suture would probably fail. Division of the bone to shorten the limb temporarily has been suggested. But it seems probable that reparative surgery will find something to transplant into the gap; already a case of transplantation of muscle into the gap left by excision of a scar from the muscles of the forearm has been reported as successful.

Open wounds of muscle are much commoner than subcutaneous ruptures. If they become septic, suppuration is often troublesome, and may lead to sloughing, diffuse myositis, and rapid scar contraction, resulting in deformity which is most difficult to remedy. Treat by fixation of part in the best position, and antiseptic dressings; in clean-cut wounds numerous buried catgut sutures would hold together the ends of muscles intersected by tendon.

Tendons are frequently wounded. When not completely divided, the chief danger is that of suppurative teno-synovitis, which often spreads widely and rapidly up the limb. If this is avoided, wounds of the sheath and tendon yield a good result, unless skin is also lost and the whole gap must heal by granulation; everything is then adherent.

When the tendon is completely divided, it should be sutured with catgut. If the central end is drawn into its sheath and cannot be brought down by forceps and relaxation of the muscle, an incision must be made into the sheath higher up and the tendon pushed down (Madelung). Quite recently, Gluck has obtained union of widely separated ends (from loss of substance), by uniting them with stout catgut; the latter became "organized" and formed the bond of union.

Atrophy of muscle results from many causes, and not infrequently comes under the surgeon's notice. One of the commonest causes is simple *disuse*, well seen in the muscles of the thigh above a chronically inflamed knee or in those of a limb which has been some weeks in splints. In these cases, fatty infiltration may prevent loss of size of the limb. Next it may rarely occur from simple *contusion* or *subcutaneous laceration* (p. 219), or from violent stretching, as of the deltoid and scapular muscles after dislocation of the shoulder; in these cases the influence of injury to nerves is not excluded.

Next we come to the results of *injury and disease of the nervous system.* The cases of cerebral paralysis which fall under the surgeon's care are those due to lesions of the motor area of the cortex; when these are permanent, they cause only slow atrophy from disuse, the paralyzed muscles do not show the "reaction of degeneration," but they are frequently the seat of tremors, rigidity, and contraction—signs of descending sclerosis in the lateral columns. Much more frequently the surgeon sees cases of spinal or peripheral paralysis, due either to destruction of the great ganglion cells of the anterior cornua (*infantile* and *acute adult spinal paralysis, progressive muscular atrophy*), or to wound, contusion, or neuritis of motor nerves, practically severing the muscles from these cells. These cases contrast with those due to cerebral lesions; atrophy is very rapid—a matter of a few days—there is no tendency to active contraction (though adaptive shortening is frequent), and the "reaction of degeneration" is marked—*i. e.*, the muscles soon cease to react to the faradic current, but exhibit increased excitability to the constant; then this, too, gradually ceases to cause them to contract. All these signs are best seen in *infantile paralysis*, in which one or more limbs are paralyzed either wholly or as regards certain groups of muscles. The affected parts are helpless, wasted, pale or purplish, and cold, and they do not grow in proportion with the other parts of the body.

TREATMENT.—When possible we must treat the cause of the atrophy, by curing the arthritis or fracture which prevents exercise, by combating myositis or neuritis, by chiselling a nerve out of callus, or finding its separated ends and suturing them. Treatment of the muscles themselves is always most important, especially in infantile paralysis. The paralyzed part should be kept warmly covered, and cold douching, followed by friction with a rough towel till the surface reddens, massage, and the constant current employed; passive exercise, and active of all the muscles over which the patient has any control, should be used regularly, every day, for several months, before the case is despaired of.

Permanent contraction or shortening of muscles may occur from constant irritation anywhere along the motor tract; hence its frequency in descending sclerosis secondary to cortical lesions. It occurs also when a limb is kept constantly in such a position that a muscle is never stretched; this is the pathology of the so-called "contractions" in infantile paralysis—*e. g.*, the foot is constantly extended, the calf muscles are at their shortest and adapt themselves to the position. It is the connective tissue in them which offers such stubborn resistance to flexion. In the latter class of cases tenotomy is often required: as also in the class due to interstitial myositis.

OSSIFICATION OF MUSCLES AND TENDONS.—Sometimes, without obvious cause, ossification extends into tendons from their insertion; usually this happens near joints affected by rheumatoid arthritis or where periostitis has been going on. Sometimes long pieces of bone (rider's bone) are found in the adductors of horsemen. There is a rare disease (*myositis ossificans*), occurring in young people, in which bony masses form first in the muscles of the back and neck, then in those of other parts, greatly impeding movement and causing much pain.

INFLAMMATION OF MUSCLE.—Some think that *muscular rheumatism* is really a serous inflammation; it often appears suddenly after an effort which might rupture many fibres. Putting aside these vague, rheumatic cases, myositis, except from wound, is rare. It is an interstitial process, and may be suppurative or productive (fibrous); the muscle-cells suffer secondarily. *Suppurative myositis* is usually due to wound or to infective irritation in pyæmia, farcy, and other septic diseases; but abscesses form in the tongue and within the sheaths of muscles, especially the rectus abdominis, often without obvious cause. There is nothing noteworthy about the symptoms. *Chronic interstitial* or *fibrous myositis*, when not due to injury, is probably of syphilitic nature; the muscle is converted into a rigid cord. *Gummata* occur, especially in the tongue. *Tubercle* is very rare.

The treatment must be conducted on ordinary principles.

New Growths of Muscle and Fasciæ.—Of simple tumors of muscle, fibroma (soft or hard), lipoma, enchondroma, and myxoma are the most usual, though all are very rare. Sarcomata—especially round and spindle-celled and alveolar—are commoner. Primary cancer does not occur, but secondary nodules, due mostly to direct extension from primary foci, are common. A tumor growing from the deep fasciæ is in all probability a sarcoma, often of the variety known as *recurrent fibroid*, which recurs again and again locally, perhaps taking years to destroy the patient. These tumors, growing from superficial muscles and fasciæ, may at first sight closely resemble fatty tumors; but by putting the muscle into action or endeavoring to move the growth along the line of greatest tension of a fascia it will be found fixed deeply, whilst a fatty tumor moves freely over the deep parts.

The *treatment* is early and free removal.

CHAPTER XXIV.

INJURIES AND DISEASES OF LYMPHATIC VESSELS AND GLANDS.

Subcutaneous rupture of lymphatics is of course very common, but the formation of a persistent lymph-swelling is very rare. It is probable that much of the early discharge from wounds comes from divided lymphatics, especially in regions like the groin and axilla, but they soon close by clotting. There are several cases on record of *wounds of the thoracic duct*, either by stabs in the neck or wounds traversing the thorax. Constant free escape of lymph is the diagnostic point, and this loss rapidly exhausts the patient. Wilms has reported a case in which the wound (in the neck) healed under a plug. Inflammation and suppuration of lymphatic glands—*e. g.*, inguinal—do sometimes appear to be connected with a violent strain, though it is not at all clear how this acts.

Acute Lymphangitis is almost invariably due to the absorption from some breach of surface—which may possibly have healed when the case comes under observation—of some infective irritant; chemical irritants may have some share in the process. Almost always an unhealthy sore is found or an infective inflammation, as erysipelas. The attacks of lymphangitis which precede the development of true elephantiasis will be noticed shortly. It is probable that the infective irritants produce lymphangitis only when they are arrested in the vessels by clotting; in the great majority of cases the products of septic absorption pass into the glands and may excite inflammation there.

Symptoms.—Aching pain and tenderness along the line of the vessels leading from a source of irritation are the first signs of lymphangitis. Then a firm tender red stripe, an inch or more wide, somewhat irregular in outline, and slightly raised above the skin, appears; often it is made up of several narrower streaks. It is due to lymph-thrombosis and to inflammatory peri-lymphatic hyperæmia and exudation. The glands to which the vessels lead are swollen and tender. The general symptoms of moderate fever are usually present; sometimes the onset is marked by a rigor and all the signs of severe fever. The fever may be prolonged, but usually subsides in two or three days.

Usually lymphangitis subsides without complication; sometimes *suppuration* occurs at some point, or at several points one after the other, the course being very protracted.

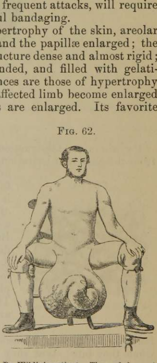
It must be remembered that the deep or subfascial lymphatics are liable to inflammation like the superficial, but pain, tenderness, and fever are the only signs.

There is a *chronic lymphangitis*, evidenced by the formation of a cord by thickening and matting of the vessels. The dorsal lymphatics of the penis in cases of hard chancre often furnish an example.

The *treatment* of acute lymphangitis is—antiseptic treatment of the source of absorption; rest, and the free application of glycerine and belladonna along the inflamed vessels, and the use of hot fomentations. Cold fomentations of lotio plumbi or of 1 in 20 carbolic lotion have also been recommended. Abscesses must be opened early. Thickening along the lymphatics, or chronic œdema of the part after prolonged or frequent attacks, will require cold douching, friction, shampooing, and careful bandaging.

Elephantiasis Arabum consists in a slow hypertrophy of the skin, areolar tissue, and bones. The epidermis is thickened and the papillæ enlarged; the true skin is immensely thickened; its fibrous structure dense and almost rigid; the areolar tissue thickened, its areolæ expanded, and filled with gelatinous-looking stuff. The microscopical appearances are those of hypertrophy of the tissues involved. The bones also of the affected limb become enlarged and heavy, and the nearest lymphatic glands are enlarged. Its favorite seats are the leg, which it converts into a huge pachydermatous resemblance of an elephant's leg (*Barbadoes leg, Bucnemia*, etc.); and the male genitals, which it converts into a huge tumor, reaching down to the knees, and weighing perhaps more than 100 lbs. (Fig. 62). It is particularly a disease of warm climates, and is endemic in many tropical places; dark races are more liable than the fair; men suffer more often than women. It is rare under puberty.

FIG. 62.

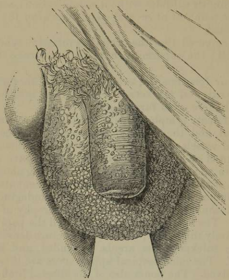


Dr. Wiblin's patient. The curled prominence in the front of the tumor is the hypertrophied prepuce.

The onset of elephantiasis is often marked by high fever, great pain in the parts affected, and rapid inflammatory swelling of them. When the scrotum is affected acute hydroceles form, and the swollen cords may dilate the abdominal rings so much that herniæ descend when the swelling subsides (Fayrer). The surface of the skin may become eczematous and discharge a chyle-like or offensive serous fluid. These febrile and inflammatory paroxysms tend to recur; they may be very frequent, and the increase in size of the part rapid, or few and far between. Without them, however, a slow increase in size goes on.

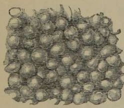
In some cases clear bead-like vesicles form on the skin, and when pricked discharge a coagulable white or pinkish fluid: they are varicose lymphatics (Figs. 63, 64). Attacks of chyluria may occur, and these are believed to be due to rupture of lymphatics into the urinary tract. (W. Roberts.) Often there is no lymphorrhagia, no superficial varix.

Fig. 63.



Lymphatic varix of scrotum; enlarged gland is shown. From a drawing in the Medical College Museum, Madras.

Fig. 64.



A portion of the above, natural size.

Pathology.—Obstruction of the lymphatics preventing return of lymph from the part, and irritation starting from the lymphatics giving rise to the inflammatory attacks, are believed to be the keys to the disease. The endemic form of the disease is probably due to the presence in the lymphatics of the scrotum or lower limb of adult nematode worms three to four inches long—the filariæ of Bancroft. These by their irritation cause the inflammatory attacks and obstruction to the lymph-flow through the inflamed glands, whence may follow varicosity and rupture of superficial lymphatics. Abscesses and buboes also may occur. The adult worms which really cause the mischief are rarely found; but at night (*i. e.*, during rest) myriads of larval forms $\frac{1}{75}$ inch long may be found in the blood. Manson believes that these are taken in by mosquitoes when they bite; that they pass through a developmental stage in these insects, then enter water, and finally find their way again to the alimentary canal of man. He says the distribution of elephantiasis is that of the mosquito.

Obstruction of lymphatics occasionally occurs from other causes and produces similar pathological results. Thus we get sporadic cases.

Prognosis.—The tendency is always to increase, though often very slowly. The bulk of the part, large loss of lymph, foul ulcers, and frequent febrile attacks may exhaust the patient; frequently the general health is good.

TREATMENT.—In early stages removal from the endemic area may lead to arrest of the disease, especially in Europeans. A Martin's bandage worn constantly may be of use. The general health must be looked to.

For Barbadoes leg, ligature of the femoral or external iliac artery has been done with a good deal of success. This failing, as it often does, amputation only remains, and this is at present the only treatment for elephantiasis scroti.

AMPUTATION OF SCROTUM.—First examine for hernia; if one is present, its neighborhood must be carefully avoided. If the tumor is large, the patient should lie on his back for an hour before the operation with the scrotum elevated by cords and a pulley attached to the ceiling. Then a very strong Esmarch's band is applied and secured by tapes from slipping forward, or a clamp of two wooden bars approximated by screws and nuts may be used (Turner). Small flaps are now fashioned round the base, where the skin is healthy and simply dragged from surrounding parts, to cover the penis, testes, and raw surface. Then the penis is found by thrusting a finger into the hole whence urine issues, and slitting up the prepuce; it must be quickly dissected out—care being taken not to divide the suspensory ligament—and held up against the pubes. Next a bold cut is made obliquely along the direction of one or other testis; these glands generally lie in large hydroceles, and are easily found, freed, and held up. Then by a clean sweep the mass is detached. Any loose-lying portions of blubber are cleaned away; the vessels (of which there may be few or a large number) tied as the tourniquet or clamp is loosened, the flaps sewn round the penis, testes, and wound, and the whole dressed with a wool dressing.

LYMPHADENITIS, or inflammation of lymphatic glands, may be acute or chronic.

Acute lymphadenitis is almost always secondary to some inflammation in the area whence its supply of lymph comes. Sometimes it is referred to strain or over-walking (p. 198). Lymphangitis is much more commonly absent than present, probably because the glands arrest infective particles which pass harmless along the vessels. Organisms believed to be the cause of the primary inflammation are often demonstrable in inflamed glands.

Acutely inflamed glands are swollen, injected, much softer than natural, and of medullary aspect; sometimes strewn with fine hemorrhages, sometimes of deep purple color throughout. The whole process consists in dense infiltration of the gland with round cells, which block the lymph-sinuses completely, and in the more intense cases red corpuscles escape in large numbers. In slight cases *resolution* may occur rapidly, but in more advanced ones the process is slower and takes place by fatty degeneration of the products; the acute process then commonly becomes chronic. When *suppuration* is about to occur yellow foci appear at different spots of the cortex, and enlarge and blend more or less rapidly. Sooner or later the periglandular tissue is infected—sometimes when the gland itself shows little change—and a periglandular abscess develops; this may cut off the blood-supply of the gland and cause it to necrose. In other cases the interglandular abscess bursts into the subcutaneous tissue; or the gland becomes adherent to the skin or to a serous or mucous membrane, and pus bursts through it.

The form of inflammation depends largely on the character of the primary disease—*i. e.*, upon the nature of the irritant, which naturally tends to excite in a gland a process similar to that which it had set up at the source. Thus the poisons of erysipelas and diphtheria rarely cause suppuration, that of soft chancre and cadaveric poisons frequently do.

Chronic Lymphadenitis.—Now and again an acute lymphadenitis passes into a chronic state; the glands remain swollen and indurated, and may never return to the normal. Glands above some chronic inflammation may become similarly swollen, and upon section such glands are grayer and more opaque than normal, firm, and more or less plainly fibroid; encapsuled abscesses, undergoing absorption, may be found, the periglandular tissue being much thickened; or there may be yellow patches of fatty degeneration. Syphilis in all its stages causes enlargement of glands; but they rarely become very prominent. The pathological process is the same as in other syphilitic lesions; but gummatous lymphadenitis is rare, affects chiefly internal glands, and usually gummata exist in the organs whence the lymph comes. But by far the most common cases of chronic lymphadenitis are the *scrofulous glands* which we have shown to be tubercular. The histology of these is that of tubercle in general (p. 93). In early stages, typical miliary tubercle—the giant cell surrounded by epithelioid cells—may be found with few or no signs of diffuse inflammation; but soon general round-celled infiltration of the gland occurs, followed by caseation, and either softening into puriform cheesy fluid, or inspissation and frequently calcification. The former result is the more usual in superficial glands, the latter in the mesenteric and bronchial. These cheesy glands, especially bronchial, are regarded by Koch as the storehouses whence by some accident bacilli in small or large numbers may be sent all over the body (p. 97). To the naked eye the glands are at first moderately swollen, pinkish or pale gray, and softer than normal; the swelling increases, the gland becomes firmer, and small cheesy foci appear, especially towards the centre; these enlarge and coalesce till perhaps the gland becomes wholly cheesy, or calcification or softening into cavities occurs. The periglandular tissue forms a dense capsule as a rule, but sometimes a periglandular abscess forms and the tubercular gland may be bodily eliminated.

The *symptoms* of *acute lymphadenitis* are rapid painful enlargement of one or more glands, accompanied by a good deal of œdema of surrounding tissues and redness of skin, the latter varying with the distance from the gland. If a perilymphatic abscess forms early, its diagnosis is generally easy; but when pus forms slowly in the gland, it is often very difficult to determine its presence. The symptoms seem to point to abscess, but an incision often evacuates no pus (see *Morbid Anatomy*).

The glands most commonly affected by *tubercular* lymphadenitis are the cervical, bronchial, and mesenteric—all receiving lymph from mucous surfaces, which, in the strumous, are subject to chronic catarrhs; but the cervical and other superficial glands may probably become infected through slight breaches of the skin, or secondarily to other tuberculous lesions, either by the lymphatic or the blood vessels. With regard to the cervical glands, it has been already noted (p. 91) that strumous lesions of the skin are specially frequent about the head and face. One or more glands enlarge slowly and painlessly, the skin being unaffected and the swellings distinct from each other. They may remain permanently in this condition, or the enlargement may continue and the glands become matted together. After a very varying time—weeks or years—one or several glands soften, the skin reddens, thins, and bursts, cheesy pus, and perhaps calcareous granules, escape, and a sinus, discharging more or less, remains, often for many months. Burrowing may occur far and wide, and the skin frequently becomes extensively undermined, thin, and purplish.

TREATMENT.—*Acute lymphadenitis* requires rest, belladonna, and fomentation, together with attention to the source of absorption. If an abscess forms it should be opened, and it is always well to give ether that this may be done thoroughly; for an imperfect opening leads to burrowing. Should a gland be found in the cavity it should be removed, either bodily or with the sharp spoon. If sinuses form, rest, drainage, well-applied pressure, and stimulant injections may bring about healing; but usually the quickest way is to slit them up, entirely or in part, and to sharp spoon them.

Chronic enlargement is reduced by friction with some ointment, douching, and constant pressure. It is often very troublesome.

Tubercular Glands.—In all cases pay attention to the general condition. In the early stage frequent friction with ung. pot. iod. is sometimes followed by disappearance of the swelling; ung. plumbi iod., or ung. iod. is used by some. If a gland has softened at once, and before the skin is affected, make a small incision into it, and remove as much of it as possible with a sharp spoon; introduce some iodoform into the cavity, and dress with a deep dressing and salicylic wool. If the abscess is pointing, treat similarly. If it has burst, enlarge the opening and slit up sinuses, if necessary, for draining; use the sharp spoon freely, endeavoring to remove all gland and tubercular granulation tissue; cut away all blue skin and dress as above.

Sometimes a gland, which is steadily enlarging and softening in spite of treatment, may be removed entire before the skin is involved, and rapid union obtained with little scarring. Occasionally, too, one may have to remove a mass of matted glands pierced by sinuses from the neck, axilla, or groin; but the mass should be the only one or a source of much trouble to justify this.

Tumors.—Under the heading of *Lymphadenoma* or *Hodgkin's Disease* we have described a progressive hyperplasia of lymphatic glands and other lymphoid structures, which it is impossible at first to diagnose from inflammatory cases; progressive involvement of glands and anæmia, or leucocythæmia, and the rarity of softening in the former are the points to rely upon.

Myxoma is the only simple tumor known to develop primarily in lymphatic glands. All forms of *sarcomata* occur primarily, even the melanotic, and the alveolar which so closely resembles cancer. They may run a slow local course, involving only a group of glands; or may prove intensely malignant. They differ from malignant lymphoma in having no tendency to spread to other groups of lymphatic glands. True *cancers* occur only as secondary growths.

CHAPTER XXV.

INJURIES AND DISEASES OF BONE.

Contusion of bone is frequent. When subcutaneous, simple periostitis, rarely running on to suppuration, results. But when compound and due to considerable violence, especially gunshot, it may be followed by septic traumatic osteomyelitis, and lead to abscess, necrosis, or death from embolic pyæmia.

Fractures.

Definition.—A fracture is a solution of continuity of a bone.

Exciting Causes.—These are two: *Mechanical violence* and *muscular action.* Mechanical violence may be *direct* or *indirect.* It is *direct* when it causes fracture at the part to which it is actually applied, as in fracture of the clavicle from a violent blow. It is *indirect* when force is applied to the ends of a bone (or chain of bones), and this gives way at the weakest point, as in fracture of the clavicle from falls on the shoulder or hand. The acromial end is rigidly fixed by the object against which the shoulder or hand rests, the sternal end is driven toward it by the momentum of the body, and the bone gives way usually about the middle.

Muscular action most often breaks the patella or olecranon; much more rarely a long bone—usually the humerus, then the femur, leg bones, or fore-arm bones. The sternum and pelvis may thus be broken. Stretched ligaments may drag off the bone into which they are inserted.

PREDISPOSING CAUSES.—1. Original conformation, the bones of some people being unusually brittle without obvious causes; rarely, this liability to fracture runs through three or four generations. 2. Atrophy from old age; prolonged disuse (accounting for the frequency of fracture during attempts to reduce old dislocations); in general paralysis of the insane, and at the ends of the shafts of long bones in locomotor ataxy. Cases of fracture from atrophy during cancerous cachexia are described, no local growth having been found. 3. Rickets and mollities ossium. 4. The presence of syphilitic, tubercular, or other form of caries. 5. The presence of some new growth, especially sarcoma or cancer in the bone.

VARIETIES OF FRACTURE.—The following are the chief: *Simple*, in which there is no wound affording either direct or indirect communication with the air; *compound*, in which such communication exists from the first, or appears later from sloughing of the soft parts; *complicated*, in which dislocation of the fractured bone, rupture of a large nerve or artery, or extensive injury to soft parts coexists. Fractures are *incomplete* or *complete*. Examples of incomplete are—a splinter or apophysis is broken from a long bone; the *willow* or *green-stick* fracture (occurring in young bones, often rickety, or in those softened by osteomalacia), in which the bone is not broken through, but torn open on one side only like an over-bent green stick (Fig. 65); a

FIG. 65.

Green-stick or willow fracture of the ulna in a young person. From the Museum of the Medical College, Madras.

fissure running through more or less of a bone, generally a flat one, but sometimes a straight or spiral fissure is found in a long bone, especially the humerus or femur. When many fissures radiate from one point the fracture is *starred* or *stellate*. *Complete* fractures may be *transverse*, *longitudinal*, or *oblique*, according to the relation of their line to the axis of a long bone; the first two are rare, every degree of obliquity is common; the line of fracture is often *toothed* or *V-shaped;* in cases from gunshot or other great violence, fissures commonly extend into neighboring joints, or far toward them, or from similar causes the bone at the seat of fracture may be *comminuted*—*i. e.*, broken into several fragments; if these are long and splinter-like, the fracture may be called *splintered*. As the size of the fragments increases, the comminuted fracture passes into the *multiple*, in which a bone is broken at two or more places, the intervening portions being unbroken. A fracture is *impacted* when the smaller fragment is driven into and fixed in the larger —*e. g.*, the neck of the femur into the head or into the trochanter, with or without splintering of the latter. A hole punched through a bone such as may be made in a flat bone by a bullet is called a *perforated* fracture, and a puncture made by a pointed instrument, a *punctured* fracture. *Separation of an epiphysis* may occur, is most common between ten and twenty years; all are usually united by twenty-five; any epiphysis may suffer, but the lower of the femur and radius, the upper of the humerus and tibia, do so most frequently. Such fractures may occur through the epiphysial cartilage, or this may carry away with it a thin layer of the shaft; in the former case soft crepitus only will be obtainable. After such injuries the epiphysis may ossify early, and growth of the bone be seriously curtailed. Fractures into or in the immediate neighborhood of joints are very likely to leave impaired movement from exuberant callus or slight displacement of the fragments.

An *examination for fracture* should be made once for all and thoroughly; an anæsthetic is often necessary. If so much swelling is present that it is impossible to feel the bones, fix the part in the best possible position for recovery, and use ice if swelling is increasing; if not, fomentations to promote absorption. It is always well to feel the pulse beyond the injury to see that the main vessels are sound.

SIGNS OF FRACTURE.—(1) *Abnormal mobility;* (2) *Deformity;* (3) *Crepitus,* are the chief; localized pain, tenderness, and swelling, and helplessness of the injured part are sometimes of value.

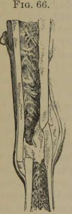
Abnormal mobility is detected by simply pressing on a bone (sternum, rib, or skull), by rotating the distal portion of the bone (radius, femur) with the thumb placed on the upper to see whether it moves with the lower, or by grasping the bone with both hands at various spots and trying to obtain movement, either angular or transversely to the axis of the bone, between the portions held. If found, this is proof positive of fracture, such a condition as an old ununited fracture being eliminated. But it may be impossible to seize or press upon the bone, or the fracture may be incomplete or impacted, and mobility consequently absent, and in some cases with slight displacement spasm of the muscles may keep the fragments securely locked. *Deformity* is due to displacement of the fragments, and this may be angular, lateral, longitudinal, or rotatory—terms which explain themselves. Displacement is due to the direction of the fracturing force and of the line of fracture, to the action of muscles and of the weight of the part, and to manipulation. Angular deformity, swelling from overlapping or projection of fragments, shortening or eversion or inversion of the limb below the fracture, may be obvious at a glance, or careful measurement may be required; but deformity is absent in simple fissures of flat bones, and even in some complete fractures of limb bones, especially in children; and it is undiscoverable clinically in many fractures of thickly covered bones and in cases of slight impaction. It is, however, the most important sign of impacted fractures. Habitual deformity must not be confounded with fracture or dislocation. When a person, after a fall or other accident, is found to have a limb shortened or misshapen, the surgeon should always ask whether or not there was any deformity before the accident, else he may fall into the ridiculous error of treating an old deformity as if it were a recent injury. *Crepitus* is the sensation communicated to the ear or hands when the fractured bones are grated against each other, by proceedings similar to those employed for detecting abnormal mobility. It is absent when the fragments are separated by displacement, or by the intervention of muscle; also when they are firmly impacted or even locked by muscular spasm in cases where the bone cannot be fairly grasped above and below the fracture. Crepitus is simulated by the crepitation of blood coagulated in the subcutaneous tissue, and still more closely by the grating in joints affected by rheumatoid arthritis, which is often conducted along a limb for some distance.

Localized *pain, tenderness, irregularity of bone,* or *swelling,* are often of much value in cases due to indirect violence or to muscular action, and especially where only one of two bones is broken. The pain may be detected by direct pressure and by gentle rotation; where there are two bones, by squeezing them towards each other, grasping them as far as possible from the painful spot.

Helplessness of the part is characteristic of fracture, but complete loss of power is not uncommon in painful contusions. Also, considerable power is retained in incomplete or impacted fractures, and even in rare cases of complete unimpacted fractures, the patient being perhaps able to walk after fracture of the neck of the femur. Ordinarily movement of a broken limb is freer than normal; but it may be characteristically limited in impacted fractures—*e. g.*, complete rotation in of the leg is impossible in impacted fracture of the neck of the femur.

REPAIR.—For a few days the broken ends, sharp and more or less denuded of periosteum, lie in partially coagulated blood among bruised and torn tissues. The vessels of *all* parts irritated by the injury and subsequent movements of the fragments allow fluid and corpuscles to pass freely out, granulation tissue develops, and the blood disappears before it. By the tenth day this soft, pink tissue is present in quantity, infiltrating the soft parts, surrounding the bones, and forming a plug in the medullary cavity. By the fourteenth this tissue is a good deal firmer, and a membrane continuous with the periosteum appears on the surface of the spindle-shaped swelling, into which the ends of the bone are stuck as into soft sealing-wax (Billroth) The new tissue is called *provisional* or *temporary callus,* the ring outside being the *external* or *periosteal,* the plug inside the *internal* or *myeloid* (Fig. 66). The amount of this provisional callus varies directly with the amount of movement permitted to the fragments—*i. e.*, the amount of irritation of tissue; it is greatest in fractured ribs, least or absent in fissures of the skull, and always in larger quantity where a bone is thickly than where it is thinly covered—*e. g.*, on back and outer rather than on inner side of tibia. In man the periosteal callus does not usually form a complete ring; it fills up angles and gaps caused by displacement.

FIG. 66.



Ordinarily this granulation tissue begins in the third week to ossify directly or after conversion into fibrous tissue; if, however, there is much movement of the fragments, islets of cartilage appear—they are common round broken ribs, and conversion into cartilage is usual in animals.

Ossification begins in the periosteal callus and appears later in the myeloid, it starts round the vessels passing from the callus to the bone, at points most distant from them; tubes of bone form and become lined by angular osteoblasts, which lay down layers of bone and establish Haversian systems. The periosteal bone thus becomes dense and adheres more and more firmly to the broken ends, and holds them strongly together. Ossification of the provisional callus is complete from the fourth to the eighth week, according to the size of the bone; and then the part is again fit for work.

Slowly a round-celled exudation from the vessels has been enlarging the Haversian spaces of the broken ends, and the granulation tissue in one fragment, either directly or mediately through the provisional callus, joins that in the opposing fragment. By this melting together of the broken ends and subsequent ossification of the uniting material, *permanent or definitive callus*, the bone is rendered continuous. Ossification of the permanent callus begins after that of the provisional is complete, and ends usually about the fourth month. Absorption of all unnecessary temporary callus is the end of the process. In accurately set fractures, after a year or two, the medullary canal may be opened up and possibly all trace of fracture removed; as a rule, some evidence of displacement remains.

When *compound fractures* are septic, the granulation tissue is exposed to constant irritation, and suppurates freely: some necrosis generally occurs, and thus it may be many months before healing, if it occur at all. Even if they do not suppurate, compound fractures heal more slowly than simple.

Though other tissues help in producing the material which ossifies, probably none of it would ossify in the absence of periosteum. If the shaft of a bone be removed subperiosteally, the granulation tissue produced frequently ossifies and a new bone forms.

The vital processes in bone are not very active; hence we find that completely detached fragments, protected from all septic irritation, derive sufficient nourishment from the surrounding fluids to maintain life until they contract fresh adhesions; by *transplanting* bits of bone under aseptic conditions, Macewen has built up part of an ulna. The effect of sepsis is shown by the necrosis so common in compound fractures.

Treatment.—When a person has received an injury which may have caused fracture, especially of a lower extremity, it is very important to prevent him from endeavoring to rise; for the bone is thus frequently thrust through the skin, and displacement and injury of tissue much increased. He should not be lifted until either the absence of such an injury is ascertained or the part is properly taken care of. If the leg is broken, one person should hold it alone, whilst others lift or carry. Further injury having been guarded against by tying the legs securely together at knee and ankle, or by the application of some temporary splint (*e. g.*, sticks, umbrella frame, bundles of straw), the patient may be carried home on a litter made of two poles and a sack or horsecloth. A broken arm may be safely held by the other hand or placed in a handkerchief sling. The patient's bed must be made as firm and level as possible; in fractures of the thigh a door or planks should be placed beneath the mattress. The patient may then be placed upon it and examined, clothes which are at all difficult to remove being cut up along the seams. Whilst splints are being prepared, have the part washed as thoroughly as possible with soap and water and a flannel. When it is necessary to fetch apparatus, place the limb in the most comfortable position (thus it is usually best to place the leg on the outer side, with hip and knee pretty fully bent) and steady it with sand-bags, bricks wrapped up, or handkerchiefs passing from the knee and ankle to the bed frame.

The *general indications for treatment* are: (1) to place the fragments in their natural position; (2) to keep them together at perfect rest until they are firmly united. The first indication is fulfilled by the *reduction* or *setting* of the fracture. This must be done as soon as possible and with the smallest amount of force, all opposing muscles being relaxed by position. Thus, in fractures of the leg, the patient should lie on his back and the hip and knee be bent to a right angle to relax the calf muscles, all apparatus being ready. One assistant now takes the foot and makes *extension—i. e., steadily* pulls upon it—whilst another, grasping the thigh with both hands just above the knee, holds it immovable or makes *counter-extension*. The surgeon watches and manipulates the fragments, directing the assistant to pull in this or that line or to rotate, and when they are drawn into place the assistants maintain extension until he has applied some retentive apparatus. The correction of rotatory displacement is often forgotten, especially in the lower limb. Considerable force is sometimes required to overcome the interlocking of fragments, and anæsthesia is often necessary. It is a rule in treating fractures to *fix the joint above and below the injury*, but the upper may be left free when it is far above the fracture.

Retentive Apparatus. Splints.—Some fractures are treated without any apparatus; usually some means are adopted to fulfil the second indication—*i. e.*, to keep the part at rest and prevent displacement; perhaps merely a bandage or strapping, more often a splint. A splint may be required simply to immobilize a joint; usually it is employed to prevent lateral, angular, and rotatory displacement, and often to maintain extension.

Splints are divided into the *movable, movable immovable,* and *immovable.* The *movable* are made chiefly of wood, tin, perforated zinc, *poroplastic,* leather, or gutta-percha; they are applied with ordinary bandages which become loose every few days, require reapplication, and necessitate more or less disturbance of the fracture. Many wood and metal splints are constructed for special fractures; but a deal plank, four inches wide and one and one-half inch thick, will enable a surgeon to treat a large number of fractures successfully. The three last named materials are cut out, softened, and moulded to limbs as the cases present themselves.

Flat wooden splints should be wider than the limb to which they are applied, and this is of especial importance in fractures of the forearm, where the bones may be pressed toward each other by the bandage. They require padding with a folded soft towel, strips of old blanket, or pads made of tow or cotton-wool sewn in soft muslin.

In the emergencies of military and railway surgery, strong splints can be improvised with the smaller gauges of telegraph wire, which can be bent into the required shape by the fingers or dressing forceps, and easily cut with a strong pair of scissors. (*Brit. Med. Journ.*, June 19 and 26, 1876.)

It is a rule never to apply a bandage to a limb beneath a movable splint, as it may cause strangulation if the limb swell. Splints should generally be applied to the limb in that position in which it is afterward to remain. When splints are used to prevent longitudinal displacement, and therefore bandaged tightly to the limb, the parts below must be equally supported by bandages or they will swell greatly. Prominent bony points must be carefully protected by "ring" pads, or the soft parts will slough over them. In all cases the tips of the fingers or toes must be left bare in order that the state of the circulation in the part may be tested by pressing upon them.

Strips of stout webbing with buckles are most useful for fixing splints before applying a bandage.

The *movable-immovable* and *immovable* appliances are made of plaster of Paris, tripolith, gum and chalk, starch, paraffin, egg and flour, silicate of soda. Splints of these materials become loose only by shrinking of the contained part; ordinarily they are applied once for all and are therefore called immovable. They afford uniform support to the injured tissues, and the fracture, once set, is not disturbed until it is united. But should circumstances necessitate its occasional examination, many of the above materials may be used to form splints, which are removable at pleasure, and still retain the qualities above mentioned.

Plaster of Paris is most generally employed. To apply it, the limb should be thoroughly washed, carbolized, and dried; then wrapped in one or more layers of boracic lint smoothly laid on. Loose muslin ("crinoline") bandages, into the meshes of which plaster has been freely rubbed, are thoroughly soaked in water, squeezed moderately dry, and rolled round the part without any pulling. When the lint is covered with one layer of bandage, long strips of tin, three-quarters of an inch wide, are placed at intervals all round the fracture, secured by two layers of bandages, and the limb held in position until the plaster has set——*i. e.*, about ten to fifteen minutes. This answers admirably for simple fractures of the leg, and may be applied immediately except when, from direct violence or pressure of the fragments, sloughing of skin is probable, or when there is much and increasing swelling from extravasation, or a large artery has been torn; or when any acute inflammatory condition is present (Gurlt).

Should the existence of small wounds or doubtful contusions render it desirable to examine a fracture from time to time, the *Bavarian* or *book-back splint* may be used. Suppose the leg is to be put up; cut two pieces of coarse flannel, each like two Cline's splints joined together behind and large enough to surround the leg and foot, with two inches to spare. Fasten them together by two rows of stitching, half an inch apart, along the mid line behind. Place them beneath the leg and bring together the inner by stitches along the front of the leg, dorsum, and sole of the foot. Thick plaster-cream is now rubbed in and spread smoothly over it to the depth of half an inch; then the outer pieces are brought together firmly, pressed down on the plaster, and cut off close to the mid-line. When necessary, the stitches in front may be cut and the splint opened, the seam along the back acting as a hinge; it is reapplied with a bandage. Much less brittle splints are made by moulding to the limb several layers of muslin, or fewer of flannel or sacking, wrung out of water and then thoroughly steeped in plaster-cream. A plain bandage should be used to bind them to the limb whilst setting; it adheres to them, and when cut down in front acts as a hinge behind. Splints of almost any shape may thus be made; anterior, posterior, or lateral; when a considerable bend must be made, cut the layers partly through on each side, and interlace the flaps; the splint will be stronger if the cuts in successive layers do not correspond exactly. When the cuts in the bandage gape, interleave short bits of soaked bandage.

Such splints may be rendered waterproof by frequent painting with shellac varnish or hot paraffin, and the absorption of urine or discharges prevented. But when a wound is to be left uncovered from which much discharge is expected, or which is to be treated antiseptically, a window cut in the splint will usually be insufficient; a break must usually be made. This is bridged over by two or more pieces of hoop iron or stout telegraph wire, held between the layers of bandage above and below the wound, and bent out into brackets opposite the gap, so that the dressing and bandages may pass easily beneath them. Projecting loops made in the anterior wire are often used for slinging the limb. If the part is heavy, plaster must be used for the splint; but if light, bandages steeped in paraffin, setting a little above the body-temperature, will answer well. In either case the angle between the skin and splint should be caulked with a little wool, painted freely with hot paraffin.

After the early application of immovable splints, it is well to raise the limb for twenty-four hours, to aid the splint in arresting swelling. The fingers or toes should be carefully watched; if they become bluish, cold, numb, and swollen, and blood driven from matrix of nail returns slowly, the splint should be at once cut up; pain may be slight or absent though gangrene is commencing. The surgeon should always see the patient in six hours.

When there is a tendency to longitudinal displacement plaster cannot be relied upon to prevent it in the thigh or arm, as there is no bony point above upon which it can hold. Such cases should be otherwise treated till the tendency to displacement is over, when the permanent splint may be applied.

A patient with a bad fracture is best kept in bed until pain and swelling have subsided. Many fractures of the upper limb may, however, be treated without such confinement. Fractures of the lower limb must be kept at rest (unless due to very slight violence) for three or four days, until it is certain that serious swelling is not going to occur beneath the splint; and fractures of the femur are best kept in bed until the tendency to displacement and shortening is over—*i. e.*, three to four weeks. They may then get about on crutches with the leg slung from the neck.

At the expiration of four to six weeks in the upper, and five to ten in the lower, the bone is carefully examined for abnormal mobility, and tested as to its power of bearing weight or strain. The examination proving satisfactory, splints are replaced by a flannel bandage, and the patient is allowed to begin to use his limb, crutches being given up, in the case of the lower extremity, as the patient gains confidence in his limb.

A few *general points* require mention. Thus shock may require treatment (p. 166); retention is common after injuries of the lower limb and requires the catheter; constipation due to confinement may require attention. If pain and starting are troublesome during the first few days, opium in grain doses, once to thrice daily, is the best remedy.

COURSE OF A SIMPLE FRACTURE.—When a recent fracture has been well put up, pain soon subsides; some swelling forms at the seat of injury, and perhaps a few bullæ rise. In a week or ten days these subside, the skin becoming discolored by blood-coloring matter soaking into it, and swelling due to callus round the bones is revealed. After most severe fractures there is slight fever, beginning within six hours of the accident, reaching its maximum in twenty-four to forty-eight hours, and lasting three to ten days (Horsley). This is the purest *traumatic* fever; it is more marked in the young than in the old, rarely rises much above 100°, and appears to be due to irritation of sensory nerves, and to absorption of blood-ferment and of pyrogenous bodies resulting from simple inflammation, the more prolonged forms being associated with a good deal of swelling. Similar fever results from severe contusions without fracture. It does not disturb the general state. In all cases some *fat-embolism* probably occurs; the droplets of fat, liberated from the crushed marrow and subcutaneous tissue, enter lymphatics and veins, and are carried by the blood current to the lung arterioles and capillaries first, then to those of organs beyond. Many of the little masses reach the kidneys, and Riedel states that he found fat free in the urine about the third or fourth day in forty-two per cent. of the cases he examined, and it may be found again at the tenth to fourteenth day; in the first few days a little albumen and casts, especially a peculiar brown granular cast, were often present (*D. Zeitschr. f. Chir.*, vol. x. p. 539); but in a considerable number of simple fractures examined at University College Hospital, I failed to detect fat, and albumen and casts were rarely met with. Horsley speaks similarly.

COMPLICATIONS OF SIMPLE FRACTURE.—*Comminution, multiple fracture, fracture higher up* in the same limb, increase greatly the difficulties of treatment, but require no special notice; *dislocation of a fractured bone* will be noticed later. The *extension of fissures into joints* leads to effusion of blood and inflammatory fluid, which are generally absorbed without trouble, but the patient should be warned that impaired movement may remain; sometimes strumous arthritis starts after such an injury. The *soft parts* may be *much injured* by direct violence, or by the sharp fragments in cases due to indirect force. So long as the skin and great vessels remain sound, such laceration, and the swelling which results, are not very serious; but if the skin is killed, or abraded or wounded over an extravasation which extends with little interruption to the fracture, the probability is that the latter will become secondarily compound. The later this occurs the less serious is it, as formation of granulation tissue will be more advanced and will diminish septic absorption. But sepsis should be prevented by putting up aseptically all cases in which the skin is injured. The results of extensive subcutaneous laceration are swelling, ecchymosis of the skin, and formation of bullæ; they are best prevented by elevation and uniform gentle compression with wool, outside which splints may be applied. Bullæ should be pricked, dusted with iodoform, and covered with salicylic wool. *Wound of a main artery* and formation of an arterial hæmatoma is a rare and serious complication, most common in fractures of the femur low down (popliteal) and of the tibia high up (post. tibial), the vessels at these spots lying close to the bones. The vessel may be wounded at the time of the accident or later. An artery may be simply bruised, and thrombosis result; or it may be torn across and not bleed; or it may be torn completely or incompletely across and bleed into the tissues. A deep diffuse swelling then forms, and at first increases rapidly, and the signs of superficial extravasation may also be present; the limb below becomes cold, pale, swollen, and numb, and pulsation is absent in the distal portion of the main artery. When extension becomes limited by coagulation and resistance of the tissues, a cavity remains round the torn ends of the vessel, and here some thrill or pulsation often develops (arterial hæmatoma, traumatic "aneurism"). The chief danger of this complication is that it may lead to gangrene of the limb, by interruption of the arterial supply and by pressure on the veins; and laceration of numerous small vessels, most likely to occur from direct violence, will much increase the difficulty of maintaining the circulation. As to treatment, in early cases, elevation and compression of the main artery for half to one hour may be tried with a view to limiting the extravasation, the part being wrapped in wool. If a localized hæmatoma result, the fracture must be treated as usual, and the complication may disappear under the necessary rest and compression. Should it not do so, digital compression of the main trunk has succeeded in several cases. Failing this, wait until the fracture is united; then the most certain treatment is the laying open of the sac and ligature of the artery above and below; but ligature of the main trunk has been successfully done when circulation in the limb has been reëstablished. If, however, swelling increase so that gangrene is imminent, the modes of treatment are two: (1) laying open the extravasation freely (see "Traumatic Aneurism"), turning out the clot and tying all bleeding vessels; or (2) amputating. Amputation is a last resource, and should be done when the artery and vein are both injured, or when extensive injury of soft parts is also present. Some surgeons say that amputation must be done in rupture of the popliteal, whilst an attempt may be made to save the limb when the post. tibial is injured; but collateral circulation should be established after relief of pressure and ligature of the popliteal, unless the soft parts are much injured. Operations for ligature of deep arteries under such circumstances are extremely difficult, so the surgeon must be prepared to amputate in case of failure, and make his incisions accordingly.

Gangrene of the limb after simple fracture may result from the original injury to the soft parts, everything beneath the skin being crushed; from diffuse inflammation starting from a wound; or from pressure of extravasation, especially when the main artery is ruptured; or from occlusion of an artery by pressure of an irreducible fragment. In these cases the surgeon will probably not be to blame; but it may go hard with him before a jury if it appear that gangrene has been caused by too tight application of apparatus, by strangulation by a bandage put on beneath splints—the limb having swollen subsequently—or by flexion of a limb after the application of a bandage. Amputation is the remedy.

Contusion or laceration of large nerves is rare (Weir Mitchell, *Injuries of Nerves*, p. 104) in simple fractures; there is most danger of it in fractures of the middle of the humerus (musculo-spiral), and of its inner condyle (ulnar). Unless division is complete or pressure permanent recovery is perfect. Exercise the muscles daily with the constant current.

Considerable *œdema* from thrombosis of large veins sometimes appears; and, rarely, the phenomena of slight or fatal *pulmonary embolism* arise, from detachment of clots and their carriage into the right heart. The clots may be small or several inches long, with impressions due to the valves of the vein in which they arose; in the latter case they block the main trunk or primary branches of the pulmonary artery. In fatal cases the symptoms are: sudden præcordial distress and sense of great alarm, pallor or cyanosis whilst air is entering the lungs freely, rapid feeble pulse, and a cold sweat breaks out before death; sometimes the patient feels the clot pass from its site of origin up to the chest. In milder cases the above symptoms may be less marked, and followed by deeply blood-stained expectoration; rarely the dulness of a large hemorrhagic infarct is detected.

Fat-embolism has been regarded as a cause of early death—a rare event—after simple fractures, the symptoms being dyspnœa with râles, more or less shock, low or depressed temperature, and death resulting from coma; post-mortem small ecchymoses are numerous, and there is great œdema of the lungs. Cohnheim and others doubt that fat-embolism ever produces the above symptoms, for large quantities of fat may be injected into the circulation in animals without any serious symptoms ensuing.

Traumatic delirium or *delirium tremens* is common; the patient does not sleep during the first night or two, and then the characteristic symptoms set in (p. 166). The fracture must be securely put up, if possible, in apparatus which will move easily with the limb, for the patient turns and twists this about in all directions, and often would stand on it if allowed. The limb may be swung, but should not be tied down.

Suppuration and *necrosis of fragments* are extremely rare, unless the skin is severely injured. It has occurred, however, without obvious reason; more often a septic wound or foul ulcer has existed elsewhere, or the patient is suffering from pyæmia or other acute infective fever, or delirium tremens. The diagnosis of suppuration is usually easy. Early antiseptic incision and thorough drainage would usually be the treatment, but amputation may be required.

Results of Simple Fracture.—In the vast majority of cases sound bony union takes place, and the patient recovers with a limb able to perform its functions. The time required for union varies from three to ten weeks, with the age of the patient, the size of the bone, and the seat of the fracture; being shorter in the young, in the smaller bones, in the face than in the upper limb, and in the upper than in the lower limb (Malgaigne). In certain fractures, *fibrous union* is the rule—*e. g.*, of the acromion, coracoid process, and transverse of the olecranon and patella, the cause being separation and mobility of the fragments; the bond of union may from the first be so long, or become so later by stretching, that, in the cases of the olecranon and patella, power of extension is lost. In other cases *no union* may occur; for causes, etc., see p. 241. On the other hand, the *formation of callus* may be *excessive*, especially when the fragments are much displaced. Lastly, *callus may soften* after apparently firm union has taken place, and re-fracture occurs; this is generally due to the onset of an acute fever or inflammation, or scurvy.

For a time, especially after middle age, the limb often remains œdematous, wasted, dry and brawny, and much affected by cold, change of weather, etc. —symptoms which are best treated by cold douches, regular friction, massage, exercise, and careful bandaging. *Wasting* is usually slight; it affects all the structures, and may be permanent; its causation then is not understood. *Shortening* and more or less *angular union* are common. In the latter case it may still be possible under anæsthesia to bend the bone straight; if not, and the deformity requires remedy, subcutaneous osteotomy should be done.

Stiffness of joints is common, especially in the old and rheumatic, and in fractures extending into joints or in their close neighborhood. It is due to adhesions from arthritis, to displacement of fragments, to growth of callus, and sometimes to matting of muscles and tendons around the fracture. Much may be done by warm douches, massage, and forcible or gentle passive movement.

After separation of an epiphysis, ossification of the growing cartilage may occur and *increasing shortening* of the limb result.

Paralysis of motion and sense of great and persistent pain may result from the involvement of a nerve in callus. The musculo-spiral as it winds round the humerus is the nerve most likely to be thus involved. The sheath of callus has been opened with a chisel and the nerve freed, with disappearance of the symptoms as a result.

COMPOUND FRACTURES.

Definition.—Fractures in which a wound of the skin and soft parts communicates with the broken bone.

Causes.—Fractures may be rendered compound (1) by the same violence which breaks the bone; (2) by the thrusting of a fragment through the skin; (3) by subsequent ulceration or sloughing of the soft parts—secondarily compound.

Varieties.—These are obviously the same as in simple fracture; the most important are the *compound complicated*, characterized by much laceration of soft parts, with extensive subcutaneous hemorrhage; laceration of large vessels; comminution of bones, or fissuring into joints.

Diagnosis.—The signs of fracture are usual; and in addition, the fragments may project from the wound, or a finger may be introduced and the bone carefully examined; the nail is most useful in detecting a fissure. Slight oozing from the vessels of the bone often goes on for hours without any large vessel being torn. Sometimes air is sucked into the connective tissue of limbs, producing *emphysema*, recognized by swelling and soft crepitation; more often, air in the tissues indicates a communication with the respiratory or alimentary tract; it deposits any germs it may contain close to where it enters.

Dangers.—The *immediate* are due to shock from the frequently great violence of the cause and the amount of injury done to the soft parts; also to the possibility of serious hemorrhage from large vessels. But the excessive mortality after *compound* fractures is due chiefly to the occurrence of wound diseases, especially cellulitis, diffuse suppuration, erysipelas, acute osteomyelitis, spreading traumatic gangrene, septicæmia, and pyæmia; and to the results of chronic suppuration, hectic, exhaustion, and albuminoid degeneration.

The wound may be a mere puncture or a very extensive cut or tear.

Healing may occur under a scab, when the fracture is immediately converted into a simple one, or it may occur more slowly, but aseptically, under appropriate treatment, the course being almost as uneventful as that of a simple fracture; or the wound may become more or less aseptic, and then the door is open to the above-mentioned diseases. In the latter case there are more or less septic inflammation and septic traumatic fever, the latter usually subsiding as suppuration is established; but hectic fever may follow when pus burrows or bags in the limb. A frequent result of this inflammation is the necrosis of fragments which would certainly have lived in simple fractures, and the separation and elimination of these may occupy months or years; operations are frequently required for their removal. Rarely dead fragments heal in, and suppuration occurs round about them after years of quiescence.

It will be seen, therefore, that the course of a septic fracture is full of anxieties, and a very large number of such cases formerly died.

Treatment.—The first point to decide is *whether amputation is or is not necessary*. The question is often a difficult one; but the operation must be performed in cases in which, (1) from damage to vessels and soft parts, circulation in the part beyond cannot be maintained; or (2) in which destruction of tissue is so great that healing either could not take place or would leave a useless limb. In other apparently less grave cases—viz., those of (3) extensive comminution and fissuring of bone, especially if (4) involving a large joint, everything will depend upon whether the parts can be rendered and kept aseptic, or fairly sweet, and most completely drained. As a rule, in hospital practice, it will scarcely be safe to trust to the latter chance. Amputate, unless it is probable that antiseptics will succeed; but in private and in the country more liberty may be allowed. In civil practice, whenever there is any doubt about the propriety of amputating, give the patient the benefit of it by rendering the part aseptic, and waiting; in military surgery the contrary seems to be the best rule—amputate when in doubt. In all cases the health, strength, and age of the patient, and the resources of the surgeon as to time, nursing, nourishment, etc., must be carefully considered; in the field, also the necessity for moving the patient long distances. Lastly, injuries of the upper limb may often be treated conservatively when similar damage to the lower would imperatively demand amputation.

Primary amputation should be done as close to the seat of fracture as possible. It is often difficult to decide whether skin near the injury will, or will not live, and consequently it is no uncommon thing for bits of the flaps to slough. The surgeon must use his judgment in each case. If the soft parts above are extensively infiltrated with blood, the strictest antiseptic precautions and fullest drainage will be required to prevent suppuration and sloughing. If there be a simple fracture close above a compound about which suppuration occurs, it is likely to become secondarily compound. In determining where to amputate in these cases, the surgeon must consider the state of the parts between the compound and simple fracture, the antiseptic precautions which he can take; the less perfect the latter, the slighter the injury which will cause him to amputate at the higher rather than at the lower fracture.

Conservative Treatment.—If it is decided to make an attempt to save the limb, the wound must be treated according to the general principles laid down at p. 173. The necessity of keeping the wound aseptic often renders difficult the treatment of the fracture. The clothes having been removed, the wound should be covered with a guard whilst the limb is carefully cleaned with soap and water. Meanwhile, whatever apparatus is required must be prepared, and the spray got ready if it is to be used—we ourselves should employ it. Then the limb is thoroughly disinfected for at least eight inches above and below the wound. The latter may now be examined with the finger, and a decision come to as to the *treatment of fragments* in cases of comminution: those which are quite loose should be removed, but those which are still attached by soft parts may be left. If the wound becomes septic, however, those from which the periosteum is widely separated will probably die, and may therefore be removed at once where antiseptics cannot be employed. Fragments of bone may be carried far from the seat of fracture, especially in gunshot injuries. Of course, bullets and all foreign bodies must be carefully removed. *Hemorrhage* from the bone is often troublesome, oozing sometimes continuing even for days; vessels in soft parts may also bleed. Elevation acts well in slight cases; but if the bleeding is at all free, enlarge the wound, and examine it carefully, turning out the ends of the bone so far as this can be done without stripping the periosteum from them; tie any vessel which can be seized, use some hot antiseptic for general oozing, and for a vessel in the bone it may be possible to plug its canal with septic gauze or wool; the cautery should not be used if it can be avoided. If pressure be applied, see that good drainage be provided, lest blood be forced widely into the tissues.

Wounds of large vessels, especially a main artery, will be evidenced by the escape of blood from the wound; or, if this is small, by the formation of a hæmatoma, with weakening or cessation of pulsation in arteries below. The vessel or vessels must be tied (perhaps through a counter-opening); failing this, amputate. This operation must be done when both femoral artery and vein are torn.

Now disinfect the wound, using 1 in 20 carbolic, or 1 in 1000 sublimate lotion if the case is seen within an hour or two and has not been subjected to septic examinations. One of these fluids must be squirted into every recess of the wound by means of a syringe to which a piece of gum elastic catheter is attached by rubber tubing. To insure its reaching all parts of the surface, the wound may be closed round the catheter; but little distending force must then be employed lest the fluid be driven into the areolar planes, and, being retained, excite inflammation there. In case of prolonged exposure the wound must be treated with a 1 in 5 solution of carbolic in alcohol, chloride of zinc, gr. xx–xl ad ℥j, or sublimate lotion 1 in 500. If thoroughly septic and inflamed even these remedies will probably fail. Then the freest drainage and immediate drying or disinfection of all discharge must be chiefly relied on. Thus, in a case of compound fracture of the lower third of the femur, with a fissure running into the joint between the condyles, antiseptics failed, and on the second day the temperature was rising fast and the limb swelling. I made a free incision down to the fracture on each side of the limb, passed a large tube across, and laid open the knee-joint, the result being recovery, with little fever and no necrosis.

Drainage must be free in proportion as sepsis is intense, and in all cases it is well to err on the side of too free drainage; the case may become septic in spite of our best endeavors.

The wound being now aseptic, the fracture must be reduced. To this end, it may be necessary to enlarge the wound, or to cut off a projecting piece of bone bare of periosteum. In all cases in which there is any difficulty in preventing displacement, the fragments should be wired, the wire being cut short and hammered down in aseptic cases. The wound, if large, should now be carefully sutured, ample provision for drainage being made.

A reliable form of antiseptic dressing must now be applied—gauze, wool, jute, moss, etc.; in bad cases, the difficulty is to obtain room for a dressing of size sufficient to deal with the discharge, and at the same time to obtain such a hold upon the limb as will fix the fragments. A large gauze dressing is the best in bad cases for the first two or three days, splints being applied *outside* this; whenever necessary, the bandage is cut, the dressing opened, *the limb raised by the surgeon,* who maintains extension with a hand on each side of the fracture, the old dressing is removed, the fresh one slipped in, and the limb lowered on to it. Thus the disturbance is reduced to a minimum. The splints used in these early days are those employed in similar simple fractures. When the free discharge which results from the injury and treatment is over, it may be possible to use some immovable interrupted or fenestrated splint (p. 233), and to combine it with some form of lasting dressing. In France, A. Guérin's "pansement ouaté" has been largely used. The part, having been thoroughly disinfected, is wrapped in a large quantity of cotton-wool, and bandaged at first loosely, then more and more tightly until as much force as a man's arm will bring to bear is used. By this time the wool should have been compressed to a layer not less than two inches thick. The limb may now be shaken without causing pain, and the advantage of such perfect fixation when a patient must be carried long distances, as with a retreating army, is very great. But an ordinary cotton-wool dressing is not a guarantee against septic disease; to render it so, the dressing must be impregnated with an antiseptic; and wool may with advantage be replaced by some more absorbent substance, as dry moss or peat. Such a dressing is intended to be a permanent one. Its disadvantages are, the difficulty in maintaining the proper relation of the fragments during all the bandaging, and the great bulk of the necessary materials.

It was formerly a frequent practice, in cases of compound fracture, with only a small wound caused by protrusion of a fragment, to close it with lint and collodion or tincture of benzoin, or steeped in blood and allowed to dry on. Most of the cases were at first converted into simple fractures by this artificial scab; but a few had already become seriously infected, and inflammation resulted. Consequently these small wounds should always be disinfected and covered with a small antiseptic dressing of some kind, which need not be changed if it does not come through. Serious cases may be successfully treated by *occlusion* (p. 199).

In *septic cases* the temperature must be closely watched for the indications which it gives of imperfect drainage and formation of fresh abscesses. Openings must be enlarged and counter-openings made; but should the patient fall into a hectic state, a secondary amputation should be done and the limb removed. This operation should not be too long postponed. Experience has shown that amputation (intermediate) during the period of high septic traumatic fever is very fatal; having missed the period for primary amputation, many think it best to temporize until suppuration is established. But this is doubtful, for it is scarcely fair to compare the relative mortality after intermediate and secondary amputations in the treatment of compound fracture, so many cases die before reaching the period of suppuration. At all events, in cases in which the patient seems in imminent danger of death from acute septicæmia, especially accompanied by spreading suppuration or gangrene, amputation must be done without delay.

In these cases supporting treatment must be given from the first. The patient may be allowed to get up and about as soon as there is no danger of displacement or of disturbance of the dressings. Sequestra come away now and then, but often remain embedded in callus, keeping sinuses open for many months after the patient has begun to use the limb. When sufficient time for the separation of the sequestra has elapsed, an operation should be undertaken for their removal; they are sometimes extremely difficult to find.

Delayed Union, Non-union, and Pseudarthrosis.—In some cases union of the shafts of long bones is delayed for several weeks; in others even after months there is no attempt at union; in others again the bones are bound together by fibrous tissue, which may form a shorter or longer, loose or dense band, perhaps partly ossified (*fibrous union*, Fig. 67), or it may be arranged as a capsule uniting the fragments which are smooth, covered by dense fibrous tissue or by true cartilage (*false joint*). In the latter case one end is generally hollowed out and enlarged, the other convex, so that the joint is of the ball-and-socket variety (Fig. 68). The capsule secretes a lubricating fluid, and may become studded with papillary growths, and these may become loose bodies in the joint.

In cases of delayed union, at the usual time for removal of the splint the bones are found still loose and incapable of bearing strain; but in the course of a few weeks, if the fracture is put up again firmly, union takes place as usual. This delay is not uncommon after compound fractures of leg in which

Fig. 67.

Fibrous union, partly ossified, of lower end of femur.

Fig. 68.

False joint of tibia and fibula, showing ends of fragments and capsule.

the wound has healed early. The same state of matters may continue for months or years, but there is no pain or tenderness. In close fibrous union the patient may retain considerable power over the limb, but in false joint and non-union the limb is flail-like. On the whole, the condition is uncommon. Agnew has collected 630 cases, of which 219 (34 per cent.) were of the humerus, 180 (28 per cent.) of the leg bones, 155 (24 per cent.) of the femur, 76 (12 per cent.) of the forearm bones. It is very rare in childhood, most common in the prime of life, old age having no special influence. As *general causes*, may be enumerated *debility* from starvation, hemorrhage, lactation, or disease, especially an acute fever; *severe syphilis; pregnancy*, the influence of which is very doubtful. *Local causes* are *wide separation of the fragments;* actual *interposition of a piece of muscle*, tendon, or other substance, which is probably frequent; *imperfect fixation. Defective blood supply*, owing to fracture through the course of the nutrient artery and consequent impaired nutrition of the fragment towards which it ran, has been mentioned as a cause, though *à priori* it does not seem a likely one. Curling thought he had found this fragment atrophied; Gurlt, however, was unable to detect any difference in Curling's specimens. *Defective innervation* is said to have an influence, when the fracture is cut off from connection with the spinal centres whence its nerves spring, by injury to either the centres or the nerves; Bognaud ("Sur l'influence de quelques lésions du système nerveux sur la formation du cal." Thèse de Paris, No. 370, 1878) gives six cases of fracture of both bones of the leg or of the fibula only, accompanied by complete paraplegia from fracture of the spine at or below the twelfth dorsal, in which no union occurred; but when the spinal lesion was higher up, more or less complete union occurred.

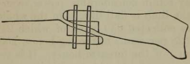
The existence of *disease of bone*, due to new growth, syphilis, osteomalacia, fragilitas ossium, may delay or prevent union; in many of these cases it occurs soundly and quickly. In compound fractures the retention of necrosed fragments, over which the skin may heal, is a not uncommon cause.

TREATMENT.—Combat any unfavorable general condition; try change of air. In cases of delayed union pay special attention to the fixation of the limb; sometimes, when the leg is firmly put up, union is hastened by allowing the patient to use it a little whilst walking with crutches, and thus to irritate the fragments somewhat, or he may walk without crutches if the fragments are fixed by a good apparatus. The constant current has been recommended.

When the case has passed into the class of ununited fracture, the patient may be anæsthetized, the fibrous tissue snapped by bending the limb to a right angle in various directions, and the ends then rubbed freely together. Or, H. Thomas's operation of percussing the bone ends with a copper mallet for five to ten minutes, whilst the skin is protected by a thick piece of felt, may be tried; the limb is then put up firmly for four to six weeks. Repeat the operation if callus does not seem to be forming.

Subcutaneous section of the fibrous tissue, or passage of a seton or needles through it, is not to be recommended; so, as further treatment necessitates the production of a compound fracture, it must be considered whether the inconvenience justifies the risk, which varies with the surgeon's ability to maintain asepsis. Should an operation be determined upon, the best is to cut down upon the fracture from that side which permits easiest access, the muscles being spared as much as possible. The fibrous tissue between the fragments must be divided or removed; it must be remembered that large, even main, vessels are sometimes adherent to this fibrous tissue. Each end is then turned out of the wound, and its surface freshened by forceps or saw —the two surfaces being so cut as to fit closely together. The ends must

FIG. 69.



Volkmann's operation.

then be drilled and secured to each other by one or two sutures of the stoutest silver wire drawn very tight, secured as in Fig. 44, the ends cut short and hammered down. Ivory, or (better, because more easily absorbed) compact bone pegs may be driven through both fragments when they tend to over-ride (Fig. 69). These operations must be done antiseptically, the wounds thoroughly drained, and the limbs fixed by some interrupted immovable apparatus if possible.

In united fractures of the forearm bones it is sometimes found that the lower fragments have fallen together, and no efforts can draw them apart to meet the upper; the ulna, as the more important bone, should then be united.

Cases of *angular union* may be re-fractured, if they yield to force which will not seriously injure the soft parts. When the union is too stout for this, antiseptic osteotomy with a chisel may generally be done, and the new fracture must be properly treated.

Amputation may be required to remove a useless limb.

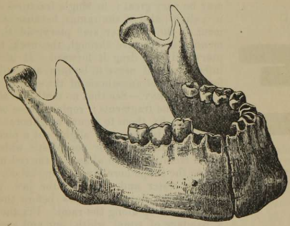
PARTICULAR FRACTURES.

Where nothing is said concerning the symptoms and diagnosis of special fractures, it is implied that there is nothing to add to the preceding general remarks.

1. Fractures of the Ossa Nasi are frequent on account of their exposed position; usually compound and comminuted, rarely involving one bone only. Deformity is often great, but masked at first by swelling; hemorrhage from the nose may be free or absent; emphysema may result from blowing the nose. These fractures may extend into the nasal processes of the superior maxillaries, and rarely to the cribriform plate, opening the door to septic meningitis; the septum is frequently broken, and its support lost.

Treatment.—Whenever suspected, a careful examination of the inner surfaces should be made for the detection and reduction of irregularity; an anæsthetic or cocaine may be necessary. The reduction is best effected by

Fig. 70.



Fracture of lower jaw at eye-tooth. Madras Med. Col. Museum.

the pressure of a steel director or similar *slender* strong instrument; it may be very difficult to keep the fragments in position, but plugs are said to be of little service; they are best made of antiseptic wool, and changed daily. Union occurs in two or three weeks; it is sometimes complicated by abscesses and necrosis of fragments. Should deformity remain, it may be relieved by operation. Emphysema requires no treatment; epistaxis nothing special.

2. Fractures of the Malar, rare; dislocation of it from its sutures very rare. Resulting from direct violence, the bone is usually driven in on the upper jaw and may interfere with the movements of the lower. It may be raised by a finger from the mouth; when firmly fixed, it is advised to make a

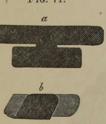
small opening in the skin, pass a hook beneath the bone or screw an elevator into it, and then raise it; it might be wired in place.

3. Fractures of the Superior Maxilla involving the body are rare, and result only from great direct violence. The bone may be separated from its fellow, or driven bodily backward toward the spine; any of the processes may be broken or the antral wall depressed. Diagnosis is generally easy, union rapid, and necrosis rare in compound cases. It may be difficult to prevent recurrence of displacement: wiring teeth, or fragments of alveolar processes, is often of great use; so also is fixing the lower against the upper jaw, especially after the teeth of the latter have been fixed in a gutta-percha trough. Use chlorate or permanganate of potash washes for offensive discharges into the mouth.

4. Fractures of the Lower Jaw are caused by direct violence and may occur at any point. Of 143 published cases, 80 were single, 49 were double, and in 14 there were more than two lines of fracture. Of 80 single ones, 5 affected the alveolar processes, in 25 the fracture affected the symphysis, in 22 the incisor region, in 15 it ran among the back teeth, in 8 behind the teeth, and in 5 through the neck (Gurlt). But published cases of so common a fracture are likely to be selected; and it would seem that the above figures place fractures through the symphysis and neck too high. Double fractures are often symmetrically placed on each side of the mid-line.

Symptoms.—Pain, swelling, crepitus, inability to use the jaw, mobility of fragments, and usually bleeding from the gums, loosening and irregularity of the teeth. In cases of double and multiple fracture, the displacement may be very great; in single fractures of the body it is slight, also of the ramus, because of the attachment of the masseter and pterygoid to both fragments; in fracture through the neck, the external pterygoid may drag it forward. It is rare for the inferior dental nerve to be torn, and still more rare for permanent anæsthesia of the skin to result.

Fig. 71.



a, shape of pasteboard splint; *b*, side-view of the splint as applied; the longer piece to the base of the jaw, the shorter one doubled back under the chin, and its ends brought up on either side.

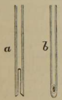
Treatment.—See that no tooth has slipped down between the fragments; replace loose or dislocated teeth and fix them to secure neighbors. When displacement is absent or slight, cut a piece of pasteboard, gutta-percha, or poroplastic wide enough to reach from the hyoid almost to the red border of the lip, to the shape here given (Fig. 71, *a*), soften it in boiling water and fit it to the jaw, placing the mental slips flat on the jaw before the submental are doubled up along the rami. Fix the splint with a bandage of equal width, one and one-half yards long, and torn into four tails except about eight inches in the middle; tie the two anterior tails over a pad of lint just below the occiput, the two lower tails in front of the sagittal suture, and lastly knot the four ends together near the vertex. The lower is thus firmly fixed against the upper jaw, and uniform pressure is kept up along the bone; when there is a large gap from loss of teeth, insert a piece of moulded gutta-percha of proper thickness. In all cases where there is the least difficulty in preventing displacement, or in which it is desirable to avoid the above uncomfortable apparatus, the fragments may be wired, as specially recommended by H. Thomas (" Fractures of the Lower Jaw "). Wire $\frac{1}{32}$ of an inch thick is used. It may be sufficient simply to pass it between firmly fixed teeth on either side, forcing them apart if necessary; or a loop may be thrown over a tooth in one fragment and its ends passed through a hole drilled between teeth in the alveolar process of the other (Fig. 74); or the alveolus of each fragment may be drilled. Thomas tightens the wire by screwing up each end with a *twister* (Fig. 73, *a*), and the tightening must be repeated by re-introducing the twister whenever mobility appears.

FIG. 72.

Four-tailed bandage for dressing wounds on chin and fractured jaw.

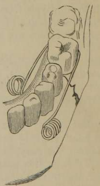
In the second method (Fig. 74) one end of the wire is passed twice from without in through the same hole, but in the third, one has to be passed from within out. This is effected by sticking it into Thomas's hollow needle (Fig. 73, *b*), introduced from without through the hole and then withdrawn with the wire. For drilling the bones, Thomas uses a watchmaker's bow-drill, and does not find anæsthesia necessary. The cure is complete in five or six weeks; pseudarthrosis is rare.

FIG. 73



a, twister; *b*, hollow needle. After Thomas.

FIG. 74.



Fracture of jaw, wired after second method. After Thomas.

The discharge into the mouth from compound fracture is often very unpleasant, and the breath offensive. Frequent washing with dilute Condy's fluid or chlorate of potash, or alum lotion, gives relief; and iodoform may be applied with a brush.

Abscesses not unfrequently form at or near the fractured points, often with necrosis. They should be opened early to prevent burrowing under the fascia and down the neck. Loose portions of bone should be removed when they are quite detached.

The patient for the first fortnight must be fed entirely with broth, gruel, bread-pap, etc.

FRACTURE OF THE CLAVICLE is generally oblique, and *caused* by indirect violence, falls on the hand and shoulder; but sometimes it results from direct violence, especially toward the acromial end, and is then usually transverse; muscular action is a rare cause. In children it is frequently *incomplete*. It may be *situated* at any point; but is most common toward the outer end of the middle third, next toward the acromial end, rarely in the sternal third.

SYMPTOMS.—The clavicle holds the scapula out from the trunk, and the upper limb is slung to its outer end by the coraco-acromial ligaments. When the bone breaks about its middle, the whole shoulder falls somewhat, and the point of the shoulder (acromial end of outer fragment) turns forward and inward, so that the distance from the sternum to the acromion is less than on the sound side. The patient cannot lift the arm, but supports it at the elbow with the other hand. The outer end of the inner fragment remains fixed by the sterno-mastoid and rhomboid ligaments; it may project beneath the skin owing to marked falling of the outer fragment. The ordinary signs of fracture are present.

When the fracture is *between the coraco-acromial ligaments*, there may be but little deformity, and often little or no crepitus; but when *external to the ligaments*, deformity is usually marked, the outer end of the acromial fragment turning till it points directly forwards.

The fracture is rarely comminuted, double, compound, or complicated, except from gunshot injury. The complications include a few cases of injury to the subclavian artery, resulting, after a few weeks, in the formation of an aneurism; compression or wound of the subclavian, internal jugular or other large vein by a displaced fragment, in either case perhaps leading to gangrene, and in the latter characterized by great extravasation into the connective tissue of the neck; laceration of, or pressure on, the brachial plexus, causing paralysis (p. 44), usually partial and temporary, and emphysema, perhaps with hæmoptysis from wound of the lung. It is difficult during life to exclude the coexistence of a fractured first rib and wound of the lung by it. These complications are almost always due to direct violence, and often to gunshot injury.

TREATMENT OF SIMPLE FRACTURE.—The object is to keep the shoulder drawn outwards, backwards, and upwards; correction is sometimes needed chiefly in one of these directions. The clavicle is so superficial that very slight displacement or a small amount of callus constitutes a deformity. When it is very important to avoid this, the patient should be kept for one month lying flat on her back on a firm mattress, with the *elbow* fixed to the side and the head slightly raised by a pillow which must not extend down to the shoulders; she may be turned slightly towards the *sound* side. Union being tolerably firm, the patient may be allowed to get up, wearing some apparatus for one to two weeks. Union is complete in three to six weeks, and is almost always bony.

Ordinarily, the best method is by *Sayre's strapping*. Cut two strips of stout strapping, each 3½ inches wide or less, and long enough for the following purposes. Wrap the upper arm on the injured side in boracic lint wider than the strapping. Stitch or pin one end of the first strap round the arm, just below the axilla; now heat the strapping, and seizing both shoulders strongly draw back their points, whilst an assistant carries the strapping across the back towards the sound side, then across the front of the chest and between the elbow and the side round again to the back, where the end is fastened by a stitch to the first part of the strap. By this strap the elbow should be drawn back somewhat *behind* the shoulder. The second strap starts from the front of the sound shoulder, crosses its *point*, and runs obliquely down across the back to the point of the elbow; it then ascends in front of the forearm and hand laid flat upon the chest, to the point of the shoulder, and ends behind it; by traction on this strap after it has passed the elbow the latter is first raised and then drawn forwards, the loop of the first strap acting as a fulcrum and the shoulder passing back as the elbow comes towards the front. A third wide strap is sometimes applied round the forearm, elbow, and trunk; it keeps the hand from working out, and is therefore useful in children, but must not be drawn tight, as it tends to drive the shoulder towards the mid-line. The strapping may not need reapplying for one to three weeks. It sometimes irritates and brings out a crop of boils;

FIG. 75.

Bandage for fractured clavicle.

FIG. 76.

"Three-handkerchief" treatment of fractured clavicle.

intertrigo in the fold of the elbow may be prevented by the free use of boracic ointment.

When strapping is not to be had, several turns of bandage may be made to represent each strap.

Treatment by *figure-8 bandage* and a thick wedge-shaped pad in the axilla is shown in Fig. 75. Place the pad with its thick end upwards in the axilla; draw back the shoulders by the figure-8 bandage; lever out the shoulder by a few horizontal turns round the elbow, and raise the shoulder well by a sling taking the elbow and forearm. Objections to it are that the pad if effectively used causes dangerous pressure on the axillary vein; and that the figure-8 bandage presses directly on the fractured bone. The latter objection applies also to the *three-handkerchief plan* (Fig. 76); two are looped round the shoulders and tied behind, leaving one end of the knot longer than the other. The long ends are then passed across the back and under the opposite loop, and finally tied together, forcibly drawing the shoulders backwards toward each other. The third forms a sling to support the elbow and forearm and bind them to the side.

Many kinds of apparatus have been devised for fractured clavicle; but no matter which is used, the patient should be told that slight irregularity will probably remain; it is often great in complicated fractures.

Cases of willow fracture should be put up in Sayre's strapping; the traction of this will considerably reduce deformity when this is present, and the fracture not seen till a week or so has elapsed.

FRACTURES OF THE SCAPULA.—The *body* of this bone may be broken across, comminuted, or starred, by great *direct* violence; one case is known due to muscular action (*Ranking's Abstract*, vol. ii. p. 194). The *symptoms* are great *pain* in moving the shoulder; *crepitus* detected by placing one hand flat on the surface, and moving the arm up and down pump-handle-wise; *abnormal mobility* upon grasping the lower angle and the upper part of the bone; and often some *irregularity* from displacement can be felt in comparison with the sound bone. Compound fractures are generally from bullets, etc. Bony union occurs in four to six weeks, sometimes with much displacement; movements good.

TREATMENT.—Immobilize the scapula by a large pad and broad flannel bandage, fixing also the arm to the side; or strapping may be used to fix the scapula. Treat compound fractures as directed on p. 238.

FRACTURE OF THE NECK OF THE SCAPULA, detaching the coracoid process and glenoid cavity, or the latter alone, from the rest of the bone, is so rare that its existence has been doubted;[1] it is due to falls or blows on the shoulder.

The *symptoms* are the following: The shoulder sunk, arm lengthened, acromion usually prominent, deltoid flattened; the head of the humerus with the fragment may be felt in the axilla; the deformity is easily removed by pushing up the arm, when crepitus will probably be detected. Crepitus may be felt also on pressing the coracoid process, situate deeply below the clavicle, beneath the margin of the deltoid; but the line of fracture may run external to this process. Crepitus, easy reduction of deformity (although with great pain), and the ready occurrence of redisplacement, are the chief points of *diagnosis* between this accident and dislocation; whilst the fact that the head can be felt to accompany the shaft in all its movements negatives fracture of the neck. Bony union should occur in four to seven weeks, with good movement.

TREATMENT.—Sayre's strapping, as for the clavicle. Sir A. Cooper recommended the bandage shown at Fig. 73 with a smaller pad. To obtain elevation, the starched figure-8 bandage, mentioned under "Fracture of the Acromion," is useful.

FRACTURE OF THE ACROMION is common, and generally occurs through its tip in front of the acromio-clavicular joint; less often through its base; up to twenty-five the epiphysis generally separates. Some cases of supposed fracture at the base are really cases of non-ossification of the epiphysis. This fracture may be due to direct or indirect violence; rarely to muscular action.

SYMPTOMS.—Flattening of the shoulder and more or less inability to abduct the arm, both most marked when the fracture is through the base; irregularity in the line of the spine; abnormal mobility, easy removal of deformity, and perhaps crepitus on pushing up the arm.

TREATMENT.—The object is to keep the head of the humerus pushed up against the acromion; this is done by means of a figure-8 bandage, the upper

[1] See a case by Mr. May, of Reading, Med. Gaz., Oct. 8, 1842. Mr. Wormald possessed a specimen, now in the Museum of St. Bartholomew's Hospital.

loop of which passes under the opposite axilla, crossing over a pad placed at the root of the neck on the injured side, while the lower loop passes down the back and under the elbow, bent at a right angle across the chest. Three or four of the concluding turns of the bandage are to be taken round the body, arm, and hand horizontally; it is well to use fixed dressings. Union is usually ligamentous, owing to the difficulty of keeping the parts in strict apposition.

Fracture of the Coracoid Process is rare; *caused* by blows on the front of the shoulder, usually inflicting much other damage; sometimes by muscular action.

Symptoms.—The patient is unable without great pain to execute the motions performed by the biceps and coraco-brachialis—that is, to bring the arm upward, inward, and forward; and motion and crepitus of the detached process may be felt by seizing and moving the tip or pressing upon it whilst the patient moves his shoulder. Thickness of fat or muscle, or swelling, renders the diagnosis very difficult. Union is fibrous, and may stretch considerably.

Treatment.—The humerus may be brought forward and inward, to relax the biceps and coraco-brachialis, and confined to the trunk, with the forearm bent over the chest; but simple fixation of the arm to the side gives almost as good a result.

Fractures of the Upper Extremity of the Humerus may run (1) through the anatomical neck, (2) through the line of junction of the epiphysis, (3) through the surgical neck, (4) the great tuberosity may be detached, (5) one and three may be complicated by dislocation of the head.

(1) Fracture through the Anatomical Neck—*i. e.*, within the capsule—is very rare, known to occur only in advanced life, due to direct violence, and difficult of diagnosis as there is little displacement. But, more often, the line of fracture leaves the anatomical neck, and runs *through the tuberosities* (one or both). There may be *comminution* from driving of the head into the cancellous tissue of the upper end of the shaft, one or both tubercles being split off; the head may be *impacted* in this position.

Signs.—Impairment of motion and crepitus are the most reliable signs (R. W. Smith); shortening is slight, not exceeding half an inch, and there may be hard swelling anteriorly due to the upper end of the lower fragment displaced (1) by force applied to the outer aspect of the shoulder, and (2) drawn up and in by muscles.

When the fracture is *impacted*, we rely chiefly on deformity. The arm is slightly shortened, the acromion projects more than usual, the shoulder has lost to a certain extent its roundness. In consequence of splitting off of the tuberosity crepitus may often be obtained when the shoulder is grasped with moderate firmness and the arm rotated. The head cannot be felt in the axilla, nor can the finger be pressed in beneath the acromion toward the glenoid fossa; passive movements are usually free, but painful.

If the impaction is not firm, the deltoid may draw the shaft upward and considerably increase the shortening during the first weeks of treatment (Hutchinson, *Med. Times and Gaz.*, 1866, vol. i. p. 247).

(2) Fracture at the Line of Junction of the Epiphysis.—The epiphysis includes the head and both tuberosities, and usually unites at twenty. This fracture is fairly common. Many cases have resulted from fracture by the finger in the axilla during labor, others from falls or violent pulls up and out upon the arms of children; later it is usually due to great and direct violence.

Signs.—The head of the bone can be felt in the glenoid cavity (by which sign this accident is distinguished from dislocation); it remains motionless when the elbow is rotated, and is sometimes so displaced by the scapular muscles that its lower surface looks forward and outward; the fingers cannot be pressed in toward the glenoid fossa, immediately beneath the acromion, but they enter a depression about 1½ inches lower down; there is a striking and abrupt projection beneath the coracoid process, caused by the upper extremity of the shaft of the bone drawn in by the muscles constituting the folds of the axilla. It is rounded, smooth, and slightly convex, not with the sharp irregular margin of ordinary fracture. Slight extension from the elbow draws the lower fragment into its natural place and crepitus may be obtained; but the bone immediately projects again when extension is discontinued; the axis of the arm is directed downward, outward, and backward, the elbow being a little from the side; shortening is considerable.

(3) Fracture of the Surgical Neck—*i. e.*, of the bone between the epiphysial line and the insertions of the pectoralis, teres major, and latissimus (Fig. 77)—is by far the commonest fracture of this part of the bone; it occurs at all ages, and may be caused either by direct or indirect violence. The signs are those of the preceding variety, but crepitus is rougher; the lower fragment often lies more deeply in the axilla, and causes more pain by pressure of its sharp end upon the brachial plexus; much swelling from extravasation is common.

Fig. 77.

Fracture of the surgical neck of the humerus, united.

The lower fragment may be *impacted* into the cancellous tissue of the upper, rendering the diagnosis much more difficult. The signs are slight shortening, (half an inch or so), some deformity, and perhaps crepitus if the head be grasped firmly whilst the arm is rotated, pain at a part not directly injured, and loss of power. Serious injury of the large vessels and nerves from this fracture is almost unknown. It is rarely compound, unless due to gunshot.

(4) Fracture of the Greater Tuberosity is caused by blows or falls on the shoulder, by violent action of the scapular muscles, or the process is left behind in dislocation of the head.

Signs.—Increased breadth of the injured joint; the head and neck of the bone are drawn forward and inward by the axillary muscles, whilst the separated tuberosity is drawn outward by the supra- and infra-spinatus and teres minor; a groove may be felt between the tuberosity and the head of the bone, the latter moves with the shaft, and crepitus is obtained if the fragments are pressed together; the whole limb can be moved in any direction by the surgeon, but active rotation out is quite lost.

Mode of Union.—All the preceding fractures usually unite firmly by bone, even fracture of the anatomical neck; for, though this fracture would seem likely to deprive the head of the bone of vascular connection, some ligamentous bands, sufficient to prevent this, usually remain untorn; in cases of impaction there is no difficulty. The patient should be informed that some deformity and loss of motion are likely to remain, though time and use will go far to restore the latter; also that growth may be impaired after separation of the epiphysis. Repair occurs chiefly from the lower fragment, and callus is often excessive. Even should the head remain loose, there is no ground for the belief that it will necessarily necrose and cause suppuration.

The time required for union varies from four to eight weeks.

Fractures of the Cervix Humeri with Dislocation of the Head.—All the above fractures must be diagnosed from dislocation; especially fracture through the surgical neck, in which we find shortening, an abnormal bony mass moving with the shaft lying in the axilla, and the elbow thrown out from the side. The diagnosis rests first upon the demonstration of the presence of the head in the glenoid fossa, and secondly upon the discovery of abnormal mobility in the length of the bone. In some rare cases, however, it is found that the shoulder is flattened, the deltoid tense, the acromion sharply felt, and the fingers sink in immediately beneath it, showing that the head is absent from its normal place. It is felt in the axilla, but does not move with the shaft, and crepitus is obtained here; the signs indicate that dislocation and fracture coexist.

TREATMENT.—In intracapsular and impacted fractures there is little to be done beyond fixing the arm to the side and treating extravasation; until this has almost or quite subsided, the patient should remain in bed.

In fractures of the surgical neck, swelling often prevents the attainment of knowledge as to the position of the upper fragment. Till swelling has subsided the limb may be comfortably arranged upon a pillow and fixed by sand-bags or weight extension to prevent shortening. Then the limb may be put up in splints. If extension has to be maintained the fingers and hand must be well bandaged; an inside angular splint reaching to the level of the fracture must be fixed to the forearm and arm, and a nicely moulded shoulder-cap of sole-leather, stout gutta-percha, or plaster of Paris reaching down to the outer condyle must be well fastened upon the shoulder by a spica. The arm is to be secured to the side, and a small sling, *supporting only the hand*, worn. Later on, the shoulder-cap alone, fixed by a starched or plaster bandage, will suffice.

When the upper fragment is abducted, Moore recommends abduction of the arm, with extension, until the fragments interlock; then bring the limb carefully to the side. Sometimes it is necessary to keep the arm abducted, the patient remaining in bed; this may be done by weight extension or by a splint like an L turned upside down (Tyrrell). This is the method for treatment of fracture of the great tuberosity.

Marked displacement inward of the lower fragment is met by a pad in the axilla.

Erichsen recommends for some cases a very simple splint consisting of a strip of leather six inches wide and two feet long, half of which is bandaged to the trunk and half to the arm, whilst the rounded bend fits closely into the axilla.

After five or six weeks the patient may swing the arm gently to and fro, gradually bringing it into use.

In FRACTURES WITH DISLOCATION an attempt should be made *at once*, under *complete anæsthesia*, to push the head back into the socket, by placing the fingers upon it and the thumbs upon the acromion. Failing this, some have permitted union to take place, and then six or twelve weeks later have tried to reduce, often without success. The best results seem to have followed the pushing of the lower fragment up into the glenoid fossa, the head being left alone.

FRACTURES OF THE SHAFT OF THE HUMERUS are often at once recognizable by deformity, shortening, helplessness, and crepitus; but in more or less transverse fractures from slight violence, especially in children, some care in examination is necessary. When the fracture is between the pectoralis major and the deltoid, the upper fragment is drawn in, and the lower upward outside it; when below the deltoid, the muscle drags the upper fragment out and the long arm muscles pull the inner fragment up inside the outer.

Complications are bruising, with consequent thrombosis, or rupture of the brachial vessels, and pressure upon or laceration of a nerve. Involvement of the musculo-spiral in callus occasionally occurs.

Treatment.—Two to four short splints of Gooch's material placed round the limb and buckled on above and below the fracture. If extension is required, replace one of these splints by an external angular. Firm pressure above will, of course, necessitate bandaging all distal parts. A sling supporting only the hand must be worn (Fig. 78). After a few days an immovable splint (plaster) may be applied.

Fractures above the middle are best treated like those of the surgical neck.

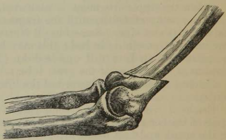
In the absence of pulse at the wrist, apply no bandage lest gangrene occur and be attributed to it; raise the limb slightly on pillows.

Fracture of the Lower Extremity of the Humerus presents many varieties. 1. A transverse or oblique fracture above the condyles (*supracondyloid*). The radius, ulna, and lower fragment are drawn up and back (Fig. 79), the triceps is tense, and the olecranon projects as in dislocation backwards of both forearm bones. The deformity is, as a rule, easily reduced with crepitus, but returns immediately. The relation of the two epicondyles to the olecranon is normal, measurements from the acromion to the outer epicondyle

Fig. 78.

Treatment of fracture of shaft of humerus.

Fig. 79.



Oblique transverse fracture above the condyles, lower fragment displaced backwards.

are a little short, but those from the epicondyles to the styloid processes are normal. The fingers cannot be pressed into the great sigmoid notch of the ulna, nor can the pit on the head of the radius be felt. 2. *Detachment of the lower epiphysial cartilage*, including the radio-ulnar surface and both epicondyles (though the internal ossifies and unites separately at eighteen), presents the same symptoms. Either this or the above fracture is very common in children; opportunities of direct examination of the bones are very rare. 3. There is a T-*fracture:* in addition to the above a fissure runs down through the articular end, separating it into outer and inner pieces, between which crepitus may be obtained. 4. The *capitellum* (Fig. 80) or the *trochlea* may be broken off with an epicondyle; the latter involves displacement backward of the ulna and often of the radius also. 5. Either *epicondyle* may be detached; pain and crepitus during pronation or supination are localized to their vicinity, and a bit of bone may sometimes be grasped and moved; the joint is not implicated.

Treatment.—Swelling is often too great to permit of an accurate diagnosis. The limb may then be placed upon an inside L splint, with the joint exposed for treatment. Usually one or two lateral L splints are used later, the joint being fixed at or a little over a right angle; sometimes a posterior gutter-splint of plaster or poroplastic acts best; again an anterior L splint. Fixed apparatus is not suitable for the immediate treatment, especially in children. It is often very difficult to keep the fragments in position by means of splints, and the patient should be warned that impaired movement is likely to result. After the third week, when the splints are changed, it is well very carefully to perform the movements of the elbow and radio-ulnar joints three or four times, and, so far as is possible, without causing pain. After the fifth week splints can generally be removed, and passive and active movement must be freely used. J. Hutchinson recommends extreme flexion as the position most likely to prevent displacement in supracondyloid fractures. Fractures of the epicondyles give but little trouble.

It has been recommended to treat fractures separating the trochlea only in the straight position, putting up the limb in a moulded posterior splint, and

FIG. 80.

Lines of fracture in the humerus, of the surgical neck, of the middle of the shaft, and of the internal condyle, passing into the joint.

FIG. 81.

Fracture of olecranon, with ligamentous union. St. Mary's Hospital Museum.

paying particular attention to the preservation of the obtuse angle which the limb naturally forms outward; when this is the same as on the sound side, it is held that the fragment must be in position.

FRACTURES OF THE FOREARM.—*Fracture of the olecranon* is usually due to direct force, rarely to violent action of the triceps; in the former case there may be much bruising and swelling.

SIGNS.—Flexion of the elbow is easy or possible, but *active* extension is impossible, and attempts at it are to be discouraged. The fracture is usually transverse, passing into the joint through the narrowest part of the process (Fig. 81). A transverse gap is felt in the bone here, just perceptible or wide enough to let the thumb sink in. Greater separation than this is usually prevented by untorn aponeuroses and ligaments. Sometimes the fracture is "starred," and there is no displacement. The distal fragment is occasionally forced through the skin, or this is perforated by the original violence.

TREATMENT.—If great swelling is present subdue it whilst the limb lies comfortably upon a pillow; if there is any possibility of the skin sloughing, put up the part antiseptically.

French surgeons treat this injury with the elbow bent to prevent ankylosis, a possible but very rare occurrence. In a perfectly straight position the lower fragment is apt to push the olecranon out of its fossa on the humerus. The best way of treating it is to use a straight anterior splint padded thickly opposite the joint, to give a slight bend, and secured by plaster bandages, in which a window over the elbow may be cut on the third day to see how the fragments are lying. The splint should reach from the level of the axilla to the wrist. When necessary an attempt may be made to bring down the upper fragment by long strips of strapping applied obliquely round the splint and arm, beginning half-way up the triceps and reaching down to the fragment; this may be renewed from time to time. Passive movement may be employed in three to four weeks, the finger pressing the olecranon toward the shaft as the elbow is bent.

Malgaigne's hooks have been used in this fracture, but antiseptic wire is certainly preferable, and in cases of compound fracture use should be made of the wound to unite the bones by suture. Passive movement may then be employed after a week.

Usually short fibrous union is obtained (Fig. 81), bony union being rare. The arm is strong and movements of the joint good or perfect. This may be the case even with a longish bond of union, but generally weakness or uselessness of the limb goes with this. It is right then to open the joint, remove the fibrous tissue between the fragments, and wire them together, allowing the suture to remain in.

Fracture of the coronoid process has very rarely been demonstrated, but may be more frequent than is generally believed. Experiments show that it is often broken by blows on the palm with the elbow bent and fixed, less often with the elbow straight. Malgaigne found the fracture frequently in backward dislocations which he had produced. Muscular action may be a cause, as when the process was torn off in a boy of eight who was hanging by one hand from the top of a wall (Liston).

FIG. 82.

Sling for fractured forearm. Supports the whole arm from elbow to fingers.

SIGNS.—These are said to be dislocation of the ulna or both bones backward, easy reduction and easy reproduction, crepitus, and the presence of a small hard movable body in the fold of the elbow.

TREATMENT.—An angular splint and sling. Union will probably be ligamentous.

FRACTURE OF THE SHAFTS OF THE RADIUS AND ULNA.—Both these bones may be broken or only one. In the former case all the signs of fracture, especially deformity and abnormal mobility, are strongly marked. When the radius is broken below the tubercle, the hand is almost always pronated, because it is cut off from the supinator brevis and biceps, but passive supination is easy; also the pronator quadratus always tends to approximate the lower ends of the bones, especially if both are broken and low down. When only one bone is cracked through with but little displacement, it may be impossible to make a positive diagnosis: slight swelling and irregularity, pain and tenderness at a point not struck, the pain being elicited not only by direct pressure but by movement of the part and by pressing the bones together at a distance, and perhaps crepitus, are chiefly to be relied on.

Treatment.—Prepare two splints of wood one inch wider than the widest part of the forearm, one to reach from the outer epicondyle to the knuckles, the other from the inner epicondyle to the wrist. Reduce any deformity by extension between the wrist and elbow, and then, the elbow being bent, apply the splints to the forearm held midway between pronation and supination (with the thumb uppermost), and fasten them firmly on with straps or buckles; next bandage the hand to the back splint and the two splints to each other, and place the forearm in a sling (Fig. 82). The fingers may be moved daily to prevent matting of their tendons. Union is generally complete in four to six weeks.

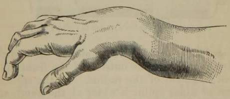
Non-union is not very rare. Sometimes *formation of callus is excessive;* it spreads across the inter-osseous space and unites one bone to the other, thus destroying the all-important movements of pronation and supination. When this has happened in cases of simple uncomplicated fractures, courts have regarded it as due to malpractice, and have given damages against the surgeon. To prevent it, some surgeons pad the splints thickly along the middle; but if they are firmly applied with ordinary padding the muscles will be pressed in between the bones. Wide splints are important to prevent pressure of the bones toward each other by the bandage in crossing from one splint to the other. In cases of comminuted or multiple fracture, the difficulties of treatment are much increased, and no action would lie on the ground of imperfect success.

The fingers must be carefully watched; in no other part has gangrene occurred so frequently, either from swelling beneath a bandage directly applied, from immovable splints, or from inflammation usually resulting from injured soft parts.

Colles' fracture is a *fracture of the lower end of the radius* half to one inch above the wrist, either transverse or rather oblique upward and backward; the lower fragment is sometimes displaced bodily backward to a greater or less extent, less often it turns on its anterior margin as upon a hinge, the posterior margin of the upper fragment penetrating the cancellous tissue of the lower for perhaps half an inch; the upper fragment may remain firmly impacted in the lower, and the latter may be split into several pieces. Usually the styloid process is carried *outward* as well as backward. The styloid process or lower end of the ulna is sometimes broken also (Fig. 83).

The fracture may occur at any age, but is exceedingly common among

Fig. 83.



Fracture of the lower end of radius and ulna, from Dr. Smith on "Fractures."

old women, being due in them to falls and slight violence. Up to twenty the epiphysis may separate. It will be seen, upon consideration of the position of the radius (running downward, forward, and inward) in ordinary falls upon the hands, that if the force running along it be resolved into vertical and horizontal components, the former will tend to tear off the lower end of the radius to displace it backward and forward and somewhat outward in most cases, the lower end of the fragment being chiefly acted upon. The radial extensors and extensors of the thumb maintain the deformity.

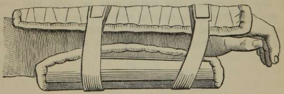
That this is the mechanism of the displacement seems to be shown by the fact that a few cases are recorded of falls on the *back* of the hand resulting in a similar fracture, but with displacement forward of the lower fragment and reversal of the clinical signs.

Signs.—The appearance is very characteristic. When the part is examined from the radial side (Fig. 83), it has much the appearance of a silver fork (Velpeau). Opposite the radio-carpal joint, behind, is a rounded prominence formed by the lower end of the radius and the carpus, and a little higher up (one inch or so) there is a marked angular depression. Opposite the latter, or rather a little lower down on the palmar aspect, is a sharpish prominence, the lower end of the upper fragment, covered by muscles. The hand is usually a little abducted, the extensors of the thumb tense, and the styloid process of the ulna prominent on the inner side; the latter may be dislocated from the carpus or even forced through the skin. The deformity may be easily reduced with marked crepitus, or reduction may be quite impossible; when effected, it may be permanent, or the deformity may return at once. The styloid process of the radius moves with the carpus, and, unless broken. constantly preserves its normal relations to it; in dislocation it does not do so. The backward dislocation of the carpus may be accompanied by chipping of the posterior border of the lower end of the radius.

Treatment.—Impaction, when present, should be undone, if possible, by strong traction on the hand and direct pressure forward on the fragment.

In the absence of better means, cases may be treated with the splints mentioned in the last section—the back splint being thickly padded *up to* the fracture to press the lower fragment and hand forward, the anterior splint being thickly padded below and reaching only *down to* the fracture. With strapping, the hand may be fixed in a position of adduction to the back splint. When all tendency to swelling has subsided, a plaster gauntlet, leaving fingers and thumb free, and running well up the forearm, will give

Fig. 84.



Application of Gordon's splints to Colles's fracture.

a good result. Gordon, of Belfast, recommends the addition of a rounded, tapering, projecting margin to the outside of the front splint, to be applied against the everted fragment of the radius. In the splints which go by his name, the posterior or ulnar splint is wider at the hand, and provided with a flange piece on which the inner border of the hand rests (Fig. 84).

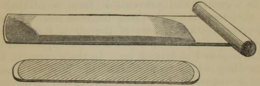
The great difficulty in all cases, especially in the old and rheumatic, is to prevent stiffness of the fingers and wrist; the fingers should be liberated as soon as possible, and the wrist may be cautiously moved after three to five weeks, according to age, etc. The patient should be informed that stiffness will last some months, and that recovery may not be perfect.

The use of Carr's splint (Fig. 85) reduces these evils to a minimum, and the simple act of grasping the bar reduces the deformity in unimpacted cases, its direction being more oblique than the line of the heads of the metacarpals to which it corresponds. A small dorsal splint is also used, and for the first four days the fingers may require to be fixed over the bar by the bandage. After a week they and the thumb are left free.

FRACTURES OF THE HAND.—The *carpal bones* are rarely fractured without a severe smash, and excision, or, in some cases, even amputation, entire or partial, may be necessary, though this should be avoided, if possible. Fracture of the *metacarpal bones*, or of the *phalanges*, will be readily recognized. The former usually form a prominence posteriorly when broken, owing to the preponderating action of the anterior muscles. With respect to compound fracture of these parts, no part of the hand should be amputated unless positively necessary, and even one finger, and especially the thumb and forefinger, should be saved, if it can be done.

TREATMENT.—For fracture of the carpus simply immobilize the wrist. For those of the middle metacarpal bones, make the patient grasp a ball of tow or some other soft substance, and bind his hand over it with a stump

FIG. 85.



Carr's splints for a left Colles's fracture.

bandage; but for fracture of the lateral metacarpal bones, support the hand on a firm wooden splint, cut into the shape of the thumb and fingers. If only one finger be fractured, fix it by a thin wooden splint long enough to reach from the wrist to the end of the finger, with the upper or palmar part broader than the lower. It must be remembered that the palmar surfaces of the metacarpals and phalanges are concave, so the splints will require suitable padding. Plaster of Paris and gutta-percha are very useful in these fractures.

FRACTURE OF THE RIBS is very common after twenty, under puberty extremely rare. In two cases, eighteen and twenty-four years old, 60–100 Kgr. pressed the sternum back to the spine without causing fracture. It is generally due to *direct* violence, when the tendency is to displacement *inward* of the fragments, and the *depression* may remain ; not uncommonly it is caused by *indirect* force, as when the thorax is violently squeezed from before back, the fracture being often bilateral, and usually situate an inch or two from the sternal end. Sometimes, and usually in the aged, one or more ribs are broken by violent coughing. (Malgaigne, quoted in *Brit. and For. Med. Rev.*, vol. vii. p. 554.)

The middle ribs break most often, the first rarely, the twelfth very rarely. These fractures may be incomplete or complete, simple or compound (through the skin or lungs), single or multiple, complicated in many ways, but comminution is generally due to gunshot injury. Several ribs, perhaps the majority on each side, may be broken.

SIGNS.—Fixed, lancinating pain, aggravated by inspiration, coughing, and all movements of the chest, and induced by pressure on the rib at a distance from the painful point; this is especially valuable when the point has not been directly injured.

Crepitus is often felt during inspiration by the hand placed flat on the painful spot, or heard here with a stethoscope, but care must be taken not to mistake pleuritic friction for crepitus. The patient often describes the "click;" pressure on the anterior end of the rib may elicit it, or alternate pressure on either side of the fracture; much fat or muscle (*e. g.*, near the spine) necessarily obscures the sign. The latter manipulations may reveal *abnormal mobility*, but often this cannot be detected, and actual falling in of the side is rare, even when several ribs are broken in two places. There may be great *dyspnœa* in this case. Exact diagnosis is not of much consequence, for in all cases of pain on inspiration after a blow on the chest the treatment is the same.

Emphysema, or presence of air in the cellular tissue, is a not infrequent complication of this fracture. The air forms a soft, diffuse swelling that crepitates characteristically, disperses on pressure, but does not pit; it may be limited to the region of the wound, or extend over the whole body, rendering the patient absolutely unrecognizable from swelling, though such extreme emphysema is very rare. It is thus produced : the broken bone pierces both layers of the pleura and wounds the lung. In cases of large wound in the lung, air now enters the pleura at each inspiration, but in expiration the soft lung tissue falls together and prevents it from reëntering the lung. A pneumothorax therefore forms, the lung becomes more or less rapidly compressed, and at each expiration some of the air is forced from the pleura through the wound in its parietal layer into the superficial cellular tissue. But little force is required to drive it on. In these cases, in addition to the subcutaneous swelling which may conceal the physical signs of pneumothorax, dyspnœa increases until asphyxia may ensue. Much more commonly the emphysema is limited to the vicinity of the fracture, and there is no pneumothorax; this has generally been explained by supposing that the pleura was not really opened by the wound, the lung being here adherent to the chest wall; but it is certain that in many cases no adhesion exists, yet the lung does not separate from the chest wall.

Slight *hœmoptysis*, lasting perhaps two or three days, is common, the blood coming from bruised or torn lung. Slight *hœmothorax* also is frequent, the blood being mixed with serous effusion, and forming six or eight ounces of purple fluid containing no clot; it comes from small vessels of the lung and pleura. Very rarely main intercostal vessels are torn, the hemorrhage being large or even fatal.

Cases are recorded in which a broken rib has wounded not only the lung, but the heart, or even the diaphragm and some abdominal viscera; they are very rare.

In simple fractures a pleuritic rub may be heard a few days after the injury in its neighborhood, but serious inflammation of pleura, or lung, or suppuration of the fracture is rare. After fractures of several ribs, and especially in the old and feeble, there is a great tendency to hypostatic congestion and pneumonia; in them, too, bronchitis often appears, or becomes much worse after this accident.

Union takes three to four weeks; is almost always bony, the callus forming in large amount sometimes uniting adjacent ribs; and cartilage is usually found in the callus before ossification.

TREATMENT.—Much relief is usually given by bandaging the thorax firmly, during expiration, with a broad flannel roller, kept up by shoulder straps. A piece of stout strapping passing once and a half round the body also answers well. A less perfect mode of fixing the fragments is to strap the injured side with three-inch strapping, passing well beyond the mid-line in front and behind, and fixed during expiration. Some patients find all bandages intolerable, especially those in whom the fragments have been driven inwards by direct force; they do well when simply kept in bed. If a fragment is markedly depressed, and apparently the cause of pain or of hemorrhage, Malgaigne's suggestion—to pass a sharp hook cautiously round its upper border and elevate it—might be acted on.

Ordinarily emphysema and hæmothorax require no treatment. Air deposits all solid particles before it reaches the finer bronchi; its presence in the tissues or over an effusion in the pleura therefore causes no decomposition. But should the lung be so compressed by air as to threaten asphyxia, a free opening must be made into the pleura; compression by fluid, on the other hand, may be relieved by aspiration.

Some surgeons still treat early severe pain and dyspnœa in the strong and healthy by bleeding to six to eight ounces. In the bronchitic or emphysematous apply no bandage; use turpentine and simple stupes early, and give the mist. ammon. carb. F. 141. Severe cases are almost always most comfortable when well raised on a bed-rest; a bed-pull, or something high up to hold, often affords relief.

Fractures of Costal Cartilages are not uncommon; the eighth is that most often broken, near the bony rib, and almost always the outer is displaced in front of the inner fragment. Complications are rare.

Fractures of the Sternum are rare, and due to direct violence or indirect, as when the body is strongly bent backward or forward. It has occurred during straining in parturition. Frequently it accompanies other and severe injuries. Compound fracture, except from gunshot, is almost unknown. The line of fracture may take any direction, but is usually roughly transverse; if there is any displacement, the lower fragment overlaps the upper.

Treatment as for fractured ribs.

Fractures of the Pelvis are generally due to very great violence, either direct or indirect; very rarely to muscular action. They are best divided into two classes, according as they do or do not break the pelvic ring. The former are by far the more serious. Sometimes the articulations are torn open; especially the symphysis from direct violence, forcible abduction of the thighs, or the wedge action of the fœtal head, chiefly in primiparæ. These injuries may be combined with fractures, which are more common. The horizontal pubic ramus and the pubic arch may be broken through on one (Fig. 86) or both sides; or this anterior fracture is accompanied by another line passing behind the acetabulum, through the sacroiliac joint or through the lateral mass of the sacrum (*double vertical fracture*). In another well-marked variety the head of the femur is driven against, fissures, and perhaps forces in the acetabulum, being itself driven into the pelvis. The hip bone may be separated into its original three component parts. In the second class we find transverse fractures of the broad part of the ilium, of the crest, of the anterior spine, of the ischium (very rare), and transverse fractures of the sacrum or coccyx. Premature ossification of the coccyx to the sacrum predisposes it to fracture during labor, and also from falls, kicks, etc.

Fig. 86.

Fractured hip bone. St. Mary's Museum.

Signs.—Fissures, neither breaking the continuity of the ring nor separating a fragment, cannot be diagnosed. Fractures of the second class are usually accompanied by displacement and all the ordinary signs of fracture, but are sometimes detected only by careful examination of the outline of the bone traced through the skin, the rectum, or the vagina. When one hip bone is detached as a whole, it is usually drawn up, so that the lower limb seems shortened, but the relation of the trochanter to the anterior spine is normal. In the double vertical fracture, displacement of the fragment often causes widening of the distance between the crests, diminution of that between the tubera ischii. Whenever the ring of the pelvis is broken, there is inability to stand, owing partly to pain, partly to sense of great lack of support.

When the head of the femur is driven into the pelvis, the injury may easily be mistaken for fracture of the cervix femoris. For the cause is similar, the limb is helpless and usually everted, deep crepitus is obtained, and the trochanter rotates in a small arc; but shortening is slight or absent, though the violence has been great enough to cause an extracapsular fracture; the hip is markedly flattened, and a finger in the rectum or vagina feels the projection into the pelvic wall. It very rarely happens that both acetabulum and cervix femoris are fractured.

Complications.—It is these which render pelvic fractures so dangerous; even severe uncomplicated fractures are usually recovered from, though the shock is often marked. The complications are: 1, rupture of the urethra, generally in the membranous, but sometimes in the bulbous portion by a displaced pubic fragment, or by the fracturing force; 2, rupture of the bladder usually by the original violence; 3, laceration of the rectum in fractures of the sacrum and coccyx; 4, laceration of the iliac arteries or veins, chiefly in double vertical fractures; 5, suppuration in the pelvic areolar tissue occasionally occurs.

Treatment.—First, in all injuries to the lower part of the abdomen, or which may have caused fracture of the pelvis, pass a scrupulously clean catheter to ascertain the state of the urethra and bladder. If blood or bloody urine has escaped from the urethra, attention will of course be drawn to the part. In this case, a soft catheter should be tied in, and the bladder kept constantly drained; but if no instrument can be passed on account of rupture of the urethra, anticipate extravasation of urine by opening the perineum freely upon the end of the catheter, and endeavor to find the proximal end of the urethra and to pass a catheter along it into the bladder Treat them as after external urethrotomy.

When the urethra is sound, but the bladder ruptured, the catheter enters easily. A fragment generally pierces the bladder on its non-peritoneal surface, but a blow over the distended organ causes it to burst where it is covered by peritoneum. Gunshot may of course wound it anywhere. The object of treatment is to prevent escape of urine into the peritoneum or connective tissue. Some rely upon constant drainage through a large catheter. Gouley and Mason recommend a free lateral cystotomy, a tube being introduced through the wound into the bladder, or even into the peritoneum for a short time. Willett and C. Heath have opened the abdomen and sewn up rents in the peritoneal surface, the patients dying. The operation is difficult, the space obtainable between the recti of a strong man being small. The simple catheter usually fails; more experience is required to decide between the alternative operations.

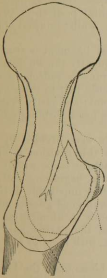
The next care is to immobilize the fragments with a firm bandage or broad belt round the pelvis, the knees being tied together; or, better, with a double spica of plaster strengthened by strips of wood or tin. The patient should lie on a thin mattress placed on planks. The following means of raising the patient to change clothes, attend to back, use bed-pan, etc., will be very useful. Have a stout rectangular wooden frame made, three feet wide and a little longer than the patient, with numerous hooks along the outer surfaces of its side; on to these are fastened by eyelets or cords bands of broad webbing or of stout calico. The ends of two ropes, each nine feet long, are fastened to the corners. The patient is placed upon the bands, and when it is desired to raise him, the ropes are hooked on to one of two pulleys, the mate of which is fastened to the ceiling or to a special frame over the centre of the frame. Any one band may be removed at will.

Much difficulty has been experienced in preventing displacement forward of the fragment in fractures of the sacrum and coccyx. This has been done by plugging the rectum with a tampon through which a tube is passed for the escape of flatus; it is removed for defecation, and replaced until displacement ceases to recur. The bowels should act easily.

In fractures breaking the pelvic ring, at least eight weeks should elapse before the patient stands.

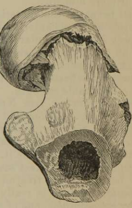
Fractures of the Femur.—These are very important, frequently laming the patient, and not uncommonly bringing disgrace upon the surgeon. The primary varieties are: (1) fractures of the neck; (2) oblique fracture through the great trochanter; (3) separation of the great trochanter; (4) fractures of the shaft; (5) intercondyloid fractures.

Fig. 87.



Section through head, neck, and trochanter of femur (Bigelow). The dotted lines are added to show the movement of the trochanter round the anterior intertrochanteric line in fracture of the base of the neck.

Fig. 88.



Impacted fracture of the neck of femur into the head; from Bigelow's "The Hip."

Anatomy of the Neck.—If a horizontal section be made through the head, neck, and trochanter (Fig. 87), it will be seen that near the head the anterior and posterior layers of cervical compact tissue are about equally strong; further out the posterior gets thin and is continued beneath the cancellous ridge of the posterior intertrochanteric line, but does not reach the outer wall of the trochanter, whilst the anterior becomes thicker until the anterior intertrochanteric line, which is entirely compact tissue, is reached. In blows upon the trochanter, tending to drive it in towards the head, this strong anterior layer resists impaction; it usually cracks more or less vertically, and acts as a hinge round which the shaft rotates as the posterior part of the neck is driven into the hinder part of the great trochanter (Fig. 87); or, if the fracture occurs nearer the head, as the hinder part of the neck is driven into the head (Fig. 88), the foot being *everted* in either case. Impaction of the base of the neck into the cancellous tissue frequently results in fissuring or comminution of the whole trochanteric region; the fragments may hold together, the trochanter being split and widened, or they may all be loose and detached. This action of blows received at right angles to the hip or in front of the mid-line is aided by the oblique position of the neck running outward and backward from the head. After mid-life all bones undergo atrophy, not diminishing in size, but becoming lighter from enlargement of cancellous and Haversian spaces and formation of fat in them. The neck of the femur is especially affected, in women more severely than men, which explains the great frequency of fracture of the neck of the femur in women over fifty. It is usually said that, as a result of this change, the angle between the shaft and neck diminishes in the aged until it becomes even acute. But Rodit found the average angle in the child and adult to be 131°, in the aged 128°—a difference too trifling to have much effect. The extremes met with were 121° and 144° (Tillaux, *Anat. Topographique*, 1882, p. 957), and there can be no doubt that a horizontal position of the neck renders fractures from indirect violence more easy, whilst unusual obliquity renders it more difficult.

It must be noted that anteriorly the ileo-femoral ligament is attached to the anterior intertrochanteric line, and that consequently the whole neck on this aspect is intracapsular; the synovial membrane is reflected from the capsule on to the neck considerably higher up, so only half to three-quarters of an inch of the neck is really in the cavity of the joint; and lastly, many capsular fibres are reflected along the neck toward the head, forming *retinacula* of very considerable strength.

(1) Fractures of the Neck of the Femur were divided by Sir A. Cooper into *intracapsular* and *extracapsular;* but this division is of little value, for it is scarcely possible for a cervical fracture to be wholly extracapsular, and many of them take an oblique course, beginning well within the joint and ending outside it. Moreover, it is often impossible during life to be certain as to the exact seat of a fracture, though good guesses may frequently be made; for treatment an exact diagnosis is unimportant. By *intracapsular* fracture is really meant a fracture of the narrow part of the neck; by *extracapsular*, one of the base of the neck, with more or less impaction into the trochanter.

Fractures of the neck may be caused by direct blows upon the hip, or by indirect violence along the femur; they may occur at any age and in either sex. After fifty, and especially in women, atrophy of the neck may be so marked that slight and indirect violence—such as missing a step, slipping off a curb, stumbling, or even turning in bed—may be sufficient to break it; it then yields usually at its narrowest part (intracapsular) near the head. Fractures about the base of the neck (extracapsular) are generally due to great and direct violence, and are consequently most often met with among laboring men, from falls in the hunting field, etc.; but they occur also in the aged when exposed to proportionately great violence. Sometimes direct violence causes an intracapsular fracture in people under middle age. In the rare fractures of the neck of the femur which occur before twenty, it becomes a question whether the case is not one of separation of the epiphysis of the head. Some twenty cases in which this diagnosis was made are on record, and one was proved by autopsy.

SIGNS.—The patient complains of more or less *pain* about the hip, increased by motion. In cases due to direct violence there are often great *swelling* and *bruising* about the hip, with more or less shock; but in those from indirect force, there is no immediate bruising and little swelling; in the latter, after three or four days a patch of bruising sometimes appears in Scarpa's space. Unless swollen by hemorrhage, the *hip is usually flattened* from driving in of the trochanter. When the base of the neck is driven into the trochanter, the latter is generally split and widened or comminuted, and this may be felt before swelling comes on or after it has subsided. In the great majority of cases the limb is more or less completely *everted* (Fig. 89), and it is always *shortened*, the amount of shortening varying greatly. *Crepitus* is often obtainable upon reducing the shortening by extension and rotating the limb; it is most easily obtained in fractures wholly within the joint, but in some cases (firm impaction) it is impossible, by justifiable force, either to reduce the shortening or to obtain any crepitus, or more than a click or two; much manipulation is worse than inexact diagnosis. In cases of impaction it will be found also that the toes on the injured side *cannot be inverted* like those on the sound side. The *arc of rotation* of the trochanter lessens as its radius is shortened by fracture or impaction of the neck; but the sign is difficult to make out except in unimpacted fractures of the base, in which rotation occurs round the axis of the shaft of the femur. The limb is perfectly *helpless*, as a rule, and the heel cannot be raised from the bed; sometimes the knee can be raised and the heel drawn up, and in not a few cases the patients have walked considerable distances, the fractures having been intracapsular or firmly impacted.

FIG. 89.

Fracture of the neck of the thigh bone within the capsule, showing shortening and eversion of the leg and foot. After Sir A. Cooper.

The *amount of shortening* varies from a fraction of an inch to two or three inches; it is least when the fracture consists of a slight impaction of the neck into the head or the great trochanter, greatest when the trochanteric region is comminuted by impaction of the neck, the capsular insertion torn, and the shaft left free to be acted upon by all the muscles passing from the pelvis to the lower limb; the fracturing force also may have driven it upward. In fractures of the narrow part of the neck, the periosteum and retinacula may remain in great part untorn, and the displacement is proportionately slight; so long as the capsule is attached to the outer fragment the displacement can hardly exceed one and a quarter inches, and interlocking of the surfaces may keep it under half an inch. In these cases, however, it is not uncommon for the shortening to increase considerably during the first week or so, owing to undoing of impaction or interlocking, or to rupture by muscular action, manipulation, or an attempt to walk, of bands softened by inflammation; whilst in fractures toward the base of the neck, the shortening usually reaches its maximum at once. It is said that *gradual* shortening of one to two inches during the six months following the injury may result from interstitial absorption of the neck.

There are several methods of ascertaining the amount of shortening. In all the patient should be lying *with the limbs symmetrically placed.* The easiest plan is to bring the limbs together in the mid-line, and see if the internal malleoli are on the same level, making sure also that there is no tilting of the pelvis—*i. e.*, that the anterior iliac spines are in the same horizontal plane. Greater accuracy is attained by measuring from the anterior spines to the internal or external malleoli. To prove that the *neck* is broken, it is necessary to show that the trochanter has risen toward the iliac crest. Simple vertical measurement from the crest to the trochanter will not do, as the latter has been driven back toward a higher part of the crest as well as upward. Nélaton's line, from the anterior spine to the most prominent point (vague) of the tuber ischii, normally touches the top of the trochanter when the thigh is neither ad- nor abducted. But the most accurate method is by means of Bryant's triangle: a vertical is dropped from the anterior spine, and from this the distance to the trochanter is measured upon each side; rotation in or out is measured by the base line from the spine to the trochanter.

Eversion has been explained above; when the fragments are loose, the foot naturally rotates out. *Inversion* sometimes occurs instead of eversion. In unimpacted fractures it may be accidental, and the foot is easily made to roll out; but when it is fixed it is probably due to an unusual direction of the fracturing force—*e. g.*, to a fall on the hinder part of the hip with the foot inverted. In some cases it has been impossible to undo this deformity by such force as could be safely used.

Diagnosis.—The possibility of shortening from *previous injury* or from *rheumatoid arthritis*, upon which an injury to the hip has been superadded, must be remembered. A simple *severe contusion* sometimes causes complete eversion and helplessness of the limb, with a good deal of bruising and pain about the hip. Fracture will be eliminated by the absence of shortening and crepitus, and the possibility of effecting completely passive inversion. It is said that gradual absorption of the neck of the femur may result from such injuries and give rise to actions for malpractice. The defence must rest upon the absence of signs of fracture, and reference to cases in which absorption is said to have occurred.[1] From *dislocation on to the pubes* cervical fractures with eversion are distinguished by the absence of swelling due to the displaced head, and by signs of fracture—crepitus, abnormal mobility; fractures with inversion differ similarly from *dorsal dislocations*. The diagnosis from *fracture of the acetabulum* with entry of the femoral head into the pelvis is best made by absence of all irregularity of the inner surface of the pelvis upon examination by rectum.

As to the *diagnosis* between *intracapsular* (narrow part of neck) and *extracapsular* (base of neck) fractures, a positive diagnosis of an extracapsular injury is possible only in cases in which great immediate shortening, comminution of the great trochanter, rotation of the trochanter upon the axis of the shaft, or the presence of a distinct bony mass in the outer part of Scarpa's space (the angle formed by bending of the neck), is present. When the swelling has subsided, the trochanter will be found thickened by external

[1] Smith, op. cit.; Canton, On Interstitial Absorption of the Neck of the Femur from Bruise, etc., Med. Gaz., Aug. 11, 1848; Norris, Boston Med. and Surg. Journ., 1838, p. 368, mentions complete absorption of the humerus in a lad of eighteen, who broke the bone near the middle five weeks after a previous fracture at same spot; Agnew, Surgery, vol. i. p. 746, saw half the humerus disappear in eight years after a fracture.

callus and matting of soft parts in extracapsular fractures. Guesses as to the state of matters may be made on the following grounds:

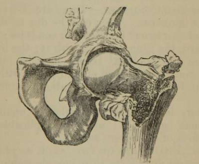
Extracapsular fracture is probable: from great, direct violence, indicated by bruising, swelling, and shock; in persons under fifty, and in strong and healthy men above that age; whenever the immediate shortening is over one inch.

Intracapsular fracture, on the other hand, generally results from slight and indirect violence, with slight local and general symptoms; in persons, especially women, over fifty; and the immediate shortening is usually about half an inch. There is no late or early thickening about the trochanter.

FIRMLY IMPACTED FRACTURES are indicated by shortening under one inch, retention of more or less power over the limb, and inability to invert completely; they generally result from direct violence. Enlargement of the trochanter shows the injury to have occurred at the base.

PROGNOSIS.—In the young, strong, and healthy, even severe injuries of this kind are generally recovered from; but in the aged, it is no uncommon thing for a fracture, due to slight violence only, to prove fatal, and usually by hypostatic pneumonia or bedsores, whilst more severe injuries kill by shock. As to the limb, it may be said that extracapsular fractures almost always unite by bone, and that the tendency to union of any kind diminishes as the head is approached, owing to the difficulty in obtaining and maintaining contact of the comparatively small broken surfaces, and to the very imperfect nourishment of the upper fragment. As a rule, intracapsular fractures do not unite at all, or there is loose fibrous union; sometimes it is

FIG. 90.



Oblique fracture through the trochanter major.

firm, very rarely bony. Impaction favors the latter. The head preserves its vitality perfectly, and when no union occurs, may become hollowed out and eburnated as a socket for the stump of a neck, which progressively atrophies. Lameness practically always results from these injuries, sometimes it is very great; the foot may be much everted, and the hip often remains sensitive and painful; in many cases the patient gets about well with a stick and a high sole. Bigelow figures a specimen of cervical fracture showing that the weight of the body may be borne in walking by the ileo-femoral ligament and the obturator internus, each hypertrophied.

(2) OBLIQUE FRACTURE THROUGH THE GREAT TROCHANTER (Fig. 90) may occur at any period of life, but is rare. The following signs have been described; eversion, about one and one-half inch shortening, and the shaft of the bone felt separated from and posterior to the trochanter, which is attached to the neck. This fracture unites readily by bone.

TREATMENT, that for fracture of the neck.

(3) Fracture of the Great Trochanter results from direct violence, and may occur before or after eighteen, at which age the epiphysis unites to the shaft. At first standing or walking may be little interfered with, but they soon become painful; there is no shortening, no crepitus, may be eversion, and the fragment has been felt loose. Union will be fibrous, and would probably occur best with the limb well abducted and rotated out.

(4) Fractures of the Shaft, (*a*) upper end, just below the Small Trochanter.—There is usually much deformity from tilting forward and outward of the upper fragment, the ilio-psoas causing its forward displacement, whilst the lower fragment is drawn up and back by the hamstrings and gluteus maximus.

(*b*) Middle Portion.—As the upper end is departed from, the tendency to displacement of it becomes less, but the action of the hamstrings and other long muscles is unimpaired; if the fragments are interlocked, an angle forward and outward usually forms; if longitudinal displacement is possible, shortening is marked.

(*c*) Lower End, Supracondyloid; and Separation of the Epiphysis, which unites at twenty-five. Sometimes there is little or no displacement; but shortening may arise in oblique fractures, or from impaction of the upper into the lower fragment. Rarely the lower fragment is flexed by the gastrocnemius upon the tibia. The latter displacement may be overlooked unless examined for, the results being non-union, great lack of steadiness, and annihilation of the movements of the knee, or sloughing of the skin over the point of the displaced bone. Ordinarily the fragments remain parallel, but the lower, together with the tibia, drops back and is drawn upward.

(5) Fractures of the Condyles.—There are T-fractures, like those of the lower end of the humerus. They may be due to direct violence or to driving of the shaft of the femur between the condyles; either condyle may be displaced backward, the tibia rotating with it; the upper fragment may penetrate the skin, or the popliteal vessels may be injured by the lower. Sometimes only one condyle is broken off and is but little displaced. Much effusion into the joint follows, rarely suppuration; stiffness is always likely to result.

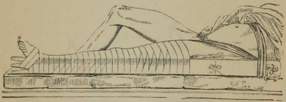
Treatment.—There is a very large number of methods by which fractures of the femur may be treated; some are applicable to fractures of one kind, others to fractures of a different sort.

In the treatment of Fractures of the Neck we must be careful not to do more harm than good by efforts to reduce shortening and eversion; in unimpacted fractures endeavors may be made in this direction. The object of treatment is to immobilize the fragments, and keep them in the closest possible contact until the strongest attainable union has occurred; but the occurrence of bedsores or of hypostatic pneumonia may, in the aged and feeble, render it necessary to get the patient up in some fixed apparatus one to two weeks after the accident—the preservation of life comes before the preservation of the function of a limb. In all cases of fracture of the femur the patient should lie on a thin mattress placed upon boards, that the pelvis may not sink into a hollow. A fracture bed (p. 260) is always useful.

The simplest and best plan of treatment for the aged is to place both limbs on a double inclined plane, made of pillows if the real thing is not at hand, and to tie them together at knee and ankle. If there is much tendency to shortening, extension may be made by fixing the limb upon a double inclined plane, so that the weight of the pelvis shall make more or less constant traction; or weight-extension from above the knee may be used, and long heavy sand-bags placed on each side of the limb. They must be frequently looked to, that eversion may not arise from their displacement. Syme placed a sheet over both limbs, not including the feet, and fastened it to the bedsides; over this he placed sand-bags as above. Some surgeons make extension by Liston's long splint (see below); it is most uncomfortable, the perineal band often causes sores, and elevation of the trunk is impossible. Where the latter is not desired, Desault's long splint and weight extension may be used. Lastly, extension may be made by oblique traction from a Smith's anterior splint or a Hodgen's splint fixed to the thigh; these are excellent.

Fractures of the Shaft are commonly treated by *Liston's long splint* (Fig. 91). It is a half-inch deal board four inches wide for an adult, narrower and lighter for a young person. It should reach from just below the axilla to five inches below the foot. At its upper end it has two holes, and at its lower end two deep notches. It must be well padded, and the perineal band is then put in place, its tapes being passed through the hole at the upper end of the splint. The dorsum of the foot being well padded, conveniently by having the splint pad long enough to turn in over it, the foot

Fig. 91.



Liston's long splint.

is fixed to the splint by a firm figure-8 bandage, the lower loops of which pass alternately through the anterior and posterior notches, the upper round the ankle and splint. The bandage being fixed, extension is made upon the foot and splint, till the length of the limb is satisfactory, and the perineal band is then tightened; thus counter-extension is maintained. The bandage is now carried up to the seat of fracture. A broad body bandage is next fixed to the splint above the hip, and carried behind the back and round the body firmly two or three times; this, and proper width of the splint, counteract its tendency to ride forward. Lastly, eversion is prevented by slipping the lower end of the splint into an interval between two rectangular brackets fixed to a narrow plank eighteen inches long, tied to the bed by a hole at each end.

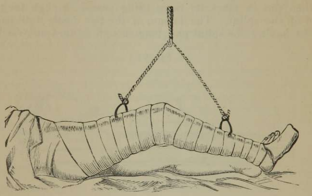
The whole apparatus is very uncomfortable; the perineal band galls, and tends to cause displacement of the upper fragment; the thigh bandage tends to draw the fragments out towards the splint; and it is difficult to keep the splint in place.

Sir W. Fergusson improved matters considerably by making counter-extension from a strong jean belt fitted accurately to the upper third of the opposite thigh; from this a band extends back and front to the upper end of the splint. This also draws the splint towards the body; but unfortunately the opposite thigh is not a fixed point.

Desault's original long splint is much better than Liston's modification. It is a plank of the above measurements used simply to prevent movement of the hip and knee and eversion of the limb. The fragments are kept in place by four short splints placed round the thigh and buckled to the limb above and below the fracture; weight extension is used if any is required and the limb is best fixed to the splint by means of a small sheet, fastened to the splint, carried beneath the limb and round again to the splint, drawn tight everywhere, and fixed with drawing-pins. In many cases short side splints, weight extension, and sand-bags, give an excellent result.

When the *fracture is high up*, and the upper fragment tilted forward, the lower fragment must be raised to its level by some kind of double inclined plane with extension. The ordinary double-inclined plane may be used, but is cumbersome and in the way. Nathan Smith's anterior splint (Fig. 92) is much better; it is made of bent telegraph wire, with cross-pieces opposite the leg and thigh, by means of which the limb is slung at the proper height, and extension is made by having the point of suspension beyond the foot, the bed being raised. The splint is fixed to the limb by a roller or by strips

FIG. 92.



Smith's anterior splint, from Hamilton's "Military Surgery," New York, 1865.

of bandage passing beneath it from bar to bar. Hodgen's splint is similar in principle, but the parallel bars run alongside the limb instead of in front of it. The foot is tied to the lower end of the splint by means of a stirrup, and the limb rests upon strips of bandage passed beneath it from bar to bar. Extension is made as with Smith's splint. Either of these splints permits the exposure of a posterior wound with the least possible disturbance. When this is not required, the ordinary MacIntyre splint bent to a suitable angle may be applied and slung.

When a Thomas's knee splint which fits moderately well is at hand, it is the most comfortable plan of treating fractures of the shaft of the femur in all but the youngest patients. Short splints are buckled round the thigh, and stout papers, like the *Field*, folded in four, make very good ones, requiring no padding. Extension, elastic or fixed, is easily made from the foot-piece, and the limb is supported by strips of bandage. The foot can be slung at any height to meet tilting of the upper fragment.

A fracture of the shaft in young children is very difficult to treat, on account of their small size and restlessness. In very young children no plan can compare with that used at Guy's, which may be called vertical extension. It is best made by means of a weight and stirrup running well on to the thigh; the block through which the cord runs is vertically above the hips, and the weight must be sufficient to maintain the length of the limb thoroughly. The child can then be lifted for purposes of cleanliness without any fear of displacement; or both legs may be rigidly tied to a crossbar, so that the pelvis is very slightly raised from the bed.

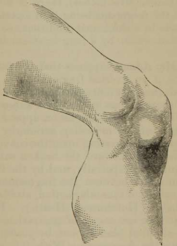
For children of four or five, Hamilton's double long splint, with a crossbar at the lower end, acts well. Both limbs are secured, short side splints, and weight extension if necessary, being used. The child can be lifted and turned at pleasure.

In supracondyloid fractures, in which the lower fragment is drawn strongly back into the ham by the gastrocnemius, the ordinary practice is to treat the fracture by some form of double inclined plane. The objection to this is that these fractures often implicate the joint, and, if ankylosis occurs, a flexed position of the knee will be most unfavorable. It is probably better to divide the tendo Achillis, and to use the long splint with weight extension, which treatment yielded good results in three cases (Treves, *British Medical Journal*, 1883, vol. i, p. 306).

Fractures of the femur are best kept in bed until there is no longer any tendency to displacement—*i. e.*, six, eight, or ten weeks. Even then it may be necessary to apply some supporting hip-splint of starch, plaster, or leather, and to sling the limb by a bandage passing round the neck and under the foot, whilst the patient gets about on crutches. Until there is no danger of shortening this sling should not be used. In old people and others whom it may be desirable to get out of bed before union has occurred, a Thomas's hip splint applied with plaster bandages will give the best result; the patient walks on a patten with crutches. If this cannot be obtained, the whole limb may be put up in starch or water-glass, finishing above with a hip spica; the splint must be strengthened round the hip with strips of mill-board, tin, etc.

Fracture of the Patella is of two kinds, according as it is caused: (1) by muscular action; (2) by direct violence.

Fig. 93.



An old fracture of the patella, with wide separation of the fragments. The patient fractured the bone twice. The first time he was treated with bandages, etc., to bring the broken parts together, and they united well. The second time the limb was laid in an easy position without bandages. The result is here shown; the upper fragment high up in front of the femur; the lower one down in front of the tibia; the power of extending the joint lost. When the knee is bent, as in the above cut, the condyles of the femur are seen with the skin tightly stretched over them.

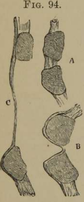
Fracture of the Patella by Muscular Action generally occurs thus: A person perhaps misses a step in going downstairs, or misses his footing after a leap, and makes a strong effort to save himself from falling; the knee is bent, and the patella lies on the convex surface of the condyles; the sudden contraction of the rectus snaps it across.

SIGNS.—The patient feels and often hears a sudden snap, falls to the ground, and has much difficulty in rising, being unable to straighten the knee. Once up and resting on the limb, the patient may discover that he can walk backward, dragging the injured limb back after the sound one. The surgeon finds the joint swelling from effusion of fluid, and it may become very tense; there is a transverse interval usually at or below the middle of the patella, varying in width from a just perceptible chink to a gap two or three inches wide, and increased by bending the knee.

MODE OF UNION.—After ordinary treatment by splints, bandages, etc., bony union is very rare; close fibrous—under half an inch—is perhaps the rule, but it may be long and weak from the first; in other cases, again, when, after six or eight months of treatment, the patient is allowed to bend his knee, an originally short fibrous bond stretches, the fragments separate more or less widely, power of straightening the knee, and of keeping it straight is, as a rule (to which there are few striking exceptions), proportionately lost, and the patient is lame and in constant danger of falling and of refracturing the patella, or of breaking the opposite one. In cases of refracture, the fibrous bond does not usually yield, but it tears off a fresh bit of bone, usually from the lower fragment.

Fig. 94, A, shows the fragments united by short fibrous union. In B the fragments are close together and equally everted; in C they are widely separate, and the lower only is everted. Mr. W. Adams has shown that in the cases in which patients recover with wide separation of the fragments (in some cases as much as four or five inches), there is no ligamentous union at all, the fragments being held together by the subcutaneous fascia in a thickened condition; so that what is commonly called union by a long ligament is in reality no union at all.

FIG. 94.



See Mr. W. Adams's paper in *Pathological Transactions*, vol. ii. p. 254.

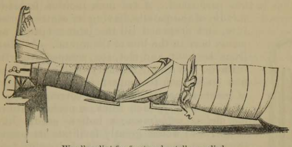
Mr. Adams supposes that the fascia adheres to the surface of an everted fragment as in C, or to both, as in B, and thus prevents further union. There are also cases of short fibrous union which subsequently stretch.

The causes of non-union appear to be separation of the fragments by muscular action, by effusion into the joint, and by their resting upon the convex surface of the femur, which tilts forward the broken surface of the lower fragment more especially, and by the intervention of clot and torn tissue between the fragments. Some surgeons deny the effect of muscular action, attributing the separation to effusion (Hutchinson, Heath). It seems fairly certain that both are causes of separation.

TREATMENT.—The simplest plan is, *first*, by *position*, to relax the muscles which tend to separate the fragments. With this view, raise the patient's body on a bed-rest to an angle of 45° with the bed, and the injured limb, straightened upon a well-padded back-splint, also to 45°; thus are relaxed the *rectus*, *crureus*, and *vasti*. *Secondly*, to bring the fractured surfaces into as close apposition as possible, it is necessary: first, to prevent effusion, or remove it if already present. It may be prevented by rolling elastic webbing round the joint, or by the immediate application of a plaster splint over wool, from the foot to the groin (C. Heath), and these also prevent tilting; it may be drawn off by aspiration, repeated if necessary, unless coagulation has occurred. In some cases separation is slight, and position and a simple splint are sufficient; in others much ingenuity is expended in endeavoring to draw the fragments together. A figure-8 bandage or strapping is the commonest plan, and is used with Wood's splint (Fig. 95), which is typical of many,

This is a straight light iron splint, provided with two movable hooks behind the knee. Over these the folds of a figure-8 bandage are passed, including

FIG. 95.



Wood's splint for fractured patella, applied.

in each opposite loop one of the broken fragments and drawing them together. In emergencies the same mechanical effect may be obtained by a straight broad splint of wood, well-padded, and placed behind the limb. Notches may be made with a saw in the edge of the splint at the proper place for fixing the figure-8 folds of bandage, or two stout nails or screws may be placed behind in the places of the hooks in Wood's splint.

Figure-8 straps and bandages applied only above and below the fragments tend to increase their eversion; pressure should therefore be made uniformly over the joint. It is doubtful whether figure-8 straps ever do much.

Very good results are obtained by the use of an immovable splint from the first, the patient being allowed after a week to go about on crutches with the limb slung.

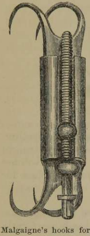
The apparatus should be worn for two months, and should then be changed for a leather knee-cap, preventing flexion, which must be worn for four months more; then the patient may begin to bend the knee. Sometimes movement is quickly recovered; at others there seems almost complete ankylosis. To remedy this an India-rubber accumulator may be worn constantly behind the knee; then, perhaps, the bond of union will stretch.

Thomas recommends the use of his knee-splint applied as usual, with extension; a piece of elastic webbing is sewn to the bandage round the leg, and then moderately stretched and stuck on to the skin of the thigh by lead-plaster on its under surface. Constant traction on the skin is thus obtained, and slight pressure on the fragments to prevent eversion. The patient walks about after the first few days. It must be worn, at least, nine months, and it may be two years before movement is restored to the joint; but Thomas does not interfere with nature.

Mechanically, the most effective instrument for treating fractured patella is Malgaigne's hooks (Fig 96). Two of these are fixed into the tendon at the upper edge of the bone, and two into the lower, and they can be brought and kept in apposition by the screw. If properly applied they *cannot* penetrate the bone nor wound the joint. They may be kept in six weeks to insure bony union. Malgaigne had treated (1853) about eleven patients, producing bony union, with no bad results. In several cases treated in the London hospitals, however, erysipelatous inflammation and burrowing of matter from the wounds have endangered both the limb and life of the patient after the use of Malgaigne's apparatus.

In view of the length of time occupied in the above treatment, and of the frequently unsatisfactory results, and of the dangers of Malgaigne's hooks as ordinarily used, Lister has proposed to treat recent fractures of the patella by opening the joint and *wiring the fragments* together (*British Medical Journal*, November 3, 1883), with the proviso that no one shall attempt the operation who does not feel certain that he will keep the wound aseptic. The operation is thus performed. A two-inch incision is made down the middle of the patella, having its centre opposite the fracture, and deepened till the joint is opened and the fragments bare in the line of the wound. All fluid is pressed from the joint, and clot, etc., scraped from the fractured surfaces. With an ordinary brad-awl oblique holes are now made from the superficial to the fractured surfaces at points as nearly as possible corresponding, and a piece of silver wire $\frac{1}{16}$ inch thick, is pushed into each hole *as the awl is withdrawn;* a hollow needle like Thomas's (Fig. 73, *b*) would greatly facilitate its passage through the second fragment. A pair of dressing forceps is next pushed from the deepest part of the joint on the outer side through to the skin, cut down upon, opened so as to tear a free passage, and then a short drainage tube is pulled into the joint as they are removed. The fragments are now drawn strongly together by pulling on the wire with sequestrum forceps, and the wire is then twisted through more than half a circle (Fig. 44), its ends cut short, and the two kooks hammered down. The skin wound is sewn up closely. Passive movement should be begun on the third day, and the patient may be discharged walking in six weeks.

FIG. 96.



Malgaigne's hooks for fractured patella.

The results of this operation will vary with the skill of the surgeon in the use of antiseptics. Of 20 completed cases collected by Turner (*Clin. Soc. Proc.*, 1883), union seemed bony in all but 1; movement was perfect or good, most of the patients being able to kick strongly, in 16, although 2 of these suppurated; in 1 union was fibrous; and in 3, more or less complete ankylosis resulted. One of the latter was again broken, the teguments also yielding, and the compound fracture required resection of the knee. A similar case of refracture has occurred. It is probable that imperfect apposition of the fragments caused weak union, hence the necessity for great care in bringing the fragments accurately together.

The dangers to life and limb, then, are at least as obvious as the advantages of the operation. Each surgeon must decide for himself whether and when he will undertake it, so much depends upon his general success in keeping wounds aseptic. We think that it should not be done in recent cases without strong special reasons; for even Lister cannot be *certain* of asepsis.

But in the treatment of old fractures with long union or none, and disabled limbs, all are agreed that the above operation is the proper treatment. In these cases it is sometimes extremely difficult to bring the fragments into contact; in one case they were left one inch apart after division of all strong tendons and bands around (Jordan Lloyd). Of 28 completed cases (Turner, *loc. cit.*), there were 2 deaths from pyæmia and acute septicæmia, the latter after amputation for acute suppuration in the joint; in 9 cases complete, and in 3 partial, ankylosis resulted, more or less suppuration occurring in all but

1 of each kind; in 1 the operation was abandoned, as the fragments could not be drawn together; in 1 the union was obviously fibrous, 1 broke again during passive movement, but was ultimately improved, and in 11 the result was good. All except those that died were benefited, as their joints were previously useless, but many were evidently in considerable danger. Doubtless the results will improve as surgeons become more experienced in antiseptic treatment.

If acute inflammation or suppuration occur during simple treatment or after wiring, employ the treatment for suppurative arthritis.

2. Fracture by Direct Violence is generally comminuted, rarely longitudinal. There is usually much inflammation, but not much separation of fragments; so that immobilization of the joint in the straight position, and relaxation of muscles, suffice until inflammation has been subdued. Then, if desirable, an immovable splint may be applied.

If there is any injury of the skin, render it aseptic, and wrap the joint in a large quantity of salicylic wool with uniform pressure.

3. Compound Fractures may be treated by wiring of the fragments, unless the other bones of the joint are comminuted, when excision will be necessary, or amputation if the soft parts are torn away or the popliteal vessels injured. If the facilities for antiseptic treatment are slight, and it is necessary that the patient should be transported any considerable distance, the surgeon will lean towards amputation rather than excision, where one or other is necessary.

Fractures of the Leg.—Both bones may be broken, or either tibia or fibula alone; the sound bone in the latter case acting as a splint, tending to prevent displacement of the fragments and rendering the diagnosis otherwise difficult. These injuries usually result from indirect violence, such as falls upon the feet, from which an oblique fracture of the tibia from behind downward and forward at about the junction of the lower and middle thirds (thinnest point) usually results; the fibula may yield at the same level or near its neck. In this ordinary fracture of the tibia the upper fragment is sharp and pointed, lies immediately beneath the skin, and is easily forced through it by attempts to stand, by the weight of the unsupported foot if the patient is carelessly lifted, or by action of the calf muscles. Hence *compound* fractures of the tibia are more frequent than of any other bone.

But fractures from direct violence are not uncommon, the bones breaking at the points affected, and the fracture of the tibia being more transverse and often comminuted; these injuries too are often compound, the skin being cut by the sharp crest of the tibia. When involving either end of the tibia they frequently extend into the joint.

The more transverse a fracture is, the less the displacement. The long calf muscles always tend to cause shortening by drawing the lower fragments up and back; in fractures of the tibia high up, the quadriceps extensor often seems to pull the upper fragment forward.

The diagnosis of fracture of both bones is usually easy; and the tibia, being subcutaneous, generally causes no difficulty—inability to stand, and some slight irregularity, localized pain, swelling, and tenderness being found at a point not directly injured even when the positive signs of fracture are slight. In the upper two-thirds of the fibula the diagnosis may be impossible; pain constantly referred to one spot when the bones are pressed together at a distance from that spot is very significant. The fibula breaks most commonly about three inches above the malleolus.

Treatment.—For mode of reducing displacement, if present, see p. 231. To guard against rotatory displacement, the rule is to *keep the ball of the great toe in line with the inner edge of the patella.* When a leg is extended, these two points and the anterior superior iliac spine are practically in line. Considerable care is required to guard against rotatory deformity with certain splints (Arnold, Macintyre), which, whilst they fix the foot, allow the femur and upper fragments to rotate out; the patient then recovers with the toes turned in, a much commoner deformity than the converse one. The ideal spint should allow the fragments to move together, but not separately.

There are many plans of treating these fractures, the most generally useful being the immovable splints, Cline's leg splints, Macintyre's and Arnold's splints.

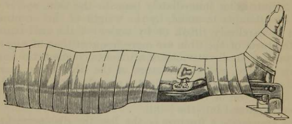
Whenever it is deemed safe to put a fracture of the leg up in plaster at once, there can be no better treatment; if swelling is at all feared, raise the foot well, or employ even vertical suspension for twenty-four to forty-eight hours.

When this is not desirable, fractures below the middle of the leg are generally best treated by buckling two Cline's splints (each with a foot-piece) firmly to the limb, whilst it is held in good position, and then applying a bandage which can be removed without disturbing the fracture. The limb may be slung in a Salter's cradle, or, if there is much difficulty in preventing upward and backward displacement of the lower fragment, it may be laid upon its outer side with the hip and knee fully bent, and the knee supported by a pillow if necessary. The patient soon gets used to the position, which relaxes the calf muscles.

In *fractures above the middle of the leg* it is necessary to control the thigh, the upper fragment not giving sufficient hold for the splints. This is done by Macintyre's and Arnold's splints. The hip should be flexed and the knee straightened as much as possible to relax the quadriceps extensor.

Macintyre's splint is very useful in cases where displacement is reduced by keeping the knee at a certain angle, for its angle can be varied at will. It is straight, and only part of the thigh-piece is shown in Fig. 97. One must

Fig. 97.



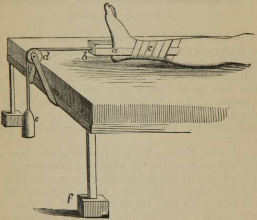
Macintyre's splint.

be chosen in which the foot-piece is not driven by the leg to the end of the slots in which it runs. Then the foot should be sewn into a close-fitting flannel sock having tapes attached to the plantar surface of the heel; these are tied to a button on the under surface of the foot-piece, and suspend the foot to it at a proper height without making any special pressure on the heel. Next fix the foot firmly to the foot-piece by strapping. Now adjust the angle of the splint, see that there is no rotatory displacement, and bandage from above the fracture up to the top of the splint. Having thus obtained a fixed point, such extension as may be necessary is made by dragging the foot and foot-piece downward, and then fixing the latter by screwing up the screws upon which it runs in the slots. Lastly, a figure-8 bandage round the foot and ankle, reaching up to the fracture, is applied. The splint is intended to be fixed to a block of wood; but this should never be done. It should always be slung to allow the foot to rotate out with the femur. Macintyre's was formerly a favorite splint for the treatment of compound fractures; the wound was left exposed, and endeavors were made to prevent the pads from becoming soaked with putrid discharge.

Arnold's splint consists of a flat iron foot-piece and back splint bent to about 160 degrees opposite the knee. The limb is fixed to this (properly padded), and then a padded wooden splint is buckled on each side of the leg. The apparatus is slung by two straps passing through slits in cross-pieces attached to the back splint, and through similar slits in the cradle. Friction prevents the splint from turning, the foot remains vertical, and the femur and upper fragment rotate out within the bandage. This splint should therefore be slung with the toes pointing a little outward, as in sleep.

In the United States fractures of the leg are usually treated by Dr. Buck's method, the *American stirrup* (Fig. 98). This consists of a broad strip of

FIG. 98.



Weight extension by the American stirrup.

strong adhesive plaster, attached by its ends to the sides of the leg below the fracture, leaving a long loop, *a*, below the heel. The ends of plaster are fastened to the leg by imbricated cross strips, *c*, and the sides of the loop are prevented from pinching the sole by a piece of wood, *b*, wider than the malleoli. To the centre of the piece of wood is fastened a cord, which passes over a pulley, *d*, fastened to the foot of the bed at the proper level. Extension is made by a weight, *e*, sufficient to neutralize the action of the muscles. Counter-extension is provided for by raising the lower part of the bedstead, *f*, on wood-blocks. Coaptation splints (Cline's) are also used to the fractured part, when the fracture is oblique.

Fractures of the fibula generally require six, of the tibia seven, and of both bones eight weeks to unite. When a joint is involved, *passive movement* should be begun in the fourth or fifth week, and the joint should always be treated in that position which will be most advantageous should ankylosis result.

FRACTURES IN THE VICINITY OF THE ANKLE are of several kinds. (1) Simple fracture of the fibula three inches or less up. (2) Ditto with fracture of the internal malleolus or rupture of the internal lateral ligament of the ankle. (3) Fracture of the lower ends of the leg-bones with fissure into the ankle-joint, and sometimes driving up of the astragalus between the malleoli, causing characteristic widening of the part. (4) Fracture of both malleoli with displacement of the foot backward. The second variety is that known as Pott's fracture; it results from violent twists outward of the foot. The foot is usually everted, sometimes extremely so, and sometimes it is also displaced backward. Cases have occurred in which these displacements, especially the latter, could not be overcome, even under chloroform and after section of the tendo Achillis.

All these injuries are best treated by Cline's splints or plaster of Paris. In extreme eversion Dupuytren's splint (Fig. 99) is sometimes used. It is a

Fig. 99.

Dupuytren's splint applied.

straight plank padded so thickly opposite the lower half of the leg—*down to the internal malleolus*—that the foot cannot be dragged in to touch the wood. It is fixed *above* first; then the foot is drawn in by a figure-8 bandage.

Compound Fractures of the leg are treated on the principles laid down at p. 238. The best splints are Cline's, one or two, outside the dressings, where the discharge is likely to be free; Arnold's splint when the fracture is high up; and a fenestrated immovable splint (p. 233) as soon as possible in all cases, and from the first in cases neither due to great violence nor largely compound.

Fractures of the Foot.—Simple fractures are rare, generally due to falls on the feet, and most commonly affect the calcaneum. If the tuberosity is torn off and drawn up by the calf muscles, the treatment is complete flexion of the knee and extension of the ankle as for ruptured tendo Achillis. A fragment of the astragalus may be thrown out of its place forward or backward and to either side; if irreducible, antiseptic excision will be necessary. Usually in these cases there is little displacement, and immovable splints fulfil all requirements. Metatarsal bones are sometimes broken by direct violence. Compound fractures are usually attended by so much damage to soft parts that amputation is necessary. When in any doubt put the part up antiseptically and wait: always save as much as is possible, especially the heel and ball of the great toe.

CHAPTER XXVI.

DISEASES OF BONE.

Atrophy of the Bones is marked by diminution in weight, the size, as a rule, remaining unaltered. The bone may be reduced to a thin shell of compact tissue and the cancelli to fine threads, the meshes between which are filled with fat. The *causes* are: 1. Disuse, atrophy being extreme in the tarsus, for example, in old-standing cases of knee-joint disease; and this atrophy must be remembered when undertaking the reduction of old dislocations. 2. Old age; the long bones suffer chiefly. 3. Pressure, seen in the effect of chronic hydrocephalus upon the skull bones and of aneurisms and tumors pressing upon but not invading the substance of bones. In all these cases Wagner states that absorption is effected, as in normal growth, by myeloplaques. 4. It occurs in some forms of mental disease and especially in general paralysis. Sometimes *fragilitas ossium* occurs in people otherwise apparently healthy, and it may run in families.

Hypertrophy of Bones is occasionally met with as a congenital defect, or as the result of hyperæmia of the part, from the existence of a large ulcer, of inflammatory disease near the epiphysis, etc. Most cases of enlarged bones are distinctly due to inflammation.

Arrest of Growth must be distinguished from atrophy. It occurs especially in parts the seat of spinal paralysis before growth is complete, also in cases of disuse. Early ossification of the epiphyses after dislocation, epiphysitis, or rickets has a like effect.

Neuralgia in Bone.—The bones, like other parts, are subject to that severe and continuous pain which is known by the name neuralgia. The patients are generally women; the part affected the condyles of the femur, or the head of the tibia or humerus. Deep-seated abscess, syphilitic or tubercular deposit, may be mistaken for neuralgia in bone. (See "Diseases of the Nerves.")

Inflammatory Processes in Bone. General Pathology.

A "bone" in the living body consists of compact and cancellous bony tissue, and is covered by the vascular periosteum, whilst its internal spaces are filled with yellow or red marrow, according to the particular bone and its age. Running through the bone are a number of fine channels, containing vessels and a little connective tissue running between the periosteum and the medulla. Each of the soft parts of a bone—periosteum and medulla—may be primarily and chiefly inflamed; but it must be remembered that very frequently *periostitis* and *osteomyelitis* occur together. The inflammation may be acute or chronic, and all degrees of the process are met with from the least to the most intense. The bony tissue takes no part in the process; it suffers only secondarily, and becomes either thickened, eroded, or dies. But it is the custom to speak of inflammation affecting the soft parts in Haversian canals or cancellous spaces as *ostitis*.

Periostitis is characterized by cell-exudation into the deeper layer of the periosteum, raising up the superficial fibrous layers and stretching them tight; at the same time the vessels entering the Haversian canals are more or less stretched and drawn out vertical to the bone surface. We now find upon the surface of the bone a low swelling usually called a *node*, dying away gradually at its edge, red or purple in color, and either soft and gelatinous or hard and fibrous in appearance, according as it consists largely of round cells or of spindle cells and fibrous tissue. The surface of the bone appears unchanged; the microscope shows cells invading the Haversian canals, but as yet little or no erosion has taken place. This is *simple periostitis*. The cell infiltration may rapidly or slowly break down into pus (*acute and chronic suppurative periostitis*), stripping up the periosteum more or less widely, and finally bursting through it at one or more points. In the *acute* case hard unaltered bone may be seen and felt through these apertures; it is white, all superficial vessels have been destroyed, but not necessarily dead. It necroses if the irritant has been so intense as to cause death of the vessels in the Haversian canals, so that circulation cannot soon be reëstablished. It is practically certain, however, that an intense irritant directly destroys the life of bone apart from its action through the circulation; for, in simple fractures, perfectly loose fragments do not die, and under aseptic conditions bone may be transplanted. *Total* necrosis is sure to occur if suppurative osteomyelitis and periostitis occur together. From periostitis alone the bone often does not die in its whole thickness; circulation is maintained in the deeper parts, and the superficial layer is ultimately thrown off by ulceration of the living bone where it joins the dead (p. 61). The dead fragment is called a *sequestrum*. This process generally occurs upon the shafts of long bones; it sometimes follows an injury or exposure to cold, and usually runs the course of a simple acute abscess, but there is an extremely acute form which is generally infective (*acute infective periostitis*).

In *chronic* suppurative periostitis, which usually occurs in connection with cancellous bone (vertebræ, tarsal or carpal bones, epiphyses of long bones), and secondarily to a focus of chronic suppurative osteomyelitis or chronic "ostitis," the bone bare at the bottom of the abscess is eroded and softened by the cell-growth of the primary inflammation. In long bones, however, erosion of the shaft, and in short bones of the surface, may start from beneath the periosteum, the young cells extending thence into the Haversian canals and widening them by ulceration. This process of ulceration of bone is called *caries*. It is usually *scrofulous*—tubercles being found in the periosteum and also in the spongy granulation tissue which often springs up after the opening of the abscess—and occurs chiefly in the young. A *syphilitic* caries is also well known.

There is a chronic suppurative periostitis met with especially about the phalanges of strumous children, coupled, not with caries, but with superficial or total necrosis.

It is much more common for a periostitis to end in ossification—*osteoplastic periostitis*—than in suppuration. Bone may form early and rapidly round the bloodvessels running between the elevated periosteum and the Haversian canals; the little tubes of bone form continuations of the latter. Together they make up a mass of spongy bone, at first easily detached from the surface of the bone, and containing a highly vascular marrow in its, chiefly vertical, spaces; but as time goes on the line between new and old disappears, and very frequently the vascular spaces in both become abnormally filled up by osseous layers, and the bone proportionally dense (*sclerosed*). These periosteal deposits are called *osteophytes*; there may be a layer of uniform or varying thickness over the whole bone, or a ring round, or a patch upon one part, or osteophytes may assume sharp-pointed and prominent, or low rounded forms. Whenever a bone is found pathologically thickened, we know that the periosteum has been laying down bone.

Chronic irritation of slight intensity is required to cause this form, and syphilis frequently supplies it in cases of osteoplastic periostitis of single and of many bones; but often no cause can be discovered. Osteophytes are common around sequestra and carious foci, over abscesses in bone; and so-called "expansion" of bone, over cysts, tumors, and foci of chronic osteomyelitis, is due to continuous deposit of bone by the periosteum whilst the deeper parts are removed by the morbid process. Bone sometimes forms in tendons inserted into the inflamed parts, and sometimes loose plates appear in adjacent connective tissue.

Ostitis.—We have already said that the hard substance of bone takes no part in inflammation, but suffers only secondarily to the changes which occur in its soft parts; nevertheless the term is justified on the same grounds as myositis, neuritis.

Acute Ostitis accompanies acute periostitis or osteomyelitis, but there is no time for naked-eye change in the bone. Consequently, ostitis may be looked upon as a chronic process having two chief results—removal of bone, such as occurs physiologically in the formation of the medullary canal (*rarefying ostitis*), and the laying down of bone, as in the formation of compact tissue (*sclerosing ostitis*).

Rarefying Ostitis (inflammatory osteoporosis, caries) is due to erosion of bone by a round-celled exudation which replaces the marrow proper. A tarsal bone thus affected will have its spaces full of vascular, grayish, semi-translucent granulation tissue instead of the usual yellow marrow. Where erosion is proceeding, the bony laminæ show numerous small semicircular notches (*Howship's lacunæ*), and in many of these lie giant cells (*osteoclasts*). The inflammation may subside and the removal of bone be replaced by its formation, generally in excess of the normal, the result being sclerosis of the diseased part. But very commonly the cell-growth degenerates, breaks down into pus, or caseates and perhaps subsequently softens. Thus a chronic abscess forms, suppurative periostitis is either coincident or secondary, and when the skin bursts a soft ulcerating *carious* surface of bone is left bare (p. 278). The abscess may not burst, but may remain locked in the bone, exciting sclerosing ostitis and periostitis (*chronic abscess of bone*). Not infrequently the infiltrating cell-growth dies and caseates before the bony septa around which it lies are absorbed; their blood supply is cut off, and they too die and appear as sequestra in the pus of chronic abscesses. Sometimes a mass as large as a filbert may thus be killed (*caries necrotica*). The inflammation, however, by no means always runs these courses. For years it may go on eating away bone without the formation of any pus (*caries sicca, fungosa*); and the bone, unable to bear the weight thrown upon it, yields and deformity results. Ultimately recovery may occur by the process above mentioned. This is most often seen in the spine and epiphyses of long bones.

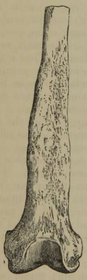
The *causes* of rarefying ostitis are many. This is the process by which the ends of broken bones are softened, melted together, as it were, and permanently united; it removes also exuberant callus; it is by a *caries simplex* that bone is removed under pressure from an aneurism; tumor, etc., or that a sequestrum is loosened. Syphilis commonly produces gummatous infiltration of the periosteum, and, starting thence, of the bone (ostitis), which assumes a worm-eaten appearance; after a time the vessels of the new growth become obliterated (p. 117), it caseates, suppuration follows, and a carious focus is left bare, often with sequestra adhering to it, as seen in syphilitic disease of the skull. Around it osteoplastic periostitis and sclerosing ostitis are generally marked. By far the greater number of cases of caries are those known as *scrofulous;* all those affections of the spine, carpus, tarsus, phalanges, and spongy ends of the long bones which are so common in children and young people. There is no longer any room for doubting that the great majority, if not all, of these cases are tubercular. Their microscopic anatomy (gray granulations being tolerably frequent), the frequent demonstration of *B. tuberculosis* in the granulation tissue and the inoculability of pus from it, the pathological course of the cell-growth, the clinical course of the disease, and especially the frequency of general tuberculosis among the causes of death, unite to make the demonstration complete.

Sclerosing or Condensing Ostitis corresponds to other "productive" inflammations; in bone the cell-growth ossifies. New bone is laid down by the medulla; Haversian, cancellous spaces, and medullary canal are more or less completely filled up, and the bone becomes solid, heavy, ivory-like, and frequently enlarged from coexisting osteoplastic periostitis (*hyperostosis eburnea*).

Its *cause*, like that of osteoplastic periostitis, is a chronic irritant of the lowest intensity. We find it round about a sequestrum, an abscess in bone, or a carious focus (though least commonly when this is tubercular). Some cases are due to syphilis; but it is often impossible to discover the cause, especially in cases where many bones are affected.

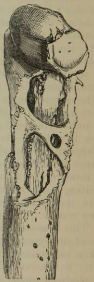
Osteomyelitis.—Having considered the chronic affections of the marrow under the varieties of ostitis, we have now to speak only of the acute inflammations, which may be *spontaneous* or *traumatic*. In *spontaneous diffuse osteo-*

Fig. 100.



The result of osteoplastic periostitis and sclerosing ostitis.

Fig. 101.



Necrosis of the humerus from acute infective osteomyelitis.

myelitis the medulla becomes at first intensely hyperæmic, then œdematous, swollen, and of purple color, often clotted with actual hemorrhages; on section the marrow projects above the level of the saw cut. Next yellow streaks and patches appear, so that the aspect is variegated—yellow, red, and purple; but distinct abscesses do not form, the suppuration being diffuse. The periosteum is always affected, and in many cases it appears to be the starting-point of the disease. The pus beneath it often contains globules of oil, forced out from the medulla. When suppuration occurs on both sides of a bone, it dies of necessity in its whole thickness; and there is great danger that it will die either superficially or centrally when pus forms on one or other surface as the result of so intense and acute an inflammation. The inflammation may remain fairly localized or may spread from end to end of the bone, causing separation of both its epiphyses and death of the whole shaft. Sometimes one or other joint suppurates.

Sometimes abscesses form in the soft parts around the bone. The veins leading from the bone are thrombosed, and in many cases contain clots undergoing puriform softening, having become infected from the abscess. It is thus that this disease is so frequently associated with secondary foci of suppuration in the viscera, serous cavities, etc.—complications which may appear before the skin is broken. The pus invariably contains micrococci, which have been cultivated, found to have a characteristic growth, and injected into animals without injurious effect until bones were broken or bruised, when suppurative osteomyelitis set in. In man a history of injury or cold is frequent. Some regard these cocci as not only the cause of the disease, but as organisms specific to the disease; others (Kocher, *D. Zeitschr. f. Chir.*, xi.) as organisms which would excite suppuration wherever they lodged.

The disease has occurred during many acute specific fevers, but whether or no from the action of the causes of these diseases is unknown.

Diffuse traumatic osteomyelitis starts from septic amputation, wounds, and compound fractures, the medulla being invaded by organisms from the wound (Klebs). The morbid appearances are much the same as those above given; but the periosteum is only slightly affected, the marrow projects from the end of the bone like a fungus, and becomes gangrenous, putrid, and discolored, whilst it is quite sweet in the spontaneous form. Embolic pyæmia and acute septicæmia are frequent complications. Severe compound contusions of bone may be followed by this disease. It may affect flat and short bones, as well as those of the limbs.

Traumatic osteomyelitis is not usually diffuse; it may be very limited, leading to the death of only a small portion of bone, such as the ring-shaped sequestrum which so often separates in septic stumps. Small sequestra, indeed, frequently form in aseptic stumps, the saw having, presumably, killed them directly.

We must now turn to the *clinical side of bone diseases.*

Acute Periostitis (p. 277).—There is usually a history of injury, exposure to cold, syphilis, or the patient is suffering from acute rheumatism or one of the acute specific fevers. It generally occurs on thinly covered bones, especially the tibia, ulna, clavicle.

The *symptoms* are more or less acute pain and tenderness, swelling fixed to the bone and dying gradually away at the edge, and the skin over it being but little affected. The ending is usually resolution; but the case may run on to suppuration, when the skin reddens and swells, the fever rises, and all the symptoms become more severe. The process is circumscribed, and necrosis is superficial, or does not occur.

Treatment.—Rest, elevation, belladonna, and fomentation in all acute cases; early incision if pus forms; iodide of potassium, if there is any history of syphilis, and anodynes for pain. In prolonged cases, marked by constant pain worse at night, a subcutaneous cut through the node down to the bone often gives great relief.

Chronic Osteoplastic Periostitis and Sclerosing Ostitis may result on the subsidence of an acute inflammation, or be due to syphilis, to the presence in the bone of a sequestrum, an abscess, or a carious focus, especially syphilitic. Sometimes many bones are affected, and without obvious cause; in children a suspicion of congenital syphilis will be justified. The *symptoms* are enlargement and weight of one or more long bones in whole or in part, with much aching pain, worse at night, and in damp, cold weather.

TREATMENT.—Iodide of potassium internally, and constant warmth locally, will usually relieve the nocturnal pain ; in tolerably recent cases counter-irritation may do good. Of course, any local disease will be looked for and treated, especially abscess. A linear cut into the bone with a Hey's saw frequently relieves the pain of chronic subcutaneous nodes; trephining is still more efficacious.

ACUTE PRIMARY INFECTIVE PERIOSTITIS AND OSTEOMYELITIS (Lücke). (Acute Necrosis, Typhus des Membres, Acute Necrosial Fever).—This disease affects long bones, usually those of the lower extremity and almost always occurs before the epiphyses are ossified. It often follows injury or exposure to cold, but these are only predisposing conditions; it is almost certainly due to the action of some generally infective organism—perhaps the micrococcus which has been isolated (p. 281.)

SYMPTOMS.—The patient is taken ill, usually suddenly, with high fever and perhaps a rigor and delirium ; there are severe pain and tenderness at the affected part, so that the limb may be quite helpless; after two, three, or more days, according as the disease begins in the periosteum or medulla, the part becomes œdematous and more or less reddened, varying with the depth of the bones. After some days crepitus may be obtained at one or both ends of the inflamed bone, indicating separation of the epiphysis; and the symptoms of fluid in a joint may be added. The fever continues very high; and at any time the rigors and metastatic inflammation of embolic pyæmia may set in.

The result may be death from septicæmia or pyæmia before or after the opening of the abscess; or, later, from hectic or some intercurrent disease. There is reason to believe from the early symptoms that some cases of this disease abort before suppuration occurs; and Beck says that those cases end in enormous thickening of the bone. In the great majority of cases abscess occurs and spreads rapidly until it is opened or bursts ; necrosis almost invariably results—total, superficial, or central ; and, as a rule, great and general thickening of the bone follows. Early ossification of the epiphysis is likely to occur if the part is separated, or the sequestrum approaches it nearly. If the epiphysis is uninjured, growth may be abnormally rapid under the stimulus of increased blood-supply.

TREATMENT.—At first, fever is the only symptom to treat. So soon as it is evident that deep-seated inflammation is its cause, foment assiduously. If the case gets worse, watch carefully for the earliest reddening or certain fluctuation, find the point of maximum tenderness and swelling, and make a free incision here under antiseptics right down to the bone. It is better to incise before pus is present than after it has bared the shaft from end to end. When the pus is evacuated, unless the patient is already suffering from pyæmia, the temperature falls considerably, but is usually some time in reaching normal. Separation of the sequestrum and thickening of the femur then proceed.

If one epiphysis is loose it should be kept in position by apparatus. Look to drainage, and await the separation of the sequestrum and the formation of a shell of new bone. If both epiphyses are loose, some surgeons still allow the shaft to remain as a spanner to keep them apart; but most surgeons remove it in one piece or after division with the chain shaw. Extension is kept up and the periosteum forms new bone.

The nature of fluid in a joint should be ascertained before anything is done; if it is pus, amputation is indicated.

Lastly, if symptoms of pyæmia set in, or if the patient is obviously losing ground, either after the opening of the abscess or later from suppuration, amputation should be done.

Diffuse Traumatic Osteomyelitis, such as results from septic amputations, resections of joints, contusions of bone, compound and especially gun-shot fractures, the general symptoms, pain, and swelling, are very similar, but the pus formed in the medullary canal escapes in quantity by the opening. The soft parts retract from bone which has necrosed, as is specially well seen in contused skull bones in which this process has arisen.

Treatment.—There are three methods : (1) In slight cases drainage and antiseptics may be employed, and the separation of the sequestrum awaited. (2) In severe cases the choice lies between amputation or reamputation at the joint above, and (3) removal of the whole of the marrow with a sharp spoon, and applying iodoform freely to the interior of the bone. If it is probable in a compound fracture that amputation will ultimately be required, and also that the patient will have a fair chance of recovery if amputation is done at once, this treatment had better be chosen. Under other circumstances scraping out of the medulla should be tried. Stoll has reported six and Petrowski eight successful cases occurring in stumps; and Keetley, in a recent fracture of a chronically inflamed femur, scraped out the marrow from end to end and then wired the fragments, union without necrosis occurring.

Chronic Abscess is a rare consequence of ostitis, and is usually tubercular; there may be a history of injury. It occurs in cancellous bone, especially in the extremities of the tibia; much more rarely in the medulla. For mode of origin, see p. 279. A cavity lined with a vascular membrane, and filled with pus, is formed in the substance of the bone, which is usually very dense around it (Fig. 102). The whole bone may be much thickened. There may possibly be a small piece of necrosed bone confined in the cavity, or some caseous stuff.

Fig. 102.

Abscess in the tibia; cavity lined by smooth glistening membrane.

Symptoms.—Abscess may be suspected when, in addition to permanent inflammatory enlargement and long-continued tenderness, there is a fixed tensive pain at one particular spot, aggravated at night, and unrelieved by any remedy, though it may have occasional remissions.

Abscess is only one of the causes of osteoplastic periostitis (p. 278); strictly localized pain and tenderness render it the probable one. There is always danger that abscess near an epiphysis will burst into the joint, causing destructive arthritis, or into the epiphysial line.

Treatment.—Suspicion of abscess justifies the performance of *linear osteotomy*—*i. e.*, a saw cut into the bone, with antiseptic precautions. The treatment will do good any way; and if pus wells up along the saw a small trephine will soon give sufficient drainage.

Necrosis.

Extensive necrosis occurs almost solely in compact tissue like the shafts of long bones, but necrosis of small fragments is frequent in cancellous bone, and a whole epiphysis may die. Its immediate *causes* may be enumerated thus: direct injury killing everything, or stripping off the periosteum and bruising the medulla—*e. g.*, in amputation; acute or chronic suppurative periostitis or osteomyelitis, and especially both together; rarefying ostitis caseating before the bone is absorbed; sclerosing ostitis, causing obliteration of the vascular canals over a considerable area, which dies as a consequence. Sir J. Paget has described this last variety as *quiet necrosis;* there is no suppuration, but the presence of the sequestrum helps to keep up the ostitis. The patient suffers from all the symptoms of chronic osteoplastic periostitis; ultimately spontaneous fracture may occur. Then the diagnosis made is likely to be "malignant growth," amputation is performed and the sequestrum found, probably only partly separated. If fracture does not occur, the trephine, used to relieve pain, may reveal the dead bone. That the sequestrum is not separate, even after many months, is owing to a continuous slow spread of the sclerosis and consequent necrosis.

In many cases we do not know the *remote causes;* but syphilis, tubercle, the acute specific fevers, especially typhoid, and phosphorus in the special case of the jaws, are recognized as such.

Separation of Sequestrum and Repair.—When a portion of the shaft of the tibia dies as the result of suppurative periostitis, the pus first of all raises up the periosteum from the bone and then bursts through it at one or several spots. The membrane now granulates and begins to form new bone, leaving apertures of varying size where it has itself been destroyed. We thus get formed a shell of new bone with holes in it (*cloacæ*), through which pus escapes and a probe passes down to touch the sequestrum. Meanwhile a rarefying ostitis has been excited all round the sequestrum, the groove of demarcation has formed, and in the course of months or even years, according to the size of the sequestrum and the bone affected, the femur and flat bones taking the longest time, the piece of dead bone is thrown off, or becomes loose in its case. Fig. 103 shows a certain amount of case, but either part has been removed, or the periosteum over the front of the tibia had sloughed and no new bone formed. Fig. 101 also shows a sequestrum in its case.

Fig. 103.

Necrosis of shaft of tibia, incomplete formation of a new shell; involvement of knee and caries of upper epiphysis of tibia.

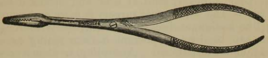
In cases of necrosis from acute suppuration, the sequestrum presents superficially a normal surface; it is irregular where living bone has been eaten away from it. But in syphilitic necrosis of the skull and cases of tubercular ostitis, the sequestrum is often rarefied from previous erosion, and in other cases it may be dense from previous sclerosis.

When the sequestrum is removed from its bed of granulations, these grow, fill the cavity, and ossify or form fibrous tissue; the new bone is often sclerosed. The shape of the bone is frequently greatly altered, but improvement occurs with time.

Diagnosis of Necrosis.—First there is the history; next, the presence of one or more sinuses through which an abscess discharges. These often have large pouting granulations at their mouths, and may have been present for months, a circumstance which at once gives rise to the suspicion that bone is at the bottom of it; examination by palpation may reveal thickening of the bone; and a probe passed along a sinus may strike bare bone. In the absence of the two latter signs, however, one would often slit up a sinus to examine more carefully for its cause. It must never be forgotten that bare bone does not mean dead bone. The longer it remains bare, the greater the probability that it is necrosed; but even after months no sequestrum may be found, only osteoplastic periostitis and ostitis complicated by abscess which left a surface of bone that does not heal.

Treatment.—The indication is to remove the sequestrum. As it is impossible to tell the limits of this until the groove of demarcation has formed well all round, we must wait for longer or shorter periods, as above said. Ultimately the probe conveys the information that the bone is loose, or it is likely that the process of erosion is far advanced, and that a little force will tear away the sequestrum. Then an attempt to remove may be made. A small nodule or a thin flake may be loose in three weeks, and lifted off with a pair of forceps. In larger cases, a free incision must be made near the

Fig. 104.



Sequestrum forceps.

chief sinus, and deepened along a probe if necessary until the cloaca or the sequestrum is reached. If small it may be lifted out; if large, the part must be rendered bloodless, and the case opened sufficiently by chisel and mallet or cutting forceps, to permit the extraction of the sequestrum, after division if this is helpful. As little shell as possible should be removed. Unless the case is aseptic it is well to sharp-spoon away all granulation tissue before applying sublimate lotion and iodoform to the cavity; this should be plugged with gauze to check oozing, which is often free. It is difficult to keep such long cases aseptic, but every effort must be made to do so.

Amputation is required in cases of fixed sequestrum in which the patient is losing ground; in certain cases of acute necrosis (p. 283); and in cases where a sharp sequestrum has wounded a main artery and in which the condition is so bad that conservation is hopeless.

Fig. 105.

A carious bone.

Caries.

The nature of caries has already been explained under the heading of *rarefying ostitis* (p. 279). Speaking roundly, caries is erosion of bone by tubercular inflammation; syphilis is almost the only other cause which need be mentioned. It attacks spongy bones far more often than compact (Fig. 105), the vertebræ being by far the most commonly affected.

Diagnosis.—If we take the tarsus, there is a history of pain followed by slow swelling, at first perhaps limited to the region of one bone, later becoming less circumscribed; the skin remains pale, unswollen and movable over the swelling for a long time; but ultimately, as all the signs increase, it assumes a dusky red color, fluid collects beneath it and finally escapes, leaving a ragged purplish opening through which pale granulations can be seen. Perhaps more than one opening forms. A probe strikes soft gritty bone, which breaks down easily, perhaps bleeds, and is tender, differing in all these points from necrosis. Thin pus escapes from the sinuses; and when these are connected with a larger focus, the discharge may be very profuse and exhausting.

The dangers are chiefly hectic, albuminoid degeneration, exhaustion, and acute tuberculosis.

TREATMENT.—First, *attend to the general condition;* it is not too much to say that everything depends upon the general health. The prognosis varies almost directly with the patient's ability to carry out expensive treatment, and to spend a long time over it. The diet should be carefully regulated and contain a good deal of milk; cod-liver oil should be taken, with any other remedy indicated; and the patient should live at Margate, or some other suitable seaside place, changing from time to time.

Under this treatment, and dressing with iodoform wool and rest, many cases get well without operation.

Among the poor, however, want of time and means necessitate steps to expedite the cure. The tendency of surgery is more and more to treat tubercular disease like malignant disease—to extirpate it thoroughly and early, whenever this can be done, to prevent it from acting as a focus whence bacilli may again be distributed. Accordingly, whenever a carious form

FIG. 106.

A gouge.

is not getting well and it is possible to do so, the part is rendered bloodless, the sinuses are slit up, and the carious bone gouged away as completely as possible; or, if seen early, this may be done when the abscess is opened or the inflamed bone cut into. Sublimate lotion may now be used, then plenty of iodoform and a wool dressing.

In more severe cases excision of joints or amputation of parts—as the foot —will be required.

OSTEITIS DEFORMANS.

This disease was described by Sir J. Paget in 1876, in *Trans. Med.-Chir. Soc.*, from which paper this account is taken. The disease begins in middle age or later, is very slow in progress, may last many years without influence on the general health, and may give no trouble than that due to bone changes. Even when the skull is hugely thickened the mind remains unaffected.

The disease affects most often the long bones of the lower limb and the skull, and is usually symmetrical. The bones enlarge, soften, and curve abnormally under pressure. The spine may sink and seem to shorten, with greatly increased dorsal and lumbar curves; the pelvis may become wide, the necks of the femora nearly horizontal; but the limbs, however misshapen, remain strong and fit to support the trunk.

At first, and sometimes throughout, pains may occur in the affected bones, varying much in severity and character; not nocturnal nor periodic. There is no fever; urine and feces normal; no syphilis; but three of five cases were associated with sarcoma.

POST-MORTEM.—The bones are greatly thickened, the surfaces of some of the long bones slightly irregular. Their compact tissue is wider but less dense than normal; whilst in most cancellous bones the structure is abnormally dense. The skull may measure one inch in thickness. Microscopically the changes are those of ostitis and periostitis; a section through a sarcomatous growth infiltrating bone scarcely differs from one through a simply inflamed part. No treatment is known to be of value.

Rickets.

This is a general disease affecting especially the children of feeble parents, and probably excited by all debilitating conditions; the chief being bad feeding, bad air, want of light, want of exercise, and dirt. Of course, syphilis often occurs in rickety children and *vice versâ;* but except that syphilis depresses the health there is no reason to regard it as a cause of rickets.

The early *symptoms* are profuse sweating about the head when asleep, throwing off the bedclothes, general tenderness, and dislike of being danced and played with. Changes in the bones now appear. The lines of junction of the shafts and epiphyses of the long bones thicken and swell out; this is most noticeable at the lower ends of the tibia and radius; the junction of the bony and cartilaginous ribs becomes beaded; all the bones soften, the flat bones thicken—or thin under pressure. If able to walk, the child ceases to do so. He suffers from indigestion, and has diarrhœa with pasty, offensive stools; the belly becomes protuberant. If the disease continues, changes in the bones become marked. The stature is stunted; the dorsal and lumbar spine bowed markedly forward, from simple weakness, in an almost *uniform* curve, but sometimes the curve is lateral; the head is large, long from before back, the forehead high, square, prominent, craniotabes common at posterior angles of parietal, fontanelles slow in closing, dentition late; the face is small, triangular, with very peaky chin; the chest is beaded (*rickety rosary*), narrow from side to side, prominent in front, with a groove running down each side just external to the beads except where heart and liver support the chest; the pelvis is flattened from before back, if the child is kept lying, but if walking about the acetabula are thrust in towards the sacrum, as in osteomalacia, and the inlet is triangular; the limbs are bowed in various directions—the humerus out at the insertion of the deltoid, forearm bones back above middle, femora forward, tibiæ forward or forward and outward; the latter is the most frequent deformity of all. Genu valgum or varum often appears later. The brain, liver, spleen, kidneys, and lymphatic glands are sometimes large from increase of fibrous tissue, and to some extent of essential structure (Dickinson). The urine contains excess of phosphates—*e. g.*, phosphate of lime.

According to Sir W. Jenner, the youngest children in large families are most affected. The onset of the disease is generally from six to eighteen months; rarely it appears at six or eight years or even later (*late rickets*). As a rule the bones are quite strong by twelve, but they are bowed and stunted, the humerus and femur being one-fourth shorter than the average (Humphry), the epiphyses uniting early after subsidence of active disease.

Pathology.—The blue line of multiplication of cartilage cells preparatory to ossification is much thickened and irregular both towards the bone and towards the epiphysis. Calcification of the walls of the primary areolæ (spaces in which the cartilage cells lie) occurs irregularly, patches of bone or of calcification being found in the preparatory zone and patches of large cartilage cells in the formed bone. The primary areolæ fuse into the secondary, but as deposit of bone on the walls of these is both slight and irregular, the bone remains weak. Beneath the periosteum there is also excessive production of cells, but calcification is very backward. Absorption of the healthy bone, formed before the onset of the disease, goes on to form the medullary canal; so ultimately the soft imperfect bone has to bear the weight alone. Bending, fracture, thickening at the epiphyses and at the margins of bones growing in membrane (skull) are thus easily explained. Nature usually throws out a buttress of bone on the concave side (Fig. 107) which gives a flat razor-like appearance to the femur or tibia.

FIG. 107.

Rickety tibia, thickening in concavity.

TREATMENT.—Diet: mother's milk only for seven to eight months (*not longer*), then cow's milk, with one-fourth to one-third water or lime-water, sweetened; this may be used instead of mother's milk if that is not forthcoming. The water may be omitted as the child gets used to cow's milk. At least a quart should be given daily; oatmeal, bread and milk, arrowroot, and other starchy foods may now be given, and after twelve months a little underdone meat finely minced, fresh fish, or egg. No sweets, cakes, tea, stimulants, or preserved meats should be given. The child is not to "live as we do" so soon as it has cut a tooth. The child should sleep alone, in a long flannel night-dress tied below the feet; the window should be open, but the child not in a draught. It should be in the open air as much as possible during the day. A child just beginning to walk should be kept off its feet for a month or two; in older cases that *will* get about, splints should be applied—wooden ones nicely padded placed inside or outside the limb, extending to the hip, as in genu valgum, or only to the knee. Little straightening can be effected so long as a child walks about, but as the limb grows longer, the curve, if prevented from increasing, will be less noticed. When walking is prevented, elastic traction will do a good deal. A tepid bath of salt and water every morning, afterwards a good rubbing with a rough towel and massage of all the muscles of the limbs are very useful. The child should be out in the open air during the day as much as possible in the sunniest and most open spot attainable, in a perambulator or playing on the ground when it is dry. Change of air, especially to the sea-side, is very beneficial.

With regard to medicine—cod-liver oil and syrup of the iodide of iron or vin. ferri seem to do more than any others. Rickety deformities of the limbs are dealt with later.

A rickety child is liable to catarrh of the bronchi and of the intestine; the former, with its weak chest-walls, is especially dangerous. Laryngismus stridulus is also frequent; chronic hydrocephalus occasional.

MOLLITIES OSSIUM (MALACOSTEON, OSTEOMALACIA).

This is a disease almost exclusively affecting adult women, especially multiparæ, in which the bones become softened and decalcified. In the first stage they are softened and extremely vascular; the marrow in the Haversian and cancellous spaces is replaced by a round-celled growth, and the laminæ of bone nearest to this present a clear decalcified appearance. The decalcification is, therefore, eccentric; the bone may be absorbed all but an incomplete, thin, subperiosteal shell; and the cell-growth, at first dark or light red, becomes pale yellow, gelatinous, and often contains much serum. As the disease advances, the bones become somewhat thickened, and so soft as to be easily cut with a knife.

The disease is constitutional, and usually affects almost every bone in the skeleton, although two instances were reported by the late Mr. Hodgson in which it was confined to the lower extremity; and in one of these amputation was performed. It is liable in women to affect the pelvis, either alone or before any other part.

Symptoms.—At the commencement of it, the patient is observed to be out of health, emaciated, complaining of violent achings in the bones, and of very great feebleness and profuse perspiration. Then, from a fall, or other slight injury, a bone breaks; at first, fractures unite, but not so finally, when bone after bone breaks from the slightest cause; the weakness increases, and the patient becomes bedridden; and now, as the bones bend or break from the slightest influences, the chest and the ribs become distorted to an almost inconceivable degree, and death at last occurs from exhaustion, or from the obstacle which the distorted thorax opposes to the action of the heart and lungs. The fatal issue may not occur for several years in the less severe cases. Softening of the bones of the pelvis in women is indicated by violent aching pains about the hips and pain or difficulty in walking. The result is a heart-shaped pelvis, with long conjugate, and short oblique diameters, the acetabula and sacrum all being pressed toward the mid-point of the pelvis.

Of the *causes* or nature of this disease nothing is known. It is evidently not a *mere atrophy*. The extreme vascularity of the bones in the earlier stages, and the results of microscopical examination show that they are the seat of a morbid cell-growth. It is stated that this is acid from lactic acid. That the urine is loaded with phosphate of lime (which in a case related by Mr. Solly formed a renal calculus) is an intelligible point in the history of the disease. The relation to repeated pregnancies is marked. The disease is endemic in some places, such as certain Rhine valleys; but sporadic cases, especially those affecting the pelvis only, occur everywhere. It is almost unknown in men. No available *treatment* is known, beyond common measures for supporting the strength and allaying pain.[1] The deformity of the pelvis may necessitate Cæsarean section.

Tumors of Bone.

These are divided into *central*, arising from the medulla or spongy bone; and *peripheral*, arising from the periosteum or compact layers.

We shall first speak of the *primary* tumors of bone, all of which really belong to the connective tissue series; then of the secondary, which may be epithelial.

Fibroma is not common. It is met with chiefly growing from the periosteum of the base of the skull, ethmoid bone, maxillary sinus, or lower jaw as a variety of epulis. Myxoma may occur more rarely in similar seats. Removal is the treatment, in either case, with the surface-bone whence the tumor grows.

Chondroma is one of the commonest tumors of bone. It occurs most often in the long bones of the hand, and here frequently calcifies and undergoes mucous degeneration, but rarely ossifies. It is common also on the

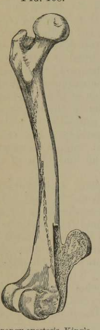
[1] See a remarkable case of softening of the bones, by Mr. H. Thompson, Med. Obs. and Injuries, vol. v., 1776 (the urine deposited a copious mortar-like sediment); Solly, Med. Chir. Trans., vol. xxvii.; Paget's Lectures, i. 135; Dr. Robert Lee's Midwifery, p. 18; Rokitansky, vol. iii.

shafts of long bones near the epiphyseal lines, especially at the lower end of femur, upper of tibia and humerus, forming more or less pedunculated growths. These always ossify and form the spongy exostosis (Fig. 108).

Lastly, enormous tumors having a large element of cartilage occur about the pelvis and ribs; these frequently are malignant (*chondrosarcoma*).

Treatment.—Chondroma of the fingers is frequently multiple. Little can be done beyond amputating, if the inconvenience or unsightliness is great. Excision may be tried in single tumors, but is not very successful.

Fig. 108.



Spongy exostosis, King's Coll. Museum.

The ossifying chondroma may be removed if it gives trouble; but the surgeon should be sure of his antiseptics, as the joint may inadvertently be injured.

Removal may be attempted in some favorable cases of chondrosarcoma.

Osteomata are also common. The *spongy exostosis* has just been dealt with. The *ivory exostosis* grows chiefly from the skull and face bones. Special seats are the external auditory canal, causing deafness, and the roof of the orbit, causing protrusion of the eyeball. The former has several times been removed by working through it with a dentist's drill, which would probably be the safest instrument for the orbit.

Sarcomata of every kind occur primarily in bone, even the melanotic and epithelial-like alveolar, which are rare. Sarcomata of bone spread by the blood path and do not involve lymphatics.

The *central growths* are less malignant than the peripheral; they are often myeloid, which growths are common in the lower jaw, less so in the upper, and occasional in the epiphyses of long bones. They cause "expansion of bone" most typically, and in the long bones not uncommonly pulsate, they are so rich in arteries. Sarcomata, largely destroyed by hemorrhage into their substance, were formerly described as "blood-cysts" of bone. The diagnosis of these tumors must be made from chronic disease of the joint, the chief point being to establish the limitation of the swelling to one or other bones. Freedom and painlessness of movement, steady increase, pulsation or egg-shell crackling may help.

The *peripheral growths* are usually round or spindle-celled, and are intensely malignant. They usually have a supporting skeleton of bone (Fig. 19), and may be so completely ossified that they would be taken for an osteoma but for a narrow layer of gray semitranslucent sarcoma-tissue on the surface.

The *treatment* of these growths is the freest removal so soon as a diagnosis can be made; in the limbs by amputation well above the mass—at the next joint if possible.

Primary Carcinoma has not been proved to occur. If an undoubted case were brought forward it would have sprung from some misplaced epithelial germ.

Secondary Carcinoma—either by direct extension from skin or mucous membrane, or by transmission through the blood-path—is common; the latter especially after cancer of the breast. The first evidence of a secondary deposit may be spontaneous fracture; no tumor may be felt even then, and its growth subsequently may be very slow.

The treatment of secondary cancer by extension is that of the primary disease. The probability that where one secondary growth by embolism has occurred there are several, renders it very doubtful whether anything serious should be done for the one discovered or suspected.

CHAPTER XXVII.

INJURIES AND DISEASES OF JOINTS.

Sprains and Contusions.

These result from violent twists and blows, and are really contusions and lacerations of synovial membrane, ligaments, tendons, and other tissues in the neighborhood of articulations. The symptoms are pain, often very acute, tenderness, more or less complete loss of function, and rapid swelling—at first from hemorrhage into and around the joint, later from inflammatory effusion from the damaged vessels. This is usually accompanied by a good deal of heat and redness. It is often difficult to eliminate fractures with little or no displacement, especially in sprains of the ankle.

The treatment should be absolute immobilization, combined, if possible, with uniform, firm, elastic pressure. This is best obtained by surrounding the part immediately with a large quantity of good cotton-wool, and compressing it down to a thickness of about two inches by bandages applied at first loosely, then tighter and tighter. A splint may be added if necessary to control so large a joint as the knee. Some surgeons employ a splint and ice from the first. When inflammatory symptoms have appeared, fixation and frequent fomentation give most relief. When swelling has subsided, the part may be placed in plaster of Paris, and kept immobile for two to four weeks or longer, varying with the size of the joint and severity of the strain.

After a bad sprain, a joint often remains weak or stiff and painful, much affected by changes of weather, especially in the aged or sufferers from gout or chronic rheumatism. Sometimes chronic arthritis is started by such injuries. The best safeguard against all these untoward results is the above treatment, especially absolute rest for a sufficient length of time. The tendency to regard a sprain as a trifle to be made nothing of is at the bottom of the common saying that a bad sprain is worse than a broken leg.

Wounds of Joints.

A small wound may often, but not invariably, be known to have penetrated a joint by the escape of glairy viscid drops of synovia.

Treatment.—If there is any doubt as to the wound having penetrated the joint, treat as though it had; any but the most cautious use of a probe may produce the penetration which it is so desirable to avoid.

The object is to avoid *septic arthritis* (p. 316), and this is done by washing the part with some reliable antiseptic, syringing out the joint, making ample provision for drainage, applying an antiseptic dressing (permanent, if possible), and immobilizing the part in the best position for ankylosis in case stiffness should result. There is no reason why large wounds should not be sewn up carefully if ample drainage is provided. Even in small wounds the above treatment is always preferable to closing the wound with collodion or tinct. benzoini co. on lint, and packing the immobilized joint in ice.

Should suppuration set in, reliance must be placed upon the freest drainage and drying up of discharge in antiseptic dressings, the joint being kept at perfect rest. Thus the knee should be laid open from top to bottom along each side, along the line of reflexion of the synovial membrane, a finger being passed into the joint through the wound, to discover the exact level of this line, and cut down upon; and it is best to make the plane of the wound shelving backward from the above line. Further, dressing forceps should be thrust through the joint to the back of the external condyle of the femur, and there cut down upon; they must then be used to draw a tube into the joint. In these cases irrigation through the tubes may be used in default of antiseptics. A careful watch upon the temperature and local state must be kept to detect burrowing of pus and formation of secondary abscess at the earliest date.

In many cases *secondary excision* will be necessary to afford sufficient drainage and to remove infected and ulcerating bone and cartilage; and, not uncommonly, danger of death from hectic will necessitate *amputation* to save life.

Primary excision is indicated by splintering of the bones, and in the upper limb is greatly preferable to amputation. As much as six inches of the upper end of the humerus have been removed with good result. In these operations the periosteum should be preserved with the greatest care.

Great injury to soft parts, vessels, or bones, especially in the lower limb, necessitates primary amputation. In gunshot injuries the facilities for antiseptic treatment and the necessity for transporting the wounded must be taken into consideration in deciding between excision and amputation.

Dislocation or Luxation.

A dislocation means the separation of two bones, a bone and cartilage, or two cartilages, at an articulation. It is *complete* when the surfaces are quite separated, *partial* when portions of them still touch. Other varieties are: *traumatic*, due to injury, with the subheadings, *simple* and *compound; complicated*—by much laceration of soft parts, of large vessels or nerves, or by fracture of one or other bone concerned; *pathological*, due to inflammation of a joint, will not be treated of here; *congenital*, due to original malformation of the bones entering into the joint.

Traumatic dislocations are rare before adult age, fractures and separations of epiphyses occurring instead; they are always much rarer than fractures, and compound dislocations are very much rarer than compound fractures. Articular ends do not tear through the skin except as a result of very great violence.

Causes.—*External violence* or *muscular action*. The circumstances that enable muscular action to produce it are—a peculiar position (as when the jaw is very much depressed); paralysis of an antagonistic set of muscles; elongation of ligaments; and fracture or ulceration of some process of bone. Thus ulceration of the acetabulum permits the head of the femur to be dislocated upward, and fracture of the coronoid process permits the ulna to be dislocated backward.

External violence, as a rule, uses the shaft of a long bone to tear the capsule and lever its head out of its socket in a certain direction; this is the *primary displacement;* then the head is carried by *secondary displacement* to some more or less permanent position determined by the action of muscles, the resistance of bones, the tension of untorn ligaments, the weight of the part, and external violence.

Morbid Anatomy.—In all traumatic dislocations there is necessarily more or less tearing of the ligaments holding the bones together, or these bands are torn from their attachments, bringing away scales or even processes of bone to which they were attached; more or less laceration of the soft parts round about must also occur, and bleeding of course follows, but is usually less than in fractures. If the dislocation is at once reduced, all these lesions heal in three or four weeks. In unreduced cases the displaced bone does not come to rest until it finds some firm point of support; thus if muscle separates it from a bony surface, the muscle will gradually disappear, and the bone come into contact with bone. The fibrous tissue round about the displaced bone thickens greatly and forms a kind of new capsule for it; but for several months no changes occur which would prevent reduction, though considerable force may be required to tear through the dense fibrous tissue. In the course of years a concave socket becomes filled up by dense fibrous tissue beneath which the cartilage disappears, and the head of the displaced bone may become similarly altered; but when it rest against periosteum, a bony cup usually forms round it and becomes lined with dense fibrous tissue or even cartilage, whilst the cartilage on the displaced bone is more or less preserved. All this, if movements are executed in the false joint or *nearthrosis;* if the bones are kept at rest, the whole of the inflammatory capsule may ossify. Such changes as these render reduction impossible; but it would seem to be impossible much earlier, and the reasons are not quite evident.

Signs.—These are made out by inspection, palpation, manipulation, and measurement. They are changes in length of the limb—generally shortening; the presence of certain attitudes of the limb which clinical experience has associated with certain dislocations; contour changes—abnormal prominences or depressions—sometimes concealed by swelling from the eye, but usually recognizable by the finger, which can gradually press through extravasated blood, and in all cases the displaced end of the bone is the most important point to be discovered; movement is obtainable, but is painful, abnormally limited in certain directions, abnormally free in others, in which perhaps no movement at all is usually allowed. Pain is, as a rule, less acute than in fractures.

Diagnosis.—Dislocations have to be distinguished chiefly from fractures occurring near joints, for, as already pointed out, the deformity present in some of the latter may cause them closely to resemble certain dislocations. (1) It must be remembered that to prove the existence of a dislocation it must be shown that *the joint surfaces of two bones are separated from each other;* and for this purpose it is necessary carefully to compare the injured joint with its fellow to see whether the relations of bony points about them are altered. In dislocation the relation of these points is abnormal, in fracture it is normal, the deformity being due to displacement of the fragments. Luxation differs from fracture also, (2) *in the absence of true crepitus,* though a soft crepitation is often present from extravasated blood. (3) A fractured bone can be moved by the surgeon more freely than natural, and a dislocated one less so. (4) *Measurement* of the distorted bones will show one or other of them to be shortened if a fracture is the cause of the deformity, but they are of normal length in dislocation. (5) If a fractured bone be drawn into its proper shape, the distortion will return when the extension is discontinued; if a dislocated bone be drawn into its proper place, it will usually remain there.

But the greatest difficulties in diagnosis will arise when, in addition to dislocation, the displaced bone is also fractured close to its head; all the signs of fracture will then be present, and the diagnosis of dislocation can be made only upon demonstration that the joint surfaces are separated from each other.

Treatment.—There are two ways of reducing dislocations; the old one of dragging the bones into position by brute force, all resistance of soft parts being removed by their laceration; the more modern plan by *manipulation*, based upon a study of the mode of production of dislocations in the various joints, in the belief that the easiest way back for the head of a bone is that by which it left the joint. The shaft of the dislocated bone is therefore used as a lever to produce in reverse order those movements by which the head left the socket—to correct first the secondary, then the primary displacement. It is only in the two ball-and-socket joints, and especially the hip, that complex proceedings are required. In most other cases the socket, the point of leaving the capsule, and the point at which the displaced bone is lying, are in a fairly straight line, and it is therefore sufficient, in order to correct both primary and secondary displacement, to fix the socket or proximal bone with one hand and to pull on the distal or displaced bone till the resistance of the muscle is overcome. The extension should be made so as to draw the head directly toward the socket, the limb being in such position as will relax resisting muscles most completely; gentle rotation, and such other movements as may help to disentangle the dislocated bone, should at the same time be employed.

After reduction, the joint must be fixed for fourteen to twenty-eight days, the latter in the hip. It is unnecessary to maintain any extension, prevention of movement whilst healing of the torn capsule is proceeding being all that is required. Ice may be used for a few hours to check extravasation, fomentations to assist absorption. After rest for the above-mentioned times varying with the size and importance of the joint, movements must be carried out, both passive and active, those which produced the dislocation being postponed until it is thought that healing is really sound.

Dislocations should be reduced under anæsthesia if muscular resistance causes the slightest trouble. Formerly, in spite of the free use of nauseants and depressants—tartar emetic, tobacco, hot bath—reduction of a hip-joint dislocation was regarded as a capital operation; now with manipulation and narcosis it rarely presents real difficulty.

In the case of *dislocation and fracture* the patient should be at once anæsthetized, and an attempt made to push the displaced head back into the socket; or, if the bone is broken so far down in the shaft that it is possible by putting it up very firmly in splints to obtain sufficient hold upon the upper fragment to employ the whole shaft as a lever, manipulation may be tried. This failing, fix the bone in such position as to obtain union to the displaced head, and then after six to ten weeks reduce by manipulation; in attempts at this, fracture may again occur, and it is useless to try again to reduce. The best result in the shoulder is then obtained by thrusting the end of the shaft up into the socket; in the hip by formation of a false joint with good movement and the limb in good position.

Compound dislocation of the larger joints is a dangerous accident, because of the acute suppurative inflammation, rapid destruction of cartilage, and violent general disturbance which are sure to follow upon decomposition of the wound fluids; they are more serious than simple luxations, also on account of the greater damage to soft parts by which they are attended. These cases must be considered and treated in very much the same way as compound fractures. In deciding what to do, the possibility of rendering and keeping the part aseptic is of the first importance. The successful application of antiseptics, of course, does away with the dangers due to the existence of a wound. If this is impossible, the probability is that even an uncomplicated case will end in ankylosis. If the wound is clean-cut it may heal quickly if the dislocation is reduced, the limb fixed, and some simple absorbent dry dressing is applied. Difficulty in reduction must be met by skilful enlargement of the wound, not by removal of sound bone. If rapid healing is impossible on account of laceration, the same treatment may be adopted with the addition of a well-placed and extremely free incision into the joint such as shall render bagging of pus difficult or impossible, and a similar incision must be practised at once should an endeavor to obtain union by first intention fail and septic arthritis ensue; otherwise, there is no knowing where the burrowing of pus will cease. Except to keep open channels leading to joints, the bones of which are in apposition, tubes are of little value in draining them, for they get compressed if passed through from front to back. If the endeavor to drain the joint thoroughly fail—and some joints are extremely difficult to drain, and constant irrigation does not prevent burrowing—the sooner a secondary excision is done the better.

As to the question of primary excision or amputation, the decision must rest upon the age and constitution of the patient, extensive bruising and laceration of soft parts, laceration of large vessels, and shattering of the bone. The probability of employing antiseptics successfully must always be taken as a point greatly in favor of the patient. When one or other operation is necessary, excision is, as a rule, to be preferred, especially in the upper limb.

Particular Dislocations.

Dislocation of the Jaw may be caused by a blow on the chin when the mouth is wide open, or by spasm of the external pterygoid muscles during yawning, by which the condyles are drawn over the articular eminence in front of the glenoid fossa. The dislocation may be on one side only, or on both. It may also be partial or complete.

Symptoms.—The mouth fixedly open; speech and deglutition difficult; saliva dribbling away; the chin protruding forwards, or a little on one side (if the dislocation is one-sided); the condyle is felt to project unnaturally under the zygomatic process, whilst there is a hollow in the upper part of the parotid space, corresponding to the empty glenoid fossa.

Treatment.—Let the patient sit on a low stool with the head against a wall. The surgeon next wraps some rag round his thumbs, and places them at the roots of the coronoid process behind and outside of the molar teeth; then he should press them downward and backward, elevating the chin at the same time with his fingers. Or a piece of cork may be put between the molar teeth whilst the chin is elevated. After reduction, the chin must be confined for two weeks by a *four-tailed bandage*, to prevent accidental re-displacement from involuntary yawning and to allow the capsule to heal thoroughly. This is important, as luxation of the jaw is one of the most common to become habitual.

Dislocations of the Clavicle.—The *sternal extremity* of this bone may be dislocated by blows on the shoulder; either *forwards* on to the anterior surface of the sternum, or *upwards* into the suprasternal fossa. There are also a few cases on record of dislocation of this end of the clavicle *backwards* by violence, with the pain and difficulty of breathing as consequences; the reduction and subsequent treatment the same as for the dislocation forwards.[1] The sternal end may be dislocated forwards from sheer relaxation of the ligaments. The *treatment* is in all respects the same as for fractured clavicle, with the addition of pressure by the thumb, and afterwards by a pad and bandage on the displaced end of the bone. Dislocation of the sternal end *backwards* has been caused by lateral curvature of the spine. In one case it produced so much pressure on the œsophagus as to threaten starvation, and was excised by Mr. Davie, of Bungay.

The *outer extremity* of the clavicle is much more frequently dislocated, and almost invariably *upwards* on the acromion. The shoulder is depressed, and on tracing the spine of the scapula the end of the clavicle can be felt upon the acromion. The outer extremity of the clavicle has been dislocated *under* the acromion by a kick from a horse on the shoulder. The *treatment*, after replacement, is the same as for fracture of the clavicle or acromion; but it is unsatisfactory as regards keeping the bone in place, though the patient recovers with a strong limb.

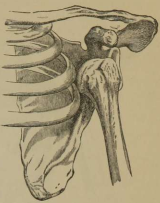
DISLOCATION OF THE SHOULDER-JOINT is far commoner than any other, which is easily accounted for by the shallowness of the socket, the laxity of the capsule, and the violence to which the upper limb is often exposed. The displacement is caused by falls on the hand or elbow, but it seems likely that violent contraction of the muscles forming the anterior and posterior axillary folds may have a good deal to do with dragging the bone inwards from its socket. In ordinary falls upon the hand, the whole length of the upper limb forms a lever, the insertions of the axillary muscles are the fulcrum, and the upper end is thrown against the lower and inner, or weakest part of the capsule, and the bone escapes usually between the subscapularis and the long head of the triceps. According to the direction of the force which subsequently acts upon the shaft, the head of the bone may come to rest low down in the axilla just inside the axillary border of the scapula; or it may lie higher up and more superficially beneath the coracoid process, or, travelling along the same line, it may be forced up and in beneath the clavicle. In rare falls upon the posterior and outer aspect of the flexed arm, the head of the humerus is driven through the lower posterior part of the capsule, and comes to lie on the dorsum scapulæ, below the spine. The dislocations of the shoulder may therefore be divided into two sets by the axillary border of the scapula; one, the *subspinous*, occurs behind this line; three, the *subglenoid* or *dislocation into the axilla*, the *subcoracoid*, and the *subclavicular*, are in front of it. The term *subglenoid*, though commonly used as synonymous with *into the axilla*, is not so; it should be reserved for very rare cases in which the head lies on the edge of the scapula just below the glenoid fossa (the arm being abducted to a right angle), whence it readily slips into the axilla. The three dislocations forward must be regarded as accidental varieties of one kind. As to relative frequency, the subcoracoid occurs most often (Malgaigne, Flower, *Trans. Path. Soc.*, vol. xii. p. 179), then that into the axilla, which is also common; the subclavicular is uncommon, and the subspinous rare.

If the student will detach the humerus of an articulated skeleton and place its head in the different positions which it may assume between the lower part of the capsule and the clavicle or spine, he will at once appreciate the differences which may be expected in the direction of the limb, its apparent length, and the relation of the elbow to the side.

[1] See a case by Mr. Brown, of Callington, Medical Gazette, August 1, 1845.

1. In the dislocation *downward*, or *into the axilla*, the head of the bone slips through the capsule between the subscapularis muscle and the long head of the triceps, and rests pressing upon the axillary plexus of nerves, between the subscapularis muscle and the ribs (see Fig. 109).

Fig. 109.



Dislocation of the shoulder downward.

Symptoms.—The elbow sticks well out from the side, and cannot be made to touch the ribs; the shoulder is flattened all round, and the deltoid tense; the fingers can be pushed in beneath the acromion revealing a hollow where the head of the bone ought to be; the arm is lengthened; the head of the bone can be felt in the axilla if the limb be raised, and this movement causes pain and numbness along the arm and fingers.

Diagnosis.—To examine the shoulder after injury, bare both joints and inspect from the front and from behind. Then, standing behind, place a hand on each shoulder, and commencing at the sternal end of the clavicles feel successively the clavicles, the coracoid processes, heads of humeri, acromia, and spines of scapulæ, comparing the injured with the corresponding sound part. Any displacement will thus be detected. Now with one hand grasp the injured shoulder from before back, and with the other seize the flexed elbow and gently rotate the humerus to see whether the head moves with the shaft. If it does so, stronger and more extensive movements may be made in all directions to endeavor to elicit evidence of abnormal mobility or crepitus in the bones of the shoulder girdle.

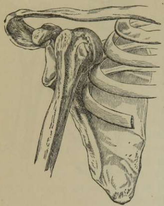
There are three fractures liable to be mistaken for this dislocation; viz. fracture of the *acromion*; of the *neck of the scapula*; and of the *neck of the humerus*. The first two may be known by the facility with which the form of the joint is restored by pushing up the elbow vertically, with an instant redisplacement on ceasing the support. In fracture of the neck of the scapula crepitus is felt on doing so. In fracture of the *cervix humeri*, the limb is *shortened*, instead of being lengthened, as it is in dislocation; the shoulder immediately below the acromion is of normal shape; the round head is felt *in situ*, but does not move with the shaft, and crepitus may be obtained; the deltoid is tense and flattened, and about one and a half inches down, *opposite the fracture*, the fingers can be made to sink in somewhat; and the rough angular end of the shaft may be felt in the axilla, instead of the smooth head of the bone.

2. In the *subcoracoid* dislocation the head of the bone, having escaped below the subscapularis tendon, ascends in front of it to lie below or just internal (Fig. 110) to the coracoid process.

Symptoms.—The elbow stands out a little from this side, being pushed to it with difficulty, and is also carried a little backward; the shoulder is flattened externally and behind, and the acromion is prominent, especially behind; the resistance of the head is gone from beneath it; on rotating the bone the head is felt, somewhat obscurely in muscular or fat people, close to the coracoid process, and there is more or less fulness over it; the limb may be slightly lengthened or shortened according as the head is below or inside the process.

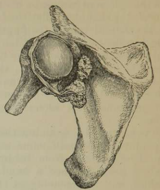
3. The *subclavicular* dislocation is produced from the subcoracoid by pushing the head further up and in beneath the clavicle, where it causes more marked fulness and is more easily felt, whilst the elbow is directed more out and back, and the shortening is greater.

Fig. 110.



Subcoracoid dislocation of the shoulder.

Fig. 111.



Subspinous dislocation of the shoulder, unreduced, new socket formed. St. Mary's Museum.

4. In the dislocation *backward* or *subspinous* (Fig. 111), the head of the bone may be felt on the dorsum scapulæ, and the elbow projects forward. There is a fulness behind, and a hollow under the acromion in front.

5. *Partial dislocation forward* is described, in which the head of the bone is thrown partly off the glenoid cavity against the coracoid process. By some it is regarded as due to rupture of the tendon of the biceps. The symptoms are: projection of the acromion, and a hollow under it at the back of the joint, whilst the head of the bone is prominent in front, and may be felt to move on rotating the elbow; cramps of the hand; and difficulty in raising the elbow, because the head of the bone strikes against the coracoid process. It is said to be very liable to recur after reduction.

Injuries of the shoulder-joint are liable to be followed by various obstinate and intractable affections, owing probably to the supervention of *chronic rheumatic arthritis*. The capsular tendons and long head of the biceps waste away, and the articular surfaces are altered in shape, and partially displaced. Such cases were described by Sir A. Cooper as *dislocation upward and rupture of the biceps*. Sometimes the deltoid muscle wastes, owing probably to injury of the circumflex nerve. Violent spasms and neuralgic pains of the arm may occur from injury to the other nerves.

Very rarely the head of the humerus has been dislocated upward, breaking off the acromion (*supraglenoid*) or the coracoid process, or in front of the latter process (*supracoracoid*).

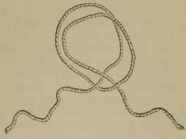
Treatment.—There are four methods of reducing dislocations of the shoulder.

1. By *the heel in the axilla*. The patient lies down on a bed, and the surgeon sits on the edge. He puts his foot (without his boot)[1] into the axilla,

[1] A case is related by Dr. Warren, of Boston, in which a person made a violent attempt to reduce a dislocation by putting the heel of his boot into the axilla. The result was a rupture of the axillary artery. Vide Ranking's Abstract, vol. iii. p. 43.

the heel resting against and fixing the axillary edge of the scapula, the wide anterior part of the foot being used to press the head of the bone outward; at the same time he makes extension *in the line of the limb*, by grasping the wrist. By means of a towel or skein of worsted clove-hitched round the arm above the elbow, an assistant may aid in making traction should extra force be necessary; but it is far better to give an anæsthetic, and to employ rotation of the humerus, rather than direct traction, to break down adhesions in old cases, or to enlarge the opening in the capsule. The clove hitch is shown in Fig. 112.

FIG. 112.



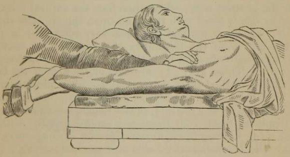
The clove hitch.

When the head has been drawn down to the level of the rent in the capsule, it is levered outward over the foot by carrying the elbow to the side, when it usually slips in with a jerk and an audible snap. Both these signs may be absent, especially in cases which are not quite recent; reduction is then evidenced by return of the normal fulness of the shoulder given by the head in its socket, also by greater freedom of movement.

The extension used in reducing any dislocation *forward* must be made in a direction downward and backward. For the dislocation *backward*, extension should be made forward.

2. By *the knee in the axilla*. The patient is seated in a chair, and the surgeon abducts the arm and places one of his knees in the axilla, resting

FIG. 113.



Reduction of dislocation of the humerus by hyper-abduction.

the foot on the chair. He then puts his hand on the shoulder to fix the scapula, and with the other extends and depresses the elbow over his knee.

The method is altogether inferior to that by the heel in the axilla.

3. According to the *method of hyper-abduction*, invented by Charles White,

of Manchester, and revived by Malgaigne, the patient lies down, and the surgeon sits behind him. The scapula is well fixed by placing one hand or a foot upon the shoulder; then the arm is raised from the side, and drawn straight upward strongly till the bone is elevated into its socket (Fig. 113).

Modifications of this process have long been in use on the Continent. English bone-setters have a plan by which the leverage afforded by the length of the limb is made available for tilting the head into its socket. For this purpose the elbow is straightened, and the limb raised and moved in a circular direction, so as to dislodge the head of the dislocated bone, and enable the muscles to draw it into its socket. This is, in fact, a closely similar proceeding to that of manipulation in dislocation of the hip-joint (see the "Flexion Method," p. 306, and Fig. 119).

4. *Kocher's method* is very successful, and must be conducted in the following steps: 1. Push the abducted elbow to the side. 2. Bend the elbow, and, using the forearm as a lever, rotate out the humerus through about 90 degrees, when a distinct check will be felt. 3. Flex the humerus fully—*i. e.*, carry the elbow forward and upward through 90 degrees. Rotate the humerus in, when its head will enter the glenoid fossa. These movements first render tense the coraco-humeral band and other untorn parts of the capsule, and then employ them as a fixed point round which to move the head. The method fails when this band is torn from the humerus, but White's plan then succeeds.

In subspinous dislocation strong abduction and forward traction coupled with direct pressure forward on the head, must be practised.

After reduction fix the arm to the side by a few turns of bandage and treat any extravasation. Begin passive movement in fourteen, active in twenty-eight days, abduction last. *Habitual dislocation* is more frequent in this joint than in any other. When dislocation has occurred more than twice, absolute rest for four or six weeks should be given to the joint, and some kind of band should be used to limit the movements, especially abduction of the joint.

Old Dislocations.—These have been reduced even so long as a year after their occurrence, and attempts made within six months will, as a rule, be successful. Owing to the matting of soft parts which always occurs around the head, it is necessary to free the latter by movements of rotation and to open up again the way into the capsule. There will probably be no sudden slip or snap when an old dislocation is reduced, and often the bone slips out of place with the greatest ease; when, therefore, the natural form is restored, the arm must be firmly fixed with the hand upon the opposite shoulder so as to preserve it. Kocher's method has been very successful in this class of cases, and it would avoid the possibility of several of the accidents which have occurred during reduction of both old and recent dislocations by the heel in the axilla. These are: (1) *Fracture of the neck of the humerus*, and of this in Kocher's method there is most danger when producing the second movement. (2) *Rupture of the axillary artery* or *vein*, an accident which is not always avoidable by any method, as the vessels sometimes contract adhesions to the displaced head. (3) *Rupture of smaller vessels*, resulting in great extravasation. (4) *Injury to the brachial plexus*, causing more or less lasting paralysis. (5) *Laceration of the skin and pectoral muscles.* (6) *Avulsion of the arm at the elbow* (Guerin) without the employment of any great amount of traction.

If the neck breaks during an attempt to reduce an old dislocation, the shaft should be pushed up at once into the glenoid fossa, to imitate as nearly as possible the result of an excision, and the case must be treated accordingly. Subsequently, if the displaced head is a source of pain, it may be removed. In a recent dislocation union should be allowed to take place between the shaft and head, and another careful attempt made to reduce.

Rupture of the axillary artery gives rise at once to a *false aneurism* (arterial hæmatoma), which must be treated by laying open the sac, turning out the clots, and tying above and below the wound in the artery, whilst the subclavian is compressed. This should not be done until it is obvious that the swelling is steadily increasing, as it has done in cases hitherto reported. Rarely an ordinary aneurism has formed several weeks after the reduction of a dislocation; this may be treated by ligature of the third part of the subclavian.

When small vessels of the axillary vein is injured, the probability is that with some elevation of the limb and friction upward constantly practised, the danger of gangrene will be escaped. Should it set in, amputation must be practised.

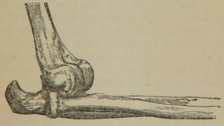
Every endeavor must be made to improve the power of movement in an old dislocation; should it, however, ultimately prove unsatisfactory, the question of excision of the head may be entertained; as also in cases of much pain due to pressure of the head upon the brachial plexus.

The shoulder is *the* joint in which luxation tends to become *habitual*—*i. e.*, to recur again and again till the head can be shaken out of joint, perhaps by missing a step coming down stairs, or by the performance of almost any over-hand movement. The pathology is unknown: too early use of the joint after reduction certainly tends to cause the state, which may consist in the persistence of a wide communication between the synovial membrane and the subscapular bursa produced by the primary injury (Roser). In confirmed cases, Hüter suggests excision as a remedy.

CONGENITAL DISLOCATION of the shoulder is rare; it is usually subcoracoid, a false socket lying at the base of this process to receive the malformed head. Attempts to improve the position have generally failed.

DISLOCATION OF THE ELBOW presents many varieties. It is remarkable for the great frequency with which it occurs in children. Falls on the hand are its cause. Both *radius* and *ulna* may be dislocated: 1, backward; 2, backward and outward; 3, backward and inward; 4, forward. The *ulna alone* may be dislocated, 5, backward; the *radius alone* either, 6, forward; 7, backward; or, 8 outward; 9, the humerus may be driven between the forearm bones, the ulna being behind, the radius in front.

FIG. 114.



Dislocation of radius and ulna backward.

1. When both radius and ulna are dislocated *backward*, the elbow is bent at a right angle and is firmly fixed. The olecranon projects much behind; a hollow can be felt at each side of it, corresponding to the great sigmoid cavity; and the lower end of the humerus forms a hard protuberance in front. The coronoid process rests near the olecranon fossa (Fig. 114). The

head of the radius and its superior hollow can be felt unless the swelling is great.

2. In dislocations of *both bones backward and outward*, the coronoid process is thrown behind the capitellum; and, in addition to the preceding symptoms, the head of the radius can be very plainly felt on the outside of the joint.

3. The dislocation *backward and inward* is known by a great projection of the outer condyle, in addition to the symptoms of the first variety.

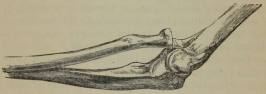
4. Dislocation *forward* without fracture of the olecranon is very rare; the elbow is flexed, the forearm lengthened, and the heads of the forearm bones are felt in front of the humerus. Considerable movement is permitted.

5. In *dislocation backward* of the *ulna solely*, the olecranon is much projected backward, the elbow is immovably bent at right angles, and the forearm is much twisted and pronated.

The TREATMENT of these five varieties is much the same. The surgeon must bend the elbow across his own knee, using this as a fulcrum over which he can lever apart and disentangle the bones: the muscles will then effect their replacement.

6. The head of the *radius alone* may be *dislocated forward*, being thrown in front of the capitellum (Fig. 115). The elbow is slightly bent, and, in

FIG. 115.



Dislocation of the radius forward.

bending it more, the head of the radius can be felt to strike against the front of the humerus. The hand is usually more supine than prone.

TREATMENT.—Straighten the elbow and press the radius into place; put a pad in front of it, and apply a stright anterior splint for three weeks or a month. In all cases where the orbicular ligament is torn, the dislocation is likely to recur.

Dislocation of the radius *backward* is very rare, *outward* much less so. The diagnosis is easily made by feeling the head in its abnormal position. Reduction is effected by flexion, abduction from the hand, and direct pressure on the head. Angular splints must be applied for three or four weeks.

When the forearm bones lie one on each side of the humerus, there is much deformity; the position of the bones is easily recognized if the case is seen before the onset of swelling, which is apt to be great and rapid. Reduce and treat like dislocation backward of the ulna.

DIAGNOSIS.—To examine the elbow, stand in front of the patient, flex the sound like the injured joint, and take an elbow in each hand, placing a forefinger on each olecranon, a thumb on each external epicondyle, and a second finger on each epitrochlea. The relation of these points belonging to the forearm and arm respectively can now be exactly examined, unless swelling obscures them.

Dislocations of the elbow may be distinguished from fractures of the lower extremity of the humerus—1, by the impaired mobility of the joint, and by the absence of crepitus; 2, by carefully observing the relative position of the epicondyles of the humerus to the olecranon; 3, by measuring the length of the humerus from its condyle to the shoulder—which in dislocation will be equal to that of the sound limb, but will be diminished in fracture of the lower extremity of the humerus. The forearm from epicondyle to styloid process, is usually shortened. When it is considered that these dislocations may be combined with various fractures of the condyles of the humerus, and of the bones of the forearm, and that great and rapid swelling is characteristic of injuries about this part, it will be admitted that the injuries of the elbow present a complicated study.

When exact diagnosis is impossible, put up the elbow on an inside angular splint and treat the extravasation. If the dislocation is complicated by fracture, passive movement should not be commenced till after four to five weeks; limited movement is likely to result.

These dislocations may be rendered *compound* by projection of the lower end of the humerus in front. The treatment will vary according to the damage to soft parts there.

Reduction of dislocations many months old is very difficult. Should it fail and the arm be useless from ankylosis in the straight position, excision may be done with benefit.

Dislocations of the Wrist are rare. They occur, with almost equal frequency, backward and forward, and are readily recognized by the alteration of the relations of the styloid processes of the radius and ulna to the bones of the carpus. They are reduced by simple extension. Such injuries are very rarely compound, and their treatment will depend on the amount of injury the bones and soft parts have sustained.

Dislocations of the Carpal Bones.—The *os magnum* and *os cuneiforme* are sometimes partially dislocated through relaxation of their ligaments, and form projections at the back of the hand, which must not be mistaken for ganglia. The *os pisiforme* has been dislocated by the action of the *flexor carpi ulnaris* muscle.

Treatment.—Pressure, mechanical support, and cold affusion later.

Dislocations of the Thumb and Fingers are not very uncommon. They are almost always due to movements of over-extension, the distal bone being displaced backward upon the proximal. Displacement is more common at the metacarpo-phalangeal than at the interphalangeal joints, the lever upon which the force acts being longer. The anterior ligament tears, and most frequently at its attachment, which is very loose, to the proximal bone. The displaced bone is found in a position of over-extension; some further extension is possible, but flexion is almost immediately checked.

Reduction is effected by seizing the displaced bone, extending it as fully as possible, then pushing it forward round the head of the proximal bone. This is far more successful than extension in a straight line, even though much more force be used.

Occasionally great or even insuperable difficulty has been met with in the reduction of these dislocations, especially in that of the first phalanx of the thumb on to the back of the first metacarpal. This difficulty has been variously attributed to nipping of the head of the metacarpal by the lateral ligaments of the joints, which are short and strong, or by the tendons of the *flexor brevis pollicis* with their sesamoid bones, to interposition of the tendon of the flexor long. poll., or of the anterior ligament of the joint which has remained attached to the displaced phalanx. Roser and Hüter regard the latter as the chief difficulty, having found it to be so in experiments on the cadaver; but Hüter thinks the others probably occur. He recommends an antiseptic incision into the joint to find out exactly the cause of the difficulty and to remove it; the part must then be carefully fixed with plaster of Paris in straight position. English surgeons usually recommend subcutaneous section of the ligaments and tendons above mentioned, and enlargement of the opening in the capsule, though how this is to be done behind the flexor longus is not clear.

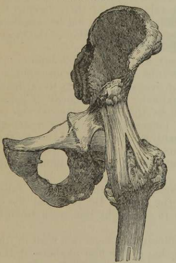
In *compound dislocations* reduce, enlarging the wound if necessary, and dress antiseptically. Amputation may be required by laceration of soft parts.

Dislocations of the Ribs and Sternum.—The *costal cartilages* may be torn from the extremity of the ribs, or from the sternum, when the longer fragment usually overrides the shorter; or the posterior extremity of the ribs may be dislocated from the spine by falls on the back; but these accidents are very rare. A case is related in which the heads of the last two ribs were driven forward from the spine, in a boy of eleven, by a violent blow on the back; abscess formed, and the case terminated fatally.[1] The body of the *sternum* also has been dislocated forward from the manubrium, and the *ensiform cartilage* is sometimes separated. In all these cases the same local and constitutional treatment must be adopted as was prescribed for fracture.

Dislocations of the Symphysis Pubis and Sacroiliac Joints have been noticed under fractures of the pelvis, which they resemble and often accompany.

Dislocations of the Hip-joint.—The strength of this articulation, given by the depth of its socket, its thick, short capsule, and the powerful muscles by which it is surrounded, is very great; but, on the other hand, the lower limb forms a long lever to multiply the action of any force, and the rim of the acetabulum forms a fulcrum against which the neck of the femur may rest whilst the head is levered out of the socket. A glance at the capsule shows that it is immensely strong in front, where it is formed by the Y-ligament of Bigelow (Fig. 116), one of the stoutest ligaments in the body; behind and below it is comparatively thin, and its attachment to the femur posteriorly is weak. The greatest violence is required to tear the Y-ligament; both its branches, as a rule, remain attached to the femur in cases of dislocation, and exercise a most important influence upon the position ultimately assumed by the head, besides preventing it from passing out of the socket through the front of the capsule; and last, and by no means least important, its attachment to the anterior inferior iliac spine serves as a fixed point round which the head may be made to play by movements imparted to the shaft, for upon this our ability to reduce dislocations of the hip by manipulation—*i. e.*, to produce in inverse order the movements by which the head reached its abnormal position—depends.

Fig. 116.



The Y-ligament (Bigelow).

Again, an examination of the bones entering into the hip-joint shows that the position of standing is one of perfect security, the femur being in contact

[1] Dublin Med. Press, Feb. 3, 1841.

with the widest part of the acetabular cartilage which overhangs the head; but the surface of contact becomes much smaller as the hip-bone is flexed upon the femur, and the position is one of obvious danger if at the same time the femur is adducted and rotated in. This is the position—one of flexion, and adduction, and rotation in—in which it is believed by most that dislocations of the hip generally occur. Another precarious position is that of flexion and abduction, and H. Morris supports the teaching of Fabbri, of Milan, that *all* dislocations are produced by extreme and forcible *abduction*, the head passing *backward* when the thigh is at the same time flexed and rotated in, *forward* when the femur is extended and rotated out.

Bigelow regards the tendon of the *obturator internus* as of considerable importance in the dorsal dislocations. In the upright position this tendon runs horizontally outward behind and about the level of the middle of the hip; but as the joint is flexed, it rises more and more above the point of chief pressure of the hip-bone against the femur. Bigelow has found experimentally that when the femur is flexed to 45 degrees and pushed out of the socket, the head passes back above the pyriformis; at 90 degrees it escapes between the pyriformis and obturator internus; and in extreme flexion, below the latter tendon. Inward rotation causes the head to pass out much lower than it otherwise would for a given amount of flexion. Bigelow thinks that the head usually passes out below the tendon, and reaches points high on the dorsum ilii by secondary displacement with stretching or rupture of the obturator internus and other external rotators, rather than that the head reaches its position primarily by a direct thrust back; and in this view Morris agrees with him.

From the above remarks it will be seen that dislocations of the hip may be divided into two classes: the *regular*, in which the Y-ligament or one of its branches remains unbroken, and in which, therefore, the symptoms are fairly constant for the different positions the head can assume; and the *irregular*, much more rare, in which the ligament is torn or its point of attachment broken, the femur being free to assume any position and the signs being correspondingly variable.

In the *regular* dislocations the primary displacement occurs through the lower and hinder part of the capsule, or even as far forward as the edge of the pubio-femoral band. The head is thrown against different points of the capsule according as the hip is flexed, adducted, and rotated in to various degrees, flexed, abducted, and rotated out, or extended, abducted, and rotated out. When the femur is in the first described position its head passes backward to the *tuber ischii*, or back toward the great *sciatic notch*—in either case "below the tendon" of the obturator internus—or it may escape "above the tendon" *on to the dorsum ilii;* in the second position the tendency of the head is down and in toward the *thyroid foramen* on to the obturator externus; and in the third position the head will be forced up and in *on to the pubic bone.* These are the chief forms of dislocation of the hip; they are like the cardinal points of the compass, between which there are many subsidiary points at which the displaced head may lie. If the student will take a hip-bone and femur united by the Y-ligament, he will find it easy to produce all the above dislocations and also the following. From the pubic, by pushing the femur up and a little out, so that its neck is immediately below the inferior spine and crossed by the Y-ligament, we get the *subspinous;* by pushing the head further down and in from the thyroid foramen, the dislocation *into the perineum* is produced; passing outward from the ordinary thyroid dislocation, the position of the dislocation *directly downward* is reached, and then of that down and out *on to the tuber ischii.* If in a dislocation above the tendon the femur is placed across the symphysis, it will be found that some force will now evert it, both branches of the Y-ligament remaining sound and the femur lying across the upper part of its fellow—the *anterior oblique*—dislocation ; by dividing the outer branch of the Y, the femur can be brought down straight, its head passing in above the inferior spine and origin of the rectus—the *supraspinous* dislocation ; and from this position the femur may be carried out on to the dorsum ilii, and being attached only by the inner band of the Y, it is everted—*everted dorsal dislocation*—but can be inverted at will. Starting from the subspinous position by flexing, circumducting, and rotating in the femur, its head may be carried through all the positions it can assume between the inferior spine and the dorsum ilii; and the production of the anterior oblique, supraspinous, and everted dorsal dislocations—all rare—is explained above. Clinically, therefore, we must expect to find that by handling and other accidental circumstances, any one form of dislocation may be converted into neighboring forms (so to speak). It is easy to note such points as whether the limb will be shortened or lengthened, inverted or everted, or either flexed or extended, etc.; and practice with the dissected joint is the only way of obtaining any real knowledge of these dislocations.

There are two *methods of reducing dislocations of the hip:* 1. By *extension* in the line of the displaced limb, or the overcoming of all resistance by force, gained by the use of pulleys, if necessary. 2. By *manipulation*, the principle of which has already been explained (p. 294). As a patient is anæsthetized, the limb descends from muscular relaxation, and the Y-ligament gets even tighter than before. Extension by pulleys in the line of the limb has, therefore, to overcome the maximum of resistance of this ligament, and does so probably by more or less laceration of it. Manipulation makes no attempt to draw the head straight to the socket; *flexion* is its *chief movement*, by which the head is brought to the level of the socket in the upward dislocations, or the Y-ligament relaxed in the downward ; flexion is aided by circumduction or rotation in one or other direction and by direct traction. Hippocrates speaks of reduction "by flexion at the joint with gentle shaking;" and this rocking movement is useful in all manœuvres.

Manipulation has almost universally replaced *force* in the reduction of recent displacements; but many hold the pulleys to be necessary in old luxations to overcome the resistance of cicatricial tissue. Bigelow, however, says that he should expect always to succeed by manipulation so long as the bones remained normal; and it seems that we ought to do so, when it is remembered that by circumduction of a displaced femur it is not difficult to tear through everything which may resist the passage of the head from the anterior spine round to this point again.

For treatment by manipulation the patient, fully anæsthetized, must lie on a mattress on the floor; the surgeon, standing by the injured side, grasps the ankle with one hand and places the other hand behind the top of the calf and flexes the hip and knee each to 90 degrees. He can now with ease cause the limb to perform any movement.

Dislocations not more than two months old have generally been reduced; then the failures have increased rapidly, but successes are recorded as late as nine months. Much, probably, depends upon the skill of the surgeon in performing manipulation ; but there is one difficulty, met with four times by Gellé in 150 experiments, which proved insuperable—the capsule tore close to the femoral neck, and hung as a curtain between it and the socket. Where attempts to reduce fail, a new socket forms for the head in its abnormal position, power of extension is gained, and the limb, though shortened, is ultimately useful.

Accidents from attempts to reduce dislocations, especially those of old standing, are not very rare. The chief are fracture of the cervix femoris and suppuration about the joint, perhaps ending fatally.

With respect to the relative frequency of these dislocations, Sir A. Cooper believed that out of twenty cases twelve would be on the dorsum ilii, five on the ischiatic notch, two on the foramen ovale, and one on the pubes.

Dislocations due to Flexion, Adduction, and Rotation In.

Dislocation on to the Dorsum Ilii.—This and the following dislocation usually result from accidents, such as a heavy weight falling on the back whilst the patient is stooping.

Symptoms.—The thigh is flexed, adducted, and rotated in, so that its line crosses the lower third of its fellow and the toes rest upon them opposite the instep (Fig. 117); the trochanter is less prominent and higher than natural, and nearer the anterior spine; eversion and complete extension of the hips are impossible; the head is felt on the dorsum ilii unless concealed by fat, muscle, or blood; the thigh is shortened one to three inches.

Fig. 117.

Dislocation on to the dorsum ilii (Sir A. Cooper).

The dislocation *backward* (*on to the sciatic notch*) may be regarded as a modification or as the early stage of the above, the head lying below and behind the tendon of the obturator internus (Fig. 118), which causes difficulty in reducing this luxation by extension—the tendon being drawn down with the head and preserving its relation between the head and the socket.

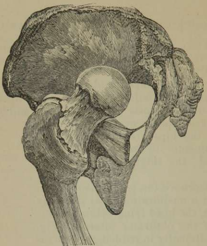
Symptoms.—These vary with the time which has elapsed after the accident. Immediately after, the thigh is more flexed, adducted, and rotated in than in the dorsal luxation, so that the thigh may cross its fellow as high as the middle. But the flexion soon becomes less, and the sciatic is then distinguished from the dorsal dislocation by the slighter shortening, half to one inch. Bigelow says the inversion is more, Sir A. Cooper that it is less, marked than in the dorsal dislocation. The head of the femur is more difficult to feel, and the trochanter is rather behind its natural position and not so prominent.

Diagnosis.—Fracture of the *cervix femoris* may be distinguished from these dislocations by the circumstance that the limb can be freely moved in any direction, although with some pain; that the toes are usually turned outward instead of inward; that the limb is neither flexed nor adducted, and that it can be drawn to its proper length by moderate extension, with some crepitus, but becomes shortened again as soon as extension is discontinued; whereas in dislocation it requires a forcible extension to restore the limb to its proper length and shape, but when once the head of the bone is replaced in its socket it remains there.

Treatment.—*Reduction of dislocations backward by manipulation.* The thigh must first be flexed and rotated in rather more to enable the head to pass easily down behind the socket, and behind the obturator tendon when this lies in front of the head; it is then to be abducted to carry the head toward the lower and hinder part of the capsule, and finally circumduction downward accompanied by rotation out, raises the head over the brim and thrusts it through the aperture in the capsule. Bigelow gives the formula:

lift up, bend out, roll out for *reduction by rotation.* A simple method, that *by traction*, will usually succeed. The pelvis is steadied by the hands of an assistant or the foot of the surgeon (without his boot), the thigh is flexed to

FIG. 118.



Dislocation below the obturator internus tendon, in the neighborhood of the sciatic notch. (Bigelow, "The Hip.")

90 degrees, and a slight pull forward is given by the hand behind the calf, with the result that the head slips in.

Formerly, *forcible traction* in the line of the limb was the method employed.

FIG. 119.

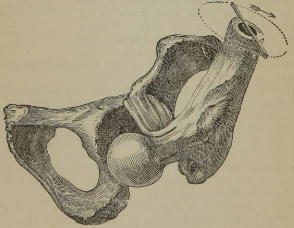
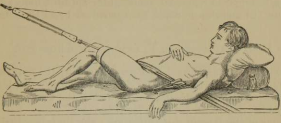


Diagram of the reduction of a dorsal dislocation by manipulation.

In old and young, muscularly feeble patients, or even in the strong whilst faint from the injury, reduction was sometimes effected by a method analogous to the *heel in the axilla.* The surgeon sits and presses his bootless foot against the pubic arch and tuber ischii, whilst extension and rotation are effected by his arms, aided by assistants.

Usually traction by pulleys was resorted to. The patient, thoroughly chloroformed, was placed, on his sound side, on a mattress on the floor; a leather girth or strong towel was passed inside the upper part of the thigh, so as to bear firmly against the tuberosity of the ischium and crista ilii (Fig. 120); and this was attached to a ring or hook securely fastened into

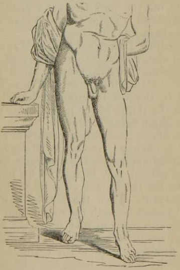
FIG. 120.



Reduction of dorsal dislocation by the pulleys; after Sir Astley Cooper.

the side-wall or post in the line of the thigh. A wetted roller was next applied to the lower part of the thigh, and over it the strap belonging to the pulleys, or a thick skein of worsted arranged in a clove-hitch, and this is fastened to the pulleys fixed to the opposite wall or to a post in the line of the thigh. Then extension was made *in the direction of the thigh.* After a

FIG. 121.



Thyroid dislocation (Sir A. Cooper).

little time the surgeon gently rotated the limb out, or lifted the upper part of it by a jack towel round the thigh, and the head of the bone often returned to the acetabulum. A long splint was then applied, a spica being used, and the patient kept in bed for from two to four weeks.

The sciatic dislocation was found to be much more difficult of reduction by direct traction than the dorsal. This difficulty is said by Bigelow to have resulted from the interposition of his tendon and subjacent portion of capsule which were rendered tense by traction, and so prevented the head of the femur from becoming replaced. By manipulation it is reduced as easily as the dorsal.

Should stronger traction than the surgeon, unaided, can exert ever be required, Bigelow advises that it should be made with the hip flexed to 90 degrees to relax the Y-ligament. The pulleys act from a tripod over the patient, being fastened to a special rectangular splint which keeps the limb bent, and counter-extension is made by a perineal band fixed to the floor.

Dislocations from Flexion and Abduction.

The dislocation *on to the thyroid foramen* covered by the obturator externus is the chief of these; as rare varieties due to secondary displacement, may be given the dislocation *directly downwards* below the acetabulum, *down and in to the perineum, down and out on to the tuber ischii.*

The *symptoms* of the *thyroid dislocation* are: the limb is a little flexed and somewhat abducted and the body is bent forwards; the heel is raised from the ground and the toes point down and either straight forwards or a little outwards; the head usually cannot be felt; there is a hollow over the situation of the great trochanter; inversion and extension are impossible; and the limb is lengthened one to two inches.

In dislocation *directly downwards,* the limb is greatly flexed; the toes may point in or out. When the head passes out *on to the tuberosity,* there are great flexion, adduction, and inversion, the head can be felt, and the hollow over the trochanter disappears; and when it passes *in to the perineum* marked flexion persists, but the limb is greatly abducted and the toes may be turned in or out; the head is plainly felt and may compress the urethra; the hollow over the trochanter is very deep.

Treatment of Thyroid Dislocations by Manipulation.—Flex the limb to 90 degrees, and abduct it slightly to disengage the head; then rotate strongly in and circumduct inwards, keeping up a little traction by the hand beneath the knee. Or the thigh may be flexed and head drawn out by a towel, pushed out by the foot in groin, or jerked up and out; or a log may be placed between the thighs of the patient whilst he sits, and the head levered out over it, the thigh being rotated in.

The variations in the above procedure necessary to reduce the rarer downward dislocations will be obvious; traction at 90 degrees is useful in all.

Forcible traction may be applied to the reduction of thyroid dislocations in two ways: (1) The patient may be laid on his back on a bed, with one of the bedposts between his thighs, and close up to the perineum, protected by a small pillow or cushion. Then the foot is drawn inwards across the median line by a hand passed beneath the sound limb to grasp the ankle, so that the bedpost, acting as a fulcrum, may throw the head of the femur outwards. The foot must *not* be *raised,* otherwise the head of the femur may slip round under the acetabulum on to the sciatic notch. (2) The pelvis may be fixed sideways by a broad band, and the pulleys applied to the upper part of the thigh, to draw it outwards at right angles to the body; whilst the knee is at the same time pulled downwards and inwards.

Dislocations Caused by Over-extension and Abduction.

Dislocation *upwards and forwards on to the pubes* and *subspinous* dislocation.

Symptoms of Pubic Dislocation.—The thigh is slightly flexed and abducted, but completely everted, the toes pointing straight outwards; there is a more or less deep hollow over the trochanter; the head is felt near Poupart's ligament, sometimes beneath, sometimes inside the vessels; inversion is impossible on account of the resistance of the inner limb of the Y and of the obturator internus; the limb is shortened about one inch. When the head passes in as far as the symphysis, the inner branch of the Y is torn.

In the *subspinous* dislocation there is less flexion, abduction, and eversion, and the head lies external to the vessels. The support given to the neck by the Y-ligament over it may enable the patient to walk.

Treatment.—*Reduction by manipulation.* Draw the femur downwards and gradually flex it to 90 degrees, thus causing the head to descend to the level of the rent in the capsule; now rotate in and circumduct inwards, carrying the femur as far over towards the sound side as possible. A towel may be used to draw the head outwards.

In *reduction by extension,* traction should be made in a direction backwards and outwards, and counter-extension by a perineal band running in the opposite direction. When the femur is drawn down sufficiently its head must be lifted over the edge of the acetabulum by a towel and traction slacked off.

Of the remaining very rare regular dislocations—the *anterior oblique,* in which the Y-ligament is sound, and the *supraspinous* and *everted dorsal,* in which its outer branch is torn—only the symptoms can be here given.

In the *anterior oblique* the limb is much flexed, completely adducted, and everted, lying across the top of the other thigh; the head is felt on the dorsum ilii not far from the anterior superior spine, and the limb is greatly shortened. Very little movement is possible.

In the *supraspinous* the limb is a little abducted, and everted so completely that the toes may point backwards; sometimes this is easily corrected; the head is felt below the anterior superior spine, but the trochanter is found with difficulty. The limb is greatly shortened and cannot be drawn down, being hooked over the rectus; movements are tolerably free.

In the *everted dorsal* the toes may be pointing backwards, but inversion can be produced; the head is felt on the ilium internal to the trochanter, and shortening is proportionate to the height at which it is situate; movements are free.

Irregular dislocations may simulate any regular one; but manipulation soon changes their signs, the stability due to the Y-ligament being gone. They are reduced by direct traction towards the socket, aided by local guidance; and two months' rest would not be too much after such an injury.

The *treatment* of *dislocation* of the hip *complicated by fracture* of the femur high up, is (1) to endeavor to manipulate the head into the socket; if this fails, (2) to obtain union, and after eight weeks again attempt reduction by manipulation. If this also fails, or the bone refractures, there is nothing for it but to obtain a false joint with as good movement as possible.

Congenital dislocation is more common in the hip than in other joints. It may occur on one or both sides, usually on both, and is most common in females. The hips are wide, flat, the trochanters are prominent and too near the crests; the lumbar spine is unduly hollow. The patient walks with a peculiar waddle. Both the head of the femur and acetabulum are usually malformed. Nothing can be done beyond drawing down the femora by weight-extension for some weeks, and then applying a well-fitting pelvic band having two strong pads descending from it to press on the tops of the femora and afford them firm points of counter-pressure.

Dislocations of the Knee.—Dislocation of the *tibia from the femur* is not common; and, when it does occur, is rarely complete. In most cases the tibia is thrown *inwards* or *outwards*, with the outer tuberosity on the inner condyle, or *vice versâ;* less often it is thrown *forward* and still more rarely *backward*. The deformity and impediment to motion will distinguish the accident. The displacement must be rectified by simple extension, the knee be kept at rest and ice applied till inflammatory symptoms have subsided, and the limb supported by a well-padded straight back-splint for several weeks afterward. There often remains a permanent inability to keep the joint firm in the straight position, especially after complete dislocations in which the laceration of soft parts is necessarily severe. As a consequence of this and of the great stretching of vessels, inflammation and gangrene are more common after this than after any other luxation. When *compound*, the laceration of tissue is very great, and amputation will often be required; but if the structures of the ham are sound, an attempt should be made to save the limb.

Dislocation of the Patella may occur *inward*, which is extremely rare; or *outward*, which is much more common and natural, seeing that the rectus and ligamentum patellæ form at the patella a very obtuse angle opening outward. This dislocation may be caused either by direct mechanical violence, or by a sudden contraction of the extensors of the thigh in knock-kneed, flabby people. The knee cannot be bent, and the bone can be felt in its new situation. There is, in general, no difficulty in reducing it by means of the finger and thumb, if the knee is straight and the leg raised.

There is one variety, *vertical*, of this dislocation, in which the patella is turned round on its long axis, so that one edge, usually the inner, lies immediately under the skin, and the other rests on the trochlea of the femur, where it is firmly fixed. It is sometimes extremely difficult to replace, at others quite easy. In one instance, the surgeon was unable to reduce it, though he divided the ligamentum patellæ, and cut through the quadriceps at its insertion into the patella; death followed in eleven months, in consequence of his wounding the joint. Three cases of this kind are given by Cooper, and one by Ballingall; Streubel states that of 120 cases, about one-sixth were vertical. In one case Mayo succeeded in overcoming the difficulty by bending the knee to the utmost, so that the patella was drawn out of the groove in which it was lodged.

Bending the knee and then suddenly extending it whilst pressure is made on the free border of the patella is usually successful. The difficulty alluded to must arise from entangling of the bone among the aponeurotic structures about the joint; and there is little doubt but that, in a case of real difficulty, it would be right to open the joint antiseptically and to seek and remove the cause.

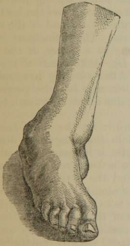
The patella is dislocated *upward* after rupture of its tendon by the extensor muscles. This rare displacement must be treated like a fracture of the patella.

Partial Dislocation of the Semilunar Cartilages.—In sudden twists of the knee-joint from tripping and like accidents, the internal, or much more rarely the external, semilunar cartilage may slip out of place and become wedged in between the tibia and femur. The symptoms are sudden, extreme, and sickening pain, and inability to stand or straighten the limb, with an interval between the bones on the side of the joint affected; sometimes the displaced cartilage may be felt under the skin. Effusion quickly sets in. This accident generally happens to people of relaxed habits, and is very liable to recur, especially if the joint becomes the seat of effusion. In a case dissected by Sir W. Fergusson, the external semilunar cartilage was found to be torn from its connection with the tibia except just at its extremities, and Godlee found it in the intercondyloid space. The best way of restoring the part to its place is to place the patient on the affected side, with the knee bent, and rotate the tibia gently on its axis. This manœuvre may be repeated at intervals until success is attained. Sometimes the fibro-cartilage becomes replaced by its own elasticity, extension then becomes possible. The patient should rest for a fortnight and put on an elastic knee-cap before he moves about.

When the displacement is irreducible, movement must be practised, and after a time the knee will become quite useful. In recurrent displacement prolonged rest with a view to obtaining fixation is useless. It might in some cases be possible to find the cartilage and sew it to the capsule.

DISLOCATION OF THE HEAD OF THE FIBULA is infrequent, except as a consequence of rickety deformity or relaxation of the ligaments from weakness, which must be treated by cold douche, friction with liniments, and

FIG. 122.



Unreduced dislocation of the tibia inward, with fracture of fibula; from a cast taken by Mr. Wilmott, of St. Mary's Hospital, a year and a half after the accident. There was no attempt at reduction.

FIG. 123.

Astragalus displaced upward between tibia and fibula. Accident of five years' standing; no attempt had been made at reduction. There was no fracture. From a cast by Mr. Wilmott.

bandages, with a pad to press on the head of the bone; or it may result from rheumatic effusion into the joint cavity, to be treated by pressure, iodine paint, and iodide of potassium. Two cases caused by violence are given in Sir Astley Cooper's work; the head of the bone could be felt to pass more backward than natural, and could be moved by the finger. The pad of a tourniquet was employed to keep it in its place.

DISLOCATION OF THE ANKLE is generally caused by jumps from great heights, or from carriages in motion, or by violent twists, and may occur in four directions, each of which is often complicated with fracture of the tibia or fibula, or both. 1. Dislocation of the *foot outward* or *tibia inward* is the most common. It is usually attended with fracture of the lower third of the fibula (Pott's fracture), and may be easily known by the side of the foot turning outward, and its inner edge turning downward, with great projection of the internal malleolus and crepitus of the fibula on being straightened. 2. Dislocation of the *foot inward*, or *tibia* and *fibula outward*, is attended with fracture of the internal malleolus, and may be known by the side of the foot turning inward. 3. In dislocation of the *foot backward* the foot appears shortened, the heel lengthened, and the toes point downward. There is also a partial dislocation backward, in which the tibia is half displaced from the astragalus, and the fibula broken; the foot appears shortened and immovable, and the heel cannot be brought to the ground. 4. A dislocation *forward* has been described, but it must be very rare. Sir A. Cooper never saw it. The case described by Mr. Colles was probably a transverse fracture of the tibia and fibula just above the joint, with displacement backward. 5. The astragalus may be thrust up between the bones of the leg, as represented in Fig. 123.

TREATMENT.—These injuries may be so various and complicated that it is impossible to lay down particular rules for every variety, although the general principles are clear. Reduction must be effected as soon as possible, and for this purpose the patient may either be laid on the side or back, with the knee and hip bent. Then an assistant holds firmly the leg just below the knee, and the surgeon grasps the instep with one hand and the heel with the other, and makes extension (aided by pressure on the end of the tibia), till he has restored the natural shape of the parts. The limbs must be put up with a Cline's splint on each side and *slung* in a swing, in the same manner as in fracture of the lower part of the leg—taking care to keep the great toe in its proper line with the patella. After swelling has subsided, the starch bandage may be applied. Chloroform may be administered, to render reduction more easy, and opium in regular doses afterward, to prevent displacement by twitching and spasm.

COMPOUND DISLOCATION OF THE ANKLE-JOINT is the most frequent example of this kind of injury. If the wound in the integument does not heal by the first intention the joint becomes septic, it inflames; suppuration occurs in about five days; much of the cartilage is destroyed by ulceration; at last the wound is filled with granulations, and the patient may recover with a tolerably good foot in from two to twelve months, more or less ankylosis having occurred. The first thing to be done is to wash away all dirt with some reliable antiseptic, with which the recesses of the joint are to be well syringed (p. 239); to remove any shattered pieces of bone gently with the fingers, and then to reduce the bone to its place; slightly enlarging the wound in the skin, if necessary, to effect this without violence. If it is very difficult to return the end of the tibia, or, if it is much shattered, or stripped of periosteum, it is better to saw it off. The foot must be held at a right angle whilst either a large gauze or a permanent wool dressing is applied. If desired, drainage holes may be made before reduction by cutting down on dressing forceps thrust from the wound backward to one side of the tendo Achillis. The leg may then be placed on a Macintyre or Arnold's splint, or two side-splints may be used; care must be taken not to let the foot be pointed, nor be turned to either side. The remaining treatment is the same as that of compound fracture, and the rules which are given as to the necessity of amputation are the same in both cases.

DISLOCATIONS OF THE FOOT.—The most important of these are the *dislocations of the astragalus*, which may be separated from its connection with the tibia, fibula, scaphoid, and os calcis in various ways. Sometimes it is thrown *forward and inward*, so as to project on the inner surface of the foot;

and in this case there appears an unusual projection below and in front of the inner ankle, and a corresponding depression below the outer one whilst the foot is more or less everted; more often it is thrown *forward and outward*, and rests upon the greater process of the os calcis whilst the foot turns in. If these dislocations are simple, reduction should be immediately attempted by extension; chloroform will be needed, and perhaps the pulleys, for the reduction is often a work of difficulty; but patience and good management will usually succeed. Chloroform ought to render unnecessary the dividing of the tendons of refractory muscles, unless they intervene between the bone and its socket in such a way as to prevent replacement. Lastly, the astragalus may be dislocated *backward*, projecting behind the ankle-joint, and protruding on one or other side of the tendo Achillis. This displacement, if only partial, it will be extremely difficult to rectify; and if complete, it will most likely be impossible. If the dislocation is compound, and the bone cannot be replaced, or, if it is much shattered, it may be dissected out. It was formerly considered that if the skin be not broken, it is better to leave the displaced bone. Even if the skin does not slough and render the dislocation compound, these dislocations generally cripple the foot. With antiseptics, therefore, the surgeon would probably do the best for his patient by at once excising an irreducible bone. If, however, sepsis after operation is to be feared and sloughing is not imminent, it is best to wait till the parts round the ankle are healed, and then to dissect out the displaced bone, rendering the foot bloodless first. In some dislocations (*subastragaloid*) the astragalus may be separated from the other tarsal bones, preserving its connections with the tibia and fibula, so that these may be regarded merely as varieties of dislocation of the ankle-joint, in which the tibia and fibula carry the astragalus with them in their displacement.

Besides these, the anterior tarsal bones with the toes may be dislocated from the os calcis and astragalus. The cuneiform bones may be dislocated upward from the navicular, the metatarsal bones from the tarsal, and the toes from the metatarsal. In any of these cases, the proper position of the parts must be restored as much as possible by pressure and extension, and be preserved by bandages; but reduction will often be very difficult, if not impossible, and excision necessary.

Diseases of Joints.

General Pathology.—A joint is made up of four parts: (1) the bone-ends, covered by (2) cartilage, held together by (3) ligaments, which are lined by (4) synovial membranes. It is surrounded by soft parts to which disease may spread from the joint, or *vice versâ*. Of the four above-named structures, two—the synovial membranes and the bones—are of infinitely greater importance as starting-points of disease than the others—cartilages and ligaments—which are dense and non-vascular, or almost so, and therefore little prone to exhibit the primary signs of inflammation; secondarily, they, especially cartilage, frequently suffer. The inflammations of joints may consequently be divided into two classes, *synovial* and *osteal*, according as they start in the synovial membrane or bone. But directly the causes of an osteal inflammation pierce the cartilage, the synovial membrane becomes affected; and it is very common for disease starting in the synovial membrane to extend to the bone. Inflammations which tend ultimately thus to involve all the structures of a joint are usually grouped under the name *Arthritis;* those limited to the synovial membrane under *Synovitis*.

Every stage of inflammation may be met with in joints, as in bursæ and sheaths of tendons. The slightest forms are those characterized by effusion of serous fluid, acute or chronic, from the vessels of the synovial membrane into the cavity of the joint. We may find some swelling and hyperæmia of the synovial membrane, especially of its processes, and effusion of a clear or turbid pinkish-yellow fluid into the joint (*Synovitis serosa acuta*). Or, the hyperæmia may be very slight, the synovial membrane gets opaque and somewhat thick, and pours out a watery straw-yellow fluid, which, if in large amount, causes the ligaments ultimately to stretch, and renders the joint loose and insecure (*S. serosa chronica, hydrops articuli*). In these chronic inflammations it is common to find hypertrophy of the synovial fringes and multiplication of their processes, so that the interior of the joint shows a few small pedunculated, connective tissue growths, or (Fig. 124) is universally papillary (*S. papillaris*), or some of the growths may be of considerable size and tuberous (*S. tuberosa*). This hyperplastic synovitis is especially common in rheumatoid arthritis; and in cases of hydrops this state of the membrane often seems to keep up the effusion.

Fig. 124.

Papillary synovitis of the knee. St. Mary's Museum.

In more acute cases shreds of fibrin appear in the fluid and on the surfaces of the joint, the hyperæmia of the synovial membrane increasing (*S. serofibrinosa*); but the shreds have no tendency to organize as in the peritoneum. At the same time the number of white cells in the fluid increases, it becomes cloudy, and in still more intense forms ultimately purulent (*S. purulenta*). This may occur with very little swelling or other change, remaining post-mortem, of the synovial membrane, the pus coming from the surface of the membrane much as it escapes from a mucous surface in purulent catarrh. Consequently, these cases are spoken of as *catarrhal suppuration* (Volkmann). But in acute "idiopathic" or septic suppuration (*suppurative arthritis*) the pus is thick, the synovial membrane greatly swollen, injected, and ecchymosed, its folds and processes prominent, the superficial parts hyperæmic and œdematous for some distance. The cartilage seems to necrose and wear away rapidly at points of pressure; no cell-growth is found absorbing it. Caries and necrosis of bone follow. Commonly, in these cases the pus bursts out into surrounding tissues through weak spots in the capsule, or abscesses form in intermuscular planes as the result of deep lymphangitis. It is by no means uncommon in these cases of acute suppuration to find the effusion more or less markedly *hemorrhagic*.

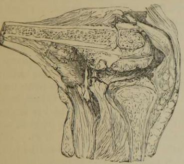
Naturally, an *acute arthritis* may occur without going on to suppuration, the pathological appearances being much the same, except that any fluid in the joint is not pus and is usually in small quantity.

We have now to speak of *chronic arthritis*, inflammation characterized by cell-infiltration of the tissues rather than by the accumulation of fluid in tissue interspaces; it is the parallel of chronic osteomyelitis and similar diseases classed together by German writers under the heading "granulirende Entzündungen." It is in this form that the distinction of primary synovial and osteal varieties is specially important.

The first signs of *chronic synovial arthritis* would seem to be a tendency for the synovial membrane to advance over the cartilage in the form of a slowly contracting vascular rim; this is often seen in joints which have been kept long at rest, especially in the neighborhood of fractures or ostitis. When resulting from simple rest, the exciting cause and nature of the process are not evident, and it can scarcely be regarded as inflammatory.

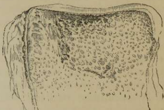
As the disease advances the synovial membrane thickens, in some cases from one-half to three-quarters of an inch, in others but slightly; any natural folds, such as the alar ligaments in the knee, become much enlarged and new folds appear. The tissue of which the synovial membrane now consists is of pinkish-gray or yellowish aspect, often granular on the surface, or when torn, and its vascularity is slight in the commonest form (tubercular). Not uncommonly the morbid granulation tissue grows out through some weak point in the capsule, forming apparently an extra-articular focus. Folds consist-

FIG. 125.



Disorganization of the knee-joint, with ulceration of the cartilages, and softening of the ends of the long bones. From a preparation in the Hunterian Museum, No. 918 A.

FIG. 126.



Caries of the astragalus, with incipient separation of the cartilage. From the King's College Museum.

ing of this tissue push inward over the cartilage, adhere to and erode it, not regularly but in a wormeaten manner—hollows and actual holes alternating, with perhaps here and there a bit of healthy cartilage. In time the cartilage is entirely removed by molecular disintegration; or the granulation tissue, which now invades the bone, may spread between the cartilage and the bone, and separate the former in flakes of considerable size that are sometimes found loose in the cavity of the joint. Ordinary caries of the bone now begins and advances most rapidly at the points of greatest pressure between the bones, the irritation of pressure being here added to that of the primary cause of the disease. It is by no means uncommon to find the bones deeply eroded at the points of maximum pressure whilst the cartilage is fairly healthy at other places. The thickening of the synovial membrane may, however, continue for many months or even years without destroying cartilage or bone, or invading ligaments and surrounding soft parts; the swollen membrane may then be almost shelled out of the capsule. In other cases, presumably of more intense irritation or of feebler resistance on the part of the tissues, the round-celled infiltration spreads widely and rapidly, the infiltrated ligaments are softened, and the more or less eroded bones become easily displaced upon each other (Fig. 125). Thus is produced one form of *pathological dislocation* by the combination of softening of ligament, erosion of articulating surfaces, muscular contraction, and faulty position of the limb. Another form occurs early, in ball-and-socket joints, from distention of the capsule with fluid and faulty position.

When the above disease starts in the bone (*chronic osteal arthritis*), it is secondary to a chronic osteomyelitis of the epiphysis. The granulation tissue eats its way to the deep surface of the cartilage, and frequently spreads out between this and the bone (Fig. 126), detaching large pieces: it also eats its way through the cartilage at several spots, round nodules of granulation tissue sprouting through small holes into the joint. The cavity of the joint and the synovial membrane thus become infected by the noxa, and the result is much the same as that above described. Osteomyelitis of the epiphysis may produce simple caries (p. 279) of the end of the bone, slight or very extensive, or small sequestra may form (*C. necrotica*, p. 279); but in more acute cases, pieces of large size or even the whole epiphysis may die.

Sclerosing ostitis is rare, but may occur; and in some forms, osteoplastic periostitis is found about the bone-ends, causing thickening of them or the growth of irregular osteophytes.

There are many causes which may give rise to a chronic arthritis such as the above, and it is probable that all are of an infective nature. There is one, however, which acts much more commonly than any other, viz., the *bacillus of tubercle*. As a rule, it is very sparsely distributed, and is therefore difficult to demonstrate microscopically; and cultivations and inoculations not uncommonly fail. But the disease is notoriously scrofulous, frequently occurring with other more rapidly progressing lesions, the tubercular nature of which is consequently more easily demonstrable; and acute tuberculosis ranks high among the causes of death. König, Schüller, and others state that tubercles are constantly present in the granulation tissue; and it is now fairly established that the ordinary chronic arthritis is really a local tuberculosis like the commonest form of chronic osteomyelitis (p. 279). The minute structure of the synovial membrane—the diffuse round-celled infiltration, containing scattered tubercles, which may be rare—is shown in Figs. 8, 9, and 10.

The tendency here, as elsewhere, of tubercular granulation tissue is to caseate and soften into thin puriform fluid, which sooner or later makes its way to the surface and escapes, leaving a sinus into the interior of the joint. Not uncommonly the abscess seems localized and *extra-articular*, due to the softening of some cell-mass outside the capsule; but on laying it open freely, an opening in the capsule may almost always be found.

Instead of suppurating, the infiltrating cells may be absorbed or transformed into fibrous tissue, which, in its turn, may ossify; fibrous or bony ankylosis results.

The same may occur after suppuration.

The term *fungous arthritis* is often applied to cases in which there is thickening of the synovial membrane but no suppuration.

The peculiarities of rheumatic and gouty inflammations of joints will receive notice in sections devoted to the subject.

THE ETIOLOGY OF INFLAMMATION OF JOINTS.—The causes of inflammation of joints may be ranged in four groups: (1) direct injury; (2) extension from surrounding parts; (3) infection through the blood; (4) nervous causes (?). These causes sometimes produce an acute, sometimes a chronic inflammation without our being able to account for the difference; though this doubtless lies in variation of intensity of the cause, or of the resistance of the tissues, or in the existence of undetected causes.

1. The *traumatic causes* include blows, wrenches and strains, over-use, penetrating wounds, burns, etc., and exposure to cold. The three former give rise chiefly to acute or chronic effusion into the joint, frequently following on hæmarthrosis. Wounds may produce any degree of inflammation from serous effusion to the most intense suppuration, and the latter is always

much to be feared from a septic wound; it is due, of course, to the action of chemical irritants (products of decomposition) upon the synovial membrane, and not to the injury done by the wound. The effect of cold seems also to be very various, every stage of inflammation, from the most chronic to the most intense, being attributed to it. In the latter cases it probably acts only as a depressant, enabling some infective cause to settle and grow where previously it could not do so. All kinds of injuries, especially the mechanical, act thus when they seem to excite chronic arthritis (*synovitis granulosa, tuberculosa*). This seems to be the class in which *gout* should be placed, its characteristic arthritis being apparently due to the deposit of needles of urate of soda in the cartilage, and later, in synovial membrane, ligaments, and bones; but as such deposits are found in joints which have never been inflamed, the etiology is doubtful.

2. The origin of *arthritis by extension* is seen in the serous or purulent effusion which sometimes occurs in acute infective periostitis, especially with separation of the epiphysis, and in the epiphysitis of congenital syphilis, also in chronic arthritis, secondary to osteomyelitis of the epiphysis. Superficial inflammations, especially erysipelas, may cause some form of inflammation of a joint over which they pass.

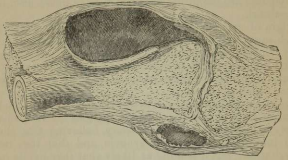
3. Many *infective poisons* are conveyed to joints by the blood and excite inflammation in them; and the different poisons excite different effects. Hüter speaks of these metastases as *secretory*, believing that the organisms are excreted into tbe joint with the synovia, and that they multiply in it and excite irritation; but it is quite as likely that they excite inflammation of the synovial membrane just as *M. erysipelatis* causes inflammation of the skin. The commonest acute infective arthritis is the *pyæmic;* occasionally serous or serofibrinous, it is usually suppurative, the suppuration being frequently catarrhal, but often leading later to destructive and deep-seated changes. There is scarcely an infective fever which is not occasionally complicated by a metastatic joint inflammation; farcy, scarlatina, typhus, and variola may be specially mentioned. In *gonorrhœal rheumatism* an acute synovitis or destructive arthritis, which does not, as a rule, suppurate, occurs. In both early and advanced *syphilis* there may be serous effusion into joints with pain and high fever much resembling acute rheumatism; and in the latter stages chronic thickening of the synovial membrane may occur: but syphilitic disease of joints is uncommon. Its diagnosis rests chiefly upon a syphilitic history and the results of treatment (p. 114). Of *tubercular* arthritis we have already said much; it is usually the most typical *synovitis granulosa*, much more rarely a chronic catarrhal suppuration; and the earlier stages of inflammation are met with at the commencement of the disease. The nature of *acute rheumatism polyarthritis synovialis* (Hüter) itself is doubtful, but its very frequent association with endocarditis, in the lesions of which cocci are found, its relation to endocarditis maligna, and many points in its clinical history incline one to the belief that it is an infective disease characterized chiefly by acute serous or serofibrinous synovitis which very rarely suppurates.

4. *Nervous Causes.*—During the last few years the labors of Charcot and others have revealed the occasional association of somewhat severe forms of arthritis with certain diseases of the brain and spinal cord, and it is held by many that the nerve lesions stand to the joint lesions as cause to effect. The point will be more fully entered into in the section upon "Joint Disease of Nervous Origin."

SYNOVITIS.

ACUTE AND SUBACUTE SEROUS SYNOVITIS. CAUSES.—The commonest is some blow or strain, much less often a penetrating wound that heals quickly, or the impaction of a loose body between the bones; extension from some neighboring inflammation—*e. g.*, erysipelas, or lymphangitis, or ostitis; the rheumatic, gouty, gonorrhœal, and occasionally syphilitic poisons; sometimes a serous effusion occurs in pyæmia, and certain cases occurring in spinal and

FIG. 127.



Section of knee, enlarged with chronic synovitis.

cerebral diseases are credited with a nervous origin. Of these causes that most frequently overlooked is probably a recent or old-standing gonorrhœa; an examination is necessary to eliminate this.

SYMPTOMS.—The joint is swollen, hot when compared with the other, and somewhat painful; the skin over it is very slightly, or not at all reddened, there is little or no periarticular œdema, the joint is not flexed unless the swelling is great, and the patient can move it freely without much suffering; the muscles are not wasted; there is little or no fever unless the synovitis is but a symptom of a general disease, as acute rheumatism or gout.

The swelling is the most characteristic symptom. It is due to rapid effusion of fluid into the synovial cavity, and it is most marked or points where the joint capsule and the surroundings are most yielding; the synovial membrane is, as it were, distended by an injection, and the eye soon gets to know the shape it assumes in the more superficial joints. In the *knee*, which is the joint most frequently affected, the patella is pushed bodily forward, the depressions on either side of it are obliterated, and there is a horseshoe-shaped swelling above the bone extending some three inches up the femur. Unless the joint is very tense, sudden pressure on the patella will force it down on to the femur with a clear tap; and this *floating of the patella* shows positively that the swelling is due, in part at least, to fluid. When there is but little fluid in the joint, floating of the patella may often be obtained if the suprapatella is emptied into the lower part of the joint by pressure on it with one hand, whilst two or three fingers of the other are placed carefully around the *centre* of the bone and used to depress it. Often the fingers are placed *toward the lower end*, depression of which may yield a tap in a healthy joint. But before seeking for this sign *fluctuation* must be obtained, and this is best done by using one hand as above described, and placing the other also astride the lower part of the joint; by now approximating the fingers and thumb of one hand, fluid, if present, will be forced between the fingers and thumb of the other. When there is but little fluid, it should all be forced into the lower, smaller part of the cavity by the upper hand. It is very important before commencing this examination to see that the extensor tendon is lax and the patella freely movable.

In the *ankle*, fulness is found behind between either malleolus and the tendo Achillis, and in front beneath the extensor tendons, raising them up; fluctuation may be obtained from in front of to behind the malleoli. In the *hip*, ill-defined fulness below Poupart and behind in the hollow between the trochanter and the pelvis is sometimes found. In the *shoulder* there is general fulness beneath the deltoid, most marked in front; and in the *elbow* there is a very characteristic horseshoe-shaped swelling fitting on top of the olecranon, one and a half inches beneath the triceps, and divided into two lateral lobes by the pressure of the tendon of this muscle.

Terminations.—The most common by far is *resolution* in the course of one to three weeks; but the effusion may persist, all acute symptoms subsiding (*hydrops articuli*). Much less commonly the effusion *becomes purulent*, or the synovial membrane becomes infiltrated, and the case ends as one of chronic *synovial arthritis*. Much care must be exercised in beginning to use the joint again, as relapses are easily induced.

Treatment.—By far the most important point is the arrest of all movement, the prevention of friction, and this must be effected variously in the different articulations. In traumatic cases seen early, cold may be applied in the hope of checking effusion ; but when this has occurred, and in non-traumatic cases, glycerine and belladonna and hot fomentations are far pleasanter and more efficacious in promoting absorption. This may be hastened by aspiration, an operation which should always be performed to relieve pain from tension. When acute symptoms have subsided, counter-irritation by tinct. iodi., or blisters, or firm pressure may be employed ; and finally, a Martin's bandage may be worn for two or three weeks after abandoning the splint.

For Gonorrhœal Synovitis and Arthritis, see p. 106. This is too common a cause of apparently spontaneous joint disease to be forgotten. The importance of curing the discharge, in order to cure the joint, renders the discovery of the cause essential.

But little is certainly known of *syphilitic joint disease*. Lancereaux recognizes two forms: a secondary synovitis with effusion and symptoms of acute rheumatism (p. 114) ; and a later form characterized by development of gummata in the subsynovial tissue. This is a subject to be inquired into.

Mercury or iodide of potassium must be given, and if the health be broken, endeavor by every means to restore it.

Chronic Serous Synovitis (*hydrops articuli*) may be left after an acute attack, or may begin as such, being due to injury, overwork, exposure to damp cold, gleet, chronic rheumatism or gout, presence of loose bodies, or of a papillary condition of the synovial membrane; often no cause can be found.

Symptoms.—The chief or only physical sign is fluid swelling, having the shape given under acute synovitis ; there is no flexion, fixation, wasting, heat, redness, or pain, but only a sense of weakness or looseness about the joint which may render it unreliable. On palpating the joint, one or more papillary growths *may* be felt slipping beneath the fingers but evidently anchored to one spot; or a loose body may be found now here, now there.

The knee is the joint most often affected.

Treatment.—Rest on a splint is always of great importance, and, if the lower limb is affected, the patient should not walk, except with a Thomas's splint. Counter-irritation is of little value; and strapping over ung.

hydrarg. co. is not much better. For most cases repeated aspiration and the constant wearing of a Martin's bandage as tight as can be borne is the most successful treatment; and it is wise to wear the bandage for six months at least after cure. In cases which do not yield to this treatment, Hüter, Volkmann, and Schede recommend the injection after aspiration of three to five per cent. carbolic lotion, as much as possible to be again withdrawn, and this is to be repeated if necessary. French surgeons similarly inject tr. iodi diluted with three parts of water, but suppurative arthritis has resulted from this treatment. It should here be said that the aspiration of a joint or other cavity requires the closest attention to asepsis; the instrument must be scrupulously clean, the surface to be punctured should be scrubbed with sublimate lotion, a bit of wool steeped in this may be kept round the needle, and the puncture must be carefully closed with a wisp of wool and collodion.

Should all these methods fail, recourse may be had to drainage of the joint if the surgeon can rely upon his antiseptics. This is effected by opening the largest portion of the synovial membrane, inserting a tube and retaining it for a fortnight or so. Any loose body must, of course, be removed, and sometimes in thus opening a joint, synovial folds—*e. g.*, alar ligaments—will be found red and swollen. Such may be excised. In cases of *papillary synovitis*, a few growths may be got at and removed from an incision, but cure of such a joint as that in Fig. 124 could be effected by excision of the synovial membrane.

ARTHRITIS.

ACUTE ARTHRITIS AND ACUTE SUPPURATIVE ARTHRITIS.—The *causes* are: septic wounds, exposure to cold (*acute rheumatic arthritis*); occasionally extension from erysipelas or other superficial inflammation, from the bursting of an abscess (suppurating bursa beneath the lig. patellæ) of the soft parts or of the bone into the synovial cavity, or, much more commonly, from acute epiphysitis of syphilitic or other origin; most frequent by far, infection during the course of an acute, infective disease, especially pyæmia; much less often of the acute specific fevers, glanders, or dysentery.

SYMPTOMS.—The disease begins usually with high fever and perhaps an intense rigor; the joint affected is the seat of extreme pain, is absolutely fixed and helpless, and the patient dreads the slightest movement; swelling is rapid, the œdema spreads up and down the limb considerably beyond the limits of the joint concealing the outline of the synovial membrane; the skin now reddens over the whole or part of the joint, the whole limb swells, the fever reaches 104°–105° daily, the rigor may be repeated, and the patient shows signs of rapid exhaustion. The part is so tender and the œdema so considerable that it may be impossible even now to be sure of the presence of fluid; but under the above circumstances an exploratory aspiration should be made early. If nothing is done, pus escapes either superficially, or large abscesses form in the substance of the limb. The patient may die exhausted by pain and fever, or of some septic disease; or may ultimately recover with an ankylosed joint or after amputation or excision.

The *acute rheumatic arthritis* generally ends after some weeks in ankylosis without suppuration; the effusion is sero-fibrinous.

CATARRHAL SUPPURATION (Volkmann) may develop in cases which are primarily serous effusions, or it may result from many of the causes of acute suppurative arthritis—especially puerperal and urethral pyæmia, and the pyæmia of infants; sometimes also from gonorrhœa.

SYMPTOMS.—These are intermediate in intensity between acute serous synovitis and acute suppurative arthritis. In many cases indeed the diagnosis would be the former, there is so little exacerbation in the constitutional state, the signs of inflammation are so slight, whilst pain may not be complained of at all. But experience has taught that an aspirator will almost surely draw off a sero-purulent fluid from a joint which during the course of pyæmia had been accidentally discovered to be full of fluid. That there is no line between these cases and the last group goes without saying; and unless the pus in a catarrhal case be soon removed, destructive arthritis will set in in most cases.

It is right to add, by way of caution, that the most surprising differences occur in the symptoms of joint disease; thick pus may cause little local and still less general reaction, and after its evacuation recovery may occur with perfect movement, as is by no means uncommon in young children; a catarrhal suppuration and still more an acute arthritis may be attended by very severe symptoms of both kinds.

TREATMENT.—Absolute fixation is of the first importance, and if the joint is in a bad position it should be at once gently straightened under chloroform, and fixed upon a reliable splint; then belladonna should be applied and fomentations assiduously used. If the local and general symptoms point to the presence of pus, but fluctuation is not obtainable, make an exploratory aspiration. If the symptoms and the result of aspiration show the case to be one of catarrhal suppuration, the joint may be emptied and washed out with 1 in 20 carbolic; and this may be repeated if fluid regathers without more acute symptoms. But if the case is one of acute suppurative arthritis, and probably in all cases in young children, the proper treatment is, aseptically, to lay the joint open as freely as possible. Thus in the knee an incision should run from top to bottom of the synovial membrane on each side along the line of reflection of the synovial membrane, and sharp hemorrhage may be expected from the enlarged articular arteries which retract into the dense fibrous tissue; dressing forceps should then be pushed through the joint on the outer side to the skin, cut down upon, and a large tube introduced here.

Young children often recover under most disadvantageous circumstances; but in adults everything depends on the maintenance of rest and asepsis. In their absence all the changes of septic arthritis ensue. Life and limb are now greatly jeopardized; sometimes with good health to start, fixation, free drainage, and careful dressing, a cure will be effected by ankylosis; in other cases, excision of the joint may save the limb; in others again the patient's age and exhausted condition, and the existence of abscesses burrowing far up the limb, will necessitate amputation to save life. In the elbow and shoulder, excision may be performed earlier than in the lower limb joints; for the results of excision are better than those of ankylosis. In the hip-joint, excision should be done whenever possible to avoid the formidable amputation.

When a cure by ankylosis is tried for, the humerus should be fixed to the side in the ordinary hanging position; the elbow should be fixed at 95°–100°; the wrist straight; the hips straight; the knee at 170°–175°; the foot at right angles to the leg.

SCROFULOUS DISEASE OF JOINTS, WHITE SWELLING, PULPY DEGENERATION, ARTICULAR CARIES, CHRONIC TUBERCULAR ARTHRITIS.—It has already been stated that many causes lead to a chronic arthritis, but that the disease which bears the above names is of tubercular nature (p. 318). Its modes of origin—in synovial membrane or in the epiphyses—have been given, and attention has been drawn to the fact that the ultimate result is much the same in either case, except that cases commencing in bone are much more liable to be complicated by necrosis and the presence of sequestra in the joint.

The disease often begins subacutely in a serous synovitis from injury, but more frequently it starts without obvious cause. The great majority of the cases occur in children and young persons, from three to twenty years, but cases are not very uncommon even in quite old people (*senile struma*).

SYMPTOMS.—The first is uneasiness and pain in the joint, leading early to a limp if a lower limb joint is affected; not uncommonly pain is referred also to some other part supplied by the nerves which supply the diseased joint; thus, pain in the knee is almost more characteristic of hip-joint disease than is pain in the hip. Very soon, if the joint be superficial, examination shows swelling, and this is soft and elastic, "pulpy," but does not actually fluctuate, though it is sometimes very difficult to be sure of this. At first all characteristic hollows are obliterated, but the shape of the synovial membrane is not usually so well shown as it is by fluid; thus the knee-joint tends to assume a uniformly rounded aspect, the widest part being at the level of the articulation instead of above the patella, as in hydrops. The part is distinctly warmer than its fellow, but not red; on the contrary, it is pale, the skin being stretched over the swollen joint, and through it the blue subcutaneous veins show plainly. The swelling is rendered more marked by the rapid wasting of muscle that occurs. There are two marked exceptions to the rule that swelling is characteristic of this affection—the shoulder, in which wasting of the deltoid often more than conceals swelling of the synovial membrane, and the hip, over which the glutæi waste. One of the earliest signs of this disease is limitation of the movements of the joint, and this limitation increases rapidly as the case goes on. At the same time many joints in this, as in acute arthritis, assume a characteristic position; the hip becomes flexed, adducted, and rotated in, the knee flexed and rotated out, the ankle more or less extended, the elbow more or less flexed, the shoulder remains in the humerus hanging. Various reasons have been given to account for this flexion of joints in arthritis. Bonnet believed the position assumed by the joint to be that in which it could hold most fluid, and to be due to distention; but we do not see these positions in serous synovitis, when the joints are much more tense than in chronic arthritis; others say that the flexor muscles are stimulated to contract by a reflex from the joint, an assumption based upon the fact that these muscles do contract. It seems most probable that many of the positions are voluntarily assumed to obtain security from injury and ease, slight flexion being the position in all joints in which the joint surfaces are least pressed together by tense ligaments; once assumed, the positions are involuntarily maintained.

After a time, sooner or later, *starting pains* begin. These are shooting pains which occur just as the patient is dropping off to sleep, waking him up, and usually causing a child to scream. They are probably due to movement of tender joint surfaces, permitted by the relaxing muscles; they do not necessarily indicate ulceration of cartilage.

If the case goes still further, the granulation tissue softens at one or more spots, an *abscess forms*, the skin reddens, thins, and bursts, and thin curdy pus escapes, leaving a sinus which may remain permanently open or heal after a time. A probe may or may not touch bone. In other cases the synovial cavity fills with a thin puriform fluid, when we get the signs of effusion into the joint together with those of arthritis. Sometimes the thickening of the synovial membrane cannot be felt in cases which have begun apparently as *hydrops;* but if a markedly turbid fluid is drawn off, the prognosis becomes much graver and the diagnosis will need to be changed. Examination at a late stage will probably show that movements which are normally prevented by ligaments—*e. g.*, side to side movements in hinge joints—can be obtained, owing to softening and infiltration of the ligaments, and at the same time the bones will be felt and heard to grate over each other. These signs should rarely be sought for unless the patient is under an anæsthetic; nor should the old and painful test of striking the heel, and thereby driving the bones roughly together at the ankle, knee, and hip, be practised. It is quite unnecessary for diagnostic purposes. Finally, destruction of ligaments and bones may lead to *pathological displacements* and *dislocations*.

TERMINATIONS.—Recovery may occur at any period—before the bones are affected in synovial arthritis, after this event, or before or after suppuration has occurred. Cases which do not suppurate are spoken of as *fungous arthritis*, and are parallel with caries sicca. It is not uncommon to find a patient walking about, lame, but suffering little or no pain, possessing tolerably free, smooth movement of his knee or ankle, of which the synovial membrane is swollen till it is one-half or three-quarters of an inch thick; and this state of matters may last even for years. It is met with chiefly after puberty in patients whose health is fair, and may end in recovery without or with abscess. Once this disease has become fairly established perfect movement can scarcely be hoped for, but very good movement may be left. On the other hand, ankylosis may be complete and either fibrous or osseous. The limb may be in good position, or in such faulty attitude as to be worse than useless. But in a large number of cases abscess after abscess forms, and the patient is worn out by pain, wasting discharge, albuminoid disease, and hectic, or acute tuberculosis carries him off.

PROGNOSIS.—*Cæteris paribus*, this depends chiefly on the age and health of the patient—the younger and more robust fare best.

TREATMENT.—The first point is, by the most judicious use of the means given at p. 98, to *raise to the highest point the general health*; residence at the seaside is particularly beneficial.

Next comes the *provision of rest*, of which we have spoken so often. The most important point is to prevent friction of the joint surfaces against each other; relief from pressure is quite secondary. When the shoulder is inflamed, the arm should be secured to the side by a few turns of bandage, and the hand slung high; the arm must not be put through sleeves. The elbow and wrist are best immobolized by plaster of Paris over wool, which exerts constant pressure. For the hip and knee-joints no splints compare with those invented by H. Thomas; for the hip, a Hamilton's splint with parallel uprights acts fairly well; for the ankle, plaster of Paris and a pin-leg having a support for the leg projecting backward.

Weight extension, one to six pounds, may be used for the shoulder, and is commonly used for the hip and knee with distinct advantage. It acts really by steadying the limb, not by drawing the joint surfaces apart, for that would require a very heavy weight; and it is always well to fix the body and limb of the patient by a sheet thrown over them, and heavy sandbags laid along the sides of the trunk and limb. If a Thomas's splint can be obtained it should be used, not only for its much more perfect fixation, but because with it patients can live in the open air.

Compression sometimes acts well, but it often disappoints; it is best made by a Martin's bandage, and should be constant.

Counter-irritation by iodine, blisters, and the cautery is of little value; it sometimes relieves starting pains for a time.

The repeated *injection of two to three grm. of three to five per cent. carbolic lotion* into the swollen tissue was strongly recommended by Hüter in fungous arthritis, and is well spoken of by a few German surgeons; most seem to have failed with it, and in a few cases in which I have tried it no positive result was obtained.

Ignipuncture has been used by Richet and Kocher in similar cases, but does not seem so good a means as a diffusible chemical on the one hand, or as erasion on the other if something radical is to be undertaken.

The more radical modes of treatment are: *erasion*, *excision*, and *amputation*, and it is still a moot point when the two former should be resorted to. Two views are held: 1. That good food, good hygiene, cod-liver oil, and sea-air, with perfect rest for the joint, will enable a large proportion of patients suffering from tubercular joint disease to recover—*if* they can devote two or three years or even longer to the cure, and are wealthy enough to obtain the advantages above mentioned. The result hoped for is a more or less complete ankylosis in the best position, and an important point urged in favor of expectancy is that, in growing bones (and most of the cases occur in children), the epiphyses are not removed, so full growth may be expected unless the inflammation leads to early ossification. It must be admitted that in spite of this treatment a good many cases go on to abscess, and some ultimately require complete excision or amputation. 2. Others say, if it is evident that, in spite of the most favorable conditions that can be secured for a patient, the disease does not improve within a reasonable time (three to six months), or that it is going on to abscess, no time should be lost in opening the articulation so freely as to be able to examine the synovial membrane and bone surfaces thoroughly, and then removing with the sharp spoon, gouge, scissors, etc., every particle of diseased tissue. This may be done in cases of synovial arthritis before the bones are affected, when only the synovial membrane may be dissected out; but if the disease has gone further, or is of osteal origin, holes must be gouged in the joint surfaces. It is only when the case has been treated too long on the expectant plan, that the epiphyses require removal, and *excision* must be done instead of *erasion*. After this operation it is well to sponge the cavity well with sublimate lotion, and then to rub it freely with iodoform. The wound must be drained, carefully sewn up, divided ligaments or tendons united, the joint absolutely fixed, and a permanent antiseptic dressing applied. Tolerably rapid union may be counted upon, but it will be necessary to wear a splint for a few months, that all may become solid. The advantages of early erasion are therefore held to be: that it greatly shortens the course of the disease, and gives at least as good results as the expectant plan in regard to mortality, length of limb, and movement of joint; that it is far better than the expectant mode in the case of the miserable children that crowd the London hospitals, for whom good hygienic conditions and often perfect rest are impossible; and lastly, that by this operation a possible focus of general infection is removed from the body (p. 96). Under antiseptic precautions the dangers are slight.

To be successful, erasion must be early, free, and thorough; tubercular tissue left behind will probably lead to recurrence and require a repetition of the operation. The presence of septic sinuses of course increases the difficulty of treating the case, but does not require any change in principle. Against erasion it must be admitted that recurrence is not infrequent.

Excision must be done in cases which are too advanced for erasion, and which are either stationary or getting worse. In the upper limb, the results in suitable cases are so satisfactory, that the operation may be undertaken with little reluctance, and it may be remembered that the periosteum regenerates bone more freely after subperiosteal excisions for early disease than for advanced destructive arthritis (Ollier); but in the lower limb it must be confessed that excision of the hip not uncommonly leaves a limb which is of little value as a support, the head and neck being rarely reproduced to any appreciable extent and union being ligamentous; and that excision of the knee sometimes bends entirely out of shape even after the bones appear soundly united. In the lower limb, therefore, and especially where the hip is concerned, we maintain the expectant attitude longer than in other cases. The presence of sequestra, which can be guessed at only from early suppuration and chronicity of sinuses, necessitates opening the joint, though possibly excision may be avoided. In very young children, excision causes great shortening, and should be postponed as long as possible.

Repair after excision and erasion is just such as occurs after compound fractures; if the periosteum of parts removed is preserved, they will be more or less completely reproduced in young subjects.

Amputation is the final resource, and is required where excision has failed to arrest the disease; or where the disease of bones or condition of soft parts from burrowing of pus is such that excision could not succeed; or where, in septic cases, the patient is exhausted by hectic, and possibly suffering from albuminoid disease, and requires that immediate and complete relief which only removal of the part can give. Lastly, amputation is almost always required in cases occurring in and below the knee after thirty-five; in the upper limb excisions may be done much later with fair prospect of success.

Gout.

Gouty Arthritis, unlike acute rheumatism, affects first the smaller joints and then the larger, generally more or less symmetrically. If the attack is not the first, there is a history of a first attack, probably between the ages of thirty and forty, which began almost certainly about 2 or 3 A.M., often during spring-time, and in the first metatarso-phalangeal joint. The pain is extreme, and is accompanied by moderate fever, which seems to depend on the number of joints affected (Charcot), and lasts several hours; then perspiration, having neither the profuseness nor sourness of that in acute rheumatism, breaks out, and the symptoms are relieved, but the joint is swollen, bright red, shiny, and very tender, the œdema involves the neighboring part of the foot, and the veins leading from the joint are full. The acute symptoms recur twice or thrice at night, and then with decreasing intensity for seven to fourteen days. Desquamation occurs as the joint symptoms subside. The tendency is for these attacks to recur—sometimes at very long intervals, again quickly; generally the second attack comes one to two years after the first, and later ones at shorter intervals. With each attack fresh joints are liable to be involved—from the periphery toward the centre; and the more widely distributed the disease, the less intense do its symptoms become. At the same time, masses of urate of soda (*chalk-stones, tophi*) have been accumulating in ligaments, bursæ, and fibrous tissues around the joints, in the sheaths of tendons (usually those in connection with affected joints), and in the cartilages of the ear, eyelid, and nose, where they form small yellow nodules. As a result of these changes, and also from the fact that nodular outgrowths from the margin of the cartilage may appear as in rheumatoid arthritis, the joints become misshapen, and more or less fixed; ultimately they may become completely ankylosed, for the infiltrated cartilage wears away, the exposed bone is irritated by friction and uratic infiltration, rarefactive ostitis is set up (*gouty arthritis*), rest is given, the opposed surfaces blend, and ossification occurs. Lastly, the chalk-stones cause irritation, the skin ulcerates over them, and the most chronic sinuses form around the joints. This is very common in the hands.

Gout may occur even in children, but when met with under thirty, or in women, there is almost always a strong family history. The tendency of the disease to skip one generation is well known.

The DIAGNOSIS of gout is often of great importance in the matter of treatment; it will be assisted by a family history of gout, which is strongly hereditary; by the patient's being of the male sex; by a history of free indulgence in strong alcoholic drinks, of high living, dyspepsia, and a sedentary, luxurious life; by the presence of lead in the system, and by the discovery of uric acid in the urine or in the fluid of a blister or blood-serum (Garrod). It is most difficult when in a first attack several joints, including large ones, are involved, or when one large one is first affected. Usually, the diagnosis of chronic gout from rheumatoid arthritis is not difficult.

TREATMENT.—In *gout* the vin. colchici (♏x–xxx) with bicarbonate of potash is the main remedy for cutting short the attack and relieving pain; then a simple dietary, abstinence from alcohol, Turkish baths, and plenty of exercise are to be insisted on (F. 149, 151, 158, *et seq.*).

RHEUMATISM.

The synovitis of ACUTE RHEUMATISM may be hereditary, often follows exposure to cold, and the first attack generally occurs under thirty. It affects usually the larger joints—knees, ankles, shoulders, elbows, and wrists; but any may suffer, even those of the hands and feet. It is rarely monarticular, and then never attacks the great toe. The affected joints differ from the type of ordinary acute synovitis chiefly in the intensity of the fever and of the pain by which its onset is announced, the patient being afraid of the least movement; at the same time the joint becomes puffy and often slightly red, and after some hours effusion occurs into it with relief of symptoms. Œdema is not marked, the veins are not full, and desquamation does not occur. Only one joint may be affected, or very many, but, as a rule, only two or three are affected at once; it is, however, a strongly marked characteristic of the disease that as, after a few hours or days, one joint gets well, another becomes painful and swollen, and the same joint may be affected more than once in the same attack. The diagnosis will be facilitated by the marked continued but irregular fever (often out of all proportion to the joint lesions, and apparently *primary* or independent of these or of visceral complications), profuse sour sweating, endocarditis, and inflammations of serous membranes which occur more or less frequently in the disease, and characteristic early anæmia. It is chiefly in subacute cases that difficulty will occur. In these the fever is less intense, sweating less marked, the articular affections more persistent and less wandering than in the acute form, a joint being affected for perhaps six or eight weeks. When two or more joints sudddenly and without evident cause fill with fluid, it is sometimes difficult to know whether or not we are dealing with rheumatism. Always take the temperature in such cases.

The joints very rarely suppurate; sometimes the disease leaves behind it ordinary chronic arthritis of one joint which ends in more or less ankylosis; or, lastly, the disease may become subacute and finally chronic, thus establishing, according to Charcot, its essential unity of nature with chronic rheumatoid arthritis.

The MORBID ANATOMY is said to point in the same direction. The cartilage in acute cases is somewhat opaque and dull; local swellings may render it mammillated, and even erosions may occur. The microscope reveals changes which are probably constant. The most superficial cells divide early, and later, fibrillation of the ground substance occurs, giving rise to a velvety condition; the cell-capsules burst, and the cells escape into the synovia. The subjacent bone becomes very vascular, and the corpuscles increase in it. After two months Charcot has found a thickened, villous synovial membrane, erosions, and a well-marked velvety state of cartilage. In still more prolonged cases these changes are more pronounced, the cartilage worn away, and the bone eburnating centrally, outgrowths are forming round the edge, and the epiphyses are becoming rarefied.

TREATMENT.—The joints are here of minor importance. They may be wrapped in cotton-wool, and the pain is relieved by sod. salicylatis, 20–30 grains every three hours till the temperature falls.

CHRONIC RHEUMATIC ARTHRITIS, RHEUMATOID ARTHRITIS, RHEUMATIC GOUT, DRY RHEUMATIC ARTHRITIS, ARTHRITIS DEFORMANS, CHRONIC OSTEO-ARTHRITIS.—This disease is much commoner in women than in men, in the lower than the upper classes (*arthritis pauperum*). Its onset generally occurs during the cold season, and is often attributed to exposure to cold and wet, to which influences the patients are always very sensitive. In women, it usually appears about the time of the menopause, but it is quite common from sixteen to thirty, and may be met with even among children. Sometimes an injury seems to determine the joint in which the disease shall start. It may follow on acute rheumatism. Some writers regard it as of nervous origin.

There are two chief forms of the disease, usually known as the *polyarticular* and *monarticular*, but better described as *progressive* and *partial chronic articular rheumatism* (Charcot). They are bound together, in spite of considerable differences between typical cases, by the occurrence of cases transitional between the two varieties, and by the following morbid anatomy which is common to both, and also, apparently (p. 328), to acute rheumatism.

MORBID ANATOMY.—The first change is seen in the articular cartilages toward their centres—*i. e.*, at the points of greatest pressure; here they become velvety, and elsewhere they may be slightly mammillated. This appearance is due to multiplication of cartilage cells, the capsules of which unite to form vertical spaces, and these burst into the joint; at the same time the interstitial tissue fibrillates. The cells often undergo mucous or fatty degeneration. Next the synovial membrane becomes very vascular, its processes, especially those round the cartilages, enlarge, and the synovia at this time is constantly increased in amount. This fluid is often acid, and is slightly turbid from presence of mucin, degenerate cartilage, epithelioid and white blood cells. As the joint moves, the soft velvety cartilage wears away more and more until the bones come to rub against each other. Thus irritated, a superficial sclerosing ostitis is set up, and the exposed bone becomes extremely dense and ivory-like in appearance (*porcellanous, eburnated*); the dense layer, however, is said not always to have the structure of true bone, but to be sometimes rendered thus dense by simple calcification of soft parts. The opposed surfaces are neither equally nor uniformly hard, and consequently, as they move to and fro upon each other in hinge joints, they are worn into corresponding grooves and ridges, but they are smoothly worn away (Fig. 128) in universal joints. Meanwhile at the margin of the cartilage rounded nodules (*ecchondroses*) have been growing, until they may form a prominent continuous rim between the cartilage and bone; they ossify rapidly, and leave low, smooth, rounded osteophytes, "like drops of tallow," on the macerated bone. Thus, whilst destruction of cartilage is going on centrally, production is progressing at the margin. The ecchondroses are formed partly by multiplication of cells at the margin of the articular cartilage, partly by metaplasia of bone cells into cartilage cells which continue to grow (Ziegler). Occasionally plates of cartilage appear in the subsynovial tissue and ossify; but much more commonly the cartilage cells normally in the synovial villi multiply, or cartilage appears there by metaplasia, and by its growth gives rise to small pedunculated cartilaginous tumors which may become detached and form loose bodies in the joint either before or after undergoing calcification or ossification. Such loose bodies are common in the knee and shoulder, rare in the hip. In these advanced stages, synovia is no longer in excess (*dry arthritis*), the membrane is thick and often quite villous, or even tuberous, from overgrowth of its processes, and adhesions may exist between parts of it that touch. The capsule also has thickened, doubtless by inflammatory tissue, and become more or less rigid; and whilst, centrally, the bones have been wearing away more and more, such interlocking outgrowths may have formed at the margin that the joint is more or less completely fixed. This fixation may be aided by extension of ossification into the ligaments and neighboring tendons. Bony ankylosis is rare, and is said to occur only in small joints (Charcot). When a perfectly fixed hip-joint is cut across, though all cartilage may have disappeared, the line of the articulation is generally visible; the femur is held by the growth over it, as it were, of the acetabular margin, and the irregularities of the surfaces correspond. By wearing away on its upper aspect and growth at its margin, the head of the femur may look like a mushroom (Fig. 128), and the acetabulum may become shallow and expanded. Changes in the shoulder are often very similar: the head flattened, glenoid cavity expanded by a new rim, the glenoid ligament and biceps tendon, with perhaps the upper part of the capsule, gone, and the head playing against an eburnated surface upon the acromion. Lastly, *when joints are not moved*, we find no eburnation, the capsule and synovial membrane thicken, the cartilage is converted into connective tissue, and a fibrous ankylosis (in most cases) results.

FIG. 128.

Head of femur in rheumatoid arthritis, from a specimen belonging to the late E. Canton. It is worn away above, surrounded by a collar of osteophytes, where it joins the neck, and the neck is greatly atrophied.

A section through the epiphyses entering into joints thus affected shows the bone to be atrophied and unduly vascular from a chronic rarefying ostitis; and macerated bones frequently show worm-eaten holes on the articular surface, even where this is eburnated. This atrophy is specially marked in malum coxæ senile, causing shortening and sinking of the neck; coincidently, osteoplastic periostitis lays down masses of new bone on the surface (Fig. 128). Interarticular ligaments, fibro-cartilages, and tendons gradually wear away. All the above changes are seen most advanced in the monarticular or partial form of the disease, and in the more chronic among the polyarticular class.

Pathological dislocations are rare, and occur only in the smaller joints, in which outgrowths from one bone may actually push the other out of place. Partial displacements from muscular contractions are common in all joints.

1. PROGRESSIVE CHRONIC ARTICULAR RHEUMATISM. — In this form several joints are generally affected, those of the upper rather than of the lower limb, and preferably the smaller ones, especially the second and third metacarpo-phalangeal; they may suffer either alone or with other larger ones. The onset in a large joint alone is much more common than in gout. As a rule, symmetrical joints are affected. In young patients (sixteen to

thirty) many joints usually suffer at once, but after forty a slow progression from the hand and foot joints towards the shoulder and hip is more common. The symptoms may appear in a joint or two, and subside once or twice, before steady advance sets in.

The affected joints are painful, red, hot, and swollen, the inflammatory symptoms being of moderate intensity and the tendency to shift slight. Pain may be constant, though varying much in acuteness, and much affected by change of weather; and similarly the inflammatory symptoms die away and return. When the joint can be moved, we at first feel soft crepitation from velvety cartilage, and perhaps villous synovial membrane; later on, perhaps, the loud, coarse crepitus of eburnated surfaces; finally, little or no movement can be obtained. Outgrowths, much enlarged villi, or loose bodies may be felt.

Quite early in the disease spasmodic contractions of the muscles round the affected joints occur and give rise to characteristic deformities; they are best marked in young patients. The finger-joints may be flexed and extended in every imaginable way; very often all are straight, flexed at the meta-carpo-phalangeal joints, and deviating toward the ulnar side. The hand becomes more or less flexed, the forearm pronated, the elbow flexed, and the shoulder may become rigid and fixed against the side. The lower limbs generally suffer after or with the arms, the knees become flexed, and the hips also, though these generally retain mobility. The foot may be in a position of talipes valgus or equino-varus, and the big toe turns outwards. The spine and jaw usually suffer late. Thus in two or three years a patient may be so crippled as to be unable to do anything but lie quiet. She may live thus for many years. At first, in rapid cases, there is a good deal of fever and profuse sweating, and cardiac disease may occur. After a time the temperature becomes remittent, then intermittent, recurring with acute exacerbations. After two to four years, in these acute cases, pain usually almost ceases and a *status quo* is established.

In the most chronic progressive cases there are no general symptoms, no local signs of inflammation, no muscular contractions; deformities are due to outgrowths.

Cases of all intermediate degrees of acuteness are met with, and rapid cases may occur in the old, slow in the young.

2. Partial Chronic Rheumatism (*Monarticular*).—In this form but few joints, and often only one, are attacked; the larger, even the shoulder and hip, which are avoided in the progressive form, are selected, and the disease belongs to the latter half of life.

This form is generally chronic from the first; but it may start subacutely or even remain after acute rheumatism. Cases of this disease frequently occur to surgeons, the hip, shoulder, or knee being affected; much less often other joints, as those of the spine or jaw.

The symptoms in all these cases commence with pain of rheumatic character and increasing stiffness; but, as a rule, some movement is preserved for a considerable time. The pain may be very severe and varies much. Usually there are no signs of active inflammation, and there is no effusion into the joint nor around it. The movements are at first accompanied by soft crepitation, then by the most marked bony grating; nodular outgrowths are plain if the joint is superficial, and enlarged villi and loose bodies may be felt. As movement of the joint becomes less, the muscles which act upon it waste—*e. g.*, glutei and thigh muscles in *malum coxæ senile*. In this disease we find also progressive shortening from wearing away of the femoral head and atrophy of the neck, and thickening of the trochanter from formation of bone about its base. This process of bone seems unduly prominent on account of the wasting and slight adduction—the pelvis being often raised on the diseased side, because the patient, to interpose another spring between the hip and the ground, walks on the toes. The toes may turn in or out. When this disease starts subacutely, the question of senile struma may arise, and some little time may be required to render the diagnosis sure.

TREATMENT.—Very little can be done to check the progressive form beyond placing the patient under hygienic circumstances, in a dry situation where the temperature is fairly uniform. The anæmia which is always present must be treated, and cod-liver oil and a nutritious diet are, of course, beneficial. The drug said to have been serviceable is iodine in quantities of ♏x to grm. vj (!) in the day, taken during meals in eau sucrée or wine; it may be continued for months if necessary without causing poisoning. Arsenic and the ammoniated tincture of guaiacum sometimes do good in early cases, but frequently produce an exacerbation at first. Salicin and salicylate of soda in large doses relieve the pain at the cost of deafness, headache, etc., next day.

Simple warm, Turkish, or mud baths give relief, as also do fomentations round painful joints. Baths in natural waters containing sulphur, arsenic, or iodine are all recommended. Something may be done to prevent the contractions in the progressive form of the disease—*e. g.*, to keep the knees straight, the foot flat, the elbow near a right angle; and faulty positions may sometimes with great advantage be forcibly remedied. In most cases rest and warmth will be found to give relief. Flannel should always be worn round the joints.

Cf. Charcot, *Lectures on Senile Diseases*, translated for the New Sydenham Society by W. S. Tuke.

JOINT DISEASE OF NERVOUS ORIGIN.

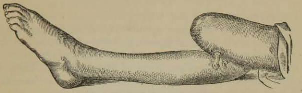
CHARCOT'S DISEASE: THE ARTHROPATHY OF LOCOMOTOR ATAXY.—Examples of this disease appear to be rare, although Charcot once stated that he could show five examples among fifty patients resident at one time in the Salpêtrière.

SYMPTOMS.—In a tabetic patient, without any appreciable external cause, and especially without any injury, an arthritis appears which is totally different in its characters from the joint diseases due to cold, and diathetic states such as gout or rheumatism. It develops usually at an early stage of locomotor ataxy, between the prodromal symptoms (frequent and painful micturition, satyriasis, Argyll-Robertson pupil, accelerated pulse (90–100) without fever, and especially lightning pains) and the phenomena of incoordination. When the disease appears late in the course of ataxy, it almost always affects the upper limbs, in which incoördination is still slight or absent. As to the local signs—suddenly, and without any prodromata, except, perhaps, a little crackling noticed by the patient for a few days before, the whole or a large part of a limb swells greatly; and this tumefaction consists (1) of a considerable hydrarthrosis forming the centre of the swelling, to which is added (2) a firm œdema, scarcely pitting. As a rule, these phenomena are accompanied by no fever or pain; exceptionally both are present. After some weeks or months the swelling vanishes, and all becomes normal (*benignant form*); in other cases (*malignant*), the swelling may pass away rapidly, crackling is present from the first, or soon appears, and within a few months luxation of some kind may occur, so rapid is the destruction of bone. These dislocations may appear suddenly and without obvious cause. A laborer at work suddenly found one leg much shorter than the other: the hip was dislocated and the man had symptoms of ataxia.

The signs of dislocation are extremely plain, for the headless shaft often projects beneath the skin (Fig. 129).

In spite of the above state of their joints, patients are prevented from using them only by their becoming flail-like, or by incoördination; suppuration does not occur in spite of this constant irritation.

Fig. 129.



Sketch from a patient of Dr. Paul's, at Camberwell House Asylum. The tibia and fibula dislocated backward, in consequence of the action of the hamstring muscles after destruction of the ligaments and ends of bones.

Several joints may be affected and the patient rendered helpless. The knee is most often attacked; then the shoulder, elbow, hip, wrist; but the smaller joints do not entirely escape.

Morbid Anatomy and Pathology.—In this the disease closely resembles rheumatoid arthritis, the chief difference being that in well-marked cases of the malignant type, erosion of bone proceeds rapidly, often destroying a whole articular end, whilst there is little or no bone formation—no eburnation, no growth of osteophytes. The rarefaction of the epiphyses which was noted in rheumatoid arthritis is here more marked and may affect the whole bone, hence the occurrence of spontaneous fractures, which generally affect the ends of bones (p. 229); but in less marked cases it is impossible by an examination of the joint to say whether it came from a case of ataxy or from one of rheumatoid arthritis. It is, therefore, held by many that Charcot's disease is only rheumatoid arthritis in an insensitive patient who persists in grinding his joint ends away when the ordinary rheumatic would keep quiet. It is not, however, by morbid anatomy that this question must be decided; the clinical history must be taken into account. Even this fails to carry conviction, and as yet attempts have failed to demonstrate a lesion of certain anterior cornual cells in constant relation with disease of any given joint.

In support of his view that ataxic arthropathy is really of spinal origin, Charcot alludes to similar affections occurring in connection with other diseases and injuries of the brain causing paralysis.

Thus acute effusion with redness and more or less severe pain occurs in *hemiplegia* from hemorrhage or softening; it appears two to four weeks from the onset, together with secondary rigidity. Similar arthropathies have been noticed in *paraplegia* from Pott's disease (generally the knee), in *progressive muscular atrophy*, and, most obviously of all, in connection with *wounds of the spinal cord*. Two cases are quoted of division of half the cord, causing paralysis of motion of the leg on the same side, followed in a few days by great swelling of the limb and arthropathy of the knee, and an acute bedsore on the *opposite* buttock.

Lastly, typical rheumatoid arthritis sometimes occurs in ataxics and retains its peculiarities. There are not wanting those who believe the disease also to be of nervous origin.

Treatment.—Little is required in the benignant form; nothing can be done in the malignant beyond applying such apparatus as will steady the joints and render their use possible. It must be remembered that the symptoms of ataxy may not be striking; the cases must not be taken for rapidly advancing strumous disease and the limbs amputated.

Cf. Charcot, *Lectures on the Nervous System*, first and second series, New Sydenham Society, and discussion in *Trans. Clin. Soc.*, 1885.

Loose Bodies in Joints.

The following varieties are met with:

1. *Melon-seed bodies*, consisting apparently of fibrin and sometimes containing hæmin crystals, may be found in cases of chronic hydrops. They are thought sometimes to originate as a kind of deposit from the fluid in the joint; at others, to form from the fibrin of blood effused. They may be very numerous, but do not of themselves give rise to symptoms necessitating their removal, though the concomitant hydrarthrus may do so.

2. Small *fibrous bodies* are met with which apparently owe their origin to detachment of enlarged villi in cases of papillary synovitis (Fig. 124).

3. Pieces of *cartilage* occur. They are usually of small size, round or oval on the whole, but irregular and nodular on the surface, single as a rule, but sometimes numerous. They may be due to detachment of synovial villi in which cartilage cells have developed; to the escape into the joint of cartilaginous masses from the subsynovial tissue, where they form in rheumatoid arthritis—the most frequent source, according to Billroth; to the detachment of the marginal ecchondroses in rheumatoid arthritis; and lastly to the separation by fracture of portions of the articular cartilage, perhaps with more or less bone.

These *cartilaginous bodies* are frequently *ossified* or *calcified;* usually small, a single one, an inch long and largely ossified, has been found in the knee-joint of a child, quite disabling it. The source of bodies so large as this is doubtful, but it seems probable that bits of cartilage actually grow in the synovial fluid, just as transplanted bits of cartilage have grown into little tumors in the anterior chamber, and that calcification and ossification go on in this medium. Joints affected by rheumatoid arthritis are obviously likely to furnish loose bodies, but these occur in articulations otherwise seemingly healthy.

The knee is by far their most frequent seat; then the shoulder and elbow. But they are uncommon anywhere.

Bodies entering from without are not usually included under this heading.

Symptoms.—The body or bodies can be felt when they present themselves near the surface. They may be very difficult to find, even in the knee, and after one has been felt it may slip away and not present itself to touch for weeks after. They usually keep up more or less effusion into the joint, and the patient is often aware of their presence. Enlarged villi, which are felt always about the same spot, must not be taken for *loose* bodies. When the latter get between the ends of the bones, as they are very apt to do during exercise, they cause sudden excruciating pain and faintness, followed by more or less effusion, the symptoms in the knee being very like those induced by dislocation of a semilunar cartilage; until the dislocation is reduced, and this generally requires some manipulation, the joint cannot be extended, but a history of flexion persisting some time after pain due to a loose body may be given.

Treatment.—Cure can be effected in three ways, (1) by obtaining fixation of the body in some part of the joint where it shall be harmless, and this may be attempted by transfixing it with a pin for a few days (which is not without danger) or by shutting it up in a corner with strapping. Both methods usually fail. (2) By removing the body from the joint. This may be done by cutting down upon it directly with antiseptic precautions; before doing so it is always well to transfix the body with a pin lest it slip away at the last moment; but this cannot be done when the body is much calcified or ossified. (3) There is also the plan of removal by subcutaneous incision, which seems to have been proposed almost simultaneously by Professor Syme and M. Goyrand to avoid the danger of a direct wound into the joint. The cartilage is to be pushed up as high as possible into one of the synovial pouches by the side of the patella, and a tenotome is passed down upon it through a puncture in the skin two or three inches above, and made to divide the synovial membrane to such an extent that the cartilage may be squeezed through into the subcutaneous cellular tissue. There the cartilage must be kept by strapping till the wound in the synovial membrane has had time to heal; when it may, if desired, be easily removed by an incision through the skin; but if it causes no inconvenience, it may be allowed to remain.

The Diagnosis of Joint Disease.

In examining a case of joint disease, symmetrically placed articulations should always be compared. The first point is to determine whether it is one of sthenic or asthenic inflammation, or, as is more usually but less correctly said, acute or chronic. The sudden onset, the intensity of the local symptoms, pain, heat, redness, and swelling from involvement of parts around the joint, the absolute or almost complete fixation of the joint, usually in some faulty position (flexion), the agony caused by attempts to move it, and the severity of the general disturbance will decide this point. Of course, subacute cases occur which may with almost equal propriety be placed in either group. Most of these cases are of a rapidly destructive nature; but it will be remembered that the symptoms in acute gout and rheumatism may be very severe, and yet the tendency to destruction of the joint is comparatively slight.

If a case is not of an intense kind, it will be either a synovitis (effusion) or a chronic arthritis, of which for clinical purposes we may make two classes—granulation arthritis and chronic rheumatic arthritis. The diagnosis between synovial effusion and granulation arthritis is that which has most often to be made. Here we rely first upon the presence of fluid and absence of thickening of the synovial membrane in synovitis, upon the presence of the latter or of both in arthritis. But these points can be made out only in superficial joints; much more important are symptoms which show that destruction of the joint is progressing—such as movement, limited more than fluid in the joint will account for mechanically, or even fixation of the joint, usually in a position of flexion; marked wasting of the muscles; more or less pain excited by attempts to obtain movement; abnormal movement—*e. g.*, side to side motion in a hinge-joint; evidence of destruction of cartilage in the shape of grating from surfaces of bone passing over each other; or evidence to sight or touch of wearing away of the ends of the bones and of their displacement. All these symptoms are absent in cases of simple effusion.

We must add that, rarely, one meets with a chronic suppuration in tubercular cases in which the symptoms are indistinguishable from those of hydrarthrus, the only sign of disease being fluid in the joint; and we may here recall the not infrequent absence of local or general symptoms in cases of pyæmic suppuration.

In the partial form of rheumatic arthritis there will be no fluid in the joint, wasting and stiffness may be marked, and there may be a good deal of pain of rheumatic character, much influenced by weather; the age and probably the history of the patient will help in recognizing the disease, and the soft crepitation followed sooner or later by rough bony grating, unaccompanied by any such pain and general disturbance as would certainly be present in so advanced a case of strumous disease, will make the diagnosis more clear.

The history and clinical course of joint trouble connected with cerebral and spinal disease are so very special that nothing need be said on their diagnosis.

Limited Movement, Contractions, and Ankylosis.

Limited Movement may be due either to (1) disease external to a joint; or (2) to disease of the joint itself.

As examples of limitation due to disease external to a joint may be mentioned the effect of abscess in the iliac or psoas muscle or inguinal glands upon extension of the hip; of contraction of scars in the skin, especially after burns; of contraction of muscles after injury—as in wry neck from tear of the sterno-mastoid during birth, or from adaptive shortening, as in paralytic equinus; of adhesions of tendons in their sheaths, most often seen in the hand.

But by far the greater number of cases of limited movement are due to changes in the joints. These may be due to old fracture with some displacement or growth of callus into the articulation, or to adhesions which form when joints in the vicinity of a fracture are kept long at rest. Much more commonly they are the result of inflammation, present or antecedent. Active inflammation may limit movement by tensely distending the joint with fluid, by rendering the synovial membrane and other joint structures abnormally tender, or, in the case of rheumatoid arthritis, by causing the growth of osteophytes. Past inflammation, on the other hand, may leave behind it contraction of the capsule and periarticular connective tissue, or adhesions between portions of the synovial membrane which normally come into contact in certain positions of the joints, or long or short adhesions between the ends of the bones.

Frequently the limitation of movement prevents the straightening of joints, which are then said to be "contracted." Such contraction may be accompanied by marked displacement of the articular surfaces upon each other, as has already been noted.

Ankylosis, which means "angular position," is a term used to signify absolute or almost complete *fixation of a joint*, and this may occur either in the bent or straight position. Ankylosis may be (1) *false* or *spurious*, the fixation being voluntary or involuntary, and disappearing under chloroform; or (2) *true*, the loss of movement being due to close union of the joint surfaces by fibrous tissue, cartilage, or bone. In *fibrous ankylosis* the bands come from the granulation tissue folds which grow in over the cartilage, eroding it more or less deeply; they may be few and long, or widespread, short, and inextensible. In the latter case no movement may be perceptible in the joint; but usually in this form, slight movement may be detected, or the attempt to obtain it causes a contraction of the muscles which oppose the movement, and may induce some pain.

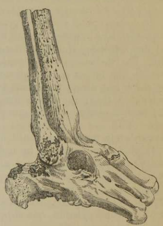
Bony ankylosis results from ossification of fibrous tissue formed from granulations which have eaten through the cartilage on opposing surfaces so as practically to render the two bones continuous (Fig. 130); the union may be quite localized or general. When this form of ankylosis is established, loss of movement is necessarily absolute, and the endeavor to obtain it causes neither muscular contraction nor pain.

Cartilaginous ankylosis (Volkmann) is uncommon. It is said to occur after fractures into joints and slight inflammation, a thin layer of connective tissue which unites the joint surfaces being converted into cartilage. It may be found even after suppuration, localized to spots where the inflammation has been less severe. It is said sometimes to ossify.

It appears, therefore, that ankylosis is first fibrous, and may remain such; or it may become cartilaginous and perhaps ultimately bony; or the fibrous tissue may ossify directly.

TREATMENT OF CONTRACTIONS, LIMITED MOVEMENT, AND ANKYLOSIS.— In certain cases of disease, especially those of tubercular nature, a cure by ankylosis is frequently the best thing that can be hoped for, as attempts to move the joint injure the granulation tissue and diminish its resisting power; in such the surgeon has to see only that it occurs in the most favorable position (p. 323). In others, especially after injuries in healthy subjects, and in cases in which limited movement is threatened by matting of tendons and other structures, the surgeon will endeavor, by systematic passive movement begun when acute symptoms have subsided, to preserve the freedom of the joint.

FIG. 130.



Result of long-continued disease of the ankle-joint. The bones are completely *welded* together by bony ankylosis.

In cases in which all morbid action has ceased, range of movement may be increased by (1) *passive movement*—*i. e.*, movement of the joint produced without action of its muscles, and best performed by some one other than the patient. Sufficient force to cause a little yielding and little pain must be used; and all the movements of the joint should be systematically gone through. The treatment should be combined with friction, shampooing, and local warm baths. There are machines by which a patient can exercise the knee and ankle. (2) *Forcible movement* under an anæsthetic assisted by the division of bands of deep fascia, of tense tendons or muscles. After this the joint is to be fixed in the most advantageous position on a splint till traumatic inflammation has subsided; after which passive motion must be practised daily for some weeks. This method requires care in its use, serious accidents having happened—*e. g.*, knee-joints torn open, united fractures rebroken, etc., and in the knee-joint forcible extension is particularly liable to throw the head of the tibia back into the popliteal space. This is the means by which bone-setters have gained much credit in cases of limited fibrous adhesions after injury which render attempts to move the joint most painful; having stated that the joint is "out," they proceed to "put it in" by a sudden sharp movement which frequently ruptures the adhesions; a crack is heard by by-standers (caused, of course, by the bone slipping into place), and the sharp pain of the movement being over, the patient finds that he can use the joint freely, and goes on his way rejoicing. (3) Sometimes, in order to obtain ankylosis in a good position, *weight extension* is used to remove deformity. It is specially valuable in cases in which disease is still present and the resistance not very great. For the knee-joint

Schede's plan is the best to prevent displacement backward of the tibia. In addition to the ordinary weight extension from the leg, the femur is fixed to the bed and vertical traction by weight over a pulley is made upon the tibia immediately below its head. (4) A constant pressure or traction machine may be used to correct deformity and increase range of motion. (5) In the hip and knee, H. O. Thomas recommends the use of his splints in such a manner that the weight of the limb shall act constantly so as to undo the contraction. The process is easier the more recent the disease; it may be impossible after resolution, when firm fibroid ankylosis has ensued. More or less pain and local excitement must be expected during the reduction of deformity by any of the above methods.

When they fail, as they certainly will in cases of cartilaginous and bony ankylosis, in many cases of stout fibrous ankylosis and of complete or partial pathological dislocation, we must resort to (6) *Resection* or (7) *Osteotomy*. *Resection* will be chosen especially in the upper limb, in the joints of which its results are so good ; it often gives the best results also in angular ankylosis of the knee. But in some cases of firm angular ankylosis of the knee and in all of the hip, *osteotomy* should be done, and the limb brought into the straight position. For the knee the operation is similar to that for genu valgum (*q. v.*) ; for the hip, the femur may be divided through its neck (W. Adams) or through the shaft just above the small trochanter (Sayre). Adams's operation is the easier. A short incision is made from the buttock on the neck of the bone, and with a pistol-handled saw the neck is divided at right angles to its long axis. The use of the chisel (Maunder) facilitates matters, and probably Gowan's new osteotome would be still simpler to work with. When the bone is divided, the femur is brought down straight, any tense bands in front being cut; then a permanent antiseptic dressing and a Thomas's hip-splint are applied. Union in the new position should be allowed to take place, firmness being here of greater importance than mobility. In 1876 Adams (*Trans. Med. Clin. Soc.*) collected twenty-two cases of this operation, of which two died (one pyæmia, one suppuration and "kidney disease") and one was still under treatment.

Sayre's operation is performed with a chain saw; its object is to obtain movement, and the upper fragment is cut so as to present a hollow socket-like surface to the lower.

In very exceptional cases of contracted limbs useless from paralysis, imperfect development, and perhaps ulceration, *amputation* will be required.

CHAPTER XXVIII.

DISEASE OF THE HIP-JOINT, OR MORBUS COXÆ.

This joint is exceedingly liable to chronic disease of tubercular nature, and "disease of the hip-joint," in common surgical language, means tubercular arthritis. But, like other joints, the hip is liable to other forms of acute and chronic inflammation; thus serous and purulent inflammations from injury and wound are by no means uncommon, the joint may suffer in the course of pyæmia, typhus, and rheumatism, suppuration may arise from acute osteomyelitis of the head of the femur, and the hip is exceedingly liable to be affected in partial chronic rheumatoid arthritis. Other causes of joint disease less commonly select the hip as their seat of action.

Acute Arthritis of the Hip.

There is little to add to what has been said as to the symptoms of this disease in general. In the hip we have the same more or less intense pain, starting, utter helplessness of the limb, fear of every movement, and rapid wasting, and the same general disturbance. In the less acute forms, and especially in synovial effusion from injury, the limb is often slightly flexed, abducted, everted, and *apparently* lengthened; and it is said (but it seems very doubtful) that actual lengthening of the limb may be present from separation of the joint surfaces by the effusion. In the more acute and painful forms, the limb rapidly assumes the position (often in an extreme degree) of flexion, adduction, and rotation in (Fig. 131), which is characteristic of the more advanced stages of chronic hip disease. This is the position in which dislocation on to the dorsum ilii most easily takes place (p. 304), and it is said that the head may be thrown out of the socket without the occurrence of suppuration. In the vast majority of cases this is the result of an acute suppurative arthritis which causes distention of the capsule and softening of its posterior portion, when the head is levered out by excessive rotation in and adduction; it escapes below the obturator tendon. This seems to be the pathology of most cases of early dislocation (p. 317).

An acute arthritis may, of course, stop short of suppuration, and subside or pass into a chronic state; but if the synovial membrane has been infiltrated with round cells at all deeply, movement is sure to be more or less limited, and may be altogether lost. On the other hand, all the destructive changes consequent upon suppurative arthritis (p. 316) may ensue, abscesses of huge size may form and point in various directions, and may lead to the death of the patient in several ways.

The Treatment consists in giving absolute rest to the joint by means of a Thomas's splint, a double one if possible, wrapping the hip in frequently renewed hot fomentations, relieving pain by anodynes, keeping a careful lookout for abscess, and opening it freely should it appear. In many cases, and always in those apparently spontaneous, rapidly suppurating cases in which necrosis of the head of the femur from acute osteomyelitis is suspected, the appearance of pus should be the signal for a free posterior incision into the joint, examination of the head, and removal of a sequestrum should one be present.

Chronic Arthritis of the Hip.

Etiology.—This disease is infinitely more common in children than in adults. It is rare under three, most common from five to ten, common from ten to fifteen, and becomes very much less frequent with completion of growth. It ranks third in order of relative frequency among carious bones (Billroth), being less common only than caries of the spine and of the knee-joint.

Very commonly the disease is attributed to an injury; sometimes it is left after an acute specific fever, especially measles; perhaps most frequently no cause is assigned. Essentially the disease is tubercular.

Opportunities of examining hip-joints in early stages of this disease are rare, and examination in later stages does not yield conclusive results as to the starting-point of the morbid process; for wherever it starts, the ultimate effects are very similar (p. 318). It is, however, generally believed that hip-joint disease is very frequently of osteal origin, beginning as a chronic osteomyelitis of the head of the femur or acetabulum, the latter chiefly in adults. Doubtless, it sometimes commences in the synovial membrane.

SYMPTOMS.—The onset may be subacute, accompanied by a good deal of pain, inability to get about, and slight fever; but much more commonly it is gradual and insidious. The first signs are almost always lameness and pain, felt chiefly in the knee, as a rule, but sometimes about the hip. It is noticed that the child in standing bears all his weight on the sound limb, and that in walking the toes turn more or less outward, and tend to drag a little as they are carried forward. If now the child is stripped, laid on his back on a smooth firm surface, and examined, it will often be found that there is slight fulness below Poupart's ligament on the affected side, and pressure here sometimes causes pain; there may be, also, some flattening of the buttock and diminution of the gluteal fold from wasting of the gluteus max. If the two limbs are placed together, it will be noticed that the line of the linea alba crosses the sound limb instead of running down between the two, that the toes point too much out, that the anterior sup. iliac spine and internal malleolus on the diseased are lower than on the healthy side, but measurement from the spine to the malleolus shows that the length of the limb is not increased. If both knees are pressed down flat upon the couch, the lumbar spine will arch up more or less markedly; if the *sound* limb is completely flexed upon the body, this arching disappears, the back touches the couch everywhere, but the knee on the diseased side has now risen more or less from the table (*fixed flexion*); if an endeavor is made completely to flex, extend, or rotate the diseased joint, it will be found to be impossible, the pelvis more or less closely accompanying the femur in all its movements, of which rotation is the most limited. Inspection, manual examination, and measurement, therefore, show that, in the early stage of hip-joint disease, the limb is usually somewhat flexed, abducted, rotated out, and *apparently* lengthened, and that the movements of the joint are limited or abolished. This is owing to fixation by the muscles, for under chloroform the movements are complete. The explanation of the above position, described as characterizing the *first stage* or *stage of apparent lengthening*, of hip-joint disease, is probably that the patient, in standing, throws his whole weight upon the sound limb, using the diseased leg only to steady himself with; for, when a healthy man does this, it will be seen that his resting limb is in a similar position, and that his ant. sup. spine is lowered. Were his knee straightened without elevation of the ant. spine, his limb would appear longer. The pain in this stage is not severe; the above position relieves it from nearly all pressure in standing, and sufficient ease is given to the joint in walking by keeping the knee slightly bent, so that it greatly lessens shocks transmitted along the lower limb. In this movement the ant. spine and side of the pelvis are depressed to bring the abducted lower limb vertically under the body-weight.

As the case progresses, the lameness and pain become more marked, starting pains occur at night, the whole limb, especially the thigh and buttock, waste, the trochanter is abnormally prominent (Fig. 132) on account of this wasting and of adduction, and the patient often loses flesh and strength, and becomes anæmic. At the same time the limb changes its position to that characteristic of the *second stage*, viz., one of greater flexion, adduction, rotation in, and *apparent* shortening (Figs. 131, 132). Sometimes this attitude is assumed from the first; but very often the earlier flexion and abduction are missed by unskilled observers, being masked by sinking of the side of the pelvis (Bonnet). The cause of the assumption of this second position would seem to be fear of injury to the painful joint. Every one has noticed that a child cowering from fear of a blow or other injury almost always throws the most exposed lower limb into the position above described; it is assumed instinctively as being that of greatest security, and once assumed in hip disease, it is maintained involuntarily, for a movement back into another position would be painful. The patient now walks on the toes, which are turned in, and thus a second elastic break (that of the ankle-joint) is interposed between the painful hip and the ground. The ant. sup. spine is raised in order to bring the adducted limb to the ground, and to render it capable of supporting the body-weight.

Fig. 131.

Hip disease, showing position of flexion, adduction, and rotation in; also apparent shortening.

Fig. 132.

Hip-disease, showing wasting, flattening, and widening of buttock, prominence of the trochanter, adduction, and elevation of side of pelvis, with secondary spinal curvature.

Finally, the pain may become so great that walking is impossible. The child now lies constantly, and mostly upon the sound side, never on the diseased; the diseased limb seeks support, and to obtain it gradually sinks into more or less complete adduction, until it lies upon the opposite thigh. This movement is accompanied by increased flexion and rotation in, and the attitude of the second stage is then seen in an extreme degree.

Walking with an abducted limb and a flat foot necessitates some sinking of the side of the pelvis, whilst with an adducted limb the side of the pelvis must be raised to bring the leg vertically under the body-weight. Either of these abnormal positions of the pelvis is necessarily followed by some lateral curvature of the spine; and this is best seen in the second stage (Fig. 132). At first, when the patient lies down, the malposition of the pelvis is easily corrected, but after some time this cannot be immediately effected. By far the most marked spinal change is that known as *lordosis*—*i. e.*, increase of the lumbar curve to compensate flexion of the hip; in proportion as movement in the hip-joint becomes limited, that in the lumbar spine increases, and thus, once more, a defect is to some extent made up for.

Hitherto we have spoken only of *apparent changes in the length* of the limb, but *real shortening* may now occur. This results—1. From impaired nutrition of the limb, and from damage to the growing epiphysial line. 2. From erosion of the head of the femur and of that portion of the acetabulum against which it presses; almost always it is the upper and posterior part of the margin which thus suffers—rarely, when abduction persists into the second stage, the lower and anterior part towards the thyroid foramen; and sometimes perforation of the floor occurs (Fig. 133). In chronic cases, as

Fig. 133.

Late stage; acetabulum perforated and enlarged chiefly downward and inward; great erosion of head and neck of femur; dislocation of the femur toward the thyroid foramen, formation of new bone where the head rested, as if for ankylosis or false joint.

the erosion advances, new bone may be thrown out beyond, and a kind of fresh socket formed; the acetabulum then seems to have enlarged in that direction—*migration of the acetabulum*. 3. From separation of the upper epiphysis, which is perhaps as common a cause as the next. 4. From pathological dislocation, which occurs much less commonly than many suppose. No sharp line can be drawn between cases of dislocation and cases of enlargement of the acetabulum. Dislocation is most common in cases of total suppuration of the joint with destruction of the ligaments, and it is said to be specially frequent in coxitis after typhus (p. 319).

Shortening from the three latter causes is accompanied by approach of the trochanter to the iliac crest, but an accurate diagnosis between them may be impossible. Strong rotation in is characteristic of dorsal dislocation, but when the head is destroyed this sign may be wanting. Strong adduction with flexion points rather to enlargement up and back of the acetabulum; and the signs of separation of the epiphysis are variable.

It now remains to speak of the *occurrence of suppuration*, which is so lamentably frequent; of 401 cases at the Hospital for Hip Disease, 69 per cent. suppurated. It is almost always present when there is marked displacement, and frequently occurs without such displacement. Abscess presents itself most frequently toward the lower part of the tensor vag. fem., and next in the buttock beneath the gluteus maximus. Much less commonly the acetabulum is perforated through the Y-cartilage, and an intrapelvic abscess forms beneath the obturator fascia and usually points just above Poupart's ligament—rarely it bursts into the rectum or vagina. Lastly, an abscess, perhaps commencing in the bursa between the ilio-psoas and the joint, which often communicates with the synovial membrane of the latter, seems to be not very infrequent; it takes the course of the psoas, and may be discovered as a swelling just above Poupart's ligament. The diagnosis from intrapelvic abscess must be made by a rectal or vaginal examination, by which in the latter fluctuation should be obtained from the examining finger to the superficial swelling. In a case of pyæmic suppuration of both hips, I have traced a huge abscess into either psoas muscle; on one side it extended quite up to the transverse processes, which were covered by periosteum, and down almost to the popliteal space; and on both sides there was great œdema of the legs from pressure on the femoral vein. Such an extensive abscess as this from hip-joint disease is very rare.

The DURATION of the disease varies from two or three months to several years.

The PROGNOSIS is very much better in children than in adults, the latter rarely if ever recover after suppuration has occurred unless excision is performed, and even then the outlook is not hopeful. Much always depends on the stage at which treatment is begun, the general health, and the possibility of placing the patient under favorable hygienic and nutritive conditions. Children frequently recover even after suppuration has occurred. Of 260 cases of suppuration at the Alexandra Hospital, 31.6 per cent. died of the disease against 10.5 per cent. of 124 non-suppurating cases.

The chief cause of death seems to be general tuberculosis and tubercular disease of other organs, especially lungs; naturally albuminoid disease ranks high as a cause of death in cases which suppurate. Of 446 cases, excision or amputation was done in 62; no operation beyond opening abscesses was performed in the others. 154 died (34.5 per cent.), and in 39 the cause is known to have been meningitis or some form of tubercular disease (9 per cent. of the whole number of cases). It will therefore be seen that hip disease is very fatal. ("Report of Committee on Excision of Hip-joint," *Clin. Soc. Trans.*, 1871.)

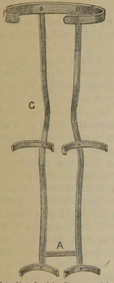
DIAGNOSIS.—*Acute inguinal lymphadenitis*, or *abscess* in the iliac fossa or anywhere in front of the joint, will prevent either full extension or flexion of the hip, and when beneath the pectineus may by pressure on the obturator nerve cause pain in the knee (Erichsen). In these cases, when the parts in front of the joint are relaxed by flexion, full rotation of the femur may be obtained; swollen glands would probably be felt, and tenderness in front of the joint would probably be excessive for hip disease. It is not very uncommon to find that the *knee* on the diseased side is being treated instead of the hip, on account of the pain complained of in it; but examination at once shows that the form and movements of the knee are perfect. Confusion with *disease of the spine* complicated by commencing abscess in the psoas is frequent: for the abscess may cause persistent flexion of the hip. But all movements of the hip except extension are free, and there are no other signs of hip-joint disease, whilst those of spinal caries, especially limited movement of the spine, are more or less marked. When a spinal abscess presents in the groin it may, of course, be taken for an abscess entering the psoas from the hip; but it is again easy to demonstrate that the hip is free from disease. *Sacro-iliac disease* causes pain about the hip and lameness; and the patient will fix the hip-joint against movements so executed that they jar the sacro-iliac articulation. But the seat of pain, swelling, and tenderness, and of abscess if it be present, is quite different from that in hip disease; care in moving the femur shows the hip to be sound, and pressing the hip-bones together or pulling them apart causes pain in the sacro-iliac joint.

Suppuration in the bursa between the gluteus max. and the great trochanter may give rise to symptoms closely resembling those of hip disease (Teale); slitting up and examination of the sinus will enable the diagnosis to be made. Caries and necrosis of the trochanter cause chronic sinuses, but do not affect the position or movements of the joint. *Sciatica* and *hysterical tenderness* need not to be mentioned as a possible source of error. From *chronic rheumatic arthritis* hip disease is distinguished, even when it occurs in the hip of a young person, by much greater fixation of the joint and more severe pain when movement is attempted.

TREATMENT.—*Attention to the general health* is of the first importance. Next comes *absolute rest* of the joint, and H. O. Thomas (*Diseases of the Hip-, Knee-, and Ankle-joints*, 1876) is doubtless right in his assertion that prevention of friction is of infinitely greater importance than prevention of pressure. The value of every apparatus used in this disease varies directly with its power to prevent *all* movement. Weight extension with a sheet over and sand-bags alongside the limb and trunk, the long splint, Hamilton's splint, Bonnet's *grand appareil* (a wire trough to receive the trunk and both lower limbs), and Thomas's splint are the only varieties of apparatus worthy of mention; and of these Thomas's splint is by far the best, for it affords the most perfect fixation, renders nursing painless, allows the patient at the same time all the advantages of getting about in the open air, leaves the joint free for the application of fomentations or dressings, and can frequently be used for the correction of deformity. It is easily made by the surgeon with the assistance of a blacksmith and a saddler, and is not very expensive. To use it will require some mechanical aptitude and a good deal of experience. The instrument maker can only make the splint to measure; the surgeon must apply it and be prepared to make such alterations of form as will insure a perfect fit.

Thomas's directions for the making of the splint are as follows; The patient should, if possible, stand on the sound limb, and books must be placed beneath the diseased one until the lumbar spine is straight. Now take a long flat piece of malleable iron ($1 \times \frac{1}{4}$ inch for adults, $\frac{3}{4} \times \frac{3}{16}$ for children), long enough to extend from the lower angle of the scapula to the lower end of the swell of the calf, and model it to the sound side. The iron must pass downward perpendicularly over the lumbar region, then just external to the posterior superior iliac spine, along the course of the sciatic nerve to a point slightly internal to the centre of the end of the calf. The lumbar portion must be practically plane; then comes a slight curve forward under the buttock, and the leg portion is plane, or almost so, and parallel to the lumbar part. Now, the gluteal bend being fixed in one wrench, the lumbar portion just above is seized with another and rotated in its axis toward the spine, so that it shall lie *flat* upon the hip, just external to the iliac spine; the rotation needed is less in fat than in thin subjects. Its effects are seen in Fig. 136. Next take a piece of hoop iron ($1 \times \frac{1}{8}$ inch) in length equal to five-sixths the circumference of the chest below the angles of the scapulæ, rivet it firmly at one-third of its length from the end next the diseased side in front of the upper end of the upright; model it to the outline of the trunk, which is oval in shape, paying special attention to the fit across the back. A second crescent of hoop iron ($\frac{3}{4} \times \frac{1}{8}$ inch), in length two-thirds the circumference of the thigh, is to be riveted to the upright, one to two inches below the fold of the buttock; and a third similar crescent, half the circumference of the leg, is to be fixed to the lower end of the upright. These, like the upper crescent, are fixed eccentrically, their long ends being *inside* the limb, and they are to have the form shown in Fig. 136. A splint with two uprights (Fig. 134) gives more perfect fixation in acute cases while the patient is confined

FIG. 134.



Thomas's splint for hip disease, with two uprights; if one is removed, it becomes a single splint. Rotation in of the lumbar, out of the leg portion occurs at G, just above the commencement of the gluteal curve (Thomas).

FIG. 135.

Thomas's hip-splint applied (Thomas).

to bed, and is essential in cases of double hip disease and in the reduction of marked deformity; except in the latter case, the crossbar between the splints below should be added. Finally, when a hip with many sinuses has to be treated, a double splint may be applied in which the upright on the diseased side has been removed between the upper and second crescents, whilst a second crossbar connects the uprights at the latter spot.

The instrument must now be padded with one layer of No. 1 boiler felt, and over this with basil leather.

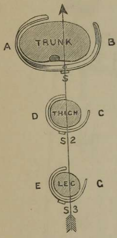
The patient being placed in the splint, a strap and buckle close the upper circle round the chest, the limb is bandaged to the upright from the calf up the thigh crescent, and finally the machine is prevented from slipping down by braces from the upper crescent over the shoulders.

However carefully modelled, the splint is almost certain to require modification in the first few days, and this the surgeon must effect with proper wrenches. Fig. 136 shows how the splint should fit; the long end, A, of the upper crescent lies close to the trunk, exercising some pressure on the sound side, the short end, B, not quite in contact. The upright must pass just external to the posterior spines, but internal to the centre of the popliteal space, S2; this is gained by bending up the long ends of the lower crescents, and prevents inversion of the limb, being aided by the slight rotation out of the leg portion upon the lumbar portion.

Should the splint rotate away from the spine, contract the long wing of the upper crescent, expand the shorter, and increase the rotation of the upright where it crosses the iliac crest; should it shift toward the spine, the opposite changes are required.

It is essential that this splint be made of inelastic iron sufficiently stout to be free from tremor or bending in moving and lifting the patient, or the nursing will be painful. In a proper splint well applied, a child with acute hip disease may be raised without suffering pain, by means of the strap of the upper crescent and a loop of towel round the splint and legs.

FIG. 136.



Sections of trunk and lower limb, showing application of cross-bars and relation of upright to limb.

Usually no local treatment is required, but everything possible must be done to improve the general health. During an acute early stage, Thomas keeps the patient in bed on a soft mattress till satisfied that suppuration has been avoided. When all acute symptoms are absent, the child goes about on crutches, wearing a single splint and a patten *at least* four inches deep (Fig. 138) under the sound foot. This he continues till the muscles are well atrophied round the trochanter, the process being more distinctly felt on the diseased than on the sound side. Then the frame may be removed at night, and worn during the day; and after a varying time, if all goes well, the frame is totally discarded and the crutches and patten alone used. These are set aside when permanence of cure seems assured. Usually the treatment occupies one to two years; if suppuration occur, it may be a good deal longer.

The splint should be applied at once, even though deformity be extreme, the weight of the lower limb being equal to reducing any angular deformity of hip or knee not due to true ankylosis. In bad cases, a double splint must be used, that on the diseased side being modelled to the limb, by bending at G (Fig. 134), until the flexion of the splint *almost* corresponds to that of the hip. Inversion is corrected as usual, but does not demand much attention, as it is always spontaneously corrected after complete cure. Quickly the muscles yield, feeling that they are giving over the limb to safe keeping; and every few days the angle at G is slowly opened out, without removing the splint, by suitable wrenches. Thomas records the case of a boy aged seven, with disease of four years' duration, leaving several scars about the hip, some tenderness, and flexion to somewhat less than 90 degrees; the gluteal angle of the splint was opened every seven days, in seven weeks the deformity was reduced, and in nine weeks the patient was up on crutches.

During the reduction of any marked deformity there is sure to be more or less pain, and perhaps some local heat and swelling, accompanied by a little fever, and the patient should be warned to expect this for a week or more (varying with the stage of the inflammation) when the apparatus is applied, or he is likely to be soon dissatisfied.

In reply to questions, Mr. Thomas has most kindly sent me his latest views as to the treatment of cases in which there is marked abduction or adduction. He corrects *abduction* by bringing down the wing of the upper crescent on the side opposite to the disease until it lies over the lower ribs, or, in severe cases, between them and the iliac crest, and keeping it strongly contracted; the wing on the healthy side runs forward and upward, ending perhaps a little above the nipple, and does not fit closely to the spine. Otherwise the splint is applied as usual; and as the limb comes toward the mid-line the upper wing on the sound side is contracted. In extreme cases, or such as cannot be watched for a week, Thomas adds to an ordinary hip-splint a half crescent, to embrace lightly the interval between the pelvis and the ribs on the sound side.

Abduction is to be corrected by connecting the outer wings of the two lower cross-pieces by a bar, and then bandaging the limb to this and the lower part of the upright.

Should *abscess* form, repeated aspiration should first be tried; this failing, open aseptically. Should sores or sinuses interfere with the splint on the diseased hip, use the modification mentioned on p. 344. Excision is to be resorted to only under conditions mentioned below. Up to 1876, Thomas had excised only one hip-joint, the knee-joint never.

We have thought right to devote so much space to Thomas's treatment of hip-disease, being assured of its great value, and believing that many who use the splint are not nearly so successful with it as they might be.

Weight extension is usually employed whilst a splint is being made, or even throughout slight cases. If the patient is a child, he should be prevented from sitting up by a girth of webbing under the armpits secured from slipping by braces; a bandage is passed through the girth on each side and tied under the bed. The foot of the bed must be raised, the stirrup should reach well on to the thigh, and extension should always be made *in the line of the limb;* gradually the normal line is approached. When the limb is straight, further fixation may be obtained by a sheet over body and limb, and heavy sand-bags down the sides of each. But the joint is necessarily disturbed in nursing.

When a Thomas's cannot be procured, a Hamilton's double long-splint should be worn; a cross-piece behind the sacrum may be used, if the child is placed chiefly on his face.

Whatever method of treatment be employed, the cure is satisfactory only if the limb is in the straight position; its permanence is then evidenced by the non-recurrence, after use, of fixed flexion of the joint.

Indications for Excision of the Hip.—We have already pointed out that shortening of the limb and looseness and insecurity of the joint are, not uncommonly, marked after this operation, whilst in recoveries without excision, though the joint may be stiff, this is covered by increased mobility of the lumbar spine, and the limb remains firm, is less shortened, and therefore more useful for progression. Excision is here, consequently, a *dernier ressort.* It must not be practised until the above treatment has failed and suppuration has resulted; and then only: 1, in certain cases of rapid suppuration (in a few weeks) with severe local and general symptoms, leading to the suspicion of necrosis of the femoral head or neck; 2, in cases of extensive burrowing, fever, and loss of ground in spite of careful treatment; 3, when sinuses persist for months, and no improvement in the joint results in spite of every obtainable advantage; 4, when exhaustion from hectic and suppuration, or albuminoid disease (p. 83) is feared or is present; 5, in cases of intrapelvic abscess it is probably the best treatment, trephining of the acetabulum being performed if necessary for drainage; but an incision above Poupart's ligament may first be tried. In the four latter cases, the disease is probably kept up by the presence of sequestra, or there is spreading tubercular ulceration of the bones and soft parts which the patient is unable to cope with and which must therefore be excised as fully as possible. It may be necessary to remove large portions of the pelvis, and this always renders the prognosis more grave.

The mortality after excision of the hip is considerable. The most recent statistics are those of Jacobsen, which embrace the earlier ones of Leisrink. Of 250 cases, 58.4 per cent. died. Contrary to what English experience shows, Jacobsen found that of 63 cases of suppuration from the Copenhagen hospitals, no fewer than 73.2 per cent. died. Croft, of St. Thomas's Hospital, lost 18 of 45 cases of excision (40 per cent.); and of these 4 died of pyæmia —a septic mortality which might well be lower.

Amputation may ultimately be required after excision when profuse suppuration continues and fresh abscesses keep forming, when disease of bone slowly progresses beyond a point removable by excision, or when acute osteomyelitis of the femur after excision leads to extensive necrosis with the symptoms given at p. 282.

White Swelling of the Knee.

A few words may be said upon this subject, chiefly for the purpose of introducing the student to the use of Thomas's knee-splint.

The *symptoms* of the disease are usually marked. Pain and tenderness about the anterior and inner part of the head of the tibia, slight elastic swellings first obvious on either side of the lig. patellæ, and fixed flexion or distinctly limited movement of the joint, causing the patient to walk upon the toes and to limp a little, are the first signs. As the disease progresses, all the above symptoms increase and starting pains at night are added. Wasting of the thigh muscles is marked, and renders more evident the swelling of the synovial membrane. Sometimes this is slight, sometimes very great; the outline of the suprapatellar pouch may be quite plain, but as, from wasting, the thickness of the muscles is always subtracted from the limb above the knee, the widest part of the swelling is not above the patella—as in synovial effusion, p. 320—but opposite the interval between the bones, and the swollen joint has rather a rounded appearance, or it is pyriform with its larger end down. The skin becomes pale, tense, thin, and often shiny, while many blue veins are seen through it; the part is hot to the touch, and the swollen parts elastic and semi-fluctuating; there may be some fluid in the joint. Flexion increases, but the tibia is dragged backward on the femur out of proportion to the flexion; at the same time it becomes rotated out more or less markedly. In some cases the inner condyle grows excessively and the deformity of genu valgum results. Abscess may form at any time. Often for a long time the patient gets about on the crippled and motionless joint; but sooner or later it becomes incapable of bearing weight, the ligaments become infiltrated and softened, also the parasynovial tissue; great destruction of the ends of the bones may occur, leading to extreme displacements, but this is not common. Once the ligaments are softened, lateral movement may be obtained by the surgeon. It always indicates great destruction of the joint.

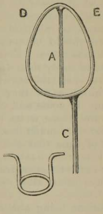
The diagnosis from *synovitis* has already been given (p. 335). Formerly cases of *joint disease in ataxy* ran some risk of amputation; but that is hardly probable now that the disease is better known. From *hysterical joint* the diagnosis may be very difficult, as a certain amount of redness, heat, and puffiness may develop in association with fixation and great tenderness. Other evidences of hysteria must give the clew; but it must be remembered that a hysterical patient may have a strumous joint. Lastly, fungous arthritis must be distinguished from *malignant growths* of the end of one of the bones entering into the joint, chiefly by limitation of the disease to this end, possibly by pulsation or eggshell crackling, by rapid and steady growth, by extension beyond the limits of the synovial membrane, etc.

TREATMENT.—1st. *Attention to the general health.* 2d. *The provision of absolute rest.* This is best made by means of Thomas's knee-splint (Fig. 137). The upper ring is made of an iron rod three-eighths of an inch thick —more or less, according to the weight of the patient; it is almost an ovoid, and is covered with boiler felt and basil leather. From its upper and lower portions two iron rods pass down to a lower smaller oval across which is a small staple, used only for fixation in the reduction of flexion.

FIG. 137.

Thomas's knee-splint, with apron, patten, and staple for retention (Thomas).

FIG. 138.



Upper ring of a left knee-splint, actual shape; points of insertion of stems. Below a patten (Thomas).

FIG. 139.

Thomas's knee-splint and patten applied (Thomas).

The upper ring should join the inner stem at 55 degrees, which angle is by proper padding reduced to 45 degrees; the padding gets rapidly thinner toward the outer side (Fig 137). The anterior crescent, E, of the upper ring is much straighter than the posterior, D; and inside stem, C, is connected to the ring in front of the mid-lateral point, the outer stem, A, being fixed to the central and uppermost point outside (Fig. 138). The stems are so long that one to two inches intervene between the toes of the *fully* extended foot and the ground. A strap passes over the shoulder of the sound side, and is attached by buckles to the front and back of the upper ring (Fig. 139).

Across the two bars is stretched an apron of basil leather, having in it two slits for the insertion of the bandage (Fig. 137). When the patient walks, the splint must fit well; a patten, high enough to make the shoulders level, is worn under the sound foot. For use in bed the fit of the upper ring need not be very exact, and the stems may be made of one rod bent at right angles below, and here a small staple is easily bent for fixation. Later, if necessary, this can be removed, and a patten welded on. In a regular bed-splint the upper ring is oval, and the inner stem attached to the end, so the splint fits either limb.

In advanced cases, when the knee is larger than the thigh at the groin, a caliper splint, opening either below or above, may be used. To make room for a dressing, the stems of an ordinary splint may be bent out at the joint.

When the patient is confined to bed, the splint should be slung to a cradle by its lower end, to keep the limb from the bed.

The splint is fixed to the limb by two flannel rolls, one for the thigh, firmly applied, that the splint may move with the thigh rather than with the leg; the other for the leg, put on less firmly, that the leg may not resist downward pressure of the femur, but may be kept from chafing (Fig. 139).

When there is much flexion the patient must be confined to bed; the apron cannot be used, but the limb must be fixed by a stirrup to the staple and bandages round the leg and thigh. The lower end of the splint must be fixed to an angle on wheels which raises the calf from the bed and keeps the patient on his back, so that the weight of the limb is constantly tending to open out the angle at the knee; or this fixation may be effected by other means. No traction on the leg should be made by the stirrup, it must be kept just tense as the limb comes down. Flexion is reduced during the stage of inflammation much more easily than after resolution.

When the joint contains fluid it should always be drawn off. Repeated aspiration should be tried for abscesses, or they may be opened aseptically, and all diseased tissue removed. In acute and chronic general suppuration, the joint must be laid open, and there is no doubt that perfect fixation renders the dangers of this procedure much less.

With regard to the length of time that the knee (or the hip) must be fixed, Thomas states that the longer the fixation, the less likely is ankylosis to occur; bony ankylosis after correct mechanical treatment is, he says, very rare. Temporary stiffness always occurs after resolution, but it will wear off without interference.

Cure is evidenced by the patient being able after using the joint voluntarily to place it in the position it occupied in the splint.

Excision will be required only in cases similar to those mentioned under hip disease; the objections to it are that it causes much shortening of the limb, and sometimes leaves a weak or deformed union. But *erasion* may be done much earlier as a truly conservative operation, and combined with Thomas's splint will yield fair results.

We may here repeat that no splint affords such perfect fixation of the knee as does this; that without the apron it is an excellent splint after excision of the knee; that it is very valuable in the treatment of fractures of the shaft of the femur (p. 268), and may be used for fractures of the patella (p. 271).

Amputation is required after failure of excision in young patients, and in others too old or otherwise unfit for this operation.

Thomas believes that the main obstacle to recovery from chronic arthritis are, friction and pressure, and that the former is, by far, the most serious. Important as they doubtless are, we must still remember that we are dealing with an infective inflammation which will continue to extend so long as the conditions are favorable, and may perhaps prove generally infective. This indeed constitutes the chief argument in favor of erasion and excision, especially among the poor.

CHAPTER XXIX.

INJURIES OF ARTERIES—ARTERIAL HEMORRHAGE AND HÆMATOMA.

Contusions of Arteries leading to symptoms are rare in civil, commoner in military practice. They are usually the result of the passage close by the vessel of some blunt object, as a railing spike or a bullet, but symptoms may follow bruises through the uninjured skin. The elasticity of bloodvessels frequently enables them to escape rupture by such bodies, but they sustain more or less severe contusions. Guthrie (*Commentaries on the Surgery of the Peninsular War*) records a case in which a bullet passed between the femoral artery and vein in Hunter's canal without opening either, but bruising both. The result was thrombosis of both vessels and gangrene of the limb; but it is hard to say how much of this was due to the presence of a septic wound. In other cases a contused piece of artery sloughs, and thrombosis being insufficient, secondary hemorrhage follows; this is almost surely due to sepsis. Lastly, injuries of the nature of a contusion or strain are rarely followed within a few weeks by the formation of a true aneurism (see p. 246) probably an arteritis is excited which softens the vessel-wall and causes it to yield.

Varieties and Causes of Wounds of Arteries.—These may be incised, punctured, contused, or lacerated ("ruptures") like the necessarily accompanying wounds of other parts. A few cases of *non-penetrating wounds* of arteries have been recorded, chiefly of the carotid in cut throats; there would be no danger of hemorrhage from rupture or sloughing, or, later, of aneurismal dilatation.

Penetrating wounds and solutions of continuity of arteries are generally due to instruments which have entered through skin or mucous membrane, inflicting an open wound. But large arteries are sometimes wounded by fragments of bone in simple fractures, or "subcutaneously" in the operations of venesection or tenotomy, or by rapier thrusts—the small wounds healing rapidly; or they may be torn, especially when diseased, by strains (extension of knee in jumping), or blows not lacerating the skin. In these cases the blood forms for itself a cavity or becomes widely diffused in the soft parts, and the tumor-like swelling which appears—communicating, as it does, with a main or large artery—is called an *arterial hæmatoma*, or *traumatic aneurism*, a term leading only to confusion. For the present we shall turn our attention to arteries injured in incised or punctured, lacerated, or contused wounds.

Characters and Diagnosis of Arterial Bleeding.—The *sign* of wound of an artery is hemorrhage of the following character. The blood is of *bright red color* and issues *per saltum*, in forcible jets; even from vessels smaller than the radial at the wrist, blood will be projected three or four feet at each heart-stroke, but during diastole the stream falls much nearer the patient. In conditions of asphyxia and deep anæsthesia, however, arterial blood may be quite dark. The pulsating flow is best seen in cases of transverse division of large arteries upon the face of a wound; it is absent in wounds of very small arteries, the stream from which is more or less steady, but well projected. When the wounded vessel lies deeply and cannot be seen, the wound fills intermittently and gushes of bright blood occur from it.

The only arterial bleeding likely to be misunderstood is that known as *recurrent* or *regurgitant,* which comes from the distal end of a divided vessel. Such bleeding in the *lower* limb occurs in a *continuous* stream of *dark* color (Guthrie, *loc. cit.*); in the upper, the circuit is so much shorter and the anastomosis so free, that even in recurrent hemorrhage the blood is bright and may even pulsate.

Results of Partial Division.—When the wall of an artery is wounded the opening, especially if transverse or oblique, tends to gape; the natural elasticity of the vessel drags the edges apart in the longitudinal direction, being slightly assisted by longitudinal muscular fibres, and in the transverse direction the circular fibres act. There is not the slightest tendency to the closure of such wounds, and, when other than very fine punctures, they usually bleed most persistently. A firm clot seems to be the only thing that can arrest it, naturally, for they can neither retract nor contract; but clot is rarely firm enough in man. Guthrie says that bleeding from an artery as large as the brachial divided for one-fourth its circumference usually ceases spontaneously before syncope occurs in dogs; whilst in horses and sheep it continues till they die. Should the wound in man heal under pressure, it does so by obliteration of the canal at the point. Smaller wounds, especially longitudinal and punctured, may heal without such obliteration; but the scar may subsequently stretch, giving rise to a true aneurism.

Results of Complete Division.—After cross-section two important phenomena appear: 1. *Retraction of the vessel within its sheath* owing to its elasticity and to the constant tension which obtains in the arterial system from the heart to the capillaries. When a limb is extended the ends of a divided main artery will separate at least a centimetre, and full flexion will not bring them quite together. 2. *Contraction of the lumen,* due partly to the elasticity of the previously distended vessel, but chiefly to active contraction of the irritated circular muscular fibres. This contraction is not immediate, as it would be with voluntary muscle, reaching at once its maximum, but commences a few seconds after the application of the stimulus, slowly increases, and endures for some time; it may also extend up the vessel for half to one inch. The result of these two processes is that the end of the artery, much diminished in size and of conical form, lies at the bottom of a short canal or sheath from which it tends to shrink; and blood escaping from the mouth of the vessel has to flow over the rough and foreign surface of the sheath. It therefore coagulates on the surface of the canal and in the meshes of the connective tissue forming it; and clot forms also between the conical end of the artery and the sheath, making some lateral pressure upon the vessel-end, which will at least support it and hinder its dilatation when the muscular contraction has passed off. All this clot is called the *external coagulum.* It is owing to the above three processes—retraction and contraction of the end and formation of an external coagulum—that small vessels, which bleed strongly when cut across, gradually cease to do so after a few seconds; and *natural* or *spontaneous arrest of hemorrhage* is assisted—1, by weakening of the heart as loss of blood and nervous shock induce faintness; and 2, by the greater tendency to coagulate which is induced by hemorrhage in the blood remaining in the body.

When bleeding has been arrested, an *internal coagulum* usually forms. This starts upon the foreign surface of the cut and inverted internal and middle coats, and extends until the movement of the blood becomes too strong to permit further clotting—usually up to the first collateral branch, below which there is almost complete stasis. It is more or less conical, and not at first adherent to the vessel-wall; and it acts as an elastic buffer between the blood-wave and the clot closing the orifice of the vessel. It is not essential to the temporary arrest of hemorrhage, for it does not form until bleeding has stopped; nor is it required for its *permanent arrest*, as in some cases it never forms.

Lateral wounds of arteries are similarly closed, if, indeed, Nature suffices to arrest the bleeding from them. An external clot prevents the escape of blood, and then an internal, totally obstructing clot forms. Should these succeed in resisting the arterial wave, permanent closure of the wound or vessel takes place, just as in instances of complete transverse division, which will now be described.

PERMANENT ARREST OF HEMORRHAGE is due to the healing of the wound in the vessel. There is nothing special in the means by which this is accomplished. The vessels round about the end of the artery, irritated by injury,

FIG. 140.

Contracted artery, from the umbilical cord of a calf.

pour out the usual exudation of fluid and cells; the red corpuscles in the clot break down and their coloring matter is absorbed, so that in a few days the external clot is replaced by more or less round-celled exudation which is becoming vascularized. The site of the artery in septic stumps is marked by a patch of yellowish or greenish lymph. Similar changes take place internally. Here exudation occurs from the vessels in the wounded arterial tissues, and a button of firm lymph, adherent to the cut edges of the vessel, appears about the third day in the base of the internal clot.[1] This increases, the vessel goes on contracting upon it, loses its endothelium, and becomes adherent; its walls also are more or less infiltrated with leucocytes. New vessels communicating with the vasa vasorum form in the cell-mass, converting it into granulation tissue; and this, both inside and outside the vessel, changes as usual (p. 59) into contracting fibroid tissue, which ultimately reduces the end of the artery into dense connective tissue, adherent to surrounding parts. The permanent barrier thus opposed to the blood may be very narrow, simply rounding off the end of the vessel; or it may be a fibrous cord of some length—differences depending apparently upon the force of the circulation in the immediate neighborhood of the wound. Thus Guthrie tied the common iliac five-eighths of an inch from the aorta and three-eighths of an inch from the internal iliac; one year later, the separated ends were just closed and connected to each other by new connective tissue. Though remaining pervious, an artery always atrophies above a point of obliteration in proportion as its work (as a conduit) is diminished;—*e. g.*, after amputation at the middle of the arm, the brachial atrophies at least as high as the origin of the subscapular.

In this process of healing it will have been noted that the actual thrombus takes no part; it is not the thrombus, but the lymph which is "organized."

[1] Some authorities describe the endothelium as proliferating, and sending many vascular processes of cells into the clot.

When the *internal coagulum* is long, and it may measure some inches after ligature of the base of the carotid, it is infiltrated only at its base; beyond this it is rapidly decolorized, and may remain for several months as a non-adherent fibrinous cord, but usually it is short, and soon disappears after closure of the vessel is accomplished.

When an artery is simply divided, healing in the lower end is much less perfect than in the upper. The lower end retracts and contracts less completely; and internal coagulum forms scantily (Guthrie). The reason of these differences is unknown, unless it be the interruption, more or less complete, of blood and nervous supply to the lower end. But their result is that *secondary hemorrhage after division of ligature in the continuity of an artery occurs much more commonly from the distal than from the proximal end.* If all goes well, the last act in these cases is the establishment of collateral circulation (p. 42); then the vessels in the scar between the ends of the divided artery enlarge markedly, and may, it is believed, bring about a direct communication between the proximal and distal portions.

It would appear from experience that natural processes are ordinarily sufficient to arrest permanently the bleeding from small vessels such as the digital or temporal, especially if they are completely divided; puncture and partial divisions even of these may give rise to recurring losses of blood. When the injured vessel is as large as the brachial or posterior tibial, bleeding will cease for a time when syncope supervenes; but as the heart recovers, the coagulum in the orifice of the vessel will probably be dislodged, and bleeding will recur again and again until it is checked by art or the patient dies. Lastly, when a large artery, as the femoral or subclavian, is divided or freely opened, and the escape of blood is in no way opposed, bleeding will be so great as to occasion death, perhaps, within a minute. But if the wound be little more than a puncture and longitudinal, it may be closed firmly by clot during syncope, and the patient may survive if properly treated.

The spontaneous arrest of hemorrhage is rendered difficult by any interference with the processes upon which it depends. Deserving of special mention in this respect are: incomplete division of a vessel; dense surroundings, preventing the usual movements of a divided artery—*e. g.*, the rigid connective tissue of the galea—the bony canals in which the superior palatine, dental, and other vessels run; abnormality of the vessel-wall, hindering or preventing its contraction, such as results from chronic inflammation of a part, or from atheroma or calcification of the artery; the effects of irritation, particularly septic, are of special importance; and there is the condition known as hæmophilia (*q. v.*), the mode of action of which is doubtful.

Results of Complete Transverse Laceration.—When an artery is *torn across* by lacerating or contusing violence, even though it be the axillary or the femoral, it may not bleed at all. This is explained as follows: the inner and middle coats, which are much softer than the adventitia, tear early when subjected to strain, contract and roll up into the lumen of the vessel; but the tough adventitia resists longer, and is drawn out and twisted into a conical cap which covers the end of the vessel, just as after torsion. After avulsion of a part it is not uncommon to see the main artery hanging exposed for some distance, and pulsating apparently to its very end; it is usually distinctly conical.

In other cases, lacerated wounds of large arteries, such as resulted from the old round bullet, were followed by severe hemorrhage, ceasing in a few minutes; being arrested apparently by violent contraction of the muscular coat assisted by faintness. The arrest was sometimes permanent, but often hemorrhage recurred as shock passed off or when the patient was moved;

and the blood then came almost always from the distal end. In the lower limb, if the temporary arrest lasted twelve hours, the dangers to be feared were, according to Guthrie, *bleeding* not from the proximal, but *from the distal, end*, or *mortification* of the limb.

An artery torn across heals in exactly the same way as one cut across. An internal clot first forms.

The Artificial Arrest of Hemorrhage.

Loss of blood being almost always extremely undesirable, surgical interference is indicated even in cases where natural means would probably prove sufficient, though tardy, and, *a fortiori*, in all more severe cases. The opportunities which a surgeon of to-day has of gaining that coolness in the great emergency of serious hemorrhage which is so conducive to its proper treatment, are few; we rarely see it.

Immediate Treatment. *Local digital pressure.*—The first point is temporarily and immediately to arrest the bleeding until more permanent means can be adopted, and for this purpose no rule of such general applicability as this can be given—*place a finger on the bleeding point.* No force is required if the pressure is accurately applied; even main arteries are easily controlled. The surgeon must open the wound, wipe away clot, see the bleeding spot, and put his finger directly on it, or take it between his finger and thumb. In deep stabs, in which this is not possible, the finger may still be used as a plug, especially by the uninitiated; the educated finger will, in such cases, often feel the point whence blood is gushing and accurately compress it. Local pressure, when it can be employed, has the advantage of ligature at the point, viz., that it certainly arrests bleeding; it can be more easily kept up than pressure at a distance; and it is the only treatment immediately available in wounds of the great arteries of the trunk and neck.

Digital compression of main arteries.—Often it is most convenient and equally efficacious to compress the main artery at a distance. The points at which main arteries may be best commanded are the following: In the upper limb, the *ulnar* and *radial* are easily compressed just above the wrist by placing a thumb on each and pressing directly backward against the bone. The *brachial* at the middle of the arm may be compressed where it lies in front of the insertion of the coraco-brachialis; it is best to place one hand in front of, the other behind the arm, so that two or three fingers of each may meet on each side of the artery and prevent its slipping in or out. The *subclavian* (third part) may be compressed against the first rib by a thumb or the padded ring of a door-key placed vertically over the vessel in the subclavian triangle. Stand above the patient, place the thumb of the same side as the artery in the triangle whilst the fingers lie over the scapula; and on the top of the thumb place that of the other hand, and press directly downward.

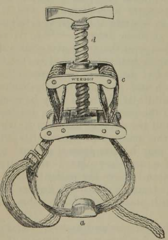
In the lower limb, the *anterior* and *posterior tibial arteries* are easily taken just above the ankle by the fingers and thumb of one hand grasping the ankle from the inner side. The *femoral artery* can be perfectly controlled by pressure driving it against the brim of the pelvis and front of the hip-joint. Stand by the side of the patient looking toward his feet; place the two thumbs, one on top of the other, on the artery, just below Poupart's ligament, and with the hands grasp either side of the limb. In thin people and children the *abdominal aorta* may be compressed for a short time in the above manner, or by direct pressure of fingers upon it; post-partum hemorrhage has been thus arrested.

The use of tourniquets.—To relieve the fingers when compression has to be maintained for some time, and also in many cases to check bleeding more completely, *tourniquets* are employed. Of these, *Esmarch's elastic tourniquet* is by far the best, and should always be kept in places where accidents are frequent. It is simply eighteen to twenty-four inches of three-quarters inch rubber tubing, and it is applied by placing the mid-point on the far side of the limb, stretching it, and winding it *rapidly* and rather tightly round above the wound; it may be tied by a tape at each end. No skill or knowledge of anatomy is required.

When used for an exarticulation at the shoulder, the tubing must be tightly coiled twice or thrice round the shoulder, crossing the axilla as high as possible, and the ring must be prevented from slipping by tapes passed through it in front and behind, and held tight by an assistant on the opposite side. In amputation at or excision of the hip, apply the tubing in a figure-8 round the groin and pelvis, and prevent the turn round the groin from slipping after removal of the limb by tapes used as above. To render the penis and scrotum bloodless, use a figure-8 of thick drainage tube round their base and the pelvis. For compression of the abdominal aorta, Esmarch places a board behind the patient and a special pad like a door-handle on a stem over the vessel, and then winds an India-rubber bandage several times round both so as to drive the pad backward.

Esmarch's tourniquet, applied too tightly, or in several coils one over the other, has produced paralysis of imperfectly covered nerves, such as the ulnar or median; this is best avoided by using, in the upper limb, instead of the

FIG. 141.



Petit's screw tourniquet. *a*, pad on the band; *c*, bridge; *d*, screw.

tourniquet, a few (four or five) turns of the India-rubber bandage on top of each other. But the chief inconvenience attributed to this instrument is due really to the anæmia of the limb which is usually produced before its application. Exclusion of blood deprives the vessels of all food, their muscular coat becomes rapidly weak, and yields before the blood-stream when this is readmitted. Consequently, when a part is kept long anæmic, general oozing may cause the loss of more blood than would have been lost had no tourniquet been applied. Hot water is the remedy; or elevation and pressure for ten or fifteen minutes.

Petit's tourniquet, formerly much used, is shown in Fig. 141, which fully explains its structure. The pad is placed over the main artery, or, preferably, a roller one and a half inches thick is laid longitudinally over the vessel, and fixed by a turn or two of its own end; this prevents the skin from being drawn up by the band through the slits in the plate. The band is first buckled close to the limb and then the screw is turned *quickly*, that arteries and veins may be compressed as nearly as possible simultaneously and venous congestion avoided.

In the absence of special apparatus, tie a handkerchief, with a stone placed in it over the artery, round the limb, and twist it tight with a stick.

There are special tourniquets for special vessels—*e.g.*. Signoroni's or Carte's, which compress the femoral artery, leaving collateral channels and veins open, and Lister's horseshoe clamp for the abdominal aorta. As the ending of this vessel may be in the mid-line, or on the left or right of it, it is essential before applying Lister's tourniquet to feel its pulsation, opposite the fourth lumbar; then place a small soft Turkey sponge over the spot, and screw the pad down upon it with *just sufficient* force to stop pulsation in the femoral. Death has been caused by injury to intestine. Under this heading must be mentioned also Davy's *rectal lever* for compression of the common iliac. It is a straight round bar of wood which is introduced into the beginning of the sigmoid flexure, and so guided that its end shall lie over the common iliac in the angle between the lumbar spine and psoas; by raising the handle, the vessel will then be compressed against the spine. Attempts to place the lever in position have failed; and there is danger of contusion or even of perforation of the bowel.

THE DELIBERATE TREATMENT OF HEMORRHAGE.—Immediate danger having been averted by one or other of the above means of temporary arrest, the surgeon will have time to consider how best more permanently to check the bleeding. To this end the surgeon places a tolerably enduring barrier in the face of the blood, and thus gives Nature time for the processes described on p. 352, which alone can permanently arrest hemorrhage.

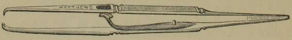
There are many methods employed by surgeons with a view to the permanent arrest of arterial hemorrhage. These are: (1) Ligature; (2) Torsion; (3) Forcipressure; (4) Acupressure; (5) Local pressure; (6) Pressure at a distance, either digital, by tourniquet, or by extreme flexion; (7) Cautery; (8) Styptics; (9) Hot water; (10) Cold; (11) Elevation. Of these the first three are employed infinitely more often than the rest.

The object which we always have in view is rapid healing of the wound, and those methods which least interfere with this will be the safest and best.

1. LIGATURE. *Mode of application.*—Two cases may occur: 1. An artery has to be tied upon the surface of a stump or similar wound. 2. The artery has been wounded in its continuity or divided. In the latter case ligatures must be applied above and below the wound, or to both ends as described in the chapter on "Ligature of Arteries."

In the first case the end of the artery must be seized with a pair of artery forceps (Fig. 142) and drawn a little from its sheath if it be of any size; the ligature is then tied firmly round it with a reef-knot. The ligature is left long or cut short, according to its nature, and the forceps are loosed. The less tissue included with the vessel, the better; but with small arteries, especially in aseptic wounds, the inclusion of a little tissue is not of much importance, and frequently it cannot be avoided when the vessel is retracted. In some cases of this kind it is recommended to pass a threaded needle at some depth through this tissue, round the bleeding point, and tie up all that it includes; or to pass a tenaculum through or near the vessel, and raise it and the surrounding tissues for the ligature; but these plans are clumsy and bad, and should, if possible, be avoided.

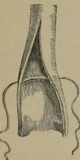
FIG. 142.



Assalini's forceps.

The effects and results of ligature.—When a thread is tied tightly round an artery, it is felt to sink a little into the substance of its wall. If the vessel is now laid open, as in Fig. 143, it is found that the ligature has divided the inner and middle coats, retaining in its knot a complete ring of the tough adventitia; the divided coats are turned in to the lumen of the vessel, and puckered up closely into a short cone. Stasis occurs up to the nearest collateral, and, as a rule, an internal clot forms up to this level. The artery contracts upon it, its base becomes infiltrated with cells, and these ultimately form vascular connective tissue, exactly as has been described at p. 59. But the formation of an internal clot is not constant, and does not occur in a good many aseptic cases. It was formerly regarded as a great safeguard against hemorrhage, and spots most free from branches were chosen for the ligature of arteries in their continuity in order that movement of the blood should not interfere with the development of a long internal clot. Doubtless it did act as an elastic buffer, and lessened the force with which the blood was thrown against the end of the artery; and this was a matter of much importance in the days of septic ligatures, which had to cut their way through the vessel as follows.

FIG. 143.



The effects of ligature upon an artery.

Septic ligature.—Ten or twelve years ago, all vessels on the face of a stump were tied with stout hempen threads; one end was cut off, and the other brought out through the wound; on the main artery both ends were left. Experience showed that these ligatures "cut through" in five to thirty days, according to the size of the vessel, and the amount of tissue included with it; consequently, after a proper time had elapsed, the threads were tugged at daily to see if they were loose, and in some case a strong pull was ultimately required to remove them. Until they came away, the strands of ligatures hung out at the corners of the wounds, affording a poor, but the only, means of drainage provided. As foreign bodies they necessarily prevented union; but, becoming soaked in septic wound fluids, they kept these irritants constantly applied to the very end of the artery, and lower down acted as setons. The piece of outer coat included in the knot was killed by pressure, and was cast off by a process of ulceration and suppuration, like any other septic slough. With a septic suppurative inflammation going on about the end of the artery, tending to destroy its sheath and vascular supply, softening its tissues, preventing organization of the lymph thrown out, and often infecting the internal clot, rendering it soft and friable; and, besides all this, with the daily disturbance of the reparative processes by pulling on the ligatures, is it any wonder that to the impossibility of complete primary union, frequent secondary hemorrhage had to be added as a fault of the ligature? Its defects were too manifest to be overlooked, and thoughtful surgeons sought in many ways to overcome them. The hemp ligature prevented union by its simple presence; even when thoroughly waxed, to render it non-absorbent, it served to conduct septic fluids to the end of the artery, and prevented tissues about it from healing over it; if cut short, either the wound did not heal until the knot and included bit of artery were eliminated, or the wound healed, and an abscess, due to the presence of the septic knot, formed, burst, and cast out the irritant. An ideal ligature should admit of being cut short, should heal in, and should then cause no injurious irritation. It was early seen that the latter result would be best attained by employing a material which would be more or less quickly absorbed, and experiments were made with several animal structures, such as silk, silk-worm gut, and catgut. Every now and again a success was recorded, the ligature being unusually clean, and the wound healing rapidly round it; but generally they did not prove satisfactory. The chief reason was that the wounds in which they were applied became septic and suppurated, and the nooses round the vessels were consequently rendered strongly irritant, and their absorption or encapsulation by living cells was thus prevented; and even prepared catgut under such conditions would rapidly soften and lose its hold.

Aseptic ligature.—The attainment of ideal success in the all-important matter of ligature is, therefore, one of the triumphs of aseptic surgery. Lister, by a beautiful series of experiments and observations, worked out a process by which *catgut* could be so prepared as to resist the softening influence of the aseptic fluids of the body, and to retain its hold upon an artery long enough to insure, almost certainly, its sound occlusion; ultimately in an aseptic wound it is gradually eroded from the surface by leucocytes which surround it, and themselves develop into fibrous tissue. This "carbolized catgut" was kept in carbolic oil, and was consequently difficult to carry about. More recently Lister has introduced the "chromic sulphurous catgut," which is kept in the dry state, and requires simply a few minutes' soaking in some antiseptic lotion to soften it sufficiently to knot well; nothing could be more convenient.

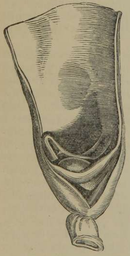
The essence of the aseptic ligature is that we have in it the minimum of irritation; the artery is occluded and held by the thread; usually, though not always, its inner coats are divided, but it is sufficiently injured to cause its vessels to pour out the usual coagulable exudation, rich in leucocytes, which seals the end of the cone into which the vessel is puckered. Being exposed to no further irritation, the lymph quickly becomes vascularized and develops into strong connective tissue. There is, of course, no suppuration, the arterial walls are not softened, their blood-supply is interfered with only by the passage of the ligature. The internal clot under these circumstances seems superfluous and, as a matter of fact, is often absent (Baumgarten); being in no way dependent upon it for successful closure of the vessel, we can, with asepsis, disregard the proximity of collateral branches. The piece of artery included in the ligature is probably killed, but is even less irritant than the catgut; and although in ligature upon the face of a wound the bit of vessel beyond the thread is cut off from all blood supply, yet it probably does not die. Sections made weeks after aseptic ligature show it still present with its lumen full of connective tissue; and a band of the same tissue occupies the place of the ligature and its included adventitia; the end of the vessel beyond the thread seems to derive nourishment from the fluid by which it is surrounded, until fresh communications between its vessels and those of granulation tissue are established. Consequently, we see that an aseptic ligature does not cut through the artery; the portion which is included in the noose is not cast off. Lastly, the wound heals uninterruptedly, and complete healing is the only sure guarantee against hemorrhage.

If catgut is not well prepared, or if it is used in septic wounds, it softens quickly, its knot loosens, and it may not hold long enough for the occlusion of large arteries; indeed, this has apparently happened with really good catgut in an aseptic wound. Consequently for tying large vessels in their continuity, *silk*, soaked for twenty-four hours in 1 in 20 carbolic, is very generally used. It heals in as readily as catgut, but is very slow in undergoing absorption, if indeed this is possible. After many weeks, a section shows numerous cells, and usually some giant cells round and between the fibres of the ligature—signs of chronic inflammation. In the great majority of cases all goes well; but a few cases of abscess after some weeks and elimination of the noose are on record.

The *tendons of the kangaroo's tail*, portions of the *sciatic nerve of the calf*, and other structures rendered aseptic have been and are employed as ligatures; the kangaroo tendon is more enduring than catgut.

With the idea of leaving the vessel-wall still stronger than it is after division of its inner coats, R. Barwell has introduced a flat, ribbon-like ligature, about one-eighth inch broad, made by cutting spirally the middle coat of an *ox-aorta*. The strips are kept dry and soaked fifteen minutes in 1 in 20 carbolic lotion before use; they do not divide the inner coats, but maintain their hold for a considerable time after they have healed in, which they readily do. After twenty months, the knot and loose ends of a ligature on the cartoid seemed little reduced in thickness and were opaque yellow; round the vessel, and closely united with its wall, was a thin, tense-looking band, perhaps one-tenth the original ligature; the whole was covered by delicate membranous connective tissue movable over it, and there was no naked-eye sign of irritation.

FIG. 144.



The effects of torsion on a large artery. (Bryant, on the "Torsion of Arteries," etc., *Med.-Chir. Trans.*, vol. ii.)

Every now and again we meet with arteries so degenerate, or situate in such soft tissue, that a ligature cuts through them. The slighter cases may be dealt with by using a somewhat thicker ligature than usual and tying less tightly, or by including a good deal of tissue with a needle; but it may be necessary to resort to other methode—torsion, acupressure, cautery, etc.

As to the *size of the ligature* to be ordinarily employed, it must of course be strong enough to resist the strain put upon it in tying; given this, the thinner it is, the less irritation does it cause, and the more slowly does it cut through in septic cases. The chromic catgut ordinarily used is very thin.

2. TORSION is the only rival of the ligature, and apparently deserves to rank equal with it. At Guy's Hospital it is always used instead of the ligature for securing vessels on the face of wounds. There are two ways of doing it—viz., *unlimited* torsion, which is that usually employed, performed by drawing out the vessel from its sheath by a single pair of *broad-pointed* torsion forceps, and then twisting it round as far as its natural connections will allow, or, as some prefer, until the end comes off; and *limited* torsion, performed by drawing out the vessel, fixing it by one pair of forceps a quarter or half an inch from the end, and then with another pair twisting the end round till it does not untwist itself. The effect

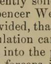
of torsion is very similar to that of tearing. The inner and middle coats are torn and invaginated more and more into the lumen of the tube as the adventitia is twisted round and round, and the end of the artery assumes a conical shape. The adventitia does not untwist, and, assisted by the invaginated coats, opposes ample resistance to the blood wave. The twisted end of the artery is killed and cut off from all blood supply, like the bit beyond the ligature; and doubtless behaves similarly in an aseptic wound. In a septic wound it would become septic and tend to irritate. But if unlimited torsion is done and the end removed, scarcely any dead tissue is left on the end of the artery. This method then obviously has as great advantages over the septic ligature as the aseptic ligature has; only a pair of forceps is required to twist a vessel; but with torsion it is often more difficult to arrest the bleeding from indefinite points at which retracted vessels probably lie.

Secondary hemorrhage is said to be very rare after torsion properly done; and Byrant states that he has found no special difficulty in dealing with degenerate arteries, in which cases he seizes as much of the surrounding connective tissue as possible, and twists that into a conical cap.

3. Forcipressure means the seizing of the end of an artery with a pair of forceps having serrated blades worked by scissor-handles provided with a catch, so that the instrument can be clamped on and left hanging. When removed after a few minutes, no bleeding will occur from the smaller vessels, the portion gripped having been welded into a mass sufficiently solid to resist the blood-pressure. It is by the use of several of Sir Spencer Wells's forcipressure forceps to clamp vessel after vessel as they are divided, that we are enabled to operate with a dry wound, even when the circulation cannot be controlled, and so effectually to prevent the escape of blood into the peritoneum in operations opening its cavity. Another use of the forceps is to seize a bleeding point too deep for the easy application of a ligature—*e. g.*, in the palm, high in the axilla, or in a lithothmy wound. They may be left on for several hours.

Formerly small bulldog clips and serrefines (Fig. 145) were sometimes used temporarily to close bleeding vessels.

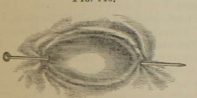
Fig. 145.



Serrefine.

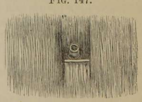
4. Acupressure was proposed by the late Sir J. Y. Simpson, as a means of avoiding the above-mentioned disadvantages of the common ligature. To this end Simpson proposed—first, to employ metallic instead of textile substances; and secondly, to use them in such a way as allows them to be removed at will, so soon as the occlusion of the artery is complete, which may be at the end of 48, 60, or 120 hours, according to the size of the vessel. The first method of employing *simple acupressure* (Figs. 146, 147) is to pass a long needle through one of the flaps of a wound, in such a way that it shall compress the bleeding artery, as we fasten

Fig. 146.



First method of acupressure; shows the outer surface of a flap with the needle passed through it.

Fig. 147.



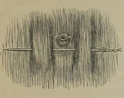
First method of acupressure, seen from flap surface; shows the mouth of the artery on the wound-surface, bridged over and compressed.

the stalk of a flower to the coat with a pin. The needle (three to six inches in length, according to the depth of the vessel) may in some cases be made to compress the vessel against a bone.

In the *second method* of acupressure, a small sewing-needle is employed, threaded with a short piece of inelastic iron wire, by which it may be pulled out. A long pin may be substituted. This is dipped down into the tissues on one side, then raised up and made to bridge over the vessel, while compressed with the point of the left forefinger. (See Fig. 148.)

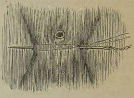
In the *third method*, which is practically the harelip suture, the sewing-needle is passed simply behind the vessel, and a noose of fine iron wire passed over the point, brought over the vessel tightly enough to close it, and then

Fig. 148.



Second method of acupressure

Fig. 149.



Third method of acupressure.

secured with a slight twist around the eye end of the needle. When the operator chooses, he can pull out the needle, and then the wire loop follows without resistance. The wire passed through the needle should be distinguished by being twisted, or in some other way[1] (Fig. 149). Mr. Wood has successfully employed this mode in bleeding from wounds of the palmar arch, which cannot be controlled by a compress: a harelip pin is passed under the radial or ulnar artery, or both, just above the wrist, and a piece of soft silk or lint, instead of the wire, twisted round it sufficiently tightly to stop the flow of blood through the vessel. The pin may be removed in a day or two if the reparative changes in the wounds have sufficiently advanced to seal up the wounded artery. The inclusion of the ulnar nerve in the acupressure rarely gives rise to more than temporary inconvenience.

There is yet a *fourth method* of acupressure: the point of a needle is stuck into the tissues close to the mouth of the bleeding vessels; the handle is then carried through half a circle or more, so as to close the mouth by twisting; and the point is then pushed on further into the tissues. There are many other means of using needles, which the surgeon's ingenuity will suggest. When several oozing points are close together, they may be compressed for some hours by a needle and loop of wire.

Acupressure controls hemorrhage whilst closure of the divided or wounded artery goes on in the ordinary way. Even in septic wounds the absence of a septic ligature, leading right up to the vessel and preventing union round it, is an immense advantage, and excellent results have been obtained by the method. But it is now used only in exceptional cases, such as that of hemorrhage from the palm above noted, being more troublesome and less certain than aseptic ligature or torsion. Acupressure seems very applicable to degenerate vessels.

5. Local Pressure follows most naturally upon acupressure. By its means we endeavor to close the end of the vessel and prevent the issue of

[1] See Sir J. Y. Simpson's original papers in the Med. Times and Gaz., January, 1864; and Dr. Joseph Hutchison's Prize Essay on Acupressure, Albany, U.S., 1869.

blood until the vessel is well closed, chiefly by contraction, retraction, and clotting. It is employed to check bleeding from wounded arteries—*e. g.*, temporal or occipital—lying immediately over bones; in cases of vessels (vertebral or deep palmar arch) lying deeply among important structures, which it is important not to wound or disturb; and, lastly, in cases of hemorrhage where it is impossible to tie either on account of the impossibility of controlling the bleeding temporarily during the operation (*e. g.*, great vessels at root of neck), or because the bleeding points are many, or cannot be reached and otherwise treated (nose, rectum, vagina). In the latter cases *plugging* is resorted to; an India-rubber bag is introduced and blown up, or a fold of muslin is pushed into the cavity and filled with sponges, lint, or wool, or the openings of the cavity are stopped; blood fills the cavity, and by its pressure prevents further bleeding; the vessels are usually small and the result of this blindly used force satisfactory. In cases of punctured wound the *graduated compress* is generally used. The results of this treatment as ordinarily employed, in wounds of the deep palmar arch, are often disastrous. The compress is made of circles of lint placed one on top of the other, and fastened by a stitch through their centres; the first circle is about the size of a sixpence, and often made of a bit of cork, the last is as big as half a crown, and the pad is an inch or so thick. To apply it, the fingers are carefully bandaged, and the hand and forearm fixed on a back splint, whilst the bleeding has been checked by local pressure; but now the brachial is controlled, the wound thoroughly dried, the small end of the compress is placed in or over the wound, and pressed down firmly by a bandage passing round it and the splint; lastly, the elbow is strongly flexed, and the forearm and arm connected by a figure-of-8 bandage. It is left undisturbed for two or three days, or longer, unless complications necessitate its removal. When danger of hemorrhage is thought to be over, the bandage is loosened, but the compress is allowed to come away of itself. Too often bleeding recurs, the parts pressed upon slough, the wound gets very foul, and septic inflammation burrows widely among the tendons of the palm and wrist, perhaps invading even the carpal joints. These complications are best prevented by avoiding the compress, using instead, if possible, forcipressure, acupressure, or pressure at a distance.

If it must be used, apply it as above, paying attention to the following points: 1. The pressure in even a largish artery is not high, and that in the deep palmar arch is easily overcome by force *accurately* applied; but force sufficient to empty the deep arch will certainly empty all vessels superficial to it, and therefore, to avoid sloughing, and to permit healing, must not be continued for more than twelve hours; after this time the bandage should be relaxed. 2. As the bleeding comes from a small point, to apply pressure accurately to this, it is necessary that the compress shall have a fine point, and this will reduce the tendency to cause sloughing. 3. In cases in which it is possible that the vessel is only wounded, not divided, put in a knife and divide it completely, unless this would be dangerous to important structures. 4. Render and keep the part aseptic, dusting it with iodoform after disinfection. To meet this and other ends, it is better not to endeavor to insert the compress into the wound, but to plug the latter carefully from the very bottom with gauze or sponge, and to place a fine-pointed compress on top of this.

In some cases it is impossible to apply compression in any way other than by the fingers of the operator and his assistants, relieving each other at regular intervals till bleeding ceases. This is termed "local digital compression," and has often saved life.

This is, perhaps, the best place to mention a valuable plan in cases of bleeding from canals in bone, that of plugging the canal. Thus a rounded match-handle stuck into the posterior palatine canal is said to have saved life after the operation for cleft palate. In aseptic cases a bit of gauze, wool, or catgut may be pushed tightly into the orifice.

6. Pressure at a Distance.—This is practised upon the main artery above the wound, in order that clotting, etc., may occur whilst the direct current is checked. The pressure may be made by the finger, by a special tourniquet—*e. g.*, Signoroni's—or, at the elbow and knee, by extreme flexion. The method is not suited to deal with severe cases, but may be a useful auxiliary.

7. The Cautery may be used to close even large arteries. When a cautery iron is pressed against the open end of such a vessel, it shrivels up into an adherent eschar which will resist the blood-wave stoutly. But such a mass of dead tissue is an excellent absorbent of putrid poisons and products, and consequently, in septic cases, irritation is likely to interfere with the formation of a firm internal clot and sound connective tissue. Secondary hemorrhage is accordingly common after such use of the cautery, and occurs when the sloughs separate, about the end of the first week. It is now never employed upon large vessels, but is found most useful in checking bleeding from small vessels in any soft, lacerable tissue in which ligature or torsion is impossible.

The most useful form of cautery is Paquelin's hollow cautery-knife, which is first heated to redness in a spirit flame, and then kept hot by the combustion of benzol vapor blown down it by a ball-syringe. This knife is used to perform operations in which avoidance of hemorrhage is important, and those who fear bleeding employ it frequently in spite of the facts that it leaves a surface which must heal by granulation, which is highly absorbent, and upon which it is hard to detect bits of new-growths left behind. When used bright red it cuts almost like a knife, and even small arteries bleed; to check hemorrhage it must be used slowly and dull red or black, and the part to which it is applied should be dried.

8. Styptics are substances which coagulate the blood or induce strong contraction of vessels, or act in both ways. Solid perchloride of iron or the strong liquor on wool or lint, solid alum, or a saturated solution, solid nitrate of silver, the powdered matico-leaf, and turpentine, are the best. The latter is potent, but excites much inflammation; all interfere with union by first intention, so they should be avoided when this is wished for. Perchloride of iron is the one usually employed; if improperly used it makes a dreadful mess of a part, and renders subsequent treatment difficult. To apply it or any styptic, dry the bleeding point thoroughly, if possible whilst the circulation is controlled above, then gently press on the spot a bit of wool well moistened (not wet) with perchloride solution; after two or three minutes relax the pressure, and a little later allow the circulation to go on. Let the wool separate naturally.

9. Hot Water, or an antiseptic lotion so hot that the hand can only just bear it, is probably the best means we have of checking bleeding from small vessels and general oozing. It must be applied with a sponge. It does not prevent primary union.

10. Cold.—Ice or iced water or lotion is applied directly to the bleeding part or to some neighboring part, as the face in epistaxis, when it acts reflexly. It generally acts speedily; but in hæmophilia, cold irrigation is required. It causes strong contraction of the vessels and of the surrounding tissues, and is of value chiefly in general oozing.

11. Elevation of a limb causes marked contraction of its arteries, and is a useful adjunct in all forms of bleeding which are not perfectly controlled. It frequently suffices to stop venous or capillary bleeding.

The Effects of Loss of Blood.

These are the more intense the larger the quantity lost and the more rapidly it is poured out. Fatal syncope may be quickly induced; short of this, symptoms of more or less intense shock appear. In acute losses patients not uncommonly lose their sight entirely or partially, and they often complain much of thirst. Œdema of extremities is common in bad cases. Dry gangrene may result (p. 86).

The quantity of blood which may be lost in repeated small or even considerable bleedings is astonishing, the patient being reduced to a state of the most profound weakness and anæmia. The anæmia may be very persistent. Women bear such loss of blood better than men; young children and old people, on the other hand, suffer severely from slight hemorrhage.

Treatment.—In acute cases the patient must be placed on a flat mattress without any pillow; the limbs, especially the lower ones, should be raised to facilitate the return of blood from them; and it may be necessary for a time to compress their main arteries, or even to apply Esmarch's bandage to them, in order to supply the brain with blood. Dr. Sainsbury has suggested the use of digitalis and ergotin in these cases, with the idea of slowing and steadying the heart's action, and, at the same time, of diminishing the capacity of the vascular system; and the suggestion would seem to be a very valuable one. In extreme cases, in which life is in great danger, transfusion of blood should be resorted to (see "Minor Operations").

The temperature must be kept up by warm coverings and hot bottles; fluid food should be given frequently by spoonfuls; a little ice may be allowed for thirst; and great restlessness may be met by small doses of opium every three or four hours.

In chronic anæmia, the hemorrhage having ceased, warmth, careful feeding —the diet being simple, nutritious, and given in frequent small doses—fresh air, and plenty of sunlight are most important. Some preparation of iron may be administered, and usually it must be a mild one at first.

In cases of hemorrhage which it is difficult to restrain by ligature or otherwise—*e. g.*, intra-abdominal—it is necessary to keep the patient recumbent and very quiet, administering opium, if necessary, and to combat shock most cautiously. We must always remember that in internal hemorrhage the patient's best chance lies in a long period of weak heart-action; it is our business to prevent it stopping, if we can, but not to excite it. Stimulants, therefore, must be very carefully used.

Primary, Intermediary, and Secondary Hemorrhage.

Hemorrhage may occur at the time of infliction of the injury, and is then called *primary;* or it may come on later, when it is termed *secondary.* Most surgeons make a third variety—*reactionary* or *intermediary*—said, arbitrarily, to occur within twenty-four hours of the injury, and to be due to recovery of the heart from shock. For purposes of treatment this variety may be considered with primary hemorrhage; the only difference being that in the latter case the wound is open, and the vessel more or less accessible, whilst in the former the wound, as a rule, has to be opened up and clot turned out to expose the artery. Secondary hemorrhage, on the other hand, differs in its etiology and pathology, and, to some extent, in the laws which govern its treatment.

Rules in the Treatment of Primary Hemorrhage:

1. *If a case is not bleeding when seen,* no matter how great the loss of blood may have been immediately after the infliction of the wound, *do not endeavor*

to tie, or otherwise deal with, the injured vessel. Dress the wound antiseptically with moderate pressure, and provide for rest. The reason for this rule is that a wound of a comparatively small artery, especially when cut close to its origin, may yield a very large quantity of blood; but when faintness comes on, hemorrhage will cease, and may not recur; it will be time enough to operate should it do so. Guthrie quotes a case of ligature of the external iliac for hemorrhage and hæmatoma, due, it was supposed, to wound of the femoral; the man died of peritonitis, and it was found that a superficial branch of the femoral had been wounded one inch from its origin.

2. The most important rule of all is, *always deal with the bleeding point.* The slightest thought will show any one who knows with what ease blood finds its way by collateral channels past an obstruction in the arterial system that this is the only safe method. A ligature applied at such a distance from a bleeding point that a branch intervenes between them *may* permanently arrest the bleeding for which it is applied—*i. e.*, firm clotting may close the opening before the diverted stream again finds its way strongly into the original channel; but *there is no security that it will do so.* When the anastomosis is free, as in the forearm and hand, bleeding may recur immediately after the operation of ligature at a distance; but more commonly the recurrence does not take place for hours or days.

3. *When an artery is wounded in its continuity or simply divided* (the distal part not being removed) *it must be secured above and below the wound.* The argument upon which this rule is based is chiefly that upon which the second rests, viz., the ease with which blood finds its way past the obstruction into the main channel below it. We have already mentioned (p. 354) the ill-understood fact that secondary hemorrhage is much more common from the distal end of a divided artery than from the proximal, and that in the lower limb the blood thus escaping is often dark and flows in a continuous stream; the less completely collateral circulation is established, the more venous will the hemorrhage appear. This fact is a further warning to us to be careful to secure the distal end, which at the time of the operation may, perhaps, not be bleeding. Of course, no branch must intervene between the ligatures and the wound. Formerly the Hunterian operation of ligature at a distance was frequently done in such instances and with extremely bad results. The double obstruction of ligature and wound frequently prevented the reëstablishment of circulation in the distal parts of the lower limb, and it mortified; whilst in the upper limb, where the anastomosis is more free, hemorrhage from the wound usually occurred. So the Hunterian operation exposed the patient to two great dangers—gangrene if the circulation were not reëstablished, hemorrhage if it were. The greater ease of the operation at a seat of election doubtless rendered it attractive; but the *raison d'être* of ligature at a distance for aneurism is disease of the artery near the seat of dilatation, a condition which does not hold in cases of wound. Further, it is quite possible in operating at a distance to tie a trunk which has no connection with the bleeding vessel; thus in wounds of the upper part of the back of the neck the common carotid has several times been tied in the belief that the occipital was wounded, whereas the vertebral really furnished the blood. The error arose primarily from the surgeon's forgetting that the vertebral does not enter its bony canal below the sixth transverse process; pressure on the cartoid below this point (Chassaignac's tubercle) stopped the bleeding, but the vertebral was compressed as well as the carotid. Another cause of failure of ligature at a distance for wound is high division or unusual distribution of the arteries; thus an enlarged median artery, or vas aberrans from the upper part of the brachial or the axillary, opening into the palmar arch

has kept up hemorrhage from it after ligature of the ulnar, radial, and brachial, necessitating finally ligature at the point.

Wherever, therefore, primary hemorrhage is occurring from a wounded artery, the latter must be secured at the bleeding point, both its ends being dealt with when there are two; and these rules are to be departed from only after a determined attempt to follow them has shown the impossibility of doing so—except in the case of the internal maxillary and its branches, and one or two other vessels, which it is practically impossible to reach.

To perform the operation when the superficial parts do not gape sufficiently to allow the artery to be seen, as in punctured wound, render the part bloodless and control the circulation whenever this is possible; then introduce a probe or finger into the wound, and taking this as a guide, carefully divide the structures in the line which will give the freest access to the vessels and do least damage to the muscles or other structures of the part; keep a sharp lookout for any divided vessel, probably covered by clot, until the level of some large known artery of the region is reached; then if no wounded vessel has been discovered, slacken the tourniquet and watch carefully for any spirt of blood which will guide to the injured spot. The main artery should now be taken by an assistant, as it may be necessary now and again to let a little blood escape as a guide to the operator; and oozing may have to be checked by hot lotion and sponge pressure before going on with the operation after the removal of the elastic band. When found, the bleeding vessel is treated according to the above rules by one or other of the methods described at p. 357 *et seq.*

We do not, of course, mean that every case of slight primary hemorrhage requires immediate opening of the wound and tying or twisting of the artery; elevation, cold, well-applied pressure, etc., will deal with many such, if there is any difficulty in at once picking up the bleeding vessel.

Secondary Hemorrhage: Its Pathology and Treatment.

Secondary hemorrhage may occur at any time until a wound has healed, though a patient may be regarded as safe from it so long as the wound is everywhere covered with healthy granulations, whilst he is in danger so long as the end of the artery is visible. It was rare before the fourth day, most common about the time of separation of the ligatures in the days of the old hempen thread, and it has become quite a rarity since the practice of aseptic surgery has become general.

Signs.—It may occur in one sudden and perhaps fatal gush; but much more commonly, small discharges of blood give warning of what may be expected. The blood may be bright and the stream jetting and forcible, or dark and welling up in a continuous stream as from a spring—in the latter case coming from the distal end (p. 354).

Its immediate *causes* are many, but they may probably be classed in five groups: 1. Certain general conditions under which repair proceeds slowly or is arrested, and of these the chief are septicæmia and pyæmia. It is, however, very difficult to be sure how much of the arrest is due to the general state and how much to the fermentative processes going on in the wound. 2. Straining, rough transport, rough handling, etc., may mechanically burst open such union as has occurred. 3. Formerly, when the tenaculum was used to pick up vessels, secondary hemorrhage was sometimes attributed to puncture of the artery above the point tied, and another assigned cause was wound of a collateral branch, which soon ceased to bleed and consequently was not tied. But in either case, if no bleeding occurred until after the intermediary period, it would seem likely that septic inflammation was really the cause. Excessive stripping off of the sheath deprives the artery of its blood-supply; but even if a portion of it died there would almost certainly be no hemorrhage in a subcutaneous injury. Again, when the ligature includes a quantity of tissue besides the artery and has to cut through, septic suppuration is prolonged about the end of the vessel and produces its usual results; hence the necessity for most carefully cleaning an artery before passing the ligature, especially in septic cases. 4. Disease of the arterial coats, atheromatous or calcareous, will, on the one hand, prevent the retraction and contraction which favor healing and render it slow, whilst, on the other, they will cause the ligature to cut through rapidly; naturally, hemorrhage is a frequent consequence. 5. But the great cause of secondary hemorrhage is excessive inflammation about the end of the artery, which prevents healing and the formation of firm clot, softens the vessel wall, injures its vitality and perhaps causes it to slough by destroying its blood-supply. Such inflammation is practically always of septic origin; and, consequently, the practice of aseptic surgery has almost banished secondary hemorrhage. Septic cases, however—cases of phagedæna and hospital gangrene, and of casting off septic sloughs—must still occur; and even in aseptic wounds secondary hemorrhage must be regarded as possible from mechanical injury, softening and loosening of a badly tied or ill-prepared catgut ligature, or separation of an atheromatous or calcareous plaque; so we must be ready to meet it.

Treatment.—The main rule for our guidance is that given as Rule 2, under "Primary Hemorrhage" (p. 366)—*always seek for the bleeding point.* Only when this is secured can the condition of the patient be regarded with anything like satisfaction. Ligature at a distance has succeeded and may succeed again in the upper limb, but in the lower almost invariable either the circulation is not reëstablished and the distal portion becomes gangrenous, or it is reëstablished and hemorrhage recurs. In the case of a stump, the danger of gangrene from a ligature placed on the main trunk a short distance above is nil; here we have to think only of the danger of recurrence of hemorrhage, either because a freely anastomosing branch is present between the ligature and the wound, or because the bleeding vessel springs from the trunk above the ligature. This latter danger is, however, sufficiently great to render the practice of ligature at a distance for hemorrhage from a stump unjustifiable until the flaps have been separated, clots turned out, and every effort has failed to secure the bleeding point. The greatest difficulty will arise from diffuse suppuration and sloughing of the stump, for neither forceps nor ligature will hold upon the end of the vessel. In these cases, the surgeon may endeavor to arrest the bleeding by pressing a cautery against the end of the artery, but in such a stump there would then be great liability to the recurrence of hemorrhage; it is therefore far better either to remove with knife or scissors so much of the artery and tissues round about it that either ligature or torsion is possible, or to carry a cut upwards along its line, and tie it as low as possible. The latter practice is easiest in cases of circular amputation or of the flap operation, where one angle lies near the line of the bleeding vessel. The opportunity of removing sloughs and applying antiseptics should be taken. Such an operation occupies some time and causes a good deal of shock if the amputation is a high one and the stump in great measure healed; but nothing short of a conviction that the patient could not endure it should cause the operator to depart from the rule. Under such circumstances we have the authority of Erichsen for tying the common femoral for bleeding from a hip-stump, or the subclavian for hemorrhage from a shoulder-stump.

In cases of secondary hemorrhage from a wound in which an artery has been tied in its continuity, wounded or divided, we shall often be able to judge from the character of the bleeding (p. 352) whether it comes from the proximal or distal end. In cases of hemorrhage from vessels of the trunk and neck, in which it is impossible temporarily to control the bleeding by digital pressure and at the same time to expose and tie the bleeding point, there is no resource left but pressure by the finger or plug. But in all other cases severe enough to justify operative interference the wound should be opened up, and every endeavor made to secure the bleeding point; and before closing the wound we must make sure that the other end of the artery also has not been bleeding. Should it be impossible to carry out this treatment, and milder means are of no avail, the only choice left to the surgeon will be that between ligature at a distance and amputation. In the lower limb the former procedure is so hopeless that the latter is always adopted; in the upper, ligature at a distance is sometimes practised—apparently because the preliminary ligature is not a serious operation, and does not interfere with the success of amputation should it fail, there being little danger of gangrene. It will, however, happen but rarely in the upper limb that a bleeding point of any size cannot be found, and it would seem probable that amputation would be required in a case in which the state of the tissues prevented the use of a ligature or of torsion either in or close to the wound.

The rules of treatment of secondary hemorrhage from a vessel tied or wounded in its continuity or divided are therefore: in almost all cases, endeavor first to check the bleeding by local measures: should one or more of these fail, and amputation be possible, it will probably prove the soundest treatment, and should be done at the level of the wound or just above it; the occurrence of hemorrhage from a disorganized part may render amputation at once the best treatment.

As in primary, so in secondary hemorrhage we have to decide whether or not to interfere in case the bleeding has ceased spontaneously when the patient is seen. Guthrie was strongly in favor of not doing so, and he quotes a case in which, having failed to make a vessel bleed, and having thus lost all guide to the source of hemorrhage, he sent the man back to bed with an orderly to look after him. Two or three recurrent bleedings were promptly checked by pressure on the femoral, and the man ultimately recovered. Many similar cases might be quoted. Guthrie's case was one of bullet-wound going right through the thigh; the wound necessary to secure the vessel would probably have been very large, and it is obvious that, if the artery which has bled will not bleed again when the wound is opened up and thoroughly cleared of clot by sponging, the only point gained by the operation will be, that, should the bleeding recur, the wound can then be rapidly opened up and the vessels found and dealt with. One could not but feel very anxious, however, in leaving a patient who had had more than one severe attack of secondary hemorrhage, knowing that bleeding would in all probability recur and perhaps kill or greatly exhaust the patient before it could be arrested. In such a case, especially if the bleeding vessel is probably a main trunk, or one of its branches cut near its origin, we should probably act for the greatest happiness of the greatest number if we at once laid open the wound and endeavored to find the bleeding point; and we should be failing in our duty if, after a second attack, we left the result to chance. But if the bleeding has not been severe, came apparently from a branch distant from the main trunk, and especially if we can remain to watch or leave in charge an assistant competent to arrest bleeding immediately, we may, in cases in which access to the vessel is difficult, wait a while, keeping the patient at perfect rest, the wound as sweet as possible, compressed over the dressing by a bandage which should include the whole limb, the part elevated, and the main current of blood may be for a time diverted by continuous pressure, by the finger or special tourniquet, or by flexion. If, however, even small losses are frequent, or show a tendency to increase in quantity, something radical must be done at once before the patient becomes exhausted.

Frequently secondary hemorrhage from an artery injured by stabs and similar wounds will be found due to incomplete division of the artery. Consequently in the case of small vessels, such as those of the palm, which commonly suffer in cuts from broken glass, it is well before applying pressure (p. 363) to put a lancet into the wound and make sure that the artery is cut across, just as was done in old days after arteriotomy of the temporal.

Arterial Hæmatoma, Diffused and Circumscribed.

Pathology.—When a large artery is wounded at some depth from the surface, the track leading to it being narrow, long, and perhaps oblique, blood is often forced into the cellular tissue to a considerable distance, forming a diffuse swelling, whilst the opening in the skin becomes closed by clot, and hemorrhage from it perhaps ceases. Sometimes the skin wound heals rapidly. A state of matters exactly similar to this results in cases of subcutaneous laceration of an artery by a broken bone or sudden strain. The swelling which forms may be widely diffused or fairly circumscribed to the region of the wound in the artery, and was formerly called a *diffused* or *circumscribed traumatic aneurism*. But this term is misleading and very confusing, for there is really nothing "aneurismal" in the case; but for the wound or rupture, the artery may be perfectly healthy; and whereas a real aneurism is limited by a *sac* composed at first of one or more of the dilated coats of the artery, the so-called traumatic aneurism either never acquires a sac, or, when circumscribed, obtains one only by exciting some inflammation of surrounding tissues which leads to their condensation. The only difference, in fact, between the blood-tumor under consideration and that which forms after any severe contusion is that in the former the blood escapes from a considerable artery, in the latter from veins and small vessels. A "traumatic aneurism" is simply a subcutaneous hemorrhage from a considerable artery, and its relation to and difference from an ordinary hæmatoma is best expressed by the term *arterial hæmatoma*.

Symptoms.—These vary according to the size of the vessel wounded and the size and nature of the wound in it, being more serious the larger the vessel and the freer the opening; the resistance, also, which the tissues round about can oppose to the diffusion of blood must be taken into account.

The first sign, after the pain of the injury, is swelling starting from its seat, and spreading more or less widely round about; it may form rapidly and be very extensive, or slowly, and remain fairly circumscribed. In a serious diffused case, the whole limb swells, partly from hemorrhage, partly from œdema, due to pressure of the confined extravasation on the veins; the part is pale or dusky, cold and numb, the seat of more or less acute tensive pain; the swelling due to hemorrhage, sometimes enormous, may be distinctly fluctuating, or simply tense and elastic, and does not pit. In such a case, the main artery would almost certainly have been wounded, and pulsation would be absent in it beyond the injury; immediately over the opening in the vessel there may be some thrill, bruit, and expansile pulsation, or, when coagulation has occurred, a general lifting up of the whole mass at each heart-stroke; but in the worst cases these signs may be quite absent.

They are most plain in large lateral wounds of arteries, least so in small, punctured, or longitudinal incised wounds and in complete division or rupture. If not early and properly treated, moist gangrene up to the wound in the artery soon occurs.

In other cases, almost always due to wound of arteries smaller than the brachial, the extravasation ceases to spread before danger of gangrene arises, and becomes more or less solid from coagulation at its circumference, whilst its centre remains fluid; and here thrill, pulsation, and a whizzing bruit are more or less strongly marked. Supposing that increase is arrested, the central fluid part is encapsuled first by clot, and next, as this is absorbed, by condensed and infiltrated tissues which form a fibroid sac; and we then have a case anatomically resembling an advanced stage of a true aneurism, except that the artery is healthy but for the wound in it. But the hæmatoma may increase and burst, or inflammation and suppuration may arise about it.

Diagnosis.—From an *acute deep abscess* the diagnosis may be difficult, especially when we have to deal with a hæmatoma which threatens to suppurate; the immediate onset of swelling after an injury, the marked interference with the circulation beyond the wound, the results of aspiration with a fine needle, and perhaps more or less central thrill, bruit, and pulsation must be relied upon as distinguishing the hæmatoma. When there is no tendency to suppuration about a hæmatoma, the part would be pale or bluish and cold, and there would usually be no fever. In a doubtful case requiring operative interference the surgeon should make an incision, being prepared for the worst.

It is possible that a circumscribed arterial hæmatoma may be mistaken for a *rapidly growing cancer*. A man may meet with a blow on the thigh, causing pain and swelling. The swelling does not subside; on the contrary, it continues slowly to increase; evidently infiltrates the tissues of the part; is somewhat elastic, perhaps displays feeble pulsation at parts; punctured with a grooved needle, it yields serum or blood. The case is supposed to be *malignant*, and amputation hopeless; the patient sinks. After death there is found no cancer, but a great collection of blood, fluid or coagulated, amongst all the deep muscles, and proceeding from an artery that had been ruptured by the blow. An incision would have revealed the mystery.

Another point to be remembered is that *a true aneurism may suddenly become diffused*. Here the diagnosis rests upon the history.

Treatment.—The only difference between a case of arterial hæmatoma and one of arterial hemorrhage is that in the former case the blood escapes into the tissues, in the latter from a free surface; consequently, the treatment is that of arterial hemorrhage, the cavity containing the blood being opened freely to permit access to the artery. On no account should the Hunterian operation be done in any diffused hæmatoma: gangrene would certainly result; but in well-circumscribed cases, in which laying open the sac would be a hazardous or very injurious proceeding, the artery may be tied a short distance above with fair hope of success—for in these cases a kind of sac has formed, and cure will be effected as in ordinary aneurism. Cure is rendered most certain, however, when the wounded artery has been tied above and below the wound or rupture—the state which alone offers security against hemorrhage. In cases seen early, compression of the main trunk above and over the wound might limit extravasation permanently by permitting coagulation of already effused blood. In established circumscribed cases compression should be tried. But if bloodless treatment fails and the hæmatoma increases, and in all cases threatening bursting or gangrene, ligature at the point must be practised. The whole field of surgery does not present a more difficult operation than that of laying open a large arterial hæmatoma, nor one requiring greater judgment, nerve, and dexterity. This is a case in which boldness is better than caution. It was thus described by John Bell in 1800: "Run your bistoury upward and downward, so as to slit up the tumor quickly; plunge your hand suddenly down toward the bottom; turn out the great clots of blood with your fingers, till, having reached the bottom entirely, *you begin to feel the warm jet of blood;* and, directed by that, clap your finger upon the wounded point of the artery: as it has but a point, your finger will cover it fairly, and your feeling the beating of the artery assures you that all is now safe." A needle was then worked round the vessel above and below the wound—what it included besides the artery was often somewhat doubtful, though Bell knew the importance of thoroughly cleaning the vessel—a ligature tied in each situation and the finger was then removed from the bleeding point.

This was the way in which John Bell successfully treated, for example, an enormous hæmatoma from wound of the gluteal artery as it issued from the pelvis, and the hemorrhage from which he had no means of controlling. The wound in this case was two feet (!) long, made by two strokes of the bistoury. (*Principles of Surgery*, 1826, vol. i.)

Nowadays we can control the bleeding from most arteries, and can consequently operate more deliberately. Only in a few cases is it necessary to adopt the above rapid plan, with pressure of a finger on the wound as the sole means of checking bleeding; then the surgeon must do his best to include the artery only in the ligature.

In the more usual case, the sac is opened freely, clots and blood turned out, and the interior rendered dry. Perhaps the wound in the artery will now be seen; if not, with a good light on the wound, loosen the tourniquet, and let a little blood escape. Pass a thick probe into the opening, first in one, then in the other direction, clean a channel round the vessel above and below the wound, pass ligatures and tie them. The distal end always gives most trouble.

If such an operation is not done aseptically, prolonged suppuration must be expected. In John Bell's case healing took seven months, being delayed by necrosis of the ilium and sacrum.

Traumatic Aneurism.

This name may be truly applied to cases resulting from punctured wounds, generally of large arteries, which have healed; but in the course of weeks or months the scar has yielded before the pressure of the blood; it may be applied also to aneurism after strain, laceration of the outer coats, or contusion of the vessel, as, for example, of the subclavian after fractured clavicle (p. 246). In these cases there is a sac from the commencement; the essential difference between them and the ordinary aneurism is, that in the former the vessel is healthy except at the dilated spot; in aneurism from disease the artery is affected widely, as a rule.

All the symptoms of ordinary aneurism are present. The history of injury and late appearance of symptoms decide the diagnosis.

The *treatment* may be—1, compression of the artery above the sac; 2, ligature above the sac, but as near to it as is convenient; or 3, the old operation of laying open the sac. The latter must be done when the cavity is very large.

Aneurismal Varix and Varicose Aneurism.

These result either from the simultaneous wound of an artery and vein lying either side by side (int. carotid and jugular) or near each other (brachial and median basilic), or from rupture of a diseased artery into a vein.

In some cases the circumference of the wound in the artery adheres directly to that of the wound in the vein, or with only a layer of fascia intervening, the opening from the one into the other vessel being so short as to be practically direct. The vein and all veins in the neighborhood are much dilated and thickened, and pulsate strongly. This is the condition in *aneurismal varix.*

In other cases, in which perhaps the vessels were originally a little further apart, the inflammatory tissue lining the channel between the vessel yields under the arterial pressure, and the short, narrow canal becomes dilated into a spherical cavity the size of a marble or walnut; or the cavity may be due to a small hemorrhage, which has been quickly circumscribed, between the artery and the vein. This cavity has a fibrous wall, opens at one pole into the artery and at the other into the vein, and pulsates with the artery; the veins of the part are in the same condition as in aneurismal varix. We have, therefore, an aneurismal varix with the addition of a kind of traumatic aneurism or circumscribed arterial hæmatoma, according to the view taken of the mode of formation of the cavity. This condition has received the meaningless name of *varicose aneurism.* In both aneurismal varix and varicose aneurism the artery below the communication is shrunken.

Seats and Causes.—These forms of disease have been met with in most places where a large artery and vein lie close, resulting from lancet-punctures, sword-thrusts, stabs, etc. They are now rare affections; formerly they were more common, resulting chiefly from bleeding at the bend of the elbow.

Symptoms.—The superficial veins are greatly swollen, thickened, and tortuous, perhaps almost bursting opposite the opening; they pulsate strongly, a thrill is felt over the opening as the blood rushes into the vein, and a rough or humming bruit, conducted along the veins running toward the trunk, is heard; the limb below is cold, and more or less weak and wasted, but there is often some œdema and thickening of connective tissue. By suitable pressure it is sometimes possible to empty the vein and feel the opening in the artery. These are the signs of *aneurismal varix,* and it is said that all are most distinct when the limb is hanging. In *varicose aneurism* we must add—the presence of a small pulsating tumor, felt through and beneath the dilated vein, and of a blowing murmur differing from that heard in the vein.

Treatment.—*Aneurismal varix* can generally be kept in check by the application of the analogue of an elastic stocking; and to this might be added a small pad pressing directly on the opening into the vein. In some cases about the neck, the bruit has been a source of great annoyance. Wherever the circulation could be controlled, cure might be effected, in cases requiring more relief than pressure gives, by cutting down through the vein on to the opening in the artery, cleaning this upon a probe, and passing a ligature above and below the wound.

In *varicose aneurism,* simultaneous digital compression of the main trunk and of the opening into the vein has been very successful. This failing, the opening into the artery must be cut down upon through the vein and sac and a ligature applied above and below it.

Diseases of the Arteries.

Atrophy and contraction of an artery follow upon diminution of its blood-carrying function, as seen in stumps (p. 354), between arterio-venous communications, etc. A general atrophy is said to occur in high degrees of anæmia and in marasmic conditions.

Degeneration: *Fatty.*—Most commonly this occurs in the products of a chronic arteritis; but fatty degeneration of the otherwise unaltered intima and media, especially of the former, is often met with. In the *intima* it is recognized by the appearance of small opaque yellow, sharply circumscribed patches, streaks, or dots, which appear quite superficial, are not raised, and can be easily scraped away with the point of a knife, leaving the media and outer layers of the intima intact. Groups of these spots are common at the base of the aorta even in young people. Microscopically, we find fatty degeneration beginning in the spindle and branched subendothelial cells of the intima, the droplets appearing later between the fibres and lamellæ. The change must be distinguished from *atheroma*, due to fatty degeneration of inflammatory products in the deeper layers of the intima. In the *media* fatty degeneration is not recognizable macroscopically; it predisposes to rupture or formation of aneurism, and is often associated with calcification.

Fatty degeneration occurs in vessels of all sizes, may be acute or chronic; general—due to various forms of poisoning, anæmia, marasmus—or quite local and of doubtful etiology. The breaking down of a patch destroying the intima may lead to a dissecting aneurism; or, if the coats are all affected, rupture may result. Birch-Hirschfeld regards this as the cause of many spontaneous hemorrhages from small vessels into internal organs.

Calcareous degeneration, though less common, is still frequently met with as a senile change. Its special seat is the muscular coat, and the first sign of it is the appearance of calcareous opaque rings, taking the line of the circular fibres (*annular calcification*). Sooner or later the rings blend, converting the artery into a rigid tube (*tubular calcification*) like a pipe-stem. Ultimately, the earthy salts may infiltrate the intima and adventitia; but usually these coats remain sufficiently healthy to prevent thrombosis (intima), and to give such toughness (adventitia) to the vessel as will prevent cracking and allow the application of a ligature. In high degrees a thread cuts through as it is tied. Calcification generally prevents dilatation.

Tubular calcification is most frequent in the tibial arteries of the aged, being the great predisponent to gangrene of the parts supplied; it occurs also in the forearm and arm vessels, and is not infrequent in the intra-abdominal vessels—*e.g.*, large uterine arteries.

Atheromatous plaques very often calcify, producing the appearance of alligator-hide, and seen chiefly in the aorta and larger vessels.

Amyloid degeneration has been described (p. 83).

INFLAMMATION OF ARTERIES.

Acute arteritis may be due to mechanical or other injury of the whole vessel from without, to spread of inflammation to it from surrounding parts (*periarteritis*), to the impaction in its lumen of an embolus mechanically or infectively irritating, or to the formation in the vessel of a clot (*endarteritis*) which may cause varying degrees of irritation according as it disappears, organizes, or softens. The effects of inflammation—the dilatation of the vasa vasorum, loss of polish of intima, and shedding of epithelium, formation of lymph on the injured surface and its development into granulation and firm connective tissue closing the vessel—have been described under "Ligature" (p. 357); as also the widespread softening or even sloughing of the arterial tissues, in cases of severe and usually septic irritation. It is this ulceration or sloughing occurring at a seat of ligature or other injury, or where an artery is laid bare by some spreading inflammation, especially hospital gangrene (p. 155), that leads to hemorrhage.

CHRONIC ARTERITIS (*arterio-sclerosis, endarteritis deformans, atheroma*).—Chronic inflammation of arteries arises from many causes. The changes induced vary much in naked-eye appearance, according as they occur in large or small vessels, are diffuse or circumscribed, and are or are not combined with various degenerative processes.

The commonest and most important form is that usually called *atheroma*, which affects chiefly the larger vessels—aorta, coronary, iliac, femoral. The changes begin *in the deeper layers of the intima*, where it is in contact with the muscular coat. Here, in the earliest stage, round cells collect and often become oval, spindle or branched; the matrix may be homogeneous or fibrillated. The new cells may be wholly converted into *fibrous tissue* nourished by a few capillaries; or, the food-supply proving insufficient, as it usually does, the cells undergo *fatty degeneration*, and this begins furthest from the endothelium. By this process a cavity full of a yellowish-white fluid, containing numerous fatty and earthy granules and cholesterine crystals, may be developed in the intima (*atheromatous abscess*); and from the naked-eye resemblance of this stuff to the contents of sebaceous cysts, the morbid process has been called *atheromatous degeneration*. But much more commonly no such fluid forms. As the cells and fibres undergo fatty degeneration, earthy salts are deposited in such quantity that a *calcareous plate* results. To the naked eye the muscular coat may appear normal or slightly thickened; the microscope, however, early shows collections of round cells, fibroid patches, and fatty degeneration of fibres. In advanced cases the adventitia is thickened and condensed.

When the above processes occur in a circumscribed area, we notice first a swelling projecting into the lumen of the vessel. At first it is low, smooth, and of gray gelatinous aspect on section—rarely seen; should it develop into fibrous tissue the surface becomes puckered and irregular, and the edge of the patch may be one sixteenth of an inch high and abrupt; should it, on the other hand, degenerate into fluid, the patch becomes soft, markedly yellow, fine openings form in the intima, the contents of the cavity escape into the blood-stream, the openings enlarge and blend, and ultimately the muscularis is exposed at the bottom of a degeneration ulcer (p. 67) upon which fibrin is usually deposited. In earlier stages, endothelium is generally demonstrable over the plaque, and there is no tendency to coagulation upon it. When calcareous plates form they are hard, more or less circular, and irregular on the surface, which is often bare or covered with fibrin.

On laying open a vessel—*e. g.*, the aorta—affected by atheroma, only one or two patches may be found; or the whole interior may be covered by them, and then, if a length of artery be taken, almost all the above stages may be seen. Thus we have dense fibroid patches, yellow patches of fatty degeneration, a few perhaps containing fluid, numerous calcareous plates covered by endothelium or fibrin, or bare, with here and there an "ulcer" due to the bursting of an atheromatous abscess or to the separation of a calcareous plate. In an advanced case, the middle and external coats will be fibroid, and the vessel will consequently be found to have lost much of its elasticity and to have become dilated uniformly or partially, and often lengthened and tortuous under the blood-pressure. Much calcification renders the lumen very unyielding.

When, however, chronic arteritis affects the whole circumference of a smaller vessel, it generally causes narrowing of the lumen instead of dilatation; for in them elasticity is greater and longer preserved, the arterial pressure is less, and relatively the effect of thickening the intima is greater. Actual closure may result, and this is most likely to occur where the branch leaves the main trunk, the disease being most advanced here; thus at the base of the aorta, if there is atheroma anywhere, a ring will be found round the orifice of the coronary arteries. Thrombosis may complete the closure of a narrowed vessel. Fatty degeneration, softening, or necrosis of parts supplied, result from such changes.

Etiology.—The variety from which the above description has been chiefly taken—the common *atheroma* or *arteritis deformans*—is a disease of the latter half of life, though it may be met with in a marked degree between thirty and forty, especially in alcoholic subjects. Its great cause seems to be *strain*, as is shown by many circumstances—*e. g.*, its special seats of election, viz., the aortic arch, thoracic and abdominal aorta, the iliacs and vessels of the legs, the coronary and cerebral arteries—all vessels in which the blood pressure is high; its rarity in the pulmonary circulation, unless the right heart is hypertrophied, then its frequency; its connection with Bright's disease and its high-tension pulse; its greater frequency in men, especially among those of laborious occupations and among athletes.

Syphilis is a distinct cause of chronic endarteritis, which differs in many ways from the above. Whereas atheroma is usually widely distributed and affects the larger arteries, syphilis affects single vessels, and often only limited portions of them or small branches, and it occurs in young people, even infants. It is best known in the vessels of the brain and trunk of the internal carotid—partly because these vessels are most open to observation, partly, perhaps, because of the anatomical peculiarities of the cerebral arteries (perivascular sheath, Lancereaux). Other vessels certainly suffer. Thus in a child that died of intraventricular hemorrhage, and in whom miliary gummata of the choroid were noted, I found two prominent fibrous patches in the arch of the aorta. The tendency of the new growth is to raise the endothelium from the membrana fenestrata, and greatly to narrow or obliterate the lumen. According to its age we find the deposit almost cartilaginous in its hardness, simply fibroid or cellular, involving only the intima or the whole thickness of the wall, and generally forming circumscribed nodules or rings upon the vessel. It shows little tendency to calcify. Friedländer, however, holds that syphilitic endarteritis cannot be diagnosed by its naked eye any more than by its microscopic characters. Sometimes distinct and characteristic gummata form in the middle or external coats of arteries, though this is much more common in veins, especially the portal.

The special causes of the endarteritis obliterans described at p. 87 are unknown.

There is no primary *tubercular arteritis*, but the walls of small vessels, in the sheaths of which tubercles have formed, are often infiltrated, and bacilli may thus find their way into the circulation (p. 96).

The *dangers of chronic arteritis* are: general or localized dilatation of the artery, from the combined effects of loss of elasticity and high blood-pressure, or from heightened blood-pressure behind an obstructing ring—sometimes seen in syphilis of cerebral arteries; actual rupture or erosion of the intima and admission of blood between the arterial tissues (dissecting aneurism); diminution or obliteration of the lumen by the new growth or by thrombosis, with softening or necrosis of the part supplied.

CIRSOID ANEURISM (ARTERIAL VARIX).

In this disease arteries, generally of medium or small size, and their branches become dilated, lengthened, and very tortuous; their walls are thin, and saccular dilatations form here and there. Capillaries and even veins dilate similarly. The ultimate result is the formation of one or more ill-defined swellings having large tortuous vessels running to them from all sides; they are often of bluish color, and are spongy and compressible to the touch, pulsate distinctly, and yield a systolic bruit.

These arterial varices may arise spontaneously, but frequently follow an injury, supposed by some to paralyze the vasomotor nerves. They rarely occur in connection with large arteries, and are most common in connection with the secondary branches of the external carotid (temporal occipital, facial). The scalp is more often affected than any other part.

These growths are distinguished clinically from true aneurisms by their spongy, indefinite feel and less forcible pulsation, and by the presence round about of tortuous supplying arteries; but when they are out of reach of the fingers, their differential diagnosis may be impossible. Pathologically, they differ from nævi in the size and nature of the vessels of which they are composed, and in the fact that they are not congenital though often appearing during the period of youth.

Fig. 150 represents this disease. Mr. Storcks tied the common carotid artery, producing a marked decrease in the tumor; and the patient was sub-

Fig. 150.

Cirsoid aneurism.

sequently treated by Sir W. Fergusson with the needle and ligature, employed as for the cure of varicose veins.

Treatment.—Excision, when possible, is the most certain mode of cure; to avoid bleeding, cut wide of the growth. When impossible, ligature of the tortuous supplying vessels has been done with scant success; or they may be acupressed between two needles and threads, like a varicose vein, and divided subcutaneously; success has attended the cutting through of the growth in several directions by the galvanocautery; and, lastly, the main supplying artery—*e. g.*, one or both common carotids—has been tied, but the results are not satisfactory.

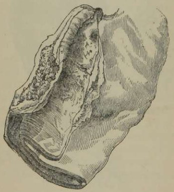
True Aneurism.

The word aneurism has been used, as we have seen, very loosely and improperly to designate a number of conditions bearing only a very superficial resemblance to the real thing. Thus: 1. "Traumatic aneurism" is often synonymous with *arterial hæmatoma*, diffuse or circumscribed (p. 370). 2. "Varicose aneurism," and "aneurismal varix" indicate simply a direct communication between an artery and a vein, or almost direct, the communication in the first case being by means of a small arterial hæmatoma between the two vessels. 3. "Cirsoid aneurism" or "aneurism by anastomosis" is best described as an arterial varix; arteries do dilate here, but uniformly and over considerable lengths—not in such a way that the dilatation of any artery produces a circumscribed, tumor-like swelling. The tumor is formed by the aggregation of enlarged arteries.

Definition.—A *true aneurism* is formed by the more or less abrupt, uniform or one-sided dilatation of a circumscribed length of artery, so that a definite *tumor*-like swelling results. The term *dilatation* is employed in contradistinction, to indicate the comparatively slight general enlargement of long tracts of vessel, such as often arises from endarteritis deformans, or from the passage of more blood than usual through vessels—*e. g.*, those round the enlarging pregnant uterus or a rapidly growing tumor, or those by means of which collateral circulation is being established.

Varieties of True Aneurism.—*Shape.* In some cases the whole circumference of the artery yields tolerably *uniformly* in all directions; if the

Fig 151.



An incipient aneurism of the arch of the aorta. The portion of artery represented is slit up, so as to show the cut edges, with the atheromatous deposit between the coats of the vessel.

yielding is gradual, the swelling of the artery will be *fusiform*, but if it almost suddenly reaches its maximum the enlargement may be *cylindriform* or *globose*. These varieties occur chiefly in the ascending aorta. In other much more common cases only a small portion of the circumference of the vessels yields, or, if the dilatation affects the whole circumference, it takes place very unequally, so that a sac-like swelling projects upon one side: this is the *saccular* aneurism. Usually, it communicates with the artery by an opening (*mouth*) situate in a more or less markedly constricted *neck;* the mouth may be very small in proportion to the sac, or it may occupy its widest part. When the artery has yielded in all directions, but very unequally, there are of course two openings into the sac at its base. When situate upon arched vessels, saccular aneurisms usually spring from the convex side.

Very irregular tumors may arise by the blending of two or more neighboring saccular aneurisms, by the saccular dilatation of fusiform aneurisms, by dilatation of branches springing from aneurismal sacs, and by excessive yielding of the less supported parts of old sacs.

Rarely, and probably upon the bursting of an "atheromatous abscess," blood finds its way into the substance of the middle coat of an artery and separates the inner from the outer coat for a greater or less distance. Ultimately the blood may burst through the intima into the artery again, or through the adventitia when the aneurism becomes diffuse. This is the *dissecting aneurism*, and is met with only in the aorta, though it may extend thence into one or more primary branches. The separation of the coats may be very extensive.

Other varieties have been founded upon the presence or absence of all three coats. The distinction is of little importance. It is only in some fusiform aneurisms, and perhaps in the smallest saccular, that all three coats are found continuous.

According to their etiology, aneurisms are divided into *traumatic* (p. 372) and *spontaneous*. One traumatic variety—the *hernial aneurism*—seems worth special mention, though it is rare. It is due to division of the external coat by injury, permitting the protrusion through it of the internal.

Morbid Anatomy.—Fusiform and dissecting aneurisms do not reach any great size, but saccular aneurisms may be as large as a child's or even an adult's head. A large aneurism usually springs from a large artery. The commonest aneurisms are those very small ones which occur upon the arteries of the brain and lungs, and are classed as *miliary:* surgery has little or nothing to do with them.

In all cases a true aneurism has a *sac*, at first formed by dilatation of one or more of the arterial tissues; and within the sac are the *contents*—blood, fluid or coagulated, according to circumstances. As regards the *sac-wall*, it may consist of all three coats in fusiform and small saccular cases. At the commencement fibroid patches often form gaps in the media; these enlarge, and in considerable saccular aneurisms muscular tissue usually stops short near the mouth of the sac, but patches of it may be found here and there in the wall. The lining of the sac will usually appear continuous with the intima, and may closely resemble it in appearance, being occasionally smooth and shining, but usually presenting numerous fatty and calcereous patches when the vessels are atheromatous; and the outer covering of the aneurism will similarly be continuous with the adventitia. But in all large aneurisms distinction of coats in the wall of the sac is impossible; there is but one coat, consisting of fibrous tissue, and this is almost entirely of new formation. For the constant pressure of the sac upon surrounding parts causes atrophy and absorption of their essential elements, whilst their fibrous tissue, thickened by inflammatory tissue, blends with the enlarging sac-wall. Even bone and cartilage disappear under this pressure; but as they resist longer than other tissues, their bare eroded surfaces often project into the interior of the cavity of the aneurism.

As a rule, the sac contains more or less clot, together with fluid, moving blood. The clot is of the kind known as *laminated*, and presents on section an onion-like appearance. The oldest layers next the sac are firm, dry, and yellow-white, the more recent become softer, moister, and redder; and, post-mortem, we find the interior of the cavity full of ordinary dark clot. When deposit of clot has ceased some time, the inner layer may be firm, smooth, and polished. The cause of the lamination is uncertain; as a rule, the clot undergoes little or no organization.

Histology and Etiology.—The question of dilatation of an artery is evidently one in which the factors are: 1, the strain thrown upon the vessel by the blood-pressure, the sole dilating force to which it is exposed; and 2, the resistance which the walls can oppose to such pressure. We may assume that normally the two are so adapted that no dilatation shall occur. Variation from the normal may occur in either direction—the arterial pressure may be raised or the resistance of the wall diminished; frequently causes of both kinds act.

Increased pressure.—Perhaps the purest instance of dilatation of a healthy vessel is that sometimes met with in the first part of the aorta when there is a congenital contraction of the vessel at the point of junction with the arterial duct. Cases of dilatation about a point of ligature or of impaction of an embolus are by no means pure. High arterial tension from Bright's disease or other cause is a powerful factor in the production of aneurism.

Diminished arterial resistance.—But, practically, aneurisms result from changes in the arterial tissues which weaken their resisting power, blood-pressure being normal. These changes are of an inflammatory, degenerative, or traumatic nature. We already know that inflammation may commence in the intima and extend outward (*endarteritis*), in the adventitia and extend inward (*periarteritis*), or it may begin in the media (*mesarteritis*); and there is no doubt that the resisting power of an artery can be sufficiently destroyed to insure its dilatation by inflammation starting in either coat, as the following remarks show.

Formerly, *atheroma* (p. 375) was regarded as the state sublying the great majority of spontaneous aneurisms. But to this view there are many objections, of which the following may be mentioned. Atheroma is very common, aneurism uncommon; atheroma is a disease of advanced life, aneurism occurs chiefly in the prime of life (thirty to fifty); atheroma is equally common in the two sexes, aneurism much more frequent (9 to 1) in the males, especially of the laboring class; atheroma is very common in Germany, yet aneurism is rare; lastly, in many cases of aneurism there is neither local nor general evidence of atheroma. But in advanced life, and earlier when marked atheroma is found, there can be no doubt that this chronic endarteritis is frequently the cause of aneurism. It is almost necessarily so from the completeness with which it destroys the arterial elasticity, leaving the vessel slowly but surely to yield before the blood-pressure. The disease is by no means confined to the intima, however; the media shows frequent fibroid foci, and the adventitia signs of infiltration (p. 375), and to the former Köster attributes the chief weakening of the wall. An atheromatous ulcer naturally detracts much from its strength; without the presence of such a process as this, it would hardly be possible to account for cases of dissecting aneurism.

Köster and Kraft regard a *mesarteritis* as the essential lesion in the production of aneurism; the vessel dilates, they say, because the muscular coat is replaced by a fibroid patch. When, in the investigation of commencing aneurisms, the middle coat is examined, foci of round cells or fibroid tissue are always frequent. This mesarteritis may exist in middle-aged people without change in the intima other than puckering from contraction of the fibroid media; whilst in older people such patches frequently correspond to atheromatous patches of the intima. These, Köster and Kraft believe to be secondary to the changes in the media, which constrict the vasa vasorum. So atheroma, instead of being a primary endarteritis, would be secondary to mesarteritis, and its degenerative changes would be due to mechanical constriction of the vasa vasorum, which do actually send branches into young inflammatory foci in the intima; and mesarteritis would replace endarteritis as the primary and perhaps sole lesion leading to aneurism. But Orth disputes the constancy of the relation between the patches in the media and intima, and points out that vessels having no vasa vasorum may suffer from atheroma. Moreover, it does not seem rational to endeavor to connect dilatation of a vessel with disease of a single coat; doubtless the thickness of an artery, which must lose its elasticity and contractility before dilatation can occur, varies in different vessels and different people; whereas loss of the muscular coat's contractility may allow a small cerebral artery to dilate, it is unlikely that this will result in the aorta, in which muscle is, comparatively, so poorly represented.

Charcot (*Lectures on Senile Diseases*, Syd. Soc.) describes a diffuse *periarteritis* of cerebral vessels leading to miliary aneurisms, which are the ordinary source of cerebral hemorrhage. The disease affects the small arteries of the brain-substance, which are remarkable for richness in muscular elements and relative poverty in elastic tissue. The first sign of disease is cell-infiltration of the lymphatic sheath, and then of the adventitia; next, conversion of the cells into fibroid tissue, which, probably, constricts the vasa vasorum. Anyway, secondary as regards time to this fibroid thickening of the, normally, very thin adventitia, the muscular cells atrophy, and disappear without undergoing previous fatty degeneration. And now, the chief resisting tissue of the cerebral artery being destroyed, bulgings of all shapes occur, unless the fibroid adventitia, lymphatic sheath, and intima blend and form so thick and firm a covering as to preserve the balance between dilating force and resistance. Changes in the intima may finally occur, but it is obvious that the disease is totally different from atheroma or endarteritis deformans, to which disease the spontaneous rupture of cerebral vessels has generally been attributed. Aneurisms of the large vessels at the base of the brain sometimes coexist with miliary aneurisms, and are said by Charcot to owe their origin to a similar periarteritis. Lastly, cases of aneurism of vessels of trunk and limbs coincident with cerebral aneurisms have also been recorded; and Charcot suggests that the pathology of many of the aneurisms met with in surgical practice may be that above given. True atheroma may coexist with this periarteritis.

Inflammation round about an artery may, by spreading to its coats and by depriving them of their normal support, lead to its dilatation. The frequent small aneurisms on pulmonary and bronchial vessels in tubercular cavities are the best examples of this. Large vessels are very resistant; they may slough from exposure in septic wounds, very rarely they have ulcerated into closed abscesses, especially in the neck (Liston); but they do not dilate under such circumstances.

Of simple *degenerative processes* likely to predispose to aneurism we may mention atrophy of the arterial coats, fatty degeneration of the media, and perhaps calcification of the same from its rendering the artery more subject to injury.

The last pathological state believed to be the starting-point of aneurism is that of *rupture of one or two of its coats*, healthy or diseased, by violence. Usually it is the intima and media which suffer, but the *hernial aneurism*, due to protrusion of the intima through the external coat, has been described (p. 379).

Just as we are often in doubt as to which of the above *pathological condi-*

tions has led to the aneurism, so we frequently fail to discover the *exciting causes* of this disease.

A history of distinct injury of the part or of a sense of something giving way in it during violent effort is common in cases of aneurism. It is, consequently, thought that the part played by *traumatism* in the production of aneurism is considerable, causing, when slight, separation of the fibres of the media or cracking of a diseased intima, whilst such violence as over-extension of the knee until the posterior ligament cracks will be found to have ruptured the two inner coats of the popliteal (Richerand). When the vessel is diseased, less force will suffice, and thus are to be accounted for rare cases of aneurism of the femoral forming a few days after its compression for popliteal aneurism, and still rarer cases of acute dilatation during sleep, attributed by Billroth and Marcacci to rupture of the intima.

Strain acts upon a vessel either in the line of its long axis, or, when exerted by the blood, at right angles to its inner surface; probably the heightened blood-pressure during a sudden violent effort in people unused to hard work often produces yielding of a weak spot of artery. With strain as a cause it seems possible to explain, in part at least, the greater frequency of aneurism in men, and among laborers; in England and America than in Germany, athletic exercises and feats of strength being more generally practised; and the relatively much greater frequency with which the popliteal among arteries of limbs, and the arch of the aorta among vessels of the trunk, are affected, for the former is fixed by small branches and subject to violent stretchings in kicking, etc., and the latter must feel the effect of all extensive movements of the neck and upper limbs. Pointing in the same direction is the fact that aneurisms of the aorta are more frequent the nearer the heart—*i. e.*, the higher the blood-pressure. It may be said that many people go about with vessels which are so diseased that extra strain would cause them to dilate, but they are still able to bear the pressure normal to them; in such, sudden strong efforts are dangerous.

There are many aneurisms which cannot be accounted for by primary arterial disease and injury or strain. The most frequent cause of these is perhaps *embolism*; to this, probably, are due most cases of aneurism in children and young people, in whom it is very rare and generally coexists with heart disease. The embolus is usually a fragment of fibrinous or calcareous vegetation in simple endocarditis, some fragment from a valve in malignant endocarditis, or a bit of a calcareous plate from a larger artery. These may actually wound the intima, or by their irritation excite more or less arteritis—even suppurative, very similar to that proceeding from a septic wound. Pressure above the blocked spot is only momentarily increased (Roy).

The characteristic *symptoms of embolism* of a large artery are sudden violent pain in a limb, numbness, coldness, loss of pulse, and tendency to gangrene (p. 88) in distal parts of it, together with tenderness and swelling about the affected artery. A boy under Dr. Green, at Charing Cross Hospital, suffered for months from a very remittent temperature and occasional rigors, which, taken with aortic disease, led to the diagnosis of endocarditis maligna. One day he complained of great pain in one forearm, and the ulnar pulse, previously felt, was missed at the wrist. Some weeks later he had severe pain in the arm, and the radial pulse became very small. Post-mortem, I found two small saccular aneurisms—one upon the ulnar, just where the vessel was narrowed by the giving off of the anterior interosseous; the other upon the brachial, above the origin of the superior profunda. Both were filled with clot, as also was the artery, for some distance above and below them.

The explanation given of aneurism from embolism probably holds good for rare cases of aneurism just above a seat of ligature. (Broca, *Sur les Anévrismes*, Paris, 1866, p. 41.)

About *syphilis* as a cause of aneurism there has been much dispute, syphilis of the larger arteries not being well known. A history of syphilis is very frequently obtainable. Besides its well-known endarteritis of small vessels (p. 117), it probably produces gummata and diffuse infiltration of the media and adventitia, leading to local or general loss of elasticity and weakening. The argument that iodide of potassium has sometimes appeared to do good in the treatment of aneurisms is not worth much to prove their syphilitic origin.

Chronic alcoholism seems to cause vascular degeneration directly or by exciting the heart. Any other condition inducing cachexia—*e. g.*, malaria, old age—may act similarly; and the strength of the arteries suffers with general or local wasting.

Situation.—The most common situation of aneurisms is the aorta, near the heart; but if aneurisms of the aorta are excluded, we find that of all the arteries of the limbs, the popliteal is the most frequently affected. Thus, out of 179 cases of spontaneous aneurism collected by Lisfranc (not including any of the aorta), there were 59 of the popliteal artery; 26 of the femoral in the groin, and 18 in the femoral at other parts; 16 of the carotid; 16 of the subclavian; 14 of the axillary; 5 of the external iliac; 4 of the innominati; 3 of the brachial, common iliac, and anterior tibial, respectively; 2 of the gluteal, internal iliac, and temporal respectively; and 1 of the ulnar, perineal, internal carotid, radial, and palmar arch respectively.

Number.—As a rule, only one aneurism develops; but two are often met with—*e. g.*, one of each popliteal, of the popliteal and femoral on the same side, or of a limb-artery and of the aorta. Rarely, more than two aneurisms are present; and as many as sixty-three have been noted in one person. These remarks refer to aneurisms of considerable size—not to miliary cerebral or pulmonary dilatations.

Before commencing the treatment of an aneurism, the surgeon should never neglect to *examine the heart and the whole arterial system.*

Symptoms.—In the development of an aneurism in the neck or limbs, the first sign noticed is often an unusual pulsation and perhaps movement of the whole part communicated from the aneurism. Next, a swelling appears and enlarges more or less rapidly; it is circumscribed to the eye and still more so to the touch, lies in the course of a large trunk, is tense, elastic, or fluctuating, and pulsates synchronously with the pulse; sometimes a marked thrill is felt with each systole. The distinctive point about the pulsation of aneurism is that it is *expansile*—due, not to the pushing forward of the whole sac as if it were a solid mass, but to the driving of blood into the sac, distending it and forcing its walls asunder. This peculiarity is easily recognized if a finger can be placed fairly on either side of the sac, but it is difficult to be sure of it when we can only lay two fingers slightly separated upon its superficial surface.

On auscultating the swelling, whilst taking care not to use such pressure as would develop a bruit in a normal artery, a blowing murmur synchronous with the pulse will usually be heard. In aneurisms of the head and neck the patient may be greatly troubled, and sleep prevented by hearing the bruit. If the main artery be compressed between the swelling and the heart, pulsation and bruit will cease, the tumor will become smaller and more flaccid, especially if direct pressure be made upon it. On removing pressure from the artery, the swelling suddenly regains its full size—often with a thrill—and pulsation and bruit return. The pulse beyond the tumor is often smaller than that on the sound side and delayed; the *sphygmograph* shows deficiency in the second or *dicrotic* elevation.

The above signs are common to all aneurisms which do not contain much clot, though they may be undiscoverable on account of inaccessibility of the sac. But as the clot accumulates in the sac the aneurism assumes more and more the characters of a solid tumor—it feels firm, does not fluctuate, does not pulsate expansilely, but rises and falls as a whole, or perhaps exhibits no movement, the artery being obliterated opposite the mouth of the sac. There will then be no bruit, and little or no change of volume on compressing the main artery above.

We now come to the *pressure-symptoms*, which vary with the site (*i. e.*, with the relations) of the tumor and in intensity directly with the rate of its development; for when its enlargement is slow, structures in contact with it may stretch, slip aside, or otherwise adapt themselves to the altered circumstances, which is not possible when they are suddenly pressed upon. There is nothing peculiar in the pressure-symptoms of aneurisms; they act simply as tumors. In aneurisms which present upon the surface, pressure-symptoms are noted to complete the case, not because they are required to diagnose or localize the disease; but in internal aneurisms—especially intra-thoracic—we rely largely upon pressure-symptoms to recognize their presence and fix their sites. An accurate knowledge of anatomy is essential for these purposes. Inquiry must first be made as to the manner in which the various structures in the neighborhood of the affected vessel discharge their functions; then the aneurism must be of such size and so placed as to produce the symptoms complained of. Frequently, however, an aneurism may reach a large size in certain directions without pressing upon any important parts.

The commonest pressure-symptoms are due to *pressure on nerves:* motor, sensory, or sympathetic. *Spasm* and *paralysis* from irritative and destructive pressure, respectively, on motor nerves, are uncommon; they are best seen in laryngeal muscles from pressure of aortic aneurisms on the recurrent laryngeal. Very severe *neuralgia* and perhaps *hyperæsthesia* are the first results of pressure on sensory nerves; *anæsthesia* may follow. These symptoms are well seen when aortic aneurisms press on intercostal nerves or upon those going to the lower limb; but still more often these swellings cause a fixed, constant burning or boring pain, with sense of weakness from erosion of the vertebræ. The results of pressure on the sympathetic are best known in the head and neck (p. 44).

Veins are commonly pressed upon, perhaps obliterated, and afford important indications; they become swollen and varicose behind the obstruction, then more or less marked œdema of the area whence they draw their blood results, and rarely even moist gangrene may ensue.

Arteries may be pressed upon by aneurisms of other vessels, but symptoms are rare. A sac may press upon the vessel whence it springs and lead to the complete cure of the disease.

No special remarks are needed upon the symptoms which result from pressure on the trachea, bronchi, lung, œsophagus, bile-duct, etc.

Progress and Terminations.—Sometimes, though comparatively rarely, an aneurism *remains stationary* for long periods, or undergoes *spontaneous cure* (see below); but in the great majority of untreated cases aneurisms tend either slowly or rapidly toward *rupture*. The sac enlarges most in the directions of least resistance (usually toward free surface), adhering to and causing the absorption of all structures with which it comes in contact (p. 379). In the limbs usually, and sometimes in the trunk, it presents beneath the skin and distends it. Inflammation succeeds; the skin becomes red, then livid and vesicated, and sloughs. When the edge of the slough separates, a fatal bleeding ensues, sometimes in a gush enough to destroy life at once; but more frequently the blood oozes away slowly, or hemorrhages occur at intervals and clot blocks the opening between times. Sometimes rupture takes place into the areolar tissue of the limb or part in which the aneurism is situate—in other words, the aneurism becomes diffuse. Aneurisms of central vessels frequently open into mucous canals (alimentary, respiratory), or serous cavities—by a small, ulcerated opening in the former, by a crack or fissure in the latter case. Occasionally aneurisms burst into large veins which have become adherent to the sac, a varicose aneurism resulting; and those of the first part of the aorta may open into the heart itself.

Signs of perforation.—Sudden, severe pain, rapidly followed by collapse, is the usual sign of the rupture of an *internal aneurism;* special symptoms may indicate the direction in which it has burst—*e. g.*, hæmoptysis, asphyxia, hæmatemesis, escape of blood per anum. The collapse varies with the intensity of the pain, and especially with the quantity of blood lost in a given time. When an *external aneurism* becomes diffuse, pain and collapse may be very marked; and sometimes with only a slight rupture there is high fever with septic symptoms. Local symptoms are generally prominent; the limb swells more or less diffusely; the circumscribed aneurismal tumor disappears; pulsation is often entirely lost—at least until the arterial hæmatoma becomes limited by the pressure of the tissues; pulsation is absent in the main arteries beyond the rupture, and the signs of venous obstruction—coldness, dilatation of subcutaneous veins, œdema, and perhaps moist gangrene—appear in the distal portion of the limb. We have, in fact, an arterial hæmatoma (p. 370), which may be circumscribed or diffuse, and lead to rupture through the skin, with or without suppuration, or to gangrene.

Spontaneous Cure.—In a small number of cases, aneurism ends in spontaneous recovery, usually by the more or less gradual deposition of laminated clot, but sometimes by the more rapid formation of ordinary clot. The local conditions favoring the formation of clot are: a rough sac-wall and stagnation of blood in contact with it. Stagnation or languid circulation of blood obtains (1) in saccular aneurisms with small mouths, whilst it cannot occur in fusiform aneurisms, through which the main current rushes; and saccular dilatations from which large vessels spring are also unfavorable to clot formation. As a rule, no clot, other than a thin layer upon calcareous plates, forms in fusiform aneurisms; but Holmes speaks of the arrest of this variety by clotting until only a narrow channel is left through which blood passes. In saccular aneurisms clot-formation goes on until the whole sac is full of onion-like layers, and the artery is usually obliterated opposite its seat by fibrous tissue; then the solid mass slowly shrinks. (2) In a few lucky cases, a portion of clot has been detached from the interior of the sac by some accidental violence, and has effected a cure by blocking up the opening out of the aneurism, or by *embolism* of the main trunk beyond the aneurism. (3) The artery has become obliterated by accidental pressure of aneurism upon it, above or below the mouth, under the resisting tension of a strong aponeurosis; or by the pressure of blood escaping from it on its bursting into the cellular tissue. (4) Inflammation about the sac may lead to primary thrombosis of the artery at the mouth of the sac and secondary clotting in the sac; or if the latter suppurates, healing by granulation will occur under favorable circumstances.

Complications.—Before rupture can occur the following complications may arise:

Cellulitis and suppuration about the sac are rare. They may occur around aneurisms in loose connective tissue, which have been increasing rapidly; but usually they appear after the application of a ligature near the sac (*e. g.*, of subclavian for axillary aneurism) or after manipulation or other injury of the swelling. The signs are ordinary. Should the inflammation end in suppuration, there is much risk that when the abscess is opened or bursts, the contents of the sac, broken down and altered in appearance by admixture with inflammatory products, will escape with the pus, and either at once or after some days be followed by hemorrhage from the main artery. This, however, does not happen in the majority of cases, the artery apparently becoming thrombosed at the mouth of the sac before the latter opens. Suppuration of the sac must not be confounded with ulceration of an artery into an unopened abscess—a very rare occurrence.

Gangrene of distal parts may result from the pressure of a rapidly enlarging sac upon the veins, but even one of the venæ cavæ may thus be completely obliterated without gangrene resulting; usually it arises from diffusion of the aneurism. Coagulation may spread widely along the main trunk leaving the sac, and, blocking the mouths of branches most important for collateral circulation, cause mortification.

DIAGNOSIS.—An aneurism may be met with in four states: (1) with contents chiefly fluid, in which it may be termed typical; (2) solid, or almost so; (3) diffused; and (4) suppurating.

1. In its typical state, aneurism is characterized chiefly by its forcible expansile pulsation, its bruit, and the distinct diminution in size that follows gentle pressure on the sac, whilst the main artery is compressed above. In this state it may be confused with fluid swellings—cystic tumors, hydatids, large bursæ, and especially chronic abscesses—lying immediately upon great vessels and receiving a communicated pulsation. Points in the history of such cases may be of value, especially as showing absence of pulsation in early stages; the swellings are often less firm and circumscribed than aneurisms; their pulsation is hardly ever expansile and forcible, they can often be drawn aside from the vessel, when pulsation and bruit cease; if the vessel can be compressed on the proximal side of the growth, the swelling, though soft and fluctuating, undergoes no diminution in size, nor does it increase with a sensation of thrill when pressure is removed from the artery.

Much more difficult than the above may be the diagnosis from *pulsating sarcomata*, which almost always spring from bones. These growths pulsate expansilely, and are the seats of a humming or whizzing bruit; compression of the artery above checks both these signs, and may cause diminution in the size of the mass. Usually these growths present in such situations that they cannot be aneurismal—*i. e.*, they are not in the lines of great arteries; but the greatest difficulty has arisen when the tumor has presented where it could not be well examined and in the vicinity of an artery—*e. g.*, in the iliac fossa or region of the great sciatic notch. Mistakes have been made by the best surgeons in such cases. Prolonged and careful observation should always precede treatment.

2. When the aneurism is solid or almost so, it is liable to be mistaken for a tumor in the line of a great vessel, for it has lost in great part or entirely its characteristic signs. In the more solid cases pulsation is absent, or, if present, consists in a rising and falling of the whole mass. The history is here of the utmost importance, and if this does not render diagnosis possible, the patient must be kept at rest and treated for aneurism in some bloodless way, whilst the swelling is carefully watched. Amputation has been performed for consolidated aneurism causing pain by pressure on a nerve and regarded as a malignant tumor; it would seem that even short observation must have prevented such an error.

The diagnosis of a solid tumor over an artery from an aneurism rests chiefly upon the ability to move the tumor away from the artery and deprive it of its aneurismal signs; its pulsation is, of course, not expansile at any time. The shape of the mass may be characteristic, as in unilateral enlargement of the thyroid, in which the isthmus may often be plainly traced into the swelling.

3. When an aneurism has become diffused, and especially when this accident is accompanied by fever, loss of pulsation, and redness and vesication from threatened bursting through the skin, the diagnosis from deep abscess has to be made; and aneurisms have several times been opened in error. Again, the history is of chief importance; and even if the existence of an aneurism had not been recognized, the suddenness of the onset and the early obstruction to both arterial and venous circulations should arouse suspicion. Exploratory puncture is apparently not conclusive, as inflammation is often excited about the hæmatoma; so in doubtful cases, with gangrene threatening, an exploratory incision must be made, everything being ready for further treatment.

4. When suppuration has occurred its signs are plain and usual, whether it happen before or after ligature. The chief difficulty would lie in recognizing as a suppurating aneurism one which had ceased to pulsate on account of periarteritis (p. 385).

Prognosis.—This must be regarded as bad if treatment is not adopted or cannot be. Yet old, feeble people, living quiet lives, may go on for many years with stationary aneurisms, and finally die of something else.

Treatment of True Aneurism.

This may be either *general* or *local*.

General treatment is directed toward: (1) diminishing the frequency and force of the heart-beats, and (2) increasing the tendency of the blood to form fibrin. Very little is known on the subject of formation of fibrin, Schmidt's views being disputed by Hammarsten. But observation has shown that fibrin forms more or less quickly and in varying amounts in different physiological and pathological states—*e. g.*, pregnancy and sthenic inflammation; we may therefore hope to influence its development, and it is thought that a dry, albuminous diet and the administration of iodide of potassium (grs. x to xxx) favor coagulation in aneurisms. Mr. J. Hutchinson values highly acetate of lead pushed till it causes the lead-line, constipation, and colic, and he would similarly push ergot; by other surgeons these drugs are little used.

The first indication is fulfilled by keeping the patient as nearly as possible at absolute rest, upon a starvation diet. The patient must be instructed to avoid every unnecessary movement and all mental excitement; the bowels should act easily, but no drastic purgatives should be given, as they cause circulatory excitement; if he is strong and plethoric and the aneurism pulsates forcibly, bleedings of three to four ounces may occasionally be employed; and his diet must be gradually lowered to something like this: Breakfast, bread and butter, 2 oz.; dinner, bread and meat, of each, 2 oz.; tea, bread and butter, 2 oz.; and milk or water, 6 oz. per diem (Tufnell); no stimulants. Tobacco may be allowed.

In patients already feeble and anæmic, most surgeons allow a fuller diet, highly nutritious and easily digestible; but fluids are limited and stimulants disallowed. Iron is often administered in such cases.

In the absence of all accurate knowledge, the general treatment of aneurism is highly empirical, and but little reliance is placed upon it. Alone it is used only in inaccessible central aneurisms. When local treatment can be employed, a moderate diet with little fluid and no stimulant is usually prescribed.

Local Treatment.—Of this there are many varieties; but all that are employed under ordinary circumstances act in imitation of nature, inducing either the deposit of laminated fibrin or the more rapid coagulation *en masse* of the blood in the sac. With regard to these two modes of cure, it was stated by Broca, and has been repeated since, that the rapid coagulation of the blood in the sac excited much irritation, and was to be regarded as a potent cause of suppuration; but suppuration of popliteal and femoral aneurisms after treatment by Esmarch's bandage is scarcely known; so it is probable that the frequent occurrence of suppuration referred to by Broca, was due, not to the coagulation, but to the methods of inducing it (direct pressure, injection of coagulants, etc.). Laminated fibrin, once formed, is stable and little prone to organization; clot, on the other hand, is at first easily broken down and washed away, but is more easily organized.

The local methods of treatment are the following: 1. *Compression* (*a*) of the sac; (*b*) of the main artery on the proximal; (*c*) on the distal; or (*d*) on both sides of the sac. 2. *Ligature* (*a*) of the vessels entering or leaving the sac after laying this open; (*b*) of the main artery on the proximal; (*c*) on the distal side of the sac. 3. *Amputation*. 4. *Manipulation*. 5. *Electrolysis*. 6. *Introduction of foreign bodies into the sac*. 7. *Injection of coagulants into the sac*. 8. *The injection of ergotin in the tissues over the sac*. 9. *Ice*.

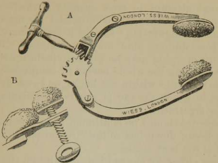
1. Compression.—This simple and very obvious mode of treatment was employed long since by Guattani and others, with some success; but it was usually applied *immediately on the sac*, was imperfect and violent, and usually failed—causing sloughing, suppuration, or rupture. Pressure on the sac is now employed but rarely, and chiefly in the endeavor to limit the advance of an aneurism which cannot otherwise be treated; thus a well-padded cap is sometimes fitted over a subclavian aneurism. The flexion method often acts partly by direct pressure.

Compression of the main artery on the proximal side of the sac was revived and perfected by the Dublin surgeons, Hutton, Cusack, Bellingham, and Tufnell, who pointed out that a cure, very similar to that resulting from the Hunterian operation, might be obtained if the main artery were compressed in an efficient manner. To this end they introduced suitable instruments, and formulated rules for their use. Vanzetti next showed that the fingers of relays of assistants were effective compressors in many cases where instruments either could not be applied or were not borne; and thus arose the two varieties of compression—*instrumental* and *digital*.

Instrumental compression is used almost solely on the lower limb, in which aneurisms are so much more frequent than in any other external part. The instruments employed are: *Signoroni's tourniquet* (Fig. 152)—an arc of steel, with a joint in the middle, and a screw by which the extremities of the instrument are pressed together; or *Carte's circular tourniquets* (Fig. 153), one of which envelops the whole pelvis firmly in a well-padded saddle, and acts on the lower end of the external iliac, whilst the other forms a circle of steel round the thigh, just below the groin, and has a wide pad behind for the limb to rest upon, and a screw-compressor playing through its anterior arch to act upon the femoral. By working these two tourniquets alternately, compression can be borne for a much longer period than when pressure is made at one spot only; but perhaps the chief merit of Carte's inventions is that the use of India-rubber bands, to connect the compressor and its bearings with the fixed part of the instrument, renders the pressure elastic and more like that of the finger. Carte's tourniquets have consequently replaced all others in the treatment of aneurisms of the lower limb. The advantages of two spots of pressure may, however, be obtained with Signoroni's tourniquet by using the double pad (Fig. 152, B). Lister's tourniquet has been used to compress the aorta and iliac aneurisms.

For compression of the femoral at the groin, the use of a four pound round-ended weight, which can be lowered on to the artery at pleasure, is excellent. By lowering a weight on to the dorsum of an assistant's thumb in digital compression, his endurance (fifteen minutes) can be at least doubled. Sometimes

FIG. 152.

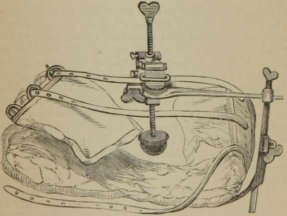


A, Signoroni's tourniquet. B, double pad. The hinder pad in A should be large and concave, to rest behind the pelvis.

a curved needle may be passed beneath the artery, which can be pressed against it, with a cork and ligature.

The conduct of compression.—The skin pressed upon should be shaved if necessary, and well powdered with French chalk. The artery and not the vein should be compressed. The pressure should be just sufficient to check pulsation in the sac, and in digital compression the assistants should work

FIG. 153.



Carte's circular tourniquet for the external iliac at the groin.

two and two—one compressing, the other with a hand on the sac. When a change is made, the fresh assistant should, when possible, compress a point of the vessel below or above that which is being compressed; and the retiring assistant should not relax pressure until the fresh one has the artery comfortably under control. Carte's tourniquets must be used similarly: the spots upon which their compressors are to act should be marked, and both should not be up at once. In many cases they, or the weight-compressor, may be left to the management of an intelligent patient. If he cannot feel the aneurism as he lies, he should know the number of turns necessary to check pulsation, and the sac should be frequently felt by an attendant. Compression may be *continuous* for twelve to twenty-four hours or longer; or it may be *discontinuous*, kept up for a few hours at a time for many days, weeks, or months.

Often a determined attempt to cure rapidly is made at first—*i. e.*, the artery is completely and continuously compressed for many hours together in the hope of inducing coagulation; should it fail, it may be repeated in a few days or the discontinuous plan may be adopted. When the patient bears the pressure ill, morphia may be given hypodermically, or he may be lightly chloroformed during the whole period of compression. The cure may be complete and the sac solid within six hours, or twice as many weeks may be spent over a case in which the sac is slowly diminishing and hardening under discontinuous treatment.

In rapid cases pressure should be continued for a few hours after solidification, lest the clot break down before the circulation; a tourniquet applied on the main artery is the best means.

The *mode of cure* is either by the sudden coagulation (unusual) of the contents of the sac (*rapid method*), or by the deposit of laminated fibrin. The more complete the control of the circulation, the more perfect the stagnation of the blood in the sac, the greater the chance of cure by coagulation; but when collateral supply is free, and blood trickles constantly into and out of the aneurism, cure, if it result, will be by the slow method of laying down layers of fibrin; and this is the usual result of digital and instrumental compression. In either case the sac shrinks to a small size and may be reduced to a mere nodule of fibrous tissue upon an obliterated artery. As to obliteration of the artery, Broca states that of 17 cured cases it was closed in 8, narrowed in 7, and almost natural in 2. Obliteration is satisfactory, for the artery is weak at the spot.

The special *advantages* of this method are: That it can be discontinued at once if need be; that it avoids all the dangers connected with an open wound, especially septic disease and secondary hemorrhage, and that patients are more willing to submit to it. Should it fail, ligature may still be resorted to, and a short preliminary compression has probably the advantage of opening up the collateral circulation somewhat, thus rendering gangrene less likely after ligature. Statistics, according to Holmes (*Lancet*, May 1, 1875), show—"to any one who trusts implicitly in figures"—that previous compression is unfavorable, the mortality and failures after secondary ligature being higher than after primary. But there is perhaps some error here, for, as C. J. Symonds points out ("Surgical Treatment of Aneurism," *Guy's Hospital Reports*, vol. xxv.), a confirmatory result derived from the Guy's statistics is certainly accidental, most of the deaths being due to wound diseases, and among cases in which compression had been practised for only a few hours. It is, however, conceivable that long compression might render the collateral circulation so free as to interfere with cure after ligature; and the difficulty of tying an artery at a spot which has long been compressed is considerably increased.

The *objections* urged against compression are: that some patients cannot bear the pain—which may be met by anæsthesia; that some cannot bear the pressure without sloughing—generally overcome by using the finger; and the somewhat doubtful one that, should it fail, ligature will be less likely to succeed.

Results of proximal compression.—Its success is variously stated. Dealing with popliteal aneurisms only, Hutchinson gives 52.1 and Holmes 53.2 per cent. of cures; whilst of all cases at Guy's (fifteen years), Symonds gives 56.89; and of 138 cases, König says 78.3 were cured. Sometimes the sac may harden once or twice before cure is ultimately attained. As to unfavorable results, we have most commonly simple failure to induce solidification of the sac. Sloughing of the skin, development of a fresh aneurism at the point of pressure, suppuration or rupture of the sac, and gangrene of the limb, are all rare accidents.

Distal compression may be tried when proximal is impossible; it is not nearly so valuable a method. When distal pressure is applied, the sac is kept distended under the full arterial pressure, and if any branches other than the main trunk arise from it, blood will move through it pretty briskly. If the collateral circulation is free, it is advisable to combine distal with proximal compression.

There remain two methods of compression which are of more limited application than the digital and instrumental spoken of above, viz.: compression by *Esmarch's India-rubber bandage*, and by *forced flexion of the limb.*

Compression by Esmarch's bandage was introduced by Dr. W. Reid, Royal Navy, in 1875, as a ready means of completely controlling flow through a peripheral aneurism, and of obtaining that perfect stagnation in the sac which was pointed out by Dr. Wm. Murray, of Newcastle, as essential to the rapid cure by coagulation. (*The Rapid Cure of Aneurism by Pressure,* 1871.) At the Congress in 1881, Pearce Gould read a paper on this method, from which the following points are taken.

Method.—With the limb horizontal an elastic bandage is applied firmly from the extremity up to the aneurism, then lightly over the sac so as not to empty it, and again firmly for a sufficient distance up the limb to control entirely the blood-supply to the sac. This, the plan adopted by Reid, has been variously modified. Thinking expression of all the blood from the limb below the sac to be useless, and possibly harmful, if the vessels into which it is forced are diseased, some surgeons have begun their bandaging only a short distance below the aneurism, a few turns being enough to keep the blood at rest in this direction. If a sufficient length of limb can be bandaged above the sac to prevent the entry of blood, that is all that is necessary; but if there is little room here, either the elastic tourniquet must be used alone to control the circulation, or it may be applied over the highest turn of the bandage, or several turns of the bandage, one on top of the other, may be made as high as possible round the part. In some cases —subclavian, axillary, inguinal—digital or instrumental compression of the main trunk must be used proximally to take off the effect of blood being pumped straight into the sac, whilst the elastic bandage applied up to the aneurism will prevent the establishment of collateral circulation. If the region of the sac is left uncovered, blood from the compressed parts (for *all* is not at once driven out) is gradually forced into this area, distending the sac and giving rise to numerous capillary ecchymoses. If the arterial circulation is not completely controlled, the results of this treatment would probably be disastrous.

It is usually necessary to keep the bandage applied for one and a half hours; in twenty-nine successful cases the time varied from a half hour to three and a half hours. Great pain is caused, and morphia, or, preferably, chloroform must be given; ether excites the heart, and is liable to cause bronchial trouble.

Before removal of the bandage the main artery should be controlled, in order that the newly formed clot may not be exposed to the direct shock of the heart-force; either digital or instrumental compression may be used, and it should be kept up for six to twelve hours. When the bandage is taken off, the aneurism may be quite solid, and remain so; or there may be some pulsation which disappears after a few hours' compression; or the pulsation may increase till all hardening has disappeared; or, lastly, no change for the better may have resulted.

Failure of a first attempt does not show that the treatment should be abandoned, but it is discouraging; for of successful cases 67.6 per cent. yielded to one application, 17.6 per cent. to two applications, and 14.6 per cent. to three.

Mode of cure.—This treatment is an excellent example of the rapid method, which acts by causing complete or almost complete stagnation of blood in the sac, thus leaving it to coagulate. Coagulation of the contents of the sac is the first step toward cure, and from the sac, clotting extends into the artery and occludes it; the cure is completed by conversion of the arterial clot into fibrous tissue, thus obliterating the vessel and shutting off the sac from its communication with the blood. An examination of the reports or specimens of the few cases that have died after this treatment leads Gould to state that the contents of the sac become dry, discolored, partially absorbed, and but little or not at all organized. He thinks that this is because the sac is dense and but slightly vascular, less capable of pouring out lymph than the artery. The mass of the clot also must be taken into account.

Among the *causes of failure* of the method are the following: Stasis is not obtained, or is not maintained long enough to allow the clot to extend into the artery and acquire some firmness. Conditions of the sac and of the blood which do not favor coagulation; of the latter we know nothing, but among the former must rank the fusiform shape or a wide mouth and presence of endothelium. When the clot has formed, exposure to the direct heart-force and other unknown influences may cause it to disappear without embolism or other ill effects; or the arterial clot may fail to organize on account of advanced arterial disease.

The following are the chief *objections* that have been raised to the treatment: (1) That expression of blood from the whole lower limb would so raise the general arterial tension as to act injuriously upon a diseased heart or artery. But the rise of arterial pressure from this proceeding is momentary; reflex dilatation of arterioles and veins accommodates the extra blood at once, and there may be even a fall of pressure. Still, caution is advisable under the above conditions. (2) That syncope might result from the great congestion of the limb on removal of the bandage; but the patient is horizontal, a tourniquet controls the main artery. and there should be a clot in it lower down. (3) That gangrene, referable to rupture of small vessels, is very liable to occur. Of sixty-five aneurisms of the main artery of the lower limb thus treated, gangrene occurred in two, accounted for in one by compression of the popliteal vein by the solid sac, and in the other, apparently, by the presence of continued thrombosis of the arteries of the leg. (4) That rupture of the sac is likely to result; and care must certainly be taken to give it such support by the bandage as is permissible, and to prevent its distention by an uncontrolled artery. Rupture occurred in one of seventy-two cases, and in one the sac was larger immediately after treatment. (5) In the upper limb paralysis may result, especially if the elastic tube is used.

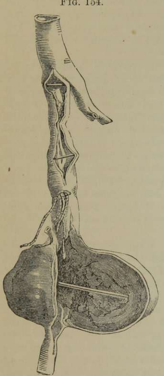
The *advantages* of treatment by the elastic bandage are: that it occupies but a few hours; that its success is great (about fifty per cent. of all cases); that combined with the elastic tube, or other form of tourniquet or with digital compression, it is very widely applicable—the abdominal aorta and the axillary falling within its province; and that, in case of failure, it interferes with no treatment which it may subsequently be necessary to employ.

Continued forced flexion of the knee or elbow stops the pulse at the ankle or wrist by producing a kink in the artery. An aneurism situate in the bend of the joint would be subjected to continuous pressure. The method has been used chiefly for popliteal aneurisms. The limb must be bandaged to the knee, gradually flexed as fully as possible, and so fixed for several hours, whilst the patient is quieted by morphia. Digital compression may be used as an aid. The chief accidents are rupture and gangrene. The method is fairly successful, and may be tried also in circumscribed arterial hæmatomata.

2. Ligature.—This is really the most perfect means of compressing an artery, a wound being necessary to its application. The dangers of a wound have been so much reduced by antiseptics that some surgeons now regard ligature of the superficial femoral as the best and easiest treatment for all concerned of popliteal aneurism. But even now ligature has very decided dangers, whilst compression is comparatively safe; its proper field is, therefore, that left by *failure*, or *unsuitability of compression*. Thus compression is unsuitable, and ligature or other treatment must be employed, when the skin sloughs easily, when the teguments are inflamed at the point for pressure, when the aneurism is suppurating, or is increasing rapidly and threatens to burst or has burst, or when the limb is much swollen from venous obstruction and gangrene threatens or is present; and if during compression such conditions arise, it should be abandoned. Lastly, in certain central aneurisms pressure cannot be employed.

Proximal Ligature or Hunterian Operation.—When possible the ligature should always be placed between the sac and the heart, the principles laid down by John Hunter being obeyed. These were that the ligature should be applied far enough from the sac for the vessel to be healthy, yet not so far away that many or large collateral branches shall intervene between it and the sac. The Hunterian operation was a very great improvement upon the old operation (that of Antyllus—see below), of opening the sac and tying the vessels entering and leaving, but its province must be clearly understood. Proximal ligature at a distance is done in aneurism; first, because the old operation yielded such bad results, partly on account of its difficulty and imperfect performance, partly from the frequently diseased state of the vessels in the neighborhood of the sac, and in great measure, doubtless, from the effect of sepsis in the necessarily large and irregular wound; secondly, because in the case of aneurism the gradual establishment of collateral circulation, after tying at a distance, provides that slow flow of blood through the sac which is necessary for the deposit of laminated fibrin; and, thirdly, because with fairly healthy vessels and in ordinary cases, in which the aneurism is circumscribed and not so large as to interfere seriously with return of blood by the veins, this establishment of collateral circulation in parts beyond the aneurism may be counted upon. The aneurism is, of course, always an obstruction to the circulation in the limb—one might *a priori* think it a greater obstruction than a transverse division, or a ligature in continuity of the main artery; but experience has amply shown that it is not so (doubtless because its gradual development allows collateral branches to enlarge and counterbalance advancing obstruction in the main trunk), and that a second obstruction (ligature) may in most cases be safely inserted higher up. These considerations show, once again, how entirely inapplicable ligature at a distance is to the arrest of hemorrhage, in which the establishment of collateral circulation probably brings recurrence of bleeding, whilst its non-establishment means death of the part. When to the obstruction of a wound that due to the pressure of a recent arterial hæmatoma—diffuse or circumscribed—is added, ligature at a distance is sure to cause gangrene. If, however, a hæmatoma does not of itself induce mortification, but becomes surrounded by a capsule of inflammatory tissue, whilst collateral circulation is developed, it becomes amenable to the ordinary treatment of aneurism; but it may with perfect propriety, and with greater certainty of cure, be treated by ligature at the spot, for the vessel is presumably healthy.

Fig. 154.



An aneurism of the common femoral artery, for which the external iliac was tied by Sir B. Brodie. The ligature is seen embedded in lymph; the coagulum in the artery above and below it; and the laminated coagula in the aneurism. St. George's Hospital Museum.

For the methods of tying arteries in their continuity at seats of election, see "Ligature of Arteries."

After-treatment. — The patient should be placed in bed, with his limb in an easy position, well wrapped up in cotton-wool to preserve its temperature, and *slightly* raised to favor venous return. Neither pressure nor cold may be employed should swelling occur, and hot bottles, if placed in the bed, must not touch the limb lest they induce sloughing.

After the operation the temperature of the limb falls several degrees; but in a few hours it may rise two or three degrees higher than the opposite limb, because the blood is forced to circulate through the superficial capillaries, and its rapid passage is permitted by very full dilatation of the vessels, due partly to the direct, partly probably to the reflex, action of prolonged anæmia. Subsequently it sinks again rather below the natural standard. The sac should from day to day become progressively harder and smaller. In the course of three or four weeks it should be quite solid and considerably shrunken. Then, all being sound at the seat of ligature, the patient may be allowed to get about.

The *mode of cure* after ligature is usually by the deposit of laminated fibrin; clot extends into the artery, which becomes obliterated opposite the sac by fibrous tissue. The vessel is, of course, obliterated in the usual way from the seat of ligature to the nearest branches, but remains pervious between the knot and the sac (Fig. 154). The latter slowly shrinks by drying, or breaking down and absorption of its contents; the most superficial layers probably organize.

Complications after Ligature, and their Treatment. — The course of an aneurism after ligature is not always smooth. Instead of solidifying, the *contents may remain fluid*, and the *sac may* even *enlarge* under the pressure of regurgitant blood supply, necessitating compression, incision of the sac, etc., or large collateral branches may open into the sac or artery above it, but below the ligature, *continued* or *recurrent pulsation*, sooner or later, being the result. The latter may rarely occur from early slipping of a catgut knot. Both these complications must be met by still further diminishing the blood-supply to the sac, by vertical elevation of the limb, compression of the main trunk above the ligature or below the sac, forced flexion, bandaging the limb firmly up to the sac and then over a soft pad placed upon the latter, or the cautious use of Esmarch's bandage. These failing, the choice lies between opening the sac and amputation, when this is possible.

Suppuration of the sac (p. 385) occurs much more often after ligature close to the sac than under any other circumstances—*i. e.*, it is most common in the neck, axilla, and groin. Probably antiseptics have greatly diminished the liability to it. Before doing anything, make sure that suppuration has occurred. Then the choice of treatment is between incision of the sac and amputation, when this is possible; and of these, free antiseptic incision should first be tried. If there has been no recurrent pulsation, this may be done at once, but under other circumstances it may be well to wait, in the hope that occlusion may occur. If, however, general or local symptoms necessitate action, and hemorrhage result, either immediately or later, the vessel must be secured or compressed from the sac. Erichsen states that attempts to ligature have hitherto failed, the vessel being softened, and recommends the cautery as preferable. Plugging is the last resource in central, amputation in peripheral aneurisms.

If not opened, the sac will burst through the skin or some mucous or serous surface; this may or may not be followed by hemorrhage.

Gangrene.—This is generally moist, and may result from many causes after ligature—*e. g.*, failure of collateral circulation from arterial disease, spreading arterial thrombosis, cardiac weakness or loss of blood (p. 85), obstruction to the venous circulation by pressure of the sac upon the main and other veins, or wound of the main vein or its inclusion in the ligature, diffusion of the aneurism, or the supervention of inflammatory œdema. The imperfectly nourished tissues slough readily from heat or cold. Gangrene usually appears from the third to the tenth day unless impending before operation.

If the aneurism is doing well, and the gangrene is limited and unaccompanied by much general disturbance, we may allow a line of demarcation to form. If, however, mortification is spreading, high amputation must be done, if possible at a point at which the circulation is satisfactory and there is no œdema.

When gangrene is threatening from pressure of the sac or diffusion, the effect of incision and removal of some or all the contents of the sac, with ligature at the point if necessary, should be tried before amputation. Diffuse inflammations must be treated by fomentations and elevation.

Distal Ligature, or Brasdor's Operatian.—When a ligature cannot be proximally applied, as in aneurisms of the innominate and roots of carotid and subclavian, distal ligature may be done. In some cases of aneurism of the arch of the aorta ligature of the left carotid, in others of the right carotid and subclavian, has been done with advantage. When ligature of the carotid and subclavian is thought desirable, it is best to tie them on separate occasions. When one of these vessels springs from the sac of an innominate or carotid aneurism, the mode of action of ligature is obvious; but in other cases in which good has resulted this is not evident, and there is no reliable means of selecting suitable cases. A moderate inflammation round the sac, starting from the wound, may sometimes have caused clotting.

Incision of the Sac or Operation of Antyllus.—This operation may be employed after failure of proximal ligature, and in some cases of diffused or suppurating aneurism instead of amputation. In the particular case of aneurism of the axillary, the results of ligature of the subclavian being very unsatisfactory (twelve deaths in twenty-one cases, Poland), Syme revived this operation, hemorrhage being controlled by the finger of an assistant placed upon the subclavian through an incision above the clavicle. This mode of commanding arteries is well worthy of note.

The operation is the same as that described by John Bell for arterial hæmatoma. It is difficult in proportion as bleeding is difficult to check, and as the sac is large and irregular. In the limbs, if Esmarch's band is used, the smaller vessels are often missed. After securing the larger, plug the sac with sponge, elevate the limb, and remove the tourniquet. After ten or fifteen minutes, the consecutive hyperæmia is over; then lower the limb and secure the small vessels (König).

3. Amputation may be required at once in certain cases of failure of the ligature, of diffusion, of suppuration, and of gangrene; incision of the sac and ligature at the spot is generally the only alternative.

Sir W. Fergusson recommended amputation at the shoulder after distal pressure had failed in aneurism of the subclavian, the object being to obtain not only the effect of distal ligature, but also the shrinking of all vessels concerned in the supply of the lower limb.

4. Manipulation.—In two cases of aneurism of the right subclavian artery, Sir W. Fergusson, instead of trying the hopeless operation of ligature between the tumor and the heart, or the doubtful one of ligature on the distal side, endeavored to block up the artery, by fibrin squeezed from the sac. He first emptied the sac by pressure with his thumb, then squeezed and rubbed the opposed surfaces against each other, so as to force some of the fibrin into the artery. The effect in each case was immediate and striking. In the first case there was giddiness; and, after one or two repetitions of the manipulation, all circulation in the vessel and its branches below was arrested, and the tumor became smaller and firmer. Finally, after muscular exertion, it burst into the brachial plexus, and the patient died seven months after the first manipulation. In the second case (in which all pulsation had ceased in the arteries below for some months before the manipulation) there was partial hemiplegia, rendering it probable that a plug of fibrin had been carried to the brain; but the tumor became gradually less, and the man was alive and well two years afterwards. Manipulation has been little used, but may occasionally prove useful; embolism of the brain is its chief danger when used in aneurism at the root of the neck.

5. Electrolysis.—The greatest confusion appears to have prevailed in the application of electricity to the treatment of aneurism; so that in spite of a long list of cases the best method is scarcely determined. Cells of all sizes and kinds, numerous or few, strong or weak, have been employed; both poles have been inserted or only one pole; and the length of the operation has varied greatly. But the great fault from a scientific point of view lies in the absence of all measurement of the strength of current actually used. This measurement is easily made by the insertion in the circuit of a galvanometer, which is now made by Gaiffe, to indicate the strength of current in ampères and milliampères—the ampère being the unit of strength of current. This should always be used.

When two needles are placed in fluid blood, a tolerably firm clot occurs round the positive, whilst a large soft frothy mass forms round the negative, and the weight of the clot formed is proportional to the strength of current (*i. e.*, quantity of electricity passing in unit of time) and the duration of its flow. The soft mixture of gas and clot round the negative needle is of little value in the cure of aneurism; sometimes the sac has become tympanitic, chiefly from hydrogen liberated here. The firm clot on the positive needle is the consolidating agent; we want as much as possible of this formed. The positive needle, unless made of gold or platinum, is dissolved, but this is an advantage, especially in the case of steel needles, the iron salts causing firm clotting.

De Watteville (*Medical Electricity*, second edition, p. 200) recommends the introduction into the sac of four to eight needles, insulated to near the points, and connected with the positive pole of a battery, whilst the negative pole is represented by a plate electrode at least 8 × 16 cm., placed anywhere on the body, a layer of modeller's clay being inserted between it and the skin to prevent burning and vesication. He would use a measured current strength of twenty to thirty milliampères *per needle*, and would allow the current to flow for half an hour at the first sitting, longer at subsequent ones, which may be held once a week. Large elements are necessary to supply quantity of electricity, whilst many in series are required to give the electromotive force necessary to overcome the great external resistance of the epidermis; a battery of zinc-carbon elements in bichromate of potash (Stöhrer's) is most convenient, and twenty-four to thirty elements will be required. The non-insertion of the medical pole suggested by Bastian is generally objected to, as causing so much waste of force in overcoming external resistance that little is left for electrolysis of blood, and little clot forms. De Watteville, however, states that a sufficient current is easily obtained. Most operators insert a needle attached to either pole, thus reducing the external resistance greatly, and increasing the strength of current (from a given battery) and the quantity of clot. The disadvantage is the formation of loose stuff and hydrogen at the negative pole.

Little pain is caused. The needles must be withdrawn by gentle rotation, the punctures closed by collodion, and ice applied. The results of each operation are usually not marked. Embolism has never occurred, though there seems ample ground to fear it. Sloughing round the needles results when these have not been properly insulated or introduced beyond their points. In a few cases cure seems to have resulted; in others, delayed progress in one direction, too often accompanied by advance in another.

6. Introduction of Foreign Bodies into the Sac.—In desperate cases of central aneurism, the sac has been punctured with a very fine canula, through which several feet of fine iron wire, silvered copper wire, watch springs which curl up as they enter, or horsehair, have been passed, in the hope that they may induce coagulation.

The plan has been tried in three cases of thoracic aneurism, but all have proved fatal. C. H. Moore (*Med. Chir. Trans.*, vol. xlvii.) many years ago introduced twenty-six yards of wire into the sac of such an aneurism. The patient died of inflammation of the sac and pericarditis, and clots like those found on the wire in the sac were found swept into many arteries. Quite lately Bacelli (quoted in *Brit. Med. Journ.*, 1885, vol. i. page 1256) similarly introduced seven 50-cm. watch springs; death from exhaustion occurred in two days, and little clot had formed.

A year ago, Loreta, of Bologna, freely opened the abdomen of a man with a large aneurism of the abdominal aorta high up, intending to tie off the sac or to empty, invert, and sew it up; but as this was impossible, he passed two metres of silvered copper wire into the sac, and touched the puncture with pure carbolic acid. The man recovered well, and the aneurism quickly became solid and shrank to the size of a walnut. Apparently cured, and in excellent health, he left the hospital in two months, but ninety-two days after the operation he suddenly died from rupture of the aorta just where the lower wall of the sac joined it. The sac was quite filled with fibrin (*Brit. Med. Journ.*, 1885, vol. i. pages 745, 955). This is the best result yet obtained by the method.

Sometimes six or eight fine gilt needles have been thrust close together into an aneurism and left for one or three days; coagulation starts upon them, and spreads till the sac is full.

7. The Injection of Coagulants.—Of these *perchloride of iron* is the most important; but it should not be used unless the circulation can be controlled, the danger of embolism is so great. In aneurisms so situate that flow of blood through them can be arrested, some more reliable mode of treatment can probably be employed. In cases in which operation is undesirable and compression fails to induce coagulation, the needle of a Pravaz's syringe may be passed into the sac from some distance, and liq. ferri perchlor. injected, drop by drop, by a turn of its screw-piston every half minute. Compression for some hours should be continued.

Under these conditions the injection of Schmidt's "blood-ferment" has been unsuccessfully tried.

8. The injection of ergotin in the tissues over the sac was recommended by v. Langenbeck, on the supposition that it would cause contraction of the sac; but in an aneurism of any size the fibroid condition of the media precludes such a hope. Bonjean's fluid extract, in one-half to three grain doses, was used. If the injections act at all, it is probably by exciting moderate inflammation round the sac.

9. Ice constantly applied to the surface of an aneurism is recommended by J. Hutchinson in combination with absolute rest and large doses of pot. iod., plumb. acetate, and ergot; sloughing must be guarded against.

The methods five to nine, inclusive, are very uncertain, and are generally used *faute de mieux*; sometimes they form adjuvants to better plans. In cases of multiple aneurism, or of two aneurisms—one central, one peripheral—no cutting operation should be done for the peripheral, if it can be avoided. But when there are two popliteal aneurisms, as is not uncommon, or a femoral and popliteal on the same side, the usual treatment may be followed.

Nævus, Angeioma, or Vascular Tumor.

There are two varieties—*capillary* and *cavernous* (see page 136, where their nature, clinical signs, and seats are given).

Nævi are so commonly noticed at birth, or shortly after, that some regard them as invariably congenital; it must be admitted, however, that some of these growths, usually deep, are first noticed later, and even in adult life. They often affect more than one child of a family. Their causes are unknown; they are sometimes attributed to maternal impressions.

Cutaneous and subcutaneous nævi may occur at any point of the surface, are most common upon the head and face, then upon the trunk, least so on the lower limbs. It is with these that we almost always have to deal; but nævi of the lips, gums, tongue, and rectum occur, and may be very troublesome, or even fatal, from hemorrhage. Nævi of internal organs cause no symptoms.

Diagnosis.—A mother's mark cannot be mistaken for anything else; and often the skin is purple from dilated small vessels over subcutaneous growths, or its translucency allows a bluish color to show through. A fatty tumor is almost the only growth a subcutaneous nævus could be taken for; but congenital lipomata are rare, not spongy and compressible, and do not swell when the child strains or cries. Nævus and lipoma may be combined—*nævo-lipoma*. When discovered after the first years of life, the diagnosis is often doubtful if the skin over them is opaque and normal.

Nævi of mucous membranes are usually characterized by their purple or scarlet, obviously vascular, aspect. In the rectum this may not be very evident, when viewed through the speculum; the chief diagnostic point here is occasional hemorrhage, commencing in early childhood.

COURSE.—Mother's marks (chiefly port wine stains) may be widespread at birth, and remain stationary, or, starting as slightly raised scarlet points, may spread rapidly or slowly; often they heal centrally, whilst spreading peripherally, a white scar tissue replacing that of the nævus; many are thus ultimately cured. Subcutaneous nævi do not usually spread far or fast, but they do sometimes grow rapidly, attain a large size, and recur again and again after removal; they often involve the skin over them, but not the deeper parts. These growths may also undergo a fibroid change, or cysts may develop in them by obstruction or dilatation of veins; rarely, when irritated, they inflame, ulcerate, and bleed. Naturally, the latter complication arises most easily on mucous surfaces.

TREATMENT.—When a *superficial nævus* shows central scar-tissue and shrinking, it may usually be left to itself, or treated by the *constant pressure* of an ivory or sheet-lead pad and elastic band, or of contractile collodion. *Freezing by ice* will sometimes check the growth of a capillary nævus. *Vaccination*, by punctures all over the surface to produce a confluent vesicle, is rarely successful in obliterating the vessels. The most generally useful treatment is that by *caustics*. *Nitric acid* is usually chosen, but its action is very superficial; to apply it, oil the skin around, almost to the nævus, and then rub on the acid with a pointed glass rod or a match-stick. *Ethylate of sodium* is preferable, and should be well rubbed in with a pointed match; it softens the epidermis rapidly, and the surface becomes red-black, as the fluid causes coagulation in the vessels. When the scab separates, in either case, the granulation tissue may be abnormally purple at some points, necessitating a fresh application. A small *cautery* may be used. For diffuse port wine stains, *scarification* (B. Squire) with closely set knives may do some good, by substituting superficial scar-tissue of white color for the dilated vessels. The same result may be attained by inserting superficially in the skin a number of fine needles, and connecting them alternately with either pole (De Watteville); no contraction results.

Subcutaneous nævi may be treated in many ways; but if stationary, and not disfiguring or discomforting, treatment will be unnecessary.

Seton.—Silk threads, simple or steeped in liq. ferri perchlor., are dragged, by a proportionately small needle, in various directions through the growth; they are withdrawn when suppuration has set in, and fresh ones inserted as may be necessary. A good deal of scarring results, but general symptoms are usually slight.

Injection.—Many irritant and coagulant fluids are introduced by a hypodermic syringe into subcutaneous nævi, but the plan is dangerous, unless circulation through the growths can be completely controlled, for pulmonary embolism has proved fatal. Therefore, before injecting, pass stout harelip pins crosswise beneath the growth, and tie a silk ligature tightly beneath these. Two or three drops should now be distributed in the tumor by screwing down the piston. The chief fluids used are—neutral liq. ferri perchlor., pure carbolic acid, solution of tannin (ʒj ad ℥j), tr. iodi (Coates). If much fluid is injected, sloughing will occur. After ten or fifteen minutes remove the pins and ligature.

Ignipuncture, with Paquelin's or other pointed cautery, is often useful where scarring is not of much moment. As many punctures as possible should be made from one centre; sloughing occurs round the punctures, and the resulting scar is larger than one expects.

Electrolysis, in moderately skilful hands, is the best method for obliterating nævi of the face and other places where a scar disfigures; if the skin is involved, a scar must result in the process of cure, but it is said that galvanic cicatrices do not contract.

In small nævi, either introduce only the negative pole, closing the circuit with a plate electrode on the surface, or pass a needle from each pole into the mass. In large growths, several needles should be inserted and connected with opposite poles alternately; needles of opposite polarity must not touch.

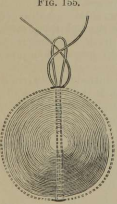
It is best to begin with a few cells, say five or six Leclanché elements, and watch the effect with the finger, the object being to solidify the tumor, but to stop short of causing sloughing. As the number of needles and size of the growth increase, add to the cells; fifteen of Stöhrer's battery are usually enough even for large masses (De Watteville).

Subcutaneous discission, with a fine knife or cataract needle, followed by pressure, and repeated if necessary, is successful in some cases.

Extirpation.—This is often the best treatment, when flaps to cover any loss of skin can be made, for the wound heals readily, and the scar is narrow and regular. Bleeding should be controlled by the needles and ligature, as above, the skin reflected—any involved being sacrificed—and the growth dissected out right down to the pins; care must be taken to go wide of the diseased tissue, as it is from this alone that bleeding is to be feared. Remove the needles and ligature; probably no bleeding follows; bring the cut together, and dress antiseptically, with uniform pressure. Healing by first intention is usual.

Ligature.— This was formerly much employed in the treatment of cavernous nævi, to avoid bleeding—subcutaneous when the skin was healthy, but when it was involved, the ligatures were caused to lie in suitable cuts in the skin, or beneath reflected flaps. Waxed silk or hemp was passed with a slightly curved Liston's needle (Fig. 43) beneath and round the growth, drawn as tight as possible, and tied in a bow, so that as the noose cut through and became loose, it might again be tightened. The necessity for this tightening is an objection which might be obviated by using strong elastic; but no method which kept a considerable septic slough in contact with living tissues, especially without free drainage, as in the subcutaneous method, can be regarded as good. In the latter treatment, not uncommonly, either the skin sloughs or the nævus is nourished through it and continues to grow. It is always difficult to include enough tissue in the ligature to destroy the nævus and to avoid healthy parts.

FIG. 155.



Wood's subcutaneous ligature for nævus.

The surgeon's ingenuity will suggest how best to pass the threads, but the following methods may be mentioned:

To tie a small round nævus *subcutaneously*, the simplest plan is to pass an unarmed needle under the skin half-way round the tumor, and then through the skin; now thread and withdraw it, leaving an end of ligature at each hole. Next pass the unarmed needle from hole to hole, on the opposite side of the growth, thread it with the end left at the hole of exit, and withdraw. The thread now includes the whole mass, and must be tightly tied.

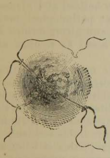
In larger growths, which most surgeons tie in two portions, after passing a double ligature through beneath its centre, John Wood uses the ingenious knot shown in Fig. 155. The loop beneath the mass is first passed, then the ligature ends are caused to include opposite halves of the growth—as in the first method—and before knotting they are passed through the projecting loop, one from before back, the other from behind forward.

If successful, pus and sloughs escape by the punctures along the threads, the nævus shrinks, and only two small spots of scar remain.

Strangulation of a nævus and involved skin over it may be effected by the following among other knots: Fig. 156, due to Sir W. Fergusson, is performed by passing a double thread beneath the growth, and dividing the loop left at the hole of exit. Thread the needle with one of these ends and pass it under the growth at right angles to the double thread. The needle is now unthreaded and the other divided end put in the eye, that it may be withdrawn with the needle. Suitable grooves are now cut in the skin, and the threads drawn tight and knotted.

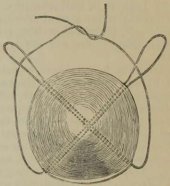
John Wood accomplishes entire strangulation of skin and tumor by a single thread, in the manner shown in Fig. 157. One loop is first carried

Fig. 156.



Fergusson's ligature for nævus, including skin.

Fig. 157.



Wood's ligature for nævi, including skin.

beneath the mass, and then the other, and in withdrawing the needle from the second it must travel along the free end.

In four or five days the strangulated parts are sloughy, and if not separated the ligature must be tightened. As the wound granulates, watch for any recurrence (marked by redness deeper than that of granulations), and destroy it by nitric acid or ethylate of sodium (p. 383).

Hæmophilia or Hemorrhagic Diathesis.

This rare condition is characterized by an abnormal tendency to bleed from small vessels and capillaries; the slightest scratch oozes for hours or days, and extraction of a tooth has frequently caused death.

Etiology.—The bleedings may be *spontaneous*, from the mucosæ of the nose, lung, bowel, kidney, or uterus, into the connective tissue of the skin and other parts, or into the cavities of joints; or they may be *traumatic*, occurring from even the slightest breech of surface or in response to slight contusions. The morbid state is always congenital and very often hereditary through several generations; and here the curious fact appears that, although men are much more commonly (11 to 1, Legg) and more severely affected by hæmophilia than are women, they usually do not hand down the tendency to bleed to their children; but the women of "bleeder" families, though as a rule they do not themselves exhibit the diathesis, almost always hand it down to the male children they bear to healthy men, and their female children may in turn do the same. The women of these families are said to be very fertile. It has been said that many bleeders have been remarkable for the delicacy of their skin and plainness of the subcutaneous vessels; but there is really nothing in the naked-eye appearance of a bleeder to distinguish him.

Pathology.—Nothing abnormal has been proved to exist, either in the blood or vessels, but it is probable that the latter are at fault. The tissues in bad cases seem to inflame and slough with abnormal readiness.

Post-mortem, recent hemorrhages and traces of former hemorrhages into connective tissue or joints, are the only positive signs.

Symptoms.—There is not usually any hemorrhage connected with the separation of the umbilical cord, but often bleedings occur during the first year of life from vaccination, lancing of gums, etc. Sometimes none occurs until the period of second dentition; cases said to begin later than this are held by Legg to be untrustworthy. It has been noticed at University College Hospital, where several bleeders attend, that pathological breaches of surface—*e. g.*, phthisical cavities, typhoid ulcers, and ulcers formed by separation of sloughs—are not nearly so liable to bleed as wounds and contusions.

Spontaneous hemorrhages, especially from the nose, are sometimes preceded by sense of fulness of the head and malaise. Subcutaneous hemorrhages may be mere ecchymoses, diffuse bloody infiltrations, or circumscribed hæmatomata; they are most frequent in the popliteal space, inside the thigh and over the lower ribs. At first they are accompanied by a little fever.

Lastly, the larger joints, especially the knee, are liable suddenly to swell and become hot and painful, with more or less fever; this is believed to be due to hemorrhage into the joint, and may occur spontaneously or after an injury. This state may last a long time, recovery being interrupted by frequent relapses; and fresh attacks are always liable to occur.

Fifty per cent. of bleeders die before the age of eight, and more than eighty-five per cent. before twenty-one (Grandidier).

Treatment.—There is no *treatment of the diathesis* known; it is sometimes said to become less marked with age. The acute or chronic anæmia resulting from hemorrhage must be treated as directed at p. 365.

As to the *treatment of hemorrhages*: interstitial hemorrhages will require absolute rest and the application of cold to the part. Epistaxis must be met by ordinary means. In hemorrhages from mucous surfaces which cannot be directly acted on, reliance must be placed upon styptics, of which acetate of lead and opium, gallic acid and turpentine in small doses, seem the most hopeful. Ergotin has not proved of service.

Hemorrhage of wounds has been treated by all the recognized methods—even by that of inflicting another wound to tie a main artery at a distance! Experience at University College (Erichsen) has shown that the most satisfactory method, when it can be adopted, is constant iced irrigation, coupled with rest and elevation of the part. Perhaps, if a wound were seen early, and rendered aseptic, a permanent antiseptic dressing might successfully be made the means of applying constant pressure; but under septic conditions, inflammation, sloughing, and fresh hemorrhage in removing the dressings are frequent. Styptics produce much the same results; the cautery is better, but the separation of septic sloughs is a source of danger. In the special case of bleeding from the socket of a tooth, this should be carefully wiped out, plugged from the bottom with a fine strip of lint, and pressure just sufficient to check the bleeding made upon the plug by the teeth of the other jaw and a piece of gutta-percha moulded to them. The jaws must be fixed together by a four-tail bandage.

It is a rule never to perform any operation that can be avoided on such patients; extract no teeth, open no abscesses. When operations cannot be avoided, endeavor to use Paquelin's cautery or the elastic ligature.

The swollen *joints* will require absolute rest and cold at first; then moist warmth to aid absorption; finally a Martin's bandage may be worn. Rest must be prolonged and great care exercised in beginning to use the joint again.

CHAPTER XXX.

INJURIES AND DISEASES OF THE VEINS.

Wounds of Veins.

Signs.—Venous hemorrhage is recognized by the dark color of the escaping blood, and by the steady, slightly forcible character of the stream. The blood "wells up," as it is said; sometimes it escapes in a steady curling jet an inch or less high, and when an obstruction to flow is placed above the wound—like the fillet in venesection—the blood may be projected two or three inches. It usually comes from the lower or distal end only.

As a rule it is not dangerous, but may be so when coming from a large trunk, or from a varicose vein in which all valves are incompetent and blood consequently escapes, not only from the distal end, but also from the proximal—from the right auricle—with force proportionate to the vertical height of the auricle above the wound.

Treatment.—Elevation or light local pressure and the removal of any obstruction at once stop venous bleeding—facts which should be known to everyone with varicose veins; a firm bandage over the dressing is usually all that is necessary. If a vein is seen bleeding in a wound, tie it like an artery with catgut or silk. When a large vein, like the axillary, is punctured during an operation, the vein around the opening may be picked up and tied; but if it is widely opened, the vein should be tied above and below the wound just like an artery. It may be difficult or impossible to do this, and we must then rely on forcipressure—leaving the clip on for several hours; or plugging or unremitting digital pressure on the point must be employed. The latter practice was resorted to "in the case of his Excellency William, Prince of Orange, who, in his hurt by the Spanish boy, as my Lord Bacon relates, when the internal jugular was opened, could find no way to stop the flux of blood, till the orifice of the wound was hard compressed by men's thumbs, succeeding for their ease one after the other, for the space of forty-eight hours, when it was hereby stanched." (Turner's *Art of Surgery*, vol. i. p. 346.)

Gangrene does not result from obstruction of a main vein by ligature if the arterial circulation is unimpaired, the intercommunication of veins being so free; but, frequently, compensation is imperfect and cyanosis, œdema, and chronic thickening of connective tissue occur. Ligature or wound and subsequent thrombosis of the main vein at the same time that the main artery is tied, is a most serious complication, almost if not quite certain to lead to gangrene in the lower limb.

Air in Veins.—The entrance of large quantities of air into a vein is a most dangerous accident, that has sometimes occurred during the extirpation of tumors from the neck or axilla, where the effect of inspiration upon the blood in the veins is most marked. With a deep inspiration the great veins of these regions may become empty and collapsed, and such inspirations were common, after prolonged holding of the breath, during operations in the days before chloroform. Further, the jugular, subclavian, and axillary veins are closely related to the dense fasciæ of the part, and cannot collapse when the fasciæ are rendered tense and drawn away from the sublying vein. If wounded when thus *canalized* or held open, a sort of bubbling, sucking noise is suddenly heard, the patient instantly faints, and generally dies soon afterward. On examination, the right side of the heart is found distended with frothy blood, which cannot be pumped through the lungs in any quantity; and it is this which kills, not the blocking of fine pulmonary vessels by air-emboli. When possible, veins in this region should be tied before division; and an inadvertent wound, followed by the above-mentioned noise and symptoms, must be instantly compressed. The patient, if faint, should be kept recumbent with the head low, and well plied with brandy. Artificial respiration should be kept up, in the hope that it may aid the pulmonary circulation and bring more blood to the heart. The air has no noxious properties in itself, and if introduced slowly does no harm.

Thrombosis.

As "thrombi" (*intra-vitam* clots) are much commoner in veins than elsewhere, and as these clots are the most frequent source of emboli, thrombosis and embolism are most conveniently mentioned in this place.

Conditions Leading to Thrombosis.—Our knowledge of these is very imperfect. The most important point known is—that so long as blood, moving or stationary, is in contact with healthy living vessel-wall, it does not coagulate; and experiment and observation have shown that it is upon integrity of the endothelium that its fluidity depends. *Injure the endothelium*, push bodies bare of endothelium (wire, horsehair) into the blood, or draw it into a basin, and coagulation will commence. Naturally, prolonged contact with an abnormal surface is favorable to coagulation, so we get a second common factor in the process—*rest*. But rest is not essential; abnormal endothelium probably is. If we add that the blood in some states of body, pathological and physiological, tends more strongly to coagulate than in others, and that the existence of such a state will predispose to thrombosis, we have probably stated all that is known upon the subject.

It seems probable, however, that cases of spontaneous thrombosis accompanied by symptoms of phlebitis (see *acute phlebitis*), as also those occurring in pyæmia at a distance from any wound (p. 161), are in some way connected with the action of organisms.

Abnormality of endothelium may be produced in many ways; by *injury* of any kind acting from without, as seen in the various methods of checking hemorrhage, and in contusion (p. 351); by *pressure* of new growths, aneurisms, etc.; by *extension of some septic or infective inflammation* to the wall; by *primary diseases of the vessel-wall*, mostly of an inflammatory nature—*e. g.*, arterio-sclerosis, atheroma, and corresponding processes in veins—which lead to tortuosity and dilatation, or to marked narrowing of the vessel, as well as to an irregular abnormal surface. Primary disease is much more often a cause of thrombosis in arteries than in veins. *Foreign bodies*, bare of endothelium, may enter vessels—*e. g.*, clots, tumors, parasites, calcareous plates; and wire, horsehair, etc., may be purposely introduced (p. 397).

Stagnation of the blood, or a tendency to it, may be due to local causes, as ligature or other pressure, or dilatation of the vessel by aneurism, varix, or gravity; or to cardiac weakness, low vascular tone, and prolonged recumbency, which act generally. Now, slow circulation means imperfect nourishment of the tissues, and, among them, of the endothelium; so stagnation of blood must be regarded as acting partly by causing abnormality of endothelium.

The above causes frequently act together.

Seats of Thrombosis.—Thrombi are uncommon in the *heart*, but occur upon inflamed foci and in parts which in marasmic states do not empty themselves completely. In the *arteries* the speed of the circulation is greatly opposed to clotting, as is seen in aneurism, in which the effect of stopping or impeding the flow is also shown; but extensive thrombi do form, and not rarely, upon abnormal arterial surfaces. In the *capillaries* clotting probably does not occur during life; they consist of endothelium only, and are most likely dead if they cannot inhibit clotting. The *veins* with their feeble circulation are *the* seat of spontaneous thrombosis, and in them clots most easily extend.

Varieties of Thrombi.—Two kinds of clot—the red, uniform, and the pale, laminated—are found in vessels, according as the blood which coagulates is still or moving: the former we have met in the "internal coagulum" (p. 352) between a wound and the first collateral, and in the "rapid cure" of aneurism; the latter, in the ordinary cure of aneurism. If a small crystal of salt is placed near a vein in a frog's foot beneath a microscope, a pale clot will form beneath the eye (Zahn) as the irritant causes change of the venous endothelium, either on one side or all round according to the situation and size of the crystal; it is due to the successive adhesion of white corpuscles and deposit of fibrin upon the injured surface, and may be *partial* or *totally obstructing*. Once formed, a clot tends to grow, for it acts like a foreign body to blood. In certain cases in which the opposing influences are weak, thrombi spread rapidly from vessel to vessel (usually veins) and reach a great length—*continued thrombi;* they extend chiefly in a central direction, and are checked most often by the quicker circulation in some larger vessel, into the lumen of which their upper end may project. There is then much danger that it will be broken off and become an *embolus*.

Fate of Thrombi.—1. *Resolution*. This in recent red clot occurs easily, as we have seen in cure of aneurism by Esmarch's bandage; what becomes of the constituents of the clot is unknown; no symptoms accompany its disappearance. 2. *Organization* is a frequent result, described at p. 353. The vessels of the new connective tissue may, especially in veins, become so largely dilated as to form a free communication between the upper and lower part, more or less completely compensating for the obstruction. Thus is explained the improvement or recovery after months from the œdematous swelling known as white leg (*phlegmasia dolens*). 3. *Softening* of two kinds —*simple* and *infective*—occurs. In each the clot breaks down centrally into a *puriform* fluid, consisting almost entirely of granular débris: in the latter case some of the granules stain deeply with aniline colors and are micrococci; in the former no organisms are present. As the softening approaches the ends of the thrombus, progressive clotting occurs, but ultimately this may fail, or some force bursts the partition and the contents of the central cavity escape into the circulation. In a simple case no harm comes: the clot is *canalized* if both ends open, and circulation goes on through it. In an infective case the entry of portions of clot and organism into the circulation will be accompanied by symptoms of pyæmia (p. 161). More frequently an abscess forms round the vein, the softened focus bursts into it, and both are discharged externally. Almost always a clot undergoing puriform softening has its peripheral end upon a septic wound or infective inflammation—*e. g.*, acute necrosis; rarely this is not the case, but a septic wound is present at a distance; very rarely no wound by which cocci might have entered is discoverable.

Calcification is rare, except in the prostatic plexus, in which concretions, often very numerous, are usually present after twenty. Such masses are

FIG. 158.

Phleboliths in veins of neck.

called *phleboliths*. Fig. 158 represents an extraordinary case of phleboliths, in which Sir W. Fergusson removed the concretions with a knife.

CHANGES IN THROMBOSED VESSELS.—A thrombus usually excites more or less inflammation, which results in the adhesion of the wall to them and their organization. Sometimes, especially in arteries, a clot above a ligature will remain non-adherent for many months. When infective softening occurs, acute phlebitis or arteritis is excited, and it may be suppurative.

THROMBOSIS OF VEINS.—The feeble circulation in veins and their thin and flaccid walls render them more liable than other vessels to thrombosis from injury (p. 236), pressure, extension of inflammation from surrounding parts; stagnation of blood occurs in them and new growths penetrate them most easily. Clots forming in states of exhaustion, and apparently in great measure due to feebleness of circulation, are called *marasmic*; in phthisis and malignant disease they are common complications, and form usually in the most dependent veins—profunda and internal iliac—whence they extend to the femoral and common iliac; they occur also in the heart and cerebral sinuses.

SIGNS.—These are: 1. Evidence of obstruction to the venous circulation in the shape of cyanosis or more or less sudden œdema, varying in amount with the magnitude of the veins affected and the freedom of their anastomoses; it is best seen in white leg after labor due to thrombosis of the common iliac vein, probably starting in a vein from the uterus. The swelling may be so tense that it does not "pit;" and if it continue long, thickening of the connective tissue is sure to occur. 2. The discovery of a cord-like hardening of the vein where superficial. 3. Signs of more or less phlebitis and periphlebitis, varying in intensity with the infective or non-infective nature of the clot.

Treatment.—Perfect rest must be insisted upon until the thrombus has resolved, or until it is probable that it is securely fixed to the vessel-wall, and manipulation of it should be avoided, lest a portion be detached and embolism occur. Phlebitis, if present, must be treated as recommended at p. 409.

In certain cases of infective softening of clots in limb-veins, especially such as start from infective osteomyelitis, amputation after symptoms of pyæmia have manifested themselves seems to have sometimes saved life.

Persistent œdema must be treated by douching, friction, and massage, and the constant application of a Martin's rubber bandage as tight as can be borne.

Embolism.

Embolism means the impaction in a vessel of some solid particle or fragment which has gained access to the blood. The solid particles are *emboli,* and they vary much in nature, size, and source. Usually they are furnished by thrombi in veins: either large clots, perhaps several inches long, are mechanically loosened, or fragments are swept off from parietal thrombi or the ends of clots projecting from collateral into main veins, or clots undergo simple or infective softening and break down. Thrombi on inflamed cardiac valves are common sources of emboli; those in aneurisms and on calcareous plates in arteries much less frequent. Cells of malignant growths (p. 127) often form emboli, and much commoner still are the vegetable parasites; rarely animal parasites enter the circulation; fragments of calcareous plates in arteries, minute drops of fat from fractures (p. 236) and contusions, air, which has entered veins, and other substances, may similarly become impacted in vessels.

An embolus is stopped by the first vessel which is too small to allow it to pass; if from the systemic veins it is usually in the pulmonary arteries or their capillaries; if from the radicles of the portal system, in the artery-like ramifications of the portal vein in the liver; and if from the left heart or systemic arteries, in the finer branches of these arteries or their capillaries. Commonly the impaction takes place where some sudden narrowing of the vessel occurs owing to the giving off of a branch (p. 382). If the arrested particle is hard and irregular and does not block the channel, thrombosis occurs round it until occlusion is complete.

The local effects of embolism are: (1) obstruction of the circulation through the occluded vessel; (2) more or less irritation according as the embolus is infective or non-infective. For the results of obstruction of arteries of different sizes, with and without anastomosing branches, see p. 42. If the embolus is non-infective and admits of absorption, this may rarely be its fate; more commonly it will be organized; but, though simple, it may so injure an artery as to give rise to an aneurism. When infective (*e. g.*, in malignant endocarditis) acute arteritis and dilatation are more likely to occur; and suppurative arteritis and periarteritis are common (p. 161).

The general effects of embolism vary with the functions of the part supplied by the blocked artery; thus apoplexy and death may result from embolism of a large cerebral artery. The results of pulmonary embolism are given at p. 235; and those of embolism of a systemic artery at pp. 87 and 382.

Inflammation of Veins: Phlebitis.

Causes.—By far the most frequent is thrombosis. The presence of a thrombus in a vein probably always excites inflammation of the vessel-wall—more or less intense according as the clot is more or less irritant (p. 406). The causes of thrombosis therefore come to be causes of phlebitis, and among them none is so common as injury. The commonest form of phlebitis is the *traumatic*. In this a vein is cut across or otherwise injured, it collapses, and a clot forms in it up to the next pair of valves. If the wound become septic, either through the open end of the vessel or through its wall if it have been tied, the thrombus (*septic traumatic*) is invaded by infective organisms, probably carried by migrating leucocytes, becomes more or less markedly irritant, often undergoes infective puriform softening, and tends to spread (p. 406), inducing symptoms of acute spreading phlebitis, to which may be added at any moment those of acute embolic pyæmia from the entry into the circulation of portions of the infective clot (p. 161). As an irritant clot spreads, or when one forms at a distance from a wound, the walls of the containing vein always become swollen, soft, and grayish or yellowish, from inflammatory infiltration, and often dotted with fine hemorrhages; and the connective tissue round the vessel suffers similarly, and more or less severely—at times being only hyperæmic and infiltrated, at others suppurating diffusely or at certain spots, giving rise to abscesses in which the vein lies bare or into which it opens.

In subcutaneous and aseptic wounds of veins a little inflammation of the vein-walls is induced for repair, but is quite localized; and the thrombosis, though sometimes continued, often fails even to obstruct the vessel.

In non-traumatic cases, phlebitis may arise *by extension from surrounding parts*, the seats of infective inflammation. The adventitia is first affected, and the morbid infiltration with its cause spreads inwards until the intima is reached and sufficiently altered to induce clotting upon it; the clot then becomes infected and irritant, and thus exactly the same results—up to periphlebitic suppuration and infective puriform softening of the clot—may be produced by infection from without as by infection from within. An excellent example of this is found in the not uncommon thrombosis of the petrosal and lateral sinuses, and often of other veins communicating with these, which arises in suppurative otitis media and ends in infective softening of the clot and pyæmia or meningitis from infection of surrounding parts. Again, in acute infective osteomyelitis ending in pyæmia, veins containing puriform clots are found leading from the unopened abscess (p. 281). But a suppurative inflammation is not necessary to induce thrombo-phlebitis, which occurs, rarely, it is true, in veins leading from catarrhal mucous membranes—*e. g.*, of the bladder in cystitis; the thrombosis may be continued to the iliac veins, and may prove infective when the cystitis is putrid.

At first sight it seems strange that thrombosis of considerable vessels, especially veins, is not more common in acute inflammation. But an explanation is probably to be found in the facts that the intima must be altered to induce thrombosis by infection from without; that this coat is nourished from the lumen of the vessel itself, and that the vasa vasorum normally penetrate only the adventitia—an arrangement rendering the two inner coats little prone to inflame. The adventitia alone is often affected.

In a number of cases no cause is discoverable: there has been no injury, no previous inflammation. Such cases are styled *idiopathic*, and occur mostly in varicose saphena veins. Occasionally in these cases the irritant in the clot, whatever its nature may be, is sufficient to induce softening of the clot and suppuration around the vein, perhaps at several spots. In other much rarer instances, death with symptoms of acute septicæmia may occur, although no wound and no puriform softening of the clot is found. In these cases an irritant thrombosis is probably the primary event, but we are in the dark as to its etiology. Sir J. Paget has noticed that recurrent phlebitis, usually of the internal saphenous, is apt to occur in *gouty* people.

SYMPTOMS.—When the affected veins are superficial, as they usually are in the idiopathic variety, a firm, tender cord, obviously a thrombosed vein, is felt, and over it the skin is swollen and reddened in a broad, ill-defined band. The affected vein is frequently varicose, and its tortuosity is very evident. There may be much spontaneous pain, or only a dull aching, increased by movement. Abscess is recognized by increasing localized redness, œdema and tenderness of skin, and progressive softening; but clots in varicose dilatations fluctuate most perfectly. The general symptoms are usually slight, but may be of very severe septic type, and even fatal.

When a deep vein is affected, as is usual in septic cases and may be in idiopathic, with the exception of perhaps some tenderness and pain along its course, the local signs of inflammation are wanting. The diagnosis will rest upon the occurrence of œdema in the area drained by the thrombosed trunk. When this is small, nothing is usually known of it until, in septic wounds, its presence is inferred from the occurrence of symptoms of embolic pyæmia, or, in simple cases, from the phenomena of embolism.

The *results* of *simple* thrombo-phlebitis may be quick disappearance of all symptoms, or obliteration of the vein and chronic thickening around it; œdema, permanent or lasting many months, and disappearing as vessels open up through the organized clot; and simple embolism is its great danger. In the case of *septic* and *infective* phlebitis, the formation and opening of a periphlebitic abscess must be regarded as favorable; septicæmia and infective embolism are the dangers.

TREATMENT.—The first point is by absolute rest and avoidance of all manipulation to reduce the chance of displacement of the clot and embolism to a minimum. A case of phlebitis should not be allowed to walk at all if it can possibly be avoided.

With regard to the inflammation, belladonna and glycerine freely applied, and assiduous fomentation are the best remedies. If one or more abscesses form, they should be opened aseptically.

The only satisfactory treatment of septic phlebitis is prophylactic, by antiseptics; once the disease has started, it is impossible to apply antiseptics to its seat. Rarely, after signs of septic embolism have occurred, life seems to be saved by amputation well above the wound or focus of inflammation: and similar treatment may be proper in idiopathic and septic traumatic osteomyelitis.

Persistent œdema must be treated as directed at p. 407, after all danger of shifting of the clot is over; if very marked, the prognosis as to complete recovery is not good.

VARICOSE VEINS.

CAUSES.—(1) *Heightened intravenous pressure,* due (*a*) to obstruction to the return of blood to the right auricle by pressure on veins, thrombosis, or obstructive lung or heart disease; (*b*) to gravity. This does not affect the driving force of the circulation in any way, but it increases the pressure upon the vein-wall in proportion to the height of the column of blood counting from the top of the head. In the lower limb gravity is a very important moment, for it dilates the veins, and if allowed to act continuously renders the dilatation permanent. (*c*) To the forcing of too large a quantity of blood into veins, as when in severe, sustained muscular effort the blood in the deep veins is squeezed into the saphenæ faster than these trunks can empty themselves (Gay). Varicose aneurism and aneurismal varix afford other examples. (2) *Impaired strength of wall* due (*a*) to periphlebitis, (*b*) to fatigue of muscle and nerve in general from overwork, heat, etc.; (*c*) to congenital deficiency; for, though varicose veins are not congenital, the tendency to them is distinctly hereditary. Some inherent defect seems to be the only possible explanation of cases which occur often without any obvious obstruction in apparently healthy young people. (*d*) To lack of support. Several causes often act together.

The disease is fairly common after fifteen or sixteen, and becomes still commoner up to middle life, then the tendency to it declines. As would be expected, it is commoner in tall than in short people, in the weak and sedentary than in the strong and active, and especially in those (laundresses, shop assistants) who have much standing, as opposed to walking, to do. In women, the pressure of the pregnant uterus on the iliac veins is a frequent cause.

Seats.—Chiefly the legs (especially internal saphena), the spermatic cords (*varicocele*), labia majora, and the rectum (*piles*); but pressure will produce varix anywhere. Probably the explanations given of the greater frequency with which the left spermatic and internal saphenous veins are affected, viz., the opening at right angles into the renal of the former, the pressure of a loaded rectum in the latter, are insufficient.

Morbid Anatomy.—As a result of the above causes, veins dilate, and at first the dilatation is easily recovered from, if the causes are removed; but if they continue or are often repeated, the dilatation becomes permanent, and the vein-wall thickens by development of fibroid tissue in the media. The vein not only widens but also lengthens and bends upon itself, assuming a tortuous or serpentine form. Dilatation is most marked upon the convexities of bends, immediately above valves, and where subcutaneous join deep veins—*i. e.*, in the popliteal space and groin. At such spots dilatation often exceeds hypertrophy, and large thin-walled cavities, covered by atrophied skin, occur. They may rupture, or the septa between contiguous sacs or bends may be perforated, when a multilocular cavity results. If a number of contiguous veins are affected and this intercommunication is carried to any great extent, an ill-defined spongy swelling, consisting of a kind of cavernous tissue, is produced.

As dilatation proceeds, the valves become incompetent, and the assistance which muscular contraction gives to the venous circulation is then annulled.

All the veins of the lower limb are never equally varicose; the superficial veins suffer earlier than the deep, being less supported; sometimes the internal, sometimes the external saphenous vein is chiefly affected; now the main trunk is the prominent object, now its branches; in some cases one or two masses of cavernous structure, coarse or fine, are alone present.

Transudation of fluid and escape of corpuscles is increased, sometimes so much as to cause some œdema of the foot and leg: and commonly more or less chronic thickening of connective tissue results, so that when a vein is empty, the finger detects a hard-edged groove.

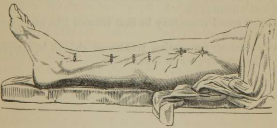
Symptoms.—Often with very marked varix of leg veins there are no symptoms; sometimes there is sense of weight, aching, and slight œdema, especially after standing or much exercise; but quite a small patch of small dilated veins may be the source of much pain and tenderness. In special parts, special symptoms arise, and naturally, piles more often than varicocele give rise to inconvenience. In the upright position dilated veins are seen and felt as tense, compressible, rounded, tortuous cords, often irregular from the presence of sac-like pouches, over which the skin may be quite thin and bluish. The grooves felt when the limb is raised are characteristic. Spongy masses caused by twists or by dilatation of neighboring vessels and their inter-communication are common; also purplish swellings in the skin in which small vessels are numerous.

COMPLICATIONS are chiefly the effects of stasis and malnutrition. *Pigmentation* of legs from escape of red corpuscles is common. The tissues are more or less *œdematous and thickened*, their *resistance* is much lowered, and obstinate catarrh of mucous membranes or eczema of skin is excited by slight injuries; *ulcers* form easily, are difficult to cure, and tend to recur after healing (p. 72); varicose veins are the usual seat of *thrombosis* often accompanied by *phlebitis*, perhaps ending in *abscess* (p. 409); calcification of thrombi may lead to *phleboliths* (p. 406); lastly, a thin spot may burst and give rise to the most *profuse hemorrhage*, as there may be no valves between the aperture and the heart.

TREATMENT may be *palliative* or *radical*. The first point is to remove any cause, any constricting band, compressing tumor, or dropsical effusion, constipation and overloaded bowels, excessive use of a part, prolonged standing, lack of exercise, and general or cardiac feebleness; with regard to catarrh or eczema, it should be cured as soon as possible, for it injures the vessel-walls and keeps the veins abnormally full. When upright, the patient should have the dilated veins supported by an elastic stocking or a well-applied Martin's rubber-bandage, or the effect of gravity may be lessened in varicocele by wearing a suspensory bandage and shortening the column of blood. When lying, it is an excellent plan, if the legs are affected, to have the foot of the bed decidedly raised. Friction with a flesh-brush in the course of the blood is strongly recommended by Mr. Vincent, and a cold douche night and morning is certainly beneficial.

Under such treatment early stages of varix may subside; mere removal of the cause is often sufficient, as is seen in women after labor. In other cases the above measures will keep patients quite comfortable.

FIG. 159.

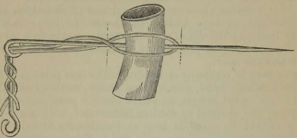


Twisted sutures applied for varicose veins.

But if the patient suffers much from weight or pain in the part, or from obstinate or frequently recurrent eczema or ulceration, or is in danger of hemorrhage from rupture of a sac, radical measures must be resorted to. There are many methods of operating. Varicose trunks are best treated by *H. Lee's operation.* The surgeon pinches up the vein between his finger and thumb and passes needles behind it at selected points; on the skin along the vein bits of bougie or drainage tube are laid opposite the pins, and figure-of-8 sutures are made over them round the ends of the pins, the points of which are cut off. The pins are inserted in pairs about three-quarters of an inch apart, and between each pair the vein is now divided with a very sharp tenotome passed beneath it. The pins are left in till the vein feels thrombosed, or until slight ulceration is caused. Instead of protecting the skin, Sir W. Fergusson used to divide it over the vein and place the ligature in the groove, thus occluding the vein more certainly and avoiding the pain of pressure on the skin. The little wounds are rather long healing.

Prof. John Wood employs subcutaneous acupressure as follows: he first, with needle and thread, draws a wire loop across behind the vein, then passes a special pin (Fig. 160) through the same openings, between the vein

FIG. 160.



Wood's method of treating varicose veins.

and the skin. The wire loop is then slipped over the pin and its ends crossed and twisted round the shaft. By daily twisting of the pin on its axis, the vein may be completely cut through, or, at any time, the pins may be withdrawn and the wire loop afterward. The method is more painful than Lee's, and, one would think, more dangerous.

Should these methods fail or be unsuitable, the most radical one of *dissecting out the veins* is left. The great length of the incisions is a serious objection in many cases. Ulcers and eczema should be quite healed, and the operation done with scrupulous antiseptic precautions. Indeed, these should never be omitted in operations upon veins, no matter how slight, for *the* danger is that of septic-thrombo-phlebitis, and a death from an operation on varicose veins is a great surgical misfortune.

Purple masses of small veins may be best treated like nævi, by the cautery, electrolysis, or excision.

After these operations preventive treatment should be employed, for the disease is very likely to appear in other veins.

CHAPTER XXXI.

INJURIES AND DISEASES OF NERVES.

INJURIES OF NERVES may be divided into (1) those which do not, and (2) those which do interrupt their conducting power. This depends upon the integrity of the axis cylinders—delicate structures which may be destroyed, even though the physical continuity of the nerve is maintained by its connective tissue. But the nature of the violence which causes the injury is also of importance, and is the usual basis for the classification of injuries.

Compression is a frequent cause of nervous symptoms. In its slighter forms it causes a part to "go to sleep;" thus after pressure on the sciatic in sitting the leg tingles, and feels numb and powerless, recovering completely in a few minutes. This pressure is slight and indirect; but Weir Mitchell has shown that direct pressure of ten pounds on the square inch applied by a mercurial column breaks up the medullary sheaths, and interrupts motor impulses for a short time—a result sometimes seen in the so-called "Sunday-morning" paralyses of the musculo-spiral or ulna after sleeping with the arm under the head or body, or resting on a sharpish edge—*e. g.*, the top of a chair; and the paralysis may now last so long as to indicate destruction of the axis cylinders. Sensation, too, may disappear, but it is always preserved longer than motion, the perceptive centres being excited by much slighter stimuli than the muscles. Similar paralyses are not uncommon from the pressure of crutches (*crutch-palsy*). Nerves are not infrequently paralyzed as a result of pinching with forceps during operations, and sometimes they are ligated by mistake, the result being paralysis as complete as after section. Even the more severe cases of this kind usually recover after some months, for the ends of the nerve are together, though its physiological continuity is gone.

Frequently nerves are exposed to constant pressure from more or less slowly growing tumors, aneurisms, etc. Up to a certain point they stretch or slip aside, and adapt themselves to altered circumstances; beyond this, they atrophy. As the limit is reached, neuralgia frequently results, and the involvement of nerves in tumors, laying bare in aneurisms, or compression against or in some resisting structure (*e. g.*, callus) excites much pain.

Contusion.—The ulnar nerve is frequently struck where it lies between the inner epicondyle and the olecranon; but most of the force usually falls on the bones. The result is some local pain with tingling and numbness of the two inner fingers. Rarely, sufficient force acts on the ulnar or other nerve to cause more or less lasting paralysis. Occasionally fragments in fractures and heads of dislocated bones contuse nerves sufficiently to cause symptoms; the musculo-spiral at the middle of the arm and the ulnar at the elbow most often suffer.

Strain.—Deliberate stretching with the finger and thumb of a large nerve does not cause paralysis; but in dislocations and fractures, especially such as result from machinery accidents, paralysis is a rare occurrence. In simple injuries it may be taken as certain that laceration has not broken the physical continuity of any large nerves. *Dislocation* of the ulnar from behind the epicondyle, with subsequent paralysis, has happened in fighting.

As to *treatment* of the above injuries, any source of pressure should be removed where possible. A nerve may be dissected out from scar-tissue; or when it is compressed by fibroid tissue in or around it, stretching may restore its functions. The tendency in all injuries due to the above causes is toward recovery, though this may not be complete for many months. The operation of suturing the ends is therefore unnecessary, at least until it is certain that physiological continuity will not be reëstablished.

To prevent wasting of muscles, warmth, massage, and electricity must be regularly employed.

The chief danger in all the above cases is that chronic neuritis (*q. v.*) may ensue.

Wounds.—We have incised, punctured, contused, and lacerated wounds, causing complete or partial division of nerves.

Nerve-trunks are commonly divided by wounds from sharp instruments, glass, etc., such as are very common about the fingers, hand, and wrist. Having but little elasticity, their ends do not separate more than an eighth of an inch, if so much; but if union does not take place, they are slowly drawn apart to a distance of two to three centimetres or more, by such movements of the limb as would stretch the nerve-trunk. The surfaces of section are rather swollen and look frayed out, the nerve fibres shortening less than the neurilemmata which contain some elastic tissue. In amputations, the retracted muscles often leave the nerve ends hanging out on the face of the stump.

A pointed instrument will do little or much damage in its passage through a nerve, according to its size and the nature of its edges; division of a few fibres or of the whole nerve may result.

Contusions rarely destroy the continuity of nerves, even when they tear skin, pulpify muscle, and crush bones; but a nerve may be so crushed that it subsequently sloughs. This sometimes happens from gunshot violence, but, as a rule, the nerve is partially or completely torn through. Nerves move out of the way of shot much less often than vessels (Fisher). When lacerated thus or in the tearing off of a part, the irregular ends hang long on the surface of the wound, and ecchymoses from stretching are found in its sheath much higher up.

RESULTS OF SECTION OF NERVES. *Degeneration and Regeneration.*—*Cæteris paribus*, partial section or interruption of the physiological continuity only of a nerve is more favorable than complete section, as the ends are held together. Speaking of complete division, the most favorable case for union and restoration of function is that of a clean-cut transverse section with the ends immediately sewn together, and the wound aseptic. Then the usual round-celled exudation (nerve-callus) infiltrates the cut ends, causing them to swell up, and also fills up the gap between them. In a few days the callus becomes firm, holds the ends together, and appears as a fusiform swelling upon the nerve-cord.

Exceptionally, divided nerves unite without suture; usually the ends separate an inch or more and both swell up into firm knobs, perhaps twice as wide as the nerve. Subsequently the distal portion of the nerve with its knob becomes gray, atrophied, hard to find and to separate from the surrounding connective tissue; the central end remains swollen, tender, and often spontaneously painful.

Histology.—Axis cylinders, being long drawn-out processes of cells, naturally degenerate when cut off from their parent cells. The motor nerves spring from anterior cornual cells in the cord, the sensory fibres are connected with the ganglia on the posterior roots; consequently, sections of spinal nerves below the latter ganglia result in speedy *degeneration* of the peripheral portion simultaneously along its whole length; whilst, with the exception of a few fibrils, (probably recurrent), the central end remains sound. The peripheral degeneration occurs almost always, if not always, in man, and is permanent unless physical union with the central end occurs; then *regeneration* is probable.

The dates at which the following *degenerative changes* occur vary somewhat in different animals. First, the nuclei of the primitive sheath swell, multiply, and protoplasm accumulates around them and elsewhere in the sheath, and at the same time the medullary sheath breaks up into larger and smaller drops of myelin. In four or five days these changes are well marked, and the axis cylinders are interrupted at many points; they ultimately disappear. The granular protoplasm, containing fat drops, increases at the expense of the myelin until the primitive sheaths, containing protoplasm and several nuclei, alone remain (middle of third month). Ultimately, in the absence of regeneration, a fibrous cord results.

Regeneration occurs as follows: both ends swell and unite as above described. The infiltrating cells become vascularized, undergo the usual changes of granulation-tissue, and form a provisional callus, through which regeneration of the nerve takes place by growth of the axis cylinders in the central ends. There is no sign of this until the middle of the fourth week or later; then it would seem that new fibres spring from the central axis cylinders at nodes close above the section. A cylinder may split into two new fibres, and these divide further, or a small brush of fibres may at once form. They grow down into and between the old primitive sheaths, passing very sinuously through the callus. At first pale, the new fibres acquire ultimately a medullary sheath with nodes of Ranvier; these are doubtless furnished by connective-tissue elements, whilst the axis cylinders, as in normal development (Balfour), grow out from the centre (Ranvier, Neumann, Eichhorst). The whole process may be complete in three months in animals, but in man a year or longer is usually required. It is more rapid in the young than the old, and is uncertain if the ends are not in contact; it may occur, however, if they are brought within one-half inch by suture. Provided the ends are brought together, the excision of a piece makes no difference. Sensation returns long before motion.

From experiments on animals, some writers support a healing of nerve without degeneration of the peripheral end; the fibres are said to become connected by processes of the connective-tissue cells, and union is complete in three weeks. Gluck succeeded in transplanting an excised piece of a rabbit's nerve into the sciatic of a hen; but the experiment has failed in man (Albert). This early union is very rare, even in animals. It is sometimes called "primary."

Early symptoms of section.—It is not always easy to detect the division of a nerve of mixed or pure function. We should expect section of a nerve to annul its function; and so, doubtless, it does, but the annulment may be concealed, especially as regards *sensation*. Section of any sensory nerve gives an area of maximum insensitiveness, which is limited in relation to the entire area of distribution of the nerve. From this central region feeling increases as we pass outwards, a fact explained chiefly by the anastomoses, coarse and microscopic, which nerves enter into. The tactile corpuscles at the margins of two contiguous sensory areæ seem to be supplied almost equally by the nerve of each. Moreover, the vibrations set up by tactile impressions upon an anæsthetic part may extend to neighboring tactile corpuscles of which the nerve-supply is normal. This indirect, together with the former direct, sensation, constitutes the *sensibilité supplée* of Letiévant. It varies greatly in different people, and, together with the area of the maximum anæsthesia, must be determined by a careful examination soon after any injury of a sensory nerve; later, fresh injury or neuritis may have caused much change. For this examination, blindfold the patient, and support thoroughly the suspected part that it may not move as a whole; then lightly go over the whole surface with a needle, find the most insensitive area and pass outward from this until feeling is acute as on the normal side. It is necessary to try the same spots several times, as patients often think they feel without really doing so. Usually the loss of sensation after section of a pure sensory or mixed nerve is such as to leave no doubt as to the nature of the injury. As regards motion, we can usually detect with ease which muscles are paralyzed after section of a motor nerve; but it may be difficult or impossible to do so when other muscles can produce, though less strongly, the movements of those paralyzed.

Later effects of section.—When a purely motor nerve—*e. g.*, facial—is cut, rapid wasting of the muscles results. The superficial parts may suffer secondarily from loss of that hyperæmia which attends the contraction of muscles, but otherwise they remain unchanged. If a growing part is deprived of motion, development of all its tissues will be imperfect. The effect of section of a purely sensory nerve is best seen in the fifth. It was thought that intracranial division of this nerve produced keratitis, panophthalmitis, and ulcers on mucous membranes; but these lesions are now regarded as due to neglected, because unfelt, injuries.

In spinal nerves we have not only motor and sensory, but also numerous vasomotor fibres. Active hyperæmia, which might *a priori* have been expected from section of such nerves, has not been noted; but soon the *skin* supplied by the divided nerve becomes bluish from passive congestion, lax, cold, prone to chilblains, bullous eruptions, and slowly spreading ulcerations, which may extend to the bones of a part, or destroy the ends of fingers and show no tendency to heal. Sometimes, especially upon the fingers and toes, and after contused or lacerated and often incomplete divisions of nerves, the skin becomes thin, tense, shiny, hairless, and the seat of intense neuralgic pain (*causalgia*), a condition known as "glossy skin" (Paget). Hair may grow excessively, sweat may be diminished or increased on such parts, nails become curved, opaque, furrowed, and brittle.

Changes in muscles are even more marked. These atrophy much more quickly than when merely kept at rest, and more quickly after an irritant lesion of nerve than after simple section. The fibres lose their cross-striation, degenerate and shrink, whilst their nuclei multiply, the interstitial connective tissue increases *pari passu* (sclerosis), and sometimes becomes so loaded with fat that the shrinking of muscle is concealed. Adaptive shortening of unopposed muscles, whether paralyzed or not, is common and leads to deformity.

Bones of paralyzed parts atrophy or fail in development. Joints become stiff and painful, and it is said that in cases of irritant lesion and neuritis, they (*e. g.*, finger-joints) may suffer as in ataxy (p. 332).

How far these changes are due to vasomoter disturbance and lack of exercise, how far to some "trophic" influence of the central nervous system, it is impossible to say. Regeneration of a nerve stops them all.

Reaction to Electricity of Nerve and Muscle after Injury of Nerve.—Pressure and other slight injuries usually have no effect; but when the physiological continuity of a motor nerve is interrupted, very characteristic changes occur, grouped together by Erb under the name of *reaction of degeneration.*

The peripheral end of the *nerve* under these circumstances rapidly loses excitability and conducting power as its fibres degenerate; both are gone by the end of the second week, or rather earlier. If, however, regeneration (p. 414) takes place, these properties reappear, first in the more central, then in the more peripheral part, and conducting power is said to return first (Erb). Excitability reappears as the new fibres acquire medullary sheaths.

To *faradism* muscles behave just like the nerves—*i. e.*, they rapidly fail to respond to the stimulus; but to the slowly *interrupted constant current* they react differently. To this stimulus during the first week the excitability diminishes, but then it rises until currents which have no effect on normal muscles cause strong contractions of those paralyzed, and the contractions differ from normal twitchings in being slow and drawn out. This state lasts perhaps six or eight weeks, and then excitability gradually disappears unless regeneration occurs. After four months the paralyzed muscles will not usually react to any form of electricity. They behave to *mechanical stimuli* just as to the galvanic. It is obvious that these signs are of great importance in investigating the nature of an injury of some standing, from the point of view of both diagnosis and prognosis.

TREATMENT.—Complete section of a nerve is always, when possible, to be treated by suture of the ends, no matter whether the injury be recent or old, provided, of course, that in the latter case spontaneous recovery is not certainly occurring, and it rarely does without suture.

Suture of a nerve is performed with the finest catgut and a small round sewing needle, which will injure but few fibres in passing through the central end. Trim the ends till they fit accurately, then pass a suture of support through them about 1 cm. from the section, and two or more sutures of apposition close to the cut surfaces. Treat the wound most carefully, and fix the limb so as to take off all tension from the nerve.

In old cases, and whenever a search for an end is necessary, apply Esmarch's bandage, make a free incision, cut down upon the upper end, which often will have been felt or discovered by its tenderness, and then seek for the lower end*:* finding this is the first difficulty. Now cut off all or part of the bulbous ends, according to the distance between the ends, and sew them together. In some cases no position of the limb, even when coupled with stretching of the nerve, will allow of their apposition. Successes are, however, recorded when a gap of quite half an inch has been left; and though transplantation has not yet succeeded in man, Tillmanns has obtained a success by cutting half through the central end a few centimetres above the division, splitting it in a downward direction, twisting the freed portion through 180°, and sewing it to the lower end.

Extreme flexion of a limb may be necessary to take off strain for some weeks after such an operation; it may be gradually relaxed as soon as returning sensation is noted. Then the wasting must be treated (p. 413). Recovery may not occur for a year or even longer and be quite rapid then, or it may be very gradual. Failure must not be accepted and suture repeated until after a year has elapsed. Even then the effect of dissecting the nerve out of the surrounding scar-tissue, or of simply stretching it, should first be tried.

DISEASES OF NERVES.

Besides the *usual results of nerve injuries* above mentioned, *neuritis* may ensue; *neuralgia* and sometimes *spasmodic affections* start from such lesions, and very rarely *tetanus* appears, or *epilepsy* with an aura starting from the scar.

NEURITIS may be traumatic or non-traumatic; acute or chronic from the first, or the former may pass into the latter.

CAUSES.—Mechanical injuries, especially contusions, lacerations without complete division, or impaction of foreign bodies; but even quite trivial subcutaneous injuries, slight strains or constant pressure, may induce neuritis, and severe ones are even more likely to do so. Cold is apparently a very frequent cause, as is most often seen in Bell's palsy (facial) and in sciatica. Extension of inflammation from surrounding parts is common; there is no better example than paralysis of the seventh, from inflammation of the middle ear. Syphilis, leprosy, and malaria are non-traumatic causes. Chronic traumatic neuritis occurs only with a special predisposition (Erb).

MORBID ANATOMY AND PATHOLOGY.—In acute cases all stages may be found, from more or less marked hyperæmia of the sheath up to purulent infiltration and sloughing of the nerve; usually the trunk is swollen uniformly, or presents fusiform enlargements due to a coagulable exudation of pinkish-yellow color. The perineurium suffers most, but the medullary substance of Schwann is more or less broken up, and also a few of the axis-cylinders; the nuclei of the primitive sheath are said to multiply, and infiltrating leucocytes are numerous. The nerve is softer than normal.

Chronic cases are characterized by increase of fibroid tissue, causing uniform or localized swellings of the nerve and its adhesion to the surrounding tissues, whilst the compressed nerve fibres atrophy in greater or less numbers. Such nerves are often gray and very tough, and they may be thin rather than thick.

Either form of neuritis may therefore suspend or destroy the conducting power of more or fewer nerve fibres, and lead to the usual degeneration changes in their peripheral portions.

Sometimes neuritis (*ascending*) extends rapidly or gradually, continuously or by jumps, toward the centre, the symptoms spreading with the disease. Branches higher up, other nerves, and even the cerebro-spinal centres, may then be attacked.

The whole pathology is very obscure, the nature of the cause which leads to a centripetally spreading inflammation starting perhaps from a very slight contusion or strain, and affecting nerves only, is quite unknown. The process has almost a mysterious aspect.

SYMPTOMS.—*Acute neuritis* is very rare. It is said to begin not uncommonly with a rigor, high fever, and delirium; intense pain radiating along the affected trunk to its ramifications, and occasionally into neighboring nerves; some redness and œdema of the skin over it when superficial, and great tenderness, usually preventing the discovery of swelling of the nerves; muscular twitching is uncommon, but tonic contraction occurs; the symptoms and result vary with the intensity and outcome of the inflammation; usually the acute symptoms subside, and *chronic neuritis remains.* This is characterized by more or less constant, dull pain of a tearing, boring, or aching kind, increased by motion or pressure, ultimately associated with some anæsthesia; no paralysis, but paresis and wasting, rarely fibrillar contractions. Proportionate to the number of fibres destroyed by the pressure is the peripheral degeneration: this is never entirely absent, and its results (p. 415) may be very marked. Especially do the finger-joints suffer in neuritis of the great trunks of the upper limb. The difficulty in these chronic cases is to eliminate disease of central origin, unless one can feel a tender, thick, perhaps irregular, cord.

TREATMENT.—In acute neuritis ice or belladonna fomentations should be applied along the nerve, and the pain subdued by morphia; this failing to relieve, a free incision down to the nerve and into its perineurium is recommended. In chronic neuritis the general health must be seen to (*see* "Neuralgia"), and syphilis or malaria must be treated; any local cause must, if possible, be removed. Free blistering over the nerve is very useful, also warm baths, and electricity to the muscles. In all cases give physical and physiological rest if possible.

Stretching the nerve should always be tried if other treatment fails.

NEURALGIA.—This is really the name of a symptom, of *pain*, which is usually intermittent or markedly remittent in character, now dying away, now shooting with intensity along the nerve. It may affect a single branch or all the branches of a nerve or several nerves, but it seldom occurs on both sides, and is never symmetrical (Fagge). "Tender points" develop sooner or later, and are fairly constant for the different nerves, occurring at spots where they enter or leave bony canals or pierce fasciæ. Pressure or even a draught on these spots may bring on an attack, but usually the onset is spontaneous. The pain may be accompanied by twitching or spasm, vasomotor, secretory and trophic changes. The skin may be tender, especially during an attack; but Erb says careful examination will always show relative anæsthesia. Proportionately, the general health seems little affected.

ETIOLOGY AND PATHOLOGY.—Fagge makes two forms: one, reflex, due to irritation of a nerve, which is not itself the seat of the pain, as in trifacial neuralgia from a diseased tooth; the other due to some morbid process in the trunk of the nerve, as in sciatica. But in the majority of cases it is said that no change is discoverable in the affected nerve; so if there is one morbid state sublying neuralgia it is unknown. Very likely there is a group of central origin.

Injuries, especially contusions and crushes, are sometimes the starting-points of neuralgia, which begins after any wound has healed; in some of these cases pressure on a filament in the scar, in others a traumatic neuritis, is the immediate cause. Pressure of new growths (especially cancers), aneurisms, callus, fragments of bones, or even of dilated veins, extension of inflammation from surrounding parts, impaction of foreign bodies, and especially exposure to cold and wet, are causes of the second variety, and demand that in all cases the whole length of a nerve, if possible, shall be carefully examined for a source of irritation. Causes of the reflex variety are caries of teeth with its complications, exostoses of fangs, ulcerations, and involvement of peripheral filaments in scars and inflammatory tissue (*e. g.*, orchitis). Besides these local causes there may be a neurotic family history, hysteria may be present, the patient may be suffering from nervous or general exhaustion or anæmia, or may have suffered from syphilis or malaria. In the latter case the attacks are probably periodic.

Varieties.—The fifth is one of the commonest seats. *Tic douloureux* is the most severe form known. It consists of sudden, extremely severe fits of pain in the area of one or more of the branches of the fifth, lasting a few seconds to a minute, and ceasing as suddenly as they begin; the paroxysms occur with varying frequency, and are less marked or absent at night; there may be remissions of days or months. The general effects upon mind and body of such pain, often brought on by movements of the jaws, can be easily imagined. The patients are almost always over forty. The causes are quite unknown, but Tomes says the teeth, though they may be tender, are never at fault.

A milder form, paroxysmal, but with less marked remissions, is often due to the teeth, and occurs in young and old, especially when they are depressed by illness, fatigue, or want of food. A meal often relieves at once. In all slighter forms of neuralgia of *any* branch of the fifth, have the teeth thoroughly examined.

Sciatica.—The great sciatic nerve is that most often attacked next to the fifth. The pain is unlike that of *tic*, being much more constant and duller; its seat usually seems to be the back of the thigh, but it may extend down to the foot. After a time the limb feels cool, is wasted, its muscles are flaccid, and there is some anæsthesia. The nerve is tender. The patients are chiefly men from twenty to forty, or older.

Treatment.—The general causes must be looked for and met by appropriate treatment, and a liberal diet with *little or no stimulant* is almost always valuable. Anstie laid stress upon the value of fat, especially ol. morrhuæ.

Any local cause must, if possible, be removed. With regard to drug-treatment: iron in simple anæmia, quinine, and arsenic in malarious and other obstinate cases, strychnia in nervous exhaustion and atonic dyspepsia may be tried. Phosphorus (gr. $\frac{1}{12}$th 4tis horis) in ol. morrhuæ has been strongly recommended; it acts within three days if at all.

Great care must be taken to prevent a patient from seeking relief in chronic alcoholism or morphinism. Except in the most severe and hopeless cases morph., gr. $\frac{1}{12}$th to $\frac{1}{4}$th twice a day, will usually give ease. The patient should never himself use the syringe.

As a local application the liniment of aconite or aconitia ointment often relieves, and counter-irritation may do so in the less severe cases.

When treatment such as the above has failed, and even when, as is usually the case, the cause of the disease is unknown, two operations, *nerve-stretching* and *neurectomy*, remain.

NERVE-STRETCHING.—This operation has been employed upon many nerves in very various morbid states, but in none with anything like the success it has met with in neuralgia. Of 222 cases, 143 are said to have been cured, 62 improved, and 17 unrelieved; its mortality is very slight (Omboni).

It is thus performed upon the sciatic: a 3-inch cut is made above the middle of the thigh through the fascia, the biceps and semitendinosus are separated, and the semimembranosus is drawn in with the latter muscle. The nerve is now seen; its connective tissue sheath is opened, and the trunk is taken between the forefinger and thumb and pulled with such force as the arm alone will give, first from the cord and then toward the cord, in the line of the nerve. Some surgeons cut down on the nerve midway between the trochanter and tuber ischii, where it is covered by the gluteus maximus alone (its lower fibres must be cut), and lies outside the hamstrings. The results are no better, and the wound is more difficult to keep aseptic.

But before cutting the skin it is well to try this bloodless method: with the patient on his back fully flex the hip and then slowly straighten the knee. This may tear some fibres of the hamstrings, and stretches the sciatic strongly.

The branches of the fifth in the face are reached by short cuts made at right angles to a line extending from the supraorbital notch, which can be felt, to the interval between the bicuspid teeth. The infraorbital nerve issues just below the margin of the orbit, the mental midway between the alveolar and lower borders of the jaw, perhaps a little beyond the above line. A blunt hook is used to stretch small nerves like these, and less force must be used.

The result of stretching is laceration of the medullary sheaths and of more or fewer axis-cylinders at the spot stretched, followed by peripheral degeneration and regeneration. Fibroid matting in and around a nerve is likely to be broken down; and Marshall suggests that it may paralyze the nervi nervorum (sensory nerves of nerves) discovered by Horsley. Clinically large nerves, like the sciatic, are not paralyzed; but a small one like the facial is.

NEURECTOMY is practised chiefly on the superior maxillary and branches of the inferior in cases in which pain recurs as the effect of stretching passes off; it cannot, however, like stretching, affect the central part of a nerve. At least half an inch should be removed to prevent regeneration, which usually occurs after simple section.

The inferior dental may be reached by trephining the lower jaw. The lingual can be felt beneath the mucous membrane below and behind the last lower molar. The superior maxillary may be cut behind Meckel's ganglion by trephining the front and back walls of the antrum, and tracing back the infraorbital in its canal. For the operation and results see T. Chavasse, *Trans. Med.-Chir. Soc.*, 1884, p. 145.

SPASMODIC TIC.—This consists in the sudden involuntary contraction at longer or shorter intervals of one or several muscles; sometimes the twitchings are almost incessant and interfere with sleep. When the face is affected the eyes may be suddenly closed at some important juncture. The seat and nature of the disease are unknown, but it sometimes dates from an injury. After years, perhaps, the spasms may shift to another part.

Medicinal treatment is useless. Stretching of the facial may relieve *his-*

trionic spasm, but rarely cures (Godlee, *Trans. Clin. Soc.*, 1882). In a case of perpetual spasm of the arm muscles, dating from a blow on the neck from a falling spar, in which the brachial plexus had been stretched both below and above the clavicle without effect, J. H. Morgan began to divide the nerves of the arm, one by one, or their motor branches, but spasms then appeared in the leg of the same side as well as in the arm, a result which Dr. Ferrier had feared.

NEUROMA.—Tumors of nerve tissue are very rare (p. 135); "neuroma" usually means an encapsuled tumor growing from the connective tissue of nerves, a fibroma, myxoma, or sarcoma, roundish or fusiform, compressing or stretching the nerve fibres. Such masses should be removed if they give rise to symptoms or are growing; much care should be taken not to pinch or bruise the nerve fibres, or months of neuralgia and palsy may follow the operation. If necessary a piece of nerve with a small tumor might be excised, and the ends sutured.

TETANUS.

DEFINITION.—Tetanus is a disease manifested by tonic or continuous spasm and rigidity of the muscles of voluntary motion.

It is divided into *idiopathic*, or that which arises without wound; and the *traumatic*, or that which is caused by a wound; the latter is by far the commoner, but the occasional absence of wound seems established. *Trismus infantum* or *neonatorum*, which attacks children soon after birth, is frequently made a distinct species, but without reason.

ETIOLOGY.—*Traumatic tetanus* is especially liable to follow lacerated, poisoned, and punctured wounds of the hands and feet, gunshot wound in particular; wounds in which nerves are exposed, or pus or foreign bodies confined under fasciæ. Frequently a nerve twig has been found partially divided by the cutting instrument, or irritated by a foreign body, etc. It is said to have been caused by a contusion with a schoolmaster's ferule, but this is doubted; it very rarely follows clean-cut incisions. The doctrine that wounds of the extremities are more liable to cause tetanus than wounds of the head, neck, or trunk is perhaps to be explained by the more frequent occurrence of injury to the extremities. The period at which it may come on after an injury is very uncertain. Sometimes it occurs very quickly; sometimes during the inflammatory stage; often not till the wound is nearly healed; most commonly from four to fourteen days from the injury.

Trismus neonatorum is prone to arise during the first nine days after birth; it seems to bear relation to the separation of the umbilical cord, and therefore would rank as a form of traumatic tetanus. The tetanus arising after abortion may perhaps also be looked upon as traumatic.

Causes favoring the occurrence of traumatic tetanus are exposure to cold and damp, fatigue, privations. Cold and damp take especial effect in tropical countries where the alternation from the heat of the day to the cold of the night is very sudden and extreme. In military campaigns all the above-mentioned predisposing causes are likely to obtain, and it is during such that cases of tetanus are most frequent, occasionally appearing like an epidemic. Tetanus is rarely absent from certain hospitals in India; and occasionally, after absence for years, small epidemics of two or three cases occur in hospitals in temperate climates. These considerations and points in its pathological course cause many to regard tetanus as probably an infective disease; some have stated that it is contagious.

Of *idiopathic tetanus* cold and damp are the most efficient known causes. It is chiefly met with in tropical climates. Malaria appears to give rise to an intermittent form of tetanus.

Men are more subject to tetanus than women; the young and middle-aged more than the aged.

Symptoms of Tetanus.—The patient first complains of stiffness and pain about the neck and jaws, as if from a cold, flexion of the neck is imperfect, and a finger in the mouth will feel the edges of the masseters; his voice is husky; it is difficult for him to put out his tongue, and his countenance exhibits a painful smile, because the corners of the mouth are drawn outward by incipient spasm of the facial muscles; the alæ nasi are drawn out, the naso-labial furrows deepened; the eyelids are half-closed but the eye muscles are rarely affected; the pupils are contracted. Next, the muscles of mastication and deglutition become rigid, so that there is great difficulty in opening the mouth and swallowing, especially liquids. The jaws may now become firmly clenched (*trismus* or *lock-jaw*). The tongue is rarely rigid; saliva flows from the mouth because the patient is unable to swallow it. To these symptoms succeed a fixed pain at the point of the stomach shooting to the back, and a convulsive difficulty of breathing, indicating that the diaphragm and muscles of the glottis are affected; and the spasm now extends to the muscles of the trunk and limbs, rendering them completely fixed and rigid. Various positions of the body are assumed in this spasm. The term *opisthotonos* describes an arching backward of the neck and trunk, more or less of which is usual; *emprosthotonos* a curving forward, *pleurosthotonos* a lateral curvature, both of which are rare.

The muscles of the extremities are not, as a rule, affected to so great an extent as those of the trunk, neck, face, and jaws; their distal portions scarcely ever suffer. In the lower limbs extension predominates over flexion; in the upper, if affected, flexion prevails over extension. The abdomen feels remarkably hard; there is obstinate constipation; frequently difficult micturition from spasm of the perineal muscles. This spasm never ceases entirely; but it occasionally has a lull, and then comes on again in fits of great violence. In severe paroxysms the chest becomes fixed, the countenance livid, and there is dread of suffocation. Arrest of respiration is sometimes due to spasm of the glottis, but as a rule it is the result of spasm of the thoracic muscles and diaphragm (Ross). Such fits are easily brought on by any disturbance, such as an attempt to swallow, or by any other bodily movement or mental excitement, and most remarkably by slight causes affecting the surface of the skin—such as currents of cold air. This would look like hyperæsthesia, but for touch and temperature the sensibility appears to vary, being sometimes exalted, sometimes lowered. The pain complained of during a convulsive seizure is that of ordinary cramp. Relaxation occurs during sleep, but this is generally absent. Meanwhile the intellect is undisturbed, and the pulse is at first natural, except during a severe paroxysm, which quickens it and causes perspiration and thirst, or when there is fever. The temperature is generally raised from 101° to 103° F., and may suddenly become hyperpyrexial; but even the most acute cases may be afebrile. The urine has in some cases contained sugar.

Terminations.—If the case is to end *fatally*, the paroxysms become more frequent and violent, and the breathing more and more embarrassed by spasm; the patient may die from exhaustion or from suffocation—either because the nervous system is worn out, or because respiration is suspended by the violence of the spasm long enough to asphyxiate. Asphyxia is probably less common than is usually thought, as carbonic acid relaxes the spasm before death occurs. Rose (*Deutsche Chirurgie*) believes cardiac failure before the resistance opposed by the tonically contracted muscles to be the common cause of death. The heart sometimes stops suddenly. The most usual *period of death* is the third or fourth day; sometimes it is postponed till the eighth or tenth, but rarely later (*chronic tetanus*). The recorded case of a negro who injured his hand and died convulsed in a quarter of an hour is doubtful; and cases of death within twenty-hour hours are uncommon. When acute tetanus terminates *favorably*, the recovery may not be complete for weeks or months; the remaining tendency to spasm may yield but slowly, and it is apt to be temporarily aggravated by very slight causes, especially cold and damp. In some rare instances the disease has been removed almost instantaneously by the removal of its exciting cause. Tetanus is liable to vary greatly in intensity. In some cases there may be only locked-jaw and some stiffness of the neck-muscles. These cases have been classed as *partial* tetanus.

PROGNOSIS.—Acute traumatic tetanus is one of the most hopeless of diseases: of 363 cases in the American civil war, 336 were fatal.[1] The idiopathic and chronic cases usually do well. Death very seldom occurs after the twelfth day. As a general rule, it may be said that in traumatic tetanus the longer the interval between the injury and the occurrence of the disease the more favorable is the prognosis. Cases arising early and marked by spasms of increasing frequency and violence are nearly always fatal. Early suffocative attacks on attempting to swallow are said to be of bad significance. A high temperature, above 103°, and a frequent pulse are also signs of danger. Strabismus is regarded by Wunderlich as a fatal prognostic.

DIAGNOSIS.—Tetanus may be distinguished from *hydrophobia* by the spasms being more *continuous*, by the clenched jaw, and by the patient being generally sensible and calm to the last; whereas in hydrophobia, if there are fits of general convulsions, there are *perfect intermissions*, and the patient is mostly delirious.

In *strychnine poisoning* the masticatory muscles are, as a rule, the last to be affected; the disease develops much more rapidly; there is generally complete muscular relaxation between the attacks. Death occurs commonly in less than three hours. Tetanus is sometimes closely simulated in *hysteria*. The diagnosis must rest on the general evidence of this emotional disease and upon imperfect simulation.

MORBID ANATOMY.—Increased vascularity of the membranes and substance of the *spinal cord* and brain are amongst the most constant changes noticed in the older books. The modern microscopical researches of Lockhart Clarke, Dickinson, and others show that the cord may be swollen at its cervical and lumbar enlargements; its bloodvessels distended, with here and there minute extravasations. The changes affect specially the gray matter. The muscles are extremely rigid after death, and ecchymosed or ruptured in many parts. In certain cases a neuritis has been discovered ascending from the wound to the cord; in others no changes either in the wound itself or in the nerves proceeding from the wound. The blood is mostly uncoagulated.

PATHOLOGY.—This is obscure; the changes in the cord and muscles are evidently results, not the cause. There is obviously present during the disease an increased excitability of the spinal cord, and with the evidence before us of the effect of strychnine poisoning, the question arises whether tetanus may not be due to the presence of a poison in the blood. Another view is, that we have to deal with an inflammatory condition of the spinal cord brought about by extension from the wound along the nerves. But either the rapid generation of a poison in the system, or its generation in the wound and subsequent absorption, or the excitation of an inflammation spreading from a wound, is most probably due to the action of some infective organism.

[1] Circular No. 6: War Department, Surgeon-General's Office, dated Washington, Nov. 1, 1865.

Nothing is known on this point, however, and evidence is wanting both as to increase of the poison and inoculability of the disease.

TREATMENT.—The indications are: 1. To remove, so far as we are able, all conditions known or believed to have the power of exciting the tetanic state. 2. To give the patient every chance of spontaneous recovery, by husbanding his strength till the disease shall cease of itself; and 3. To use any special sedative or other treatment which the surgeon would sincerely desire to have employed on himself if he were the patient.

For *local treatment*, all extraneous bodies should be removed from the wound. Render the wound aseptic, slitting it up freely if necessary, using sublimate lotion (1 in 500), and applying boracic fomentations. Measures have been proposed in order to remove local irritation—such as amputation; or division of the principal nerve leading from the wound; or making a $\wedge$-incision above, so as to isolate it and cut off as much nervous communication as possible; or destruction of a ragged, contused, ill-conditioned wound by the *actual cautery*, which Larrey practised with great benefit; or *excision of the scar* if cicatrized, or nearly so. Of late *stretching* of the main nerve or nerves of a part has been practised, with a view of temporarily destroying its conducting power (see "Neuralgia"). Ten of fifty-one cases recovered and eleven were relieved (Omboni). *Amputation* is an extreme remedy of this class, and should not be recklessly practised. Curling (*A Treatise on Tetanus*, p. 122) observes that the tetanic condition of the spinal cord, when fully established, is mostly independent of its local exciting cause, and does not cease on its removal. Hence, treatment of the above kind must be adopted early if at all.

GENERAL TREATMENT.—The chief thing is perfect quiet. The room should be dark; the patient should neither speak, move, nor swallow oftener than he can help. The administration of remedies should be effected as gently as possible. Everything harsh and violent should be avoided. Cold affusion, and the extraction of a tooth to admit an œsophagus-tube, have each been known to cause death suddenly.

In all cases an abundant supply of nourishment should be given, with wine or brandy. If nourishment cannot be swallowed, it should be given *per rectum*. (See *Nutrient Enemata, soups*, etc., in the Appendix.) Where there is difficulty in feeding, Rose suggests giving chloroform twice daily and using a stomach tube. In some cases recovery has followed the use of spirits in large quantities. It may seem expedient to add quinine or muriated tincture of iron, if the debility be very marked.

Constipation may require relief; but it is mischievous to irritate empty bowels, and under any conditions it is best to avoid cathartics in the established disease.

Ice to the spine is proposed by Dr. Chapman; but of this further experience is wanted. The cold bath may be employed if the temperature rise suddenly to a dangerous degree.

Warm baths or vapor baths may be employed to soothe the patient.

Opium, or morphia, may be given in large doses, in the form of enema, suppository, or subcutaneous injection. The success of this drug is not great.

Chloral hydrate enjoys the highest reputation as a sedative. Dr. McNamara gives 40 grains of chloral at bed-time, and in severe cases an extra dose of 30 grains at noon. He does not think it controls the individual attacks of spasms, and his purpose in the above is simply to rest the organism so as to enable it to bear the strain of the repeated attacks. Others strive to obtain constant sleep by repeated enemata of the drug.

Chloroform inhalation is employed to remove the spasm of the separate attacks. In hopeless painful cases it may be used freely and constantly until death occurs. It must be given very slowly lest it excite spasm of the glottis.

Indian hemp has been employed; it must be given in large doses.

Curare, a poison which paralyzes by affecting the motor nerve endings, has been used with success. It may be injected subcutaneously in doses of $\frac{1}{200}$th to $\frac{1}{100}$th of a grain; it is a poison of uncertain strength.

Calabar bean, tobacco or nicotine, bromide of potassium, are other drugs which have been used.

It is probable that chloral hydrate alone, or combined with bromide of potassium, is the best sedative treatment to adopt in the milder cases.

CHAPTER XXXII.

INJURIES OF THE HEAD.

These derive their importance chiefly from the frequency with which the injuries affect also the brain, and from the danger that diseases of the superficial structures will spread to the brain and its membranes.

Injuries of the Scalp.

Contusions scarcely need treatment. Subaponeurotic hemorrhage may occur in considerable amount, forcing its way or gravitating to parts distant from the point struck; thus, discoloration of the forehead is common some days after a blow on the vertex. *Cephalhæmatoma* is a subperiosteal effusion of blood, occurring usually on one parietal from strangulation of the veins by the os uteri during a long labor: it may arise in children from other injury. A ring of bone generally forms in the angle between the bone and raised periosteum. Absorption is perfect without any treatment.

Wounds.—Even the slightest should not be neglected; fortunately, abrasions and small cuts usually heal under a scab, or complications would probably be more frequent.

Wounds are divided into two classes: those which do not open the loose tissue beneath the galea, and those which do. In the latter, nothing is easier or more natural than that defective drainage and decomposition of the discharges should lead to *diffuse subaponeurotic suppuration;* and with this goes the danger that emissary veins will become thrombosed, and that the thrombi will undergo infective softening—leading to *pyæmia* or conducting a septic inflammation into the skull and causing *subcranial suppuration, meningitis,* or *cerebral abscess. Erysipelas* is said to be an unusually frequent complication of wounds of the head, but this is denied by others. It may occur in either form of wound, and is, of course, favored by decomposing discharges. It may lead to subaponeurotic suppuration or meningitis, and be complicated with pyæmia. Its characteristic rash is often absent, only a pale and œdematous swelling resulting in the tough tissues of the scalp; but it extends irregularly on to the face and neck, where its sharp red edge generally appears. Early general symptoms, the absence of much deep swelling, irregular extension beyond the attachment of the aponeurosis, early affection of glands, and possibly the presence of a characteristic rash, must be relied upon in the diagnosis between erysipelas and diffuse subaponeurotic suppuration; the distinction is often impossible.

TREATMENT.—There is nothing special in the treatment of wounds of the scalp. *Hemorrhage* is often free, the part being very vascular. If not easily checked by pressure, acupressure by a needle used to close the wound will at once succeed, or bringing the edges together firmly by ordinary sutures. It is difficult to seize vessels with forceps in the dense tissues of the scalp.

The danger of sepsis and imperfect drainage being so great, no effort should be spared to prevent their occurrence. First, *shave the head* for some distance round the wound; in bad cases shave the whole scalp. *Drain* thoroughly all wounds of the galea which are sewn up, bringing the tubes out at the lowest points through holes made in the flap, if necessary, and cutting them obliquely so as to be quite level with the surface. Superficial wounds require no drainage.

It is very difficult satisfactorily to *disinfect* the scalp; wash it well with soap and carbolic lotion, using a brush, the wound being tightly plugged with wool or lint steeped in sublimate lotion; then wash wound and scalp with sublimate lotion. Now bring together the edges with sutures; *if the drainage is free,* there is no danger in their use. Either a gauze or wool dressing may be used, over all a firmly applied bandage, adapted to maintain uniform pressure on the wound and to prevent all slipping of the dressing.

If the edges of a deep wound lie well together use no sutures, but apply a small *absorbent* antiseptic dressing with uniform pressure. The practice of sealing these wounds with dry lint and blood or strapping is thoroughly bad.

Under this treatment cases in which most of the scalp has been torn off by cart-wheels or machinery do well. No matter how dirty and bruised a piece of scalp may be, clean it carefully and fix it in place.

Diffuse cellulitis will be indicated by the ordinary symptoms (p. 152), and must be treated as usual. The temperature gives the earliest indications of inflammation. Fluctuation will probably not be obtained even though suppuration has occurred; pain, tense swelling, and continued high fever, are its signs, and should be met by short incisions through the galea, made too early rather than too late. It is impossible to avoid wounding small arteries, but bleeding should be quite stopped before the patient is left. Even a woman's head must be completely shaved in these cases.

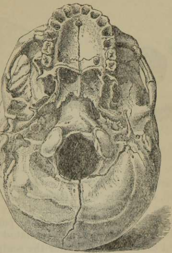
INJURIES OF THE SKULL-BONES.

CONTUSION occurs chiefly in compound injuries from considerable violence, often insufficient to cause fracture, such as the oblique impact of a bullet; it may cause death of the parts struck and contusion of the brain, either beneath it or on the opposite side, and in septic cases suppurative osteomyelitis, intracranial suppuration, and pyæmia are not uncommon. From the injury to the brain or consecutive inflammation, symptoms rendering the patient unfit for work not uncommonly result—*e. g.*, epilepsy.

FRACTURES are almost always due to direct violence applied with flat, blunt, sharp, or pointed objects of all sizes; special cases are: blows on the chin, cracking the glenoid fossæ and even driving the condyles of the jaw into the skull; or falls on the feet or buttocks, when the skull is driven on to the spine; or falls on the head upon soft earth, when the after-coming spine drives in the condyles. The force necessary to fissure some skulls is very slight.

All forms are met with. *Fissures* are the most common, due generally to violence acting over a large area, as in falls on the head or blows with a rifle-butt. They almost always start in the roof, *from the point struck,* and may be limited to it or extend into the base. Usually fissures from blows on the frontal pass into the anterior fossa, on the parietal into the middle (the most common), on the occipital (Fig. 161) into the posterior (Aran); if the violence is great, fissures may extend through all three fossæ. A fissure extending from the posterior to the middle fossa generally passes through the internal auditory canal and tympanum, whilst fissures of the middle fossa frequently fracture the tegmen tympani, cross the line of the middle meningeal (anterior branch), and extend forward into the cribriform and orbital

Fig. 161.



Fractured base of skull, due to a fall from a height. One fracture extends backward from the foramen magnum, another traverses the left posterior condyloid fossa, involving also the jugular process. Museum of the Medical College, Madras. Drawn by Moonesawmy.

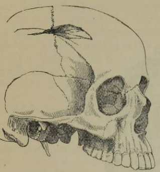
plates. At the moment of origin the edges of these fissures may gape or be displaced on each other sufficiently to tear structures closely bound to the bone on each side—*e. g.*, sinuses or the middle meningeal, especially when in its bony canal. In cases of great violence fissures may enter sutures, open them for some distance, then as suddenly leave their line; they commonly pass across the basal foramina, perhaps injuring the contents.

Rarely, after a blow on the head, a fissure of the orbital plate is found; and either there is none starting from the point struck or it does not reach the orbital plate; this is a fracture from indirect violence by *contrecoup*, and due to the general change of form which the skull undergoes when struck at one point. It is of little importance.

When a fracture is produced by the corner or edge of a brick, a hammer, a sabre, bayonet, or bullet, a gutter-like depression (Fig. 162) of the outer table is found, or a considerable piece of bone is loosened, or there is a more or less clean-cut hole in the skull, and fissures may radiate (starred fracture) from the seat of injury. Very rarely a bullet or other body produces a simple concave depression of the outer table without fissuring. In all these cases, many of which rank as *punctured* or *incised* fractures, *the inner table is much more widely splintered than the outer* (Fig. 163), its fragments carried inward, and perhaps through the dura mater, into the brain. There is little or no such splintering from a rapidly travelling conical ball; the greater the force and the more suddenly it is applied, the less marked it is. In the slower slighter injuries the force spreads; also, the table first struck is well supported, that last reached is practically without support.

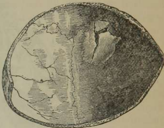
Fractures may be *simple, compound*, or *complicated* by depression, or injury to the membranes or brain. Their seriousness depends largely upon the complications.

FIG. 162.



Fractured skull with depression and fissure.

FIG. 163.



Splintering and depression of inner table. St. Mary's Museum.

DIAGNOSIS. *Fractures of the vault.*—*A simple fissured fracture* cannot be felt through the scalp, especially when this is much bruised. When the bone is *depressed*, effused blood often conceals it, but a careful examination of the shaved scalp may show a depression at one part, bounded by a sharp edge. This edge and depression may be simulated by a firm clot at the margin of a small fluid extravasation under the scalp, but the clot yields to pressure and forms a rim round the apparent depression, *raised* above the level of the surrounding skull. The effects of previous injuries and of syphilitic disease must be thought of, also depression of the outer table, generally of the parietal and often symmetrical, due to atrophy of the diploë in old people. Irregular formation of a suture, one bone—*e. g.*, occipital—being too prominent, has led to the suspicion of a suture being opened.

In young children great indentations may be produced, due to green-stick fractures. There are often no symptoms whatever, and the bone may, in time, rise to its proper level.

Abnormal mobility and crepitus are found only when there are detached fragments (rare); remember that the brain lies beneath them.

When there is a wound the edges should be held apart, the wound well sponged and examined with a good light; a fissure oozing blood may be seen; more often it is felt by the nail passed carefully over the bare bone in all directions; it frequently remains undiscovered. Do not mistake a suture for a fracture, and remember that a Wormian bone may give rise to a suture where there should be none. Splintering and depression, crepitus and mobility may be recognized, or there may be brain substance in the wound; rarely cerebro-spinal fluid escapes.

Fracture of the base of the skull may sometimes be suspected from the thrusting of foreign bodies into the orbit, nose, or ear. Much more often the patient has had a fall or blow on the head; he may be sensible or insensible. If there is a wound a *fracture may be found* starting in its neighborhood; if there is none, we rely on the following symptoms: there may be *free hemorrhage* (1) from one or both ears, due to fissure through the tympanum and its membrane; it issues through the latter, but is too free to be due to rupture of it alone, and injury of the external ear must be eliminated; (2) from the nose or pharynx, from fissure of the cribiform plate, or across body of sphenoid, or it may come from the ear down the Eustachian tube. Direct injury of the nose and pharynx should be eliminated. The blood may be swallowed and subsequently *vomited*. In these cases the fracture is necessarily compound. (3) Ecchymosis beneath the conjunctiva bulbi, in fissure of the orbital plate, *tearing the periosteum;* it appears usually after two or three days near the outer canthus, and may cause considerable chemosis. It does not occur in all cases of this fracture. If there has been any injury to the lids, causing them to become filled with blood, ecchymosis beneath the conjunctiva loses much of its value, as blood often passes from the lids to the ocular conjunctiva, and always at the outer side; but chemosis is rarely extreme (Lucas, *Guy's Hospital Reports*, xix.). Of course, the lids may be filled with blood from a fissure. *Escape of cerebro-spinal fluid,* generally from the ear, rarely from the pharynx, nose, or vault, may appear without precedent bleeding, or after free hemorrhage. For this symptom the arachnoid must be torn, and the subarachnoid space opened—usually where it enters the internal auditory canal, round the eighth nerve. This fluid may run for days at the rate of six or seven ounces a day; it is clear, contains little albumen and a trace of sugar, often demonstrable only after concentration. Hewett records two cases of free discharge of fluid from the ear without fracture of the petreous part; source? ("Lectures," *Medical Times,* 1855 and 1858). In children this fluid may collect under the galea, forming perhaps a pulsating swelling (*traumatic cephal-hydrocele*) which is said always to communicate with the ventricle. *Escape of brain-substance* is, of course, proof positive.

Nerves may be injured in their foramina by fissures or pressure of clot; most commonly the seventh and eighth suffer, causing facial paralysis and deafness, and loss of sense of balance has been noticed from injury to semicircular canals (?). Various disturbances of sight result from extravasation in sheath of the optic. Lesion of other nerves is rare. Paralysis of seventh may appear in the first to third week and disappear after a month, due to copious formation of callus (Marshall) or to neuritis.

Treatment.—Contusion of bone at the bottom of a wound requires no treatment but that proper to keep the wound aseptic. Subsequent abscess may call for trephining, and this operation has apparently saved patients after well-marked pyæmic symptoms from septic osteomyelitis had set in. If a *simple fracture* is suspected, absolute rest and quiet, ice to the head, a darkened room, light diet, no stimulants, and attention to the bowels will form the treatment. These form part of the treatment of almost all severe head-injuries. When the *fracture is compound* there is nothing to add to what has been said concerning the treatment of serious scalp wounds, except again to urge the importance of obtaining and maintaining asepticity. All foreign bodies, such as hair in the fissure, impacted bullets, must be removed. The wound, if large, must be sewed up and drained, that union by first intention may occur. When the fracture is compound through the tympanic membrane, the external ear must be carefully disinfected with chloride of zinc (five per cent.), carbolic or sublimate lotion, and covered with gauze or salicylic wool which will receive all discharges. A pad of wool should be worn for six weeks after such an injury. A fissure of the cribriform plate and olfactory membrane must be left to nature.

A *simple depressed* fracture without symptoms is common in children, and may be left alone, or elevation by "pneumatic traction,"—*i. e.*, exhaustion of air in a dry cupping-glass or receiver of an air-pump fixed over the depression—tried. In adults such injuries are rare, and the probability of the skin sloughing over them must be guarded against. If there are no symptoms, even though some depression is diagnosed, do nothing.

In a *compound depressed* fracture, and in *all cases of incised and punctured fracture*, and of depression without fracture of the external table, the rule is to remove all detached fragments, to pick out any that have pierced the dura mater and penetrated the brain, to elevate and leave those which retain their connection with periosteum and dura mater unless drainage seems to require the removal of one or more of them. The reasons for this are: 1, that the depressed fragments cause compression of or irritate the dura mater and brain; 2, that the irritation will be greatly increased if decomposition of the fluids occur, and that secondary perforation of the dura by a fragment is likely then to happen, if it has not been present from the first; 3, that such irritation, if the cases recover, is likely to lead to neuroses such as epilepsy.

It is uncertain yet how far antiseptics will modify the rule. It must be rare for a depression of the skull to cause any great diminution of the brain cavity, so, although such diminution is very sudden, it does not seem likely that mere depression of fragments, often lying loose on the dura, is a frequent cause of compression; insensibility, if present, is much more probably due to concussion or hemorrhage. In aseptic wounds absolutely loose fragments would probably live, as does the circle removed by the trephine if replaced; and sepsis may be prevented in cases seen early. But asepsis cannot prevent the irritant effects of the fragments upon the brain. At present, most people will prefer to follow the above rule; departures from it should be made only in strictly aseptic fractures over the motor area, without monoplegia or monospasm; elsewhere laceration or even impaction of splinters in the brain cannot be detected except by sight or touch.

To carry out the accepted treatment, it may be necessary simply to open the wound and remove the fragments, seeking carefully all round beneath overhanging edges for loose bits of the inner table; or, some of the fragments being jammed, a bit of sound bone must be cut away with Hey's saw, or, preferably, Hoffman's gouge forceps, until the bits can be elevated; or, lastly, in cases of pure punctured or incised fractures, or of simple depression of the outer table, it will be necessary to enlarge the opening or make one with a trephine before the elevator or forceps can be inserted. Treat the case like an ordinary wound; if long exposed before seen, disinfect with chloride of zinc (five per cent.) or sublimate lotion upon plugs of cotton-wool; be careful that little runs into the cranial cavity when the dura is wounded.

The intracranial complications of fracture will be described in the following sections. All compound cases, should they become septic, are of course liable to the septic diseases of wounds.

Results.—Fractures of the skull and all injuries of the head are much less fatal in children than in adults; it is quite astonishing from what injuries, including large losses of brain substance, children recover. Formerly fracture of the base was looked upon as a fatal injury, but this it was shown not to be before antiseptics were used. Evidence is rapidly accumulating to prove that the mortality in all injuries of the head with wound has been greatly diminished by modern modes of treatment.

The tendency to formation of callus in skull-fissures is very slight, probably because of the absolute fixity of the edges and consequent absence of irritation. In thin parts it is not uncommon to find fibrous union only; or, in the macerated skull, a chink with rounded borders, occasionally interrupted by a bridge of bones. Where considerable pieces of bone have been removed, the gap is closed only by a fibrous scar which moves with the brain. A metal or vulcanite shield must be fitted over the scar in these cases.

Wound of the Dura Mater is a very serious complication of fracture, because it admits germs and irritant fluids to the cranial cavity, and thus leads to *septic meningitis*, the great cause of death in compound fractures not immediately fatal from injury to the brain. Asepsis, free drainage, and provision for early union of the wound make up the appropriate prophylaxis.

Hernia Cerebri is not uncommon in these cases, especially in the young, and is more likely to occur through a small than a large aperture. The *true variety* is due to serous or purulent exudation within the skull; if the drainage is insufficient—and a small aperture is more easily closed than a large one by the brain falling against it—intracranial pressure rises and more or less *brain-substance* is forced through the aperture, and this occurrence is much facilitated by the inflammatory softening and swelling of the brain beneath the aperture. There is also a *false variety*, of almost pure *granulation-tissue*, and either form may contain much *extravasated blood*. The fungus is a round, more or less pedunculated soft mass of red color or clot-like aspect, sometimes covered by a layer of pale lymph. It may increase rapidly to a large size and recur if shaved off, or it may remain stationary and of small size, finally shrinking and healing. It pulsates with the brain. It may contain very little recognizable brain-substance, but consists chiefly of extravasated blood, round cells, etc., or *vice versâ*. So much cerebral substance may protrude that slicing off of the hernia has opened the ventricular cavity. The hernia usually appears a few days after the injury, but may not do so for weeks. Rarely it results after syphilitic necrosis of the skull, the dura mater probably being softened by round-celled infiltration.

The great majority of cases in which hernia cerebri occurs die either from diffuse meningitis or abscess beneath the swelling. In a case at University College Hospital, the hernia contained large numbers of varicose nerve-fibres and myelin drops, and was apparently formed by the upper ends of the ascending frontal and parietal convolutions, and a cavity full of yellow fluid beneath it separated the cortex of the parietal lobule and ascending parietal convolutions from the corpus striatum. The child died of meningitis, but in consequence of the above state of matters, the convulsions did not affect the left limbs, which were paralyzed from the first by laceration of their centres.

Treatment.—Sometimes without any treatment the hernia shrivels and disappears; it has been known to skin over and remain as a pulsating swelling. Pressure applied to it usually hastens the appearance of compression symptoms. Sometimes, but rarely, shaving off the mass and applying a lead plate over the stump has been successful. Of eighteen cases from gunshot fracture of the skull, complicated by laceration of the dura and brain, four recovered without operative interference, the hernia shrinking, granulating, and finally skinning over, leaving a depressed pulsating scar; the rest, whether left alone, compressed, or shaved off, were all fatal (Circular No. 6; War Department, Surgeon-General's Office, Washington, Nov. 1, 1865). Extreme cleanliness, absorbent dressings, cold to the head, absolute rest, low diet, and purgation, seem indicated to prevent inflammation and keep the blood-pressure low.

General Injuries of the Brain.

All violence reaches the brain through the skull and the superficial soft parts. Sometimes all three are more or less injured, sometimes only one;

and, naturally, injuries of the brain are by far the most important. These naturally fall into two classes according as they are *general*, affecting the whole mass of the brain, or *local*, damaging only a portion or portions of its substance; in the former we have *concussion* and *compression*, and in the latter *contusions* and *wounds*.

CONCUSSION OF THE BRAIN.

Concussion is a state much resembling shock but distinguished from this by the greater tendency to insensibility, and characterized by the fact that it is due to direct or indirect violence to the brain. The force which causes it is usually diffused over a considerable area and does not act with extreme suddenness. We know nothing of the *morbid anatomy* of cases which do not die; in fatal cases congestion of the vessels, punctiform or larger ecchymoses, and laceration of the cortex away from the motor area are found, the coarse lesions being insufficient to account for death. An experiment of Lister seems to us to throw some light on the *pathology*. Studying the effect of electricity in producing inflammation in a frog's foot, he caused insensibility by sending through the brain the current which he subsequently passed through the foot. In the latter stasis in dilated vessels resulted, and as this after a time cleared up, consciousness also returned. The vessels of the brain doubtless suffered like those of the foot, and of course all the tissue elements of the part suffered like the vessels; the alteration is visible in neither case, but it is nevertheless sufficient to impair or even arrest function. Similarly, mechanical force transmitted across the head will doubtless produce an injury of the cerebral cells, impairing or arresting their function; its effect is universal, depressing all the centres, and most so the more delicate ones of the cortex. The result of concussion of the cardiac and vasomotor centres is probably to cause directly that vasomotor paralysis which is reflexly induced in shock (p. 165). The violence may be so great as to cause local visible lesions, contusions, such as have been noted in fatal cases, but these do not belong to concussion, pure and simple. Koch and Filehne have shown that all the symptoms of fatal concussion may be produced in animals by prolonged gentle hammering of the skull; yet the microscope reveals no lesion of the nerve-substance. Force, except compressing, can scarcely be applied to the skull without causing more or less concussion.

Symptoms.—These are giddiness, mental confusion, or dulness, from which the patient is easily roused to answer a question, increasing up to the deepest insensibility, with loss of superficial reflexes; the limbs are more or less flaccid, the sphincters may be relaxed. The pupils are equal and generally small, but they dilate in extreme cases; the pulse is quick, feeble, intermittent, or hardly perceptible; the breathing is slow, shallow, and regular, or only a feeble sigh occurs at intervals; the surface is pale, cold, and often clammy, with a ghastly, death-like aspect; the temperature is more or less depressed. Vomiting may occur once or repeatedly; it is not present in very slight or very severe cases, and it often indicates approaching reaction and return of consciousness. The symptoms of a slight or serious case may easily be picked out from the above. Any paralysis or twitching shows that the case is not one of pure concussion, but includes some local lesion. Diabetes mellitus or insipidus may be a symptom, and sometimes persists; due to injury of centre in fourth ventricle. As to *duration*, insensibility may pass off in a few minutes or hours, or may last, in its slighter forms, a week or more. But in the latter cases laceration and subdural hemorrhage have almost certainly occurred.

As consciousness returns the surface warms, the pulse becomes fuller and steadier, and the temperature rises perhaps to 100° F. Headache, drowsiness, inability to think, and sometimes tendency to vomit, remain for hours or days. Sometimes the reaction is excessive, being accompanied by severe throbbing headache, obvious pulsation of the carotids, flashes of light, noises in the ears, with intolerance of light and sound; the eyes are suffused, and the face flushed, during this vascular disturbance. It is said that this may run on to meningitis, but such a termination must be very rare in simple concussion uncomplicated by wound.

The symptoms of concussion may pass directly into those of compression; or the latter may supervene after an interval of consciousness. Concussion is occasionally succeeded by a peculiar state which may last some days. The patient lies as if in tranquil sleep; his pulse is regular, but on the slightest exertion it rises to 130 or 140, and the carotids beat vehemently; when roused he answers questions, but immediately relapses into unconsciousness. Some patients in this state resemble somnambulists; they may get out of bed, bolt the door, shave, or make water, but still are insensible to what passes around. Concussion may leave feeble health and intellect; impairment of memory or of the senses, especially of smell and hearing; and lack of self-control, with tendency to extravagant actions after drink or excitement. Insanity may occur in distinct relation to concussion; and Savage has seen instances of children, begotten soon after the father had recovered from severe concussion, incurably insane, other children being healthy.

Prognosis.—Insensibility so deep that the superficial reflexes are absent, great feebleness of the pulse, and marked depression of temperature are of evil import.

Treatment.—Treat the collapse. Place the patient in bed with the head low, warmly covered, with hot bottles at feet and sides; a little hot coffee may be given if the patient can swallow. Unless the depression is dangerous, it is best not to use other stimulants, as there is always the possibility that hemorrhage from torn vessels is threatening, or that over-reaction may be provoked. If the collapse is dangerous, stimulants, subcutaneously, by mouth, or rectum, must be freely used; also excitation of the skin. When the pulse is very small and rapid, atropin ($\frac{1}{200}$ – $\frac{1}{100}$ gr.) may be given subcutaneously. In prolonged insensibility, feeding must be carried on by the mouth, rectum, or stomach-tube. During insensibility, examine for other injuries (fractures, dislocations, etc.), and treat them.

When consciousness has returned an ice-bag to the head is usually comforting, and cold should be energetically used (by Leiter's tubes if possible) and the head raised if overaction or compression is threatened. The diet must be light and unstimulating. Keep the bowels open by medicine or enema; they tend often to be much confined. A darkened room and perfect quiet should be obtained until reaction has passed off. Complete rest in bed must be insisted on until all symptoms are gone; and rest of mind is advisable for at least four to six weeks—six months, if possible—after any head-injury causing insensibility. Intemperance of all kinds is to be strictly guarded against. For troublesome after-effects, headache, loss of memory, etc., change of air, rest of mind, regular habits and diet, bathing and bracing treatment are the remedies.

COMPRESSION OF THE BRAIN.

Etiology and Pathology.—Any condition which either diminishes the cavity of the skull or increases its contents must cause compression of the brain, provided that the diminution or increase is so marked, and takes place with such suddenness, that compensation by distention of the spinal dura mater, by the absorption of cerebro-spinal fluid, and later by atrophy of the brain, is impossible.

The causes connected with injury are (1) Extravasation of blood from any vessels in the skull. (2) Depression of bone and introduction of foreign bodies into the brain-cavity. (3) Accumulation of inflammatory products—serous effusion or pus—or of simple œdema-fluid in the skull. The first two cause immediate or early (within twenty-four hours) compression, whilst the last manifests itself later. Apart from all injury, meningo-encephalitis may of course occur, and certain rapidly growing vascular tumors may be accompanied by attacks of coma with compression symptoms.

The *general effect of the above causes* is to produce rise of intracranial pressure, and this surely leads to slower circulation through the brain. The adult skull is quite unyielding, and the result of (say) hemorrhage into its cavity is first to displace some cerebro-spinal fluid into the theca vertebralis, which becomes distended. As the limit of distensibility of the spinal dura mater and the structures covering it—especially the posterior atlanto-occipital ligament—is reached, intracranial pressure rises much more rapidly than at first, and small increments to the contents produce a great result. Pagenstecher found that a very variable amount of wax—2.9 to 6.5 per cent. of the whole contents—could be injected into dogs' skulls without causing symptoms; and this variation may explain why, of two patients with equal small extravasations, one may have no symptoms whilst the other is comatose. Beyond this point, if pressure rises, symptoms appear, due to slowing of the circulation through the brain and consequent malnutrition, the result of more or less complete compression of the capillaries. A very slight diminution of the diameter of capillary tubes was found by Poiseuille greatly to diminish the delivery from them—*e. g.*, diminution of the diameter of a capillary tube by one-tenth reduces the delivery to little more than half; and as experiment has shown that inflammatory effusion or hemorrhage may raise the intracranial pressure even above that in the cerebral capillaries, the flow through these would sometimes be absolutely arrested were it not for the resistance of the tissue in which they lie.

Action of hyperæmia.—If, when the tension in the cerebro-spinal cavity or any other closed space is at a certain point, even a slight addition to the contents will impair the circulation, it is obvious that any hyperæmia will have this effect, for an abnormal quantity of blood will be introduced into the cavity. In mechanical congestion not only is this so, but transudation and further addition to the intracranial contents quickly result. In passive hyperæmia due to loss of vascular tone, much of the arterial force, usually met by the contractility of the vessel, is transmitted to the cerebro-spinal fluid, the circulation lags and transudation is increased. This, *under the above conditions*, leads to further compression of the capillaries and a *circulus vitiosus* is once more established. Active hyperæmia in a closed cavity, in which high tension already exists, will similarly impede the circulation. The analogy between the eye and the brain as regards their circulatory conditions is obvious (Leyden); in chronic glaucoma, in which the intra-ocular tension is raised, pulsation of the veins is either present or easily induced by slight pressure with the finger, the blood being driven back out of the retinal veins to make room for the blood entering the arteries at each systole. Similar pulsation has been seen through a window in a dog's skull. It is perhaps to active hyperæmia that some apoplectiform attacks in tumors of the brain are due; and the harm which hyperæmia of any kind—active or passive, acute, frequently repeated or constant—may do in cases of head-injury is obvious and has been known practically in all times.

Finally, experiment and observation have shown that parts of the brain are not all similarly or simultaneously affected by general rise of pressure and by consequent anæmia. The highest centres in the cortex are the most delicate, and drowsiness, passing on to insensibility, is early induced. Some of the lower centres in the medulla and pons are at first stimulated by anæmia—*e. g.*, the vasomotor centre, causing rise of arterial pressure; the vagus centre, causing slow pulse and to some extent keeping the pressure down; and still later, when these centres are paretic, the spasm centre (Nothnagel) may be excited and general convulsions occur; ultimately all are paralyzed. For experimental proofs of these statements see Bergmann, Kopfverletzungen, *Deutsche Chirurgie*, p. 324.

SYMPTOMS.—Clinical cases of head-injury are almost invariably mixed lesions, concussion, compression, laceration, and so forth; and it is therefore very difficult to extract from them the symptoms which should be attributed to each morbid condition. Consequently experiments upon animals have been made.

Leyden's researches upon animals (*Virch. Arch.*, 1866, Bd. 37, S. 520) and Pagenstecher's (*Exp. ü. Studien u. Gehirndruck*, 1871) give the following as the signs of pure compression, and their results are well borne out by clinical observation.

Pain is probably the first sign and is thought to be due to tension of the dura mater, supplied largely by the fifth; then, as the intracranial pressure rises, *drowsiness* appears and progressively deepens into *stupor* and *absolute coma*—symptoms which are due to interference with the circulation in higher centres of the cortex. This region is supplied by capillaries only, springing from the pia mater, and is peculiarly sensitive to anæmia. Sudden high pressure (*e. g.*, raising from 100 to 200 mm. of mercury, Pagenstecher) caused *general, epileptiform, clonic spasms*, usually ending in opisthotonos; they are due to more or less complete anæmia of the brain (Kussmaul and Tenner), and are rare in man, for depressed bone alone, perhaps, never (Bergmann) causes symptoms of general compression, and extravasation of blood is always gradual. Direct pressure on pons and medulla might excite them. The *pulse* becomes *fuller, stronger*, and *progressively slower*, down to 40, 30, or even less per minute, but continues regular until the pressure has passed a certain point; then it becomes small, rapid, and irregular. The slow heaving pulse is one of the most important and constant signs of pressure, and is due to excitation of the vasomotor and vagus centres, which, sooner or later, become paralyzed. *Respiration* is affected like the pulse, being *slow, deep*, and *labored*, until the pulse yields—then quick superficial breathing alternates with deep breaths or long pauses, in one of which death occurs. The pulse continues 1–2 minutes later, so death seems due to paralysis of the respiratory centre. The breathing is often deeply *stertorous* and *puffing* from falling back of the tongue, and paralysis of the soft palate, buccinators, and lip muscles. *Involuntary defecation* and *retention of urine* are usual from palsy of the sphincter ani and of the bladder. With complete coma, all muscles are flaccid, and the superficial reflexes are lost. The *surface* is generally *warm* and *moist*, sometimes *flushed* and *sweating*; in animals the *temperature* is undisturbed, or falls steadily; but in man *hyperpyrexia* is not uncommon, probably from interference with a heat centre.

Besides these *general symptoms*, certain *unilateral phenomena* arise in man, due to the direct pressure of the compressing body upon a nerve or upon some part of the brain (motor area), having obvious functions; for the brain is solid, not fluid, and consequently pressure at a point is not transmitted equally in all directions, but is specially felt at the spot pressed upon; and equalization of pressure throughout the brain is still further prevented by its division into three parts by the falx and tent, which septa resist the displacement of one part towards another (Niemeyer). Thus a part pressed on becomes specially anæmic and damaged. In animals lower than apes unilateral symptoms are not thus induced, localization of function in the cortex being imperfect.

At first the *pupil* on the side of the compression may contract (irritation of 3d), but as coma supervenes both pupils dilate (general rise of pressure), that on the same side *often* fully (excessive pressure on 3d), that on the opposite side moderately. Frequently *paralysis of the face or limbs on the side opposite* to the pressure occurs early, being due to interference with the cortical centres of these parts; ultimately it is lost in general paralysis. The patients being unconscious, nothing accurate is known of sensation, but at first pinching excites movements.

Double optic neuritis or *choked disk* is a frequent sign of increased intracranial pressure; it occurs in 95 per cent. of cerebral tumors. Cases of well-marked early compression certainly occur without any such symptom; and, on the other hand, fractures through the optic canals (usually on one side only) frequently cause hemorrhage into the optic sheaths, compression of the nerves, and choked disk. Choked disk may pass off completely or lead to atrophy and blindness. Other disturbances of vision after injury may occur from compression, contusion, or laceration of the optic nerve between its cortical centre and the optic foramen.

Terminations.—These depend upon the mass of the compressing substance, whether it tends to increase or decrease, and the possibility of successful treatment.

Spontaneous recovery from well-marked compression symptoms is common. The patients recover after weeks of stupor and slow pulse (compression?); on the other hand, coma, complete paralysis, and dilated pupils are almost always followed by *death*.

The tendency of heightened intracranial pressure still further to increase must be remembered; œdema of the brain and slow compression induced in this way with ill-marked symptoms is frequent after head injuries.

Paralyses from local pressure usually disappear; sometimes they remain, being due probably to deep laceration. Then atrophy is slow, from disuse; late rigidty may occur from descending sclerosis.

Sometimes the brain seems to become accustomed to pressure, *e. g.*, from permanently depressed bone; fluid is absorbed, and the brain atrophies somewhat.

Treatment.—This varies with the cause; depressed bone must be elevated, extravasated blood may require removal, and pus must be evacuated—as stated under special sections on the subjects. But in all cases three general points require attention.

1. *To render venous return from the head easy.*—To this end the head and shoulders should be well raised in cases of head injury in which there is no tendency to syncope. Some surgeons still employ the old practice of venesection in cases of intracranial hemorrhage or of commencing inflammatory effusion. Sufficient blood is drawn to depress the pulse moderately; this lessens the intracranial pressure, permits blood to pass more freely through the cerebral capillaries, and improves the nutrition of the brain. In hemorrhage, weakening of the heart favors spontaneous arrest; in inflammation lowering of blood pressure lessens exudation; but after bleeding the blood becomes watery and transudes more readily than the normal fluid. Any tendency to active hyperæmia will be checked.

2. *To favor absorption of cerebro-spinal fluid.*—Purgatives which cause watery motions (*e. g.*, sulphate of magnesia) render lymphatic absorption more active, and this is facilitated also by high intracranial pressure; some surgeons give

calomel, as routine treatment, in all head injuries; if the bowels are very obstinate, croton oil, ♏j–ij, may be required. Drastic purgatives depress the pulse and are often employed as "derivatives" in inflammations.

3. *To cause contraction of the cerebral arteries*, and thus lower intracranial pressure and ease the circulation. The constant current has been employed, but the great remedy is cold. Ice-bags are very unsatisfactory; Leiter's tubes should always be used in preference. Some employ in addition occasional gentle douches from a rose, lasting a quarter to half an hour. When there is a wound an antiseptic dressing must always be applied; it may be thin and changed often, and Leiter's tubes can be used outside it.

INJURIES OF INTRACRANIAL VESSELS.

The danger of hemorrhage from these vessels is a special one—that of compression of the brain.

We may classify hemorrhages from intracranial vessels as follows: (1) External (escaping through a wound), and subcranial (between bone and dura). (2) Subdural, subarachnoid, and into meshes of pia. (3) Cerebral and intraventricular.

1. External and Subcranial Hemorrhage.—These result from injuries of sinuses in contact with the skull, of the middle meningeal artery, or of the internal carotid.

Wounds of sinuses may be due to penetrating instruments, bullets, depressed fragments, or simply to stretching and tearing—almost always from the gaping of a crossing fissure, though simple change of shape of the skull is, rarely, sufficient. The longitudinal sinus is most exposed to injury from weapons, falling stones, etc., whilst the lateral suffers most often from falls on the head, and accidents which cause fissures. The bleeding externally is just like that from a vein (p. 403) and is easily arrested by pressure; the sinus does not collapse and may heal without obliteration. If blood were escaping into the subdural space as well as externally, it might be necessary to tie the sinus, a threaded needle being used if necessary. The great danger of these injuries when bleeding is arrested and compression avoided, is infective softening of a thrombus and pyæmia. Volkmann has recorded a death from entry of air; but except with *very* deep inspiration the blood pressure is too high to permit this.

The *symptoms* of subcranial bleeding from a sinus are those of compression (p. 435), usually developing more slowly than when the meningeal artery is wounded.

Wound of the middle meningeal artery is by far the most common source of subcranial hemorrhage—twenty-seven times in thirty-one cases (Hewett). This vessel may be cut or torn like the sinuses; it usually suffers from the sudden gaping or displacement of the edges of a fissure crossing its groove or canal; rarely, it also has been ruptured owing to sudden change in form of the skull, to which it is closely adherent and gives many branches. It is said to have been found thus torn on the side opposite to that struck as often as thrice in ninety-nine cases (Bergmann).

Of the two branches of this artery, the anterior suffers much more often than the posterior: it is generally torn opposite to the parietal, but of course it may be wounded at any point of either trunk or branches. The hole is often very difficult to find. The size of the extravasation will, *cœteris paribus*, be proportionate to the size of the vessel injured, but the firmness of adhesion of the dura varies much, being greater in the old. The clot may weigh six to seven ounces and strip the dura from the whole lateral region of the skull. In one case (Godlee) the meningeal vein was the source of the blood.

It has been noted that injuries which give rise to subcranial hemorrhage almost always cause more or less laceration of the brain, which may affect the symptoms greatly.

The *internal carotid* is rarely wounded by pointed instruments thrust through the orbit or roof or side of the skull, or torn by fractures—mostly from crushing violence, as of a tree falling on the head—crossing the carotid canal or body of sphenoid. In the few cases recorded much blood has escaped by mouth and nose, and death has been early before compression has set in.

The *symptoms of subcranial hemorrhage* from the middle meningeal are those of compression in its most typical form: the conditions are almost exactly similar to those of Pagenstecher's experiment of injecting wax (p. 435). As the blood has to strip up the dura mater, and to overcome the existing intracranial pressure, it collects but slowly beneath the bone, so *there is always an interval* varying from one to twenty hours, *between the injury and the onset of symptoms.* Often the patient is stunned by the injury, and exhibits signs of concussion, then recovers after a varying time and to a varying extent—sometimes being able to go on with his work, at others only to give his name and perhaps some history of the accident; then, again after a varying time, the patient gets headache, perhaps vomits, and the signs of compression (p. 435) set in, and usually deepen rapidly. Sometimes the injury is so slight that there is no preliminary concussion; the person continues his occupation, and only after some hours, perhaps during natural sleep, do signs of compression appear.

2. Subdural and Subarachnoid Hemorrhage are common results of head-injury—much commoner than subcranial. Either may occur alone. Blood is commonly found in the furrows between the convolutions, occupying the subarachnoid space, while the subdural space contains none; but subdural hemorrhage is almost always accompanied by subarachnoid, proceeding from torn vessels of the pia mater, and generally also from obviously lacerated brain. The sources of subdural hemorrhage are (1) vessels of the pia and cerebral cortex, the arachnoid being torn; (2) the large veins of the surface of the brain which tear somewhat readily, together with the arachnoid over them, just where they reach the longitudinal sinus, when the brain is forcibly displaced; (3) the great sinuses and meningeal artery, the dura being torn. Hemorrhage from the first two sources is common without fractures.

Blood in the subarachnoid space may find its way in the sulci over considerable areas; in the subdural space it may smear the surface or form a layer of clot upon it on one or both sides. The clot is but slowly absorbed and leaves widespread pigmentation, with some thickening of the dura (pachymeningitis), or it may give rise to the formation of membranes which are soft and vascular at first, then dense and fibrous like the dura to which they usually adhere; but they may lie loose in the space, and contain between them cavities full of bloody or serous fluid, so as to resemble cysts. Similar conditions are found without any injury in atrophy of the brain from age, alcohol, or general paralysis.

Symptoms.—*Subarachnoid hemorrhage* is characterized chiefly by the signs (if any) of the laceration from which it almost always proceeds. Of course, in proportion to its amount it increases intracranial pressure, and also exercises local pressure upon damaged parts, and thus still further embarrasses circulation in them. The slight general rise of pressure causes, when any effects of concussion have passed off, perhaps headache and irritability, coupled with general dulness. The laceration may heal, but the circulation at the injured spot suffers more than elsewhere; the effusion of fluid here still further raises the pressure and the *circulus vitiosus* is established. The general symptoms then increase for three or four days, and may become very grave. Should they subside the local œdema exercises a deleterious influence upon the damaged nerve tissue, tending to cause degeneration.

Subdural hemorrhage.—Fagge quotes three spontaneous cases, fatal in five to ten minutes—a rare result of intracranial hemorrhage; it sometimes gives rise to all the symptoms of subcranial hemorrhage. But, coming usually from smaller vessels and veins, it is as a rule sooner checked than bleeding from the middle meningeal, and consequently causes only the lesser degrees of pressure. Sometimes, after concussion has passed off, a patient will lie for days or even weeks in a state of stupor or deep sleep; he can be roused to some extent and is often very irritable; left alone he may be quiet or restless—grinding his teeth, moaning or crying out, and showing signs of headache; the pupils are generally small and equal, the temperature little or not at all raised, and the pulse not slowed. This state varies a good deal, apparently owing to attacks of active hyperæmia. These are evidenced by heat of head, injection of the face, contraction of the pupils, and strongly pulsating carotids, whilst the patient becomes restless, exhibits markedly the symptoms above noted, perhaps has an attack of clonic spasms, and is left comatose or less conscious than before. Clinical observation alone has to be relied upon to furnish the symptoms of this state, and it is doubtful what share the frequently concomitant laceration has in the production of those given.

Unless death occurs from œdema and slow compression, from compression of the pons and medulla by gravitation of blood into the subarachnoid space and pressure of clot upon these parts, and perhaps on the floor of the fourth ventricle, or from inflammatory complications in septic cases, attacks of congestion cease to occur and consciousness is slowly or rapidly regained. It will then often be found that memory is deficient, especially with regard to the accident and events immediately preceding it.

3. Cerebral and Intraventricular Hemorrhages of any size from injury are usually due to penetration of the brain by a foreign body, as a dagger or bullet. By such instruments any vessel anywhere may be divided. The special symptoms of such injuries must obviously vary with the fibres and parts of the brain destroyed or interfered with; the general effects of shock, concussion, or compression may be superadded.

Rupture of a central artery of the brain by violence applied to the exterior of the skull is very uncommon. Fagge quotes five cases of hemorrhage into the corpus striatum or optic thalamus, sometimes bursting into the lateral ventricles; in one a blow seemed undoubtedly to have caused the hemorrhage, and in the others it seemed more probable than disease. In three of these cases the kidneys were granular, wasted, or cystic, and in the other two they were not described; so Fagge suggested that in all the cerebral vessels were very likely diseased and predisposed to rupture.

The *results* of 99 cases of meningeal hemorrhage, as given by Bergmann are: 83 died, 16 recovered; in 12 of the latter, the blood escaped through a compound fissure, in 3 trephining was successful, and in one recovery occurred without operation, after a long illness; 36 cases died within 24 hours, 7 on the second, 4 on the third day, and 10 later.

The *causes of death* are: in rapid cases paralysis of the respiratory centre; in less rapid a low basic pneumonia may help, and frequently a thin frothy secretion fills the bronchi and causes asphyxia. Hyperpyrexia sometimes occurs.

Diagnosis.—Cerebral hemorrhage has not yet come under operative treatment. Subdural is not very suitable, as the brain is often gravely lacerated; it is difficult to remove the blood when the dura is opened, and, when the clot does not cause very typical compression-symptoms, the probability is in favor of its absorption if the brain-injury does not prove fatal. It has happened that subdural hemorrhage has been successfully treated by opening the dura, but only by accident, so to say, the diagnosis before trephining having been subcranial hemorrhage.

But this latter variety can be checked by trephining, if only it can be recognized and localized. With regard to its recognition, a great deal depends upon a good history; if there is any doubt that the symptoms are due to a head-injury the difficulties are enormously increased, for its signs are those of ordinary apoplexy and of other morbid states.

We shall first consider *cases of insensibility undoubtedly due to injury of the head and in which the history is known.* The first questions which arise are: Is the patient suffering from concussion? If from compression, to what is this due? Is the case complicated by local lesion of the brain? (see "Laceration") What injury has been sustained by the bones and soft parts? (pp. 425, 427).

Putting aside the two latter questions, as to be dealt or already dealt with, a reference to the symptoms of *concussion* (p. 432) and *compression* (p. 435) will show that the two states contrast in every way—collapse characterizing the former, coma, with slow full pulse and deep stertorous respiration, the latter. Concussion is always immediate, compression is rarely so—never when due to intracranial hemorrhage. If, then, compression-symptoms occur immediately after an injury, we look for their cause in markedly *depressed bone* or in the *impaction of some large foreign body*, and in any case a most careful examination of the skull and soft parts must be made. Much more commonly we find that *a more or less conscious interval varying from less than one hour up to about twenty hours has elapsed between the injury and the onset of compression;* this means *hemorrhage.* We have now to determine the relation of the blood to the brain and its membranes, the side upon which it is effused, and whether the brain is so injured that it would not recover if relieved from over-pressure.

Seat of hemorrhage.—The reply to the first question rests largely upon the statistical observation that well-marked compression-symptoms from hemorrhage due to injury are in the great majority of cases due to subcranial bleeding from the anterior branch of the middle meningeal artery (p. 437). As above said, this, for purposes of treatment, is the injury which we wish infallibly to recognize; but it must be admitted that we cannot do so. We may make three kinds of mistakes: 1. The hemorrhage may be subcranial, but due to laceration of the posterior branch of the meningeal or of the lateral sinus. 2. We may meet with cases of subdural, or very rarely of cerebral, hemorrhage of traumatic origin, giving the typical symptoms of subcranial hemorrhage noted at p. 438. 3. We may fail to recognize the presence of subcranial or other intracranial hemorrhage, pressure-symptoms being entirely masked by those of concussion.—(1) A temporo-parietal injury (Aran's law, p. 427), fulness in the temporal fossa, and opposite hemiplegia, protrusion of the eye, and full conjunctival veins point almost conclusively to wound of the anterior branch. Bergmann believes that opposite hemiplegia does not occur even when the posterior branch is injured, still less the lateral sinus, which is further from the motor area; but, if this is so, it would be of no help in the later stages when all limbs are flaccid, and the other points are often absent. Occipital injury with very gradual onset of symptoms, and perhaps some subcutaneous swelling, point to the lateral sinus. (2) The cases of subdural hemorrhage most likely to be mistaken for hemorrhage from the meningeal are apparently those proceeding from tearing of large superficial veins (p. 438); the brain may be little or not at all injured, and blood is rapidly and copiously effused. Both these and cases due to extensive cortical laceration are generally distinguished by the absence of any conscious interval between their onset and the injury; and pressure-signs will probably be ill-marked among the latter. (3) This failure is little to be regretted, as the patient would probably die of brain-injury even if blood and clot were removed.

As to *the side upon which the blood is effused:* practically subcranial blood is always on the injured side (p. 438), due to a fissure starting from the point struck. But there may be no bruises, fulness or wound of the shaven scalp, and we must then rely upon unilateral symptoms, such as opposite hemiplegia, or dilatation of pupil on side of injury. Both these, however, will be absent in deep coma. If there is a wound near the mid-line of the skull, it should be enlarged and the fissure sought and traced to determine its direction.

Lastly, much safety from error is given by regarding with suspicion—as likely to prove other than subcranial—all cases in which consciousness is not known to have returned in the interval between the injury and compression-symptoms. For prolonged insensibility ending in compression probably means laceration and subdural hemorrhage, besides a severe shake of the brain. This argument, however, does not hold when pressure symptoms appear early, within an hour or two, for concussion lasting thus long is not necessarily severe.

We see that, even where the history of the case is known, there are many sources of error; but, *when a patient is found insensible, under circumstances in which accidental injury or foul play is possible or probable,* the diagnosis becomes extremely difficult. The testimony of eye-witnesses may indeed be misleading rather than helpful, for they may describe a patient who has fallen in an apoplectic or epileptic fit as losing his balance, etc.

The following case exemplifies the difficulties of the class: A man of forty-five was found completely unconscious at the bottom of twelve stone steps at Euston Station; he could not have been there long: pupils small, equal; pulse very intermittent, irregular, 90–112; respirations 30, loud tracheal râles; surface warm, sweating slightly about the face, no pallor; muscles of trunk and limbs flaccid, diaphragm and extraordinary muscles of inspiration working. Small wound near right parietal eminence; bleeding had occurred from right ear, fresh blood in pharynx. Death in two and one-half hours, pulse continuing two minutes after respiration. There were found: depression of large piece of parietal and temporal beneath the right temporal muscle, and fissure through tympanum and body of sphenoid; posterior branch of meningeal torn; large subcranial clot; extensive subdural hemorrhage on each side, with contusion and laceration of some convolutions; *multiple hemorrhages into pons.* Doubtless the latter lesion was primary, caused the fall and prevented the manifestation of all pressure signs.

In such cases knowledge of medicine must be relied on, the following being the chief causes of insensibility to be considered: Drink, opium, uræmia, epilepsy, the different forms of intracranial hemorrhage and concussion. A history of previous habits and health will be of much help. The head must be carefully examined. If a man has received a severe blow on the head, even though he is obviously drunk, it is only prudent to detain and watch him until he is rational; if he is comatose, though probably from drink, he should certainly be kept and the stomach-pump used. Deep opium-poisoning cannot be diagnosed from hemorrhage into the pons when the pupils are contracted, insensibility complete, and all muscles flaccid. Here matters could hardly be made worse by using the stomach-pump for diagnosis and perhaps therapeusis. Uræmia is characterized by convulsions and coma, without paralysis and stertor, which varies much in depth between the attacks; congestion of the face is usually absent; the presence of a quantity of albumen in the urine of a comatose patient is no proof that the kidneys are diseased (Fagge); other signs of renal disease must be sought for. Epileptic coma can be diagnosed only by a history of previous attacks. Finally, the symptoms and onset of ordinary apoplexy may be such as to tally exactly with the history of subcranial hemorrhage. Under these circumstances, therefore, no operation should be undertaken without strong evidence that the symptoms are due to injury—such as signs of a fracture crossing the temporal fossa—and that the patient will die if nothing is done.

Treatment of Hemorrhage from the Middle Meningeal Artery.—The source of bleeding from a scalp wound should always be seen, lest by closing the wound blood issuing through a fissure be retained within the skull. When a fissure is found oozing at all freely, an opening should be made where its line crosses that of the chief artery or vein beneath it, and the wound in this treated directly (see below). In the American War, seven cases of gunshot wound of the middle meningeal were treated by primary ligature of the common carotid; three recovered. Possibly ligature of the external carotid would be preferable.

Usually there is no external escape of blood, though the temporal muscle may be largely infiltrated. Under these circumstances if, in spite of such treatment as was given at p. 436, signs of pressure increase, it will be necessary to trephine with a view to removing the clot and to securing the bleeding vessel. On making the usual incision down to the bone over the artery, a fissure is generally found crossing the line of the vessel, and just at this point the pin of the trephine is to be applied. The course of the artery is found thus: Draw a line horizontally backward from the external angular process of the frontal, and take points along it at from one to two and one-half inches; through them draw vertical lines of length from the zygoma equal to the distances from the external angular process of the points through which they pass. The upper ends of these vertical lines mark out the anterior branch of the meningeal. At distances from one to one and one-half inches the artery is usually in a canal (M. Beck). When the circle of bone is removed, a clot ought to fill the opening; this must be scraped out with a small lithotomy scoop, and the bleeding point exposed if possible. But often this is no easy matter, for the brain and dura may remain depressed, and blood escaping conceals the deeper parts; also the wound may not be at the selected point, but higher or lower, or there may be general oozing. Make pressure on the carotid to check bleeding. If the wound is seen, try to pick up and tie the ends in the usual way, or pass a fine-threaded needle round the trunk below the wound, or even clamp the bleeding point. To this end the aperture in the skull may be enlarged subperiosteally up or down if such a proceeding seems likely to expose the wound. If it cannot thus be reached or the oozing seems general, try the effect of exposure, elevation, ice to the head and neck, and compression of the carotid. Should bleeding still continue in spite of depression of the pulse, tie the external carotid.

If no fissure is found crossing the meningeal artery, it is nevertheless possible (437) that the vessel is ruptured and bleeding. But it is possible, also, that a fissure has crossed and wounded the lateral sinus or posterior branch of the meningeal, especially when the point struck is somewhat far back or is not evident. Under these circumstances an aseptic incision backward from the mastoid process along the line of the lateral sinus would certainly be justifiable to examine the bone here before opening the skull over the meningeal. In other cases there may be doubt even as to the side; perhaps unilateral symptoms are doubtful or their stage is past; or the injury is almost in the mid-line (see p. 441); or there is a wound on one side and a bruise on the other and unilateral symptoms are absent. Here examine the bone at one or both seats of injury, or in either temporal fossa, for fracture.

A final difficulty is that, on removing a circle of bone over the meningeal, no hemorrhage is found. Paralysis of the opposite side was due to laceration of the motor area, and a blue color seen through the dura shows that there is much blood in the subdural space. It is hard to decide whether or not to open the dura, which much increases the risks of the operation. But if the pressure symptoms are very grave and antiseptics are used, it is probably best to make a free crucial opening and remove as much clot as possible. No anæsthetic is needed in these cases unless consciousness is recovered before the operation is over; and in acute cases all reasonable haste should be made in removing the clot, lest the patient die unrelieved.

Hyperpyrexia may occur after the operation, the patient having recovered consciousness; it must be met by the cold bath.

Trephining for hemorrhage is an uncommon operation and its results have not been satisfactory. There do not appear to be more than six successful cases on record. The patients have either remained insensible with unexpanded brain, or meningitis or hyperpyrexia has supervened. It would be worth while trying whether expansion of the brain could be produced by stopping the patient's mouth and nostrils for thirty seconds or longer after a deep inspiration.

LOCAL INJURIES OF THE BRAIN.

Under this heading are included cases of contusion and wound—incised, punctured, lacerated, and gunshot. Certain of these injuries may be either simple or compound, others are invariably compound; the question of prognosis turns largely upon this point. Contusions and wounds differ from the morbid states described under concussion and compression in that they affect only one or more definite parts of the brain—by far most commonly some part of the cortex of the convexity of the cerebrum, alone or with more or less of the subjacent white substance; whilst in the latter the whole cerebral substance and the circulation through it are more or less affected. General and local lesions are frequently combined in the same case—*e. g.*, concussion and contusion, compression and wound; in compression, indeed, there is usually something local, because that part of the brain which is directly pressed upon suffers most. The symptoms of the general conditions afford evidence of all or the chief brain-functions, especially consciousness; but those of local lesions are necessarily connected with depression or increase of the functions of the damaged part according as this is destroyed, compressed, or merely irritated. The presence of a local injury of the brain may therefore be established in two ways: (1) by the history and physical signs; (2) by the presence of symptoms due to affection of some distinct portion of the brain mass. But in a very large number of cases it causes no symptoms for reasons shortly to be explained.

Incised Wounds either go straight into the brain, the instrument having first produced an incised fracture of the skull, probably with much splintering of the inner table (p. 427); or a slice of skull and brain may be cut off by a sabre or left hanging as a flap. The wide wound, escape or exposure of brain matter, or, in the case of linear cuts, a comparison of their length with the arching of the skull, makes the diagnosis simple. It must be remembered that escape of cerebro-spinal fluid is uncommon in these cases, which generally affect the vertex.

Punctured Wounds result from injuries which produce punctured fractures of the skull (p. 427). Bits of bone may be carried along the tract. Special mention must be made of wounds inflicted through the orbital plates by instruments, even so large as the point of an umbrella, passed beneath the upper eyelid; very little damage to the latter may be evident, though the point may have lodged in the brain. In young children death from meningitis has been excited by passing needles through the fontanelles, or slate-pencils or other slender bodies through the cribriform plate. In traversing the brain, the motor tract, the basic ganglia, or other parts, perhaps far distant from the superficial wound, may be divided.

Gunshot Wounds.—Bullets either furrow the skull, lacerating the brain beneath (most common), or they perforate skull and brain, either traversing the cavity or lodging. In either case the brain around the bullet tract shows the signs of contusion; in perforating wounds the channel collapses, and its sides come together, very often including between them bits of bone or lead, or wisps of hair. Bullets are simply one of the causes of contusions and lacerations of the brain; they may produce only symptoms due to these local lesions, but very commonly they cause concussion, and sometimes compression by injury of large or many vessels; and parts of such importance are often affected that immediate or speedy death follows. Sometimes a sinus remains and abscesses keep forming. Of the few that recover, most suffer from some grave symptoms: insanity, paralysis, blindness, deafness, etc. Healing in of bullets is very rare.

CONTUSION AND LACERATION OF THE BRAIN.

Injuries of the brain of the above kinds are by no means rare in civil practice; but most commonly we have to deal with the contusions and lacerations which accompany fractures from blows and falls upon the head. We shall therefore describe these more specially.

Contusion or Laceration of the Brain may result from force applied to the head without any wound of the soft parts or fracture of bone; but the skull is usually broken in the more severe lacerations. When the force is of considerable intensity and acts suddenly upon a small area of the skull—as when a bullet strikes it obliquely—it may bend the bone in without breaking it and bruise the brain beneath. Duret filled a skull with paraffin and allowed the latter to solidify. He then dropped it from a small height and found a distinct depression immediately beneath the point struck, which was not broken. Usually the bone breaks, and its fragments, depressed momentarily (in fissures), or permanently (in splintered fractures), do the damage; or the instrument which breaks the skull, as a bullet or dagger, may enter the brain and lacerate or cut its way to a greater or less depth from the point of entry. In civil practice, these cases of laceration beneath the point struck, and in which there may be no insensibility or evidence of commotion of the brain in general, are not so common as those of laceration exactly opposite. These are due to the action of less sudden force over a considerable area, as in falls upon the head, and are generally accompanied by insensibility. The explanation of these lacerations by *contrecoup* seems to be that the brain, during the fall, moves uniformly with the skull, and maintains a fairly close contact with its wall; when the head strikes the ground, the lowest part of the skull is suddenly stopped, the brain not being in rigid connection with it, tends to move on, flattens itself against the skull, leaving a flat space superiorly to be filled by fluid, then recoils, dashes itself against the superior wall from which it had separated, and is lacerated more or less by the impact. Naturally this laceration occurs more easily when the brain is thrown against an irregular surface, such as that of the orbital plates and middle fossæ, or the sharp edge of the small wing of the sphenoid, and consequently laceration by *contrecoup* is most frequently found about the apices and under-surfaces of the frontal and tempero-sphenoidal lobes.

It is not uncommon to find the brain lacerated at the point struck and also at the point opposite to this, in both varieties of cases. Multiple contusions occur, as at the apices of both temporo-sphenoidal and under aspects of both frontal lobes from falls on the occiput.

It is very unusual to find a focus of laceration from injury deep in the substance of the brain without concomitant laceration of the cortex; such lesions are almost always due to cerebral hemorrhage from disease. Continuous with lesions of the cortex, however, deeper lesions are not very rare. Minute ecchymoses are common. They differ from puncta cruenta in that they cannot be washed away, and, when removed with the point of a knife, they do not reappear on gentle pressure of the brain. Rarely, they are found scattered through the brain as the only lesion in cases belonging clinically to "concussion." Most commonly in these cases they are found in the floor of the fourth ventricle, a situation so crowded with important centres that the presence there of even minute extravasations must indicate considerable danger. Duret believes that they are produced be a sudden forcible expulsion of fluid from the lateral ventricles by the change of form of the brain due to the blow; on account of its small size, as compared with the lateral ventricles, and the existence of the foramen of Magendie, the 4th becomes violently disturbed. The brain may be burst by this force acting from within (Bergmann).

Laceration of the brain is the most fertile source of hemorrhage into the subdural, subarachnoid, or ventricular spaces.

Results.—The chief point in all injuries of the brain is the part affected; but, assuming that this is one in no way essential to life, the brain will recover from great injuries provided that suppurative inflammation does not set in. The inflammatory complications are given elsewhere. To the prevention of this all treatment must be primarily directed. Klebs and Hüter (*D. Zeitschr. Chir.*, 1878, Bd. ix. p. 401) have endeavored to show that even perforating gunshot wounds will, when aseptic, heal readily. A certain amount of exudation follows injury to the vessels of any part of the brain; this raises the intracranial pressure, and may establish in severe cases, the *circulus vitiosus* described at p. 434. By this *traumatic œdema* Bergmann accounts for the death after subcutaneous lacerations; but the pathology of these cases is probably still a problem to be solved.

Should the œdema subside, the case will probably end in the formation of a scar of rusty color from presence of hematoidin; the membranes are adherent over it. Sometimes the scar becomes spongy or even cystic, the cavities containing a brown or yellow fluid. Very rarely the *scar-tissue spreads*, without obvious reason, over the surface and in the substance of the brain, a shrinking interstitial encephalitis resulting.

Another termination is *yellow softening;* the damaged tissue first becomes red and soft, then yellow from fatty degeneration; and beneath the pia is found a cavity with red-brown wall full of fat emulsion. Though usually this condition is stationary, it also *in some cases spreads*, the reason being unknown. The main importance of this process is that it gives rise to symptoms closely resembling those of abscess (Bergmann); so long as a chronic suppuration or a yellow softening involves only parts, the function of which can be taken on by other healthy parts, it may remain latent clinically; but so soon as either involves a brain-area in which some important function is localized, focal symptoms arise. The final stage is not always, however, ushered in by spasms or paralysis; in either, coma may be the first and last symptom.

Such processes as chronic interstitial encephalitis, spreading, softening, simple atrophy of the cortex, or calcification of the ganglion cells (Virchow), beneath an injured point of the skull must account for mental and other brain-symptoms coming on late after head injuries.

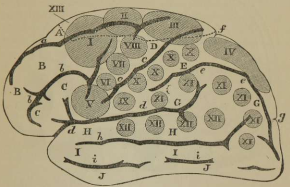
The last pathological result of injuries of the cortex which must be alluded to is the *descending sclerosis* in the anterior and lateral columns, which follows destruction of the cortex in the motor area and here only. Its symptoms are given in medical text-books (lateral sclerosis of cord), and are chiefly tremors, rigidity, and progressive contraction of the limbs.

The Symptoms of Local Injuries of the Brain.—A local injury may occur alone, or it may accompany one of the general affections—concussion and compression. Clinically, of course, our object is to recognize both. The general or diffuse nature of concussion and compression is shown by the absence of all symmetry in their symptoms; anything unilateral points to the existence of some local lesion, as also do symptoms due to special affection of one centre—*e. g.*, diabetes.

Local injuries of the brain from violence are far commoner upon the surface of the cerebrum than elsewhere. So long as the whole cortex was regarded as subservient to "Mind," and it was thought that if a portion were destroyed its functions would be assumed by other parts, there could not possibly be any diagnosis of local lesions. But the researches of Hitzig and Ferrier have established the existence in the cortex of each hemisphere of an area (motor) which presides over the voluntary movements of the opposite side of the body, and have shown that in this area tolerably definite portions are constantly connected with the movements of certain parts—*e. g.*, the face, hand, lower limb. Here then, function is "localized;" irritation of a certain patch, and of it only, will cause movements of the lower limb of the opposite side; and if this patch be completely destroyed, voluntary movement of the part is lost—permanently in man and apes, temporarily in lower animals. This difference Ferrier explains by showing that such actions as standing and walking, in animals able to perform them at birth or soon after, are really automatic and not voluntary, and are probably provided for in the basal ganglia. In front of and behind the motor area the surface of the brain is not excitable. It is probable that centres of hearing and vision occupy the outer surface of the temporo-sphenoidal lobe; there is apparently a vision centre in the occipital lobe, which is regarded by Ferrier as being the seat of visceral sensations also; whilst the frontal lobe seems connected with the intellectual and moral faculties. But in all these regions function is more or less "diffuse," so that when a considerable part is destroyed no loss is appreciable, its duties being performed by cells round about or on the opposite side; and even extensive loss of tissue causes weakening rather than abolition of function. The manner in which this *compensation* is effected is unknown. Sometimes it is not real, the whole centre not having been destroyed, in experiments perhaps from ignorance of its full extent. Thus, in apes, movements, represented chiefly by centres in the fronto-parietal area, depend in part on centres in the marginal convolution, and not until these also are destroyed does complete paralysis result. In other cases the connection appears to be equally intimate with both sides of the brain; thus the trunk muscles are paralyzed only after destruction of the marginal convolution on each side, a fact which seems to render unnecessary Broadbent's theory of "associated movements" (Horsley and Schäfer, *Proceedings Royal Society*, No. 231, 1884). Hughlings Jackson long ago expressed the belief that all parts of both sides of the body are represented in each hemisphere, though very unequally; after destruction of the chief centre for a movement on the opposite side, the minor centre on the same side may develop, and recovery occur *pari passu*.

THE ARRANGEMENT OF CENTRES IN THE MOTOR AREA is shown in Fig. 164, taken from Ferrier. It will be understood that this plate exhibits only approximately the positions, their extent and relations of the various cen-

FIG. 164.



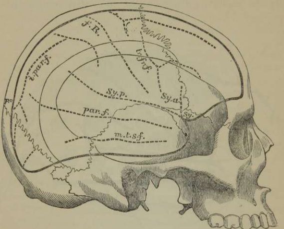
I. In bases of first and second frontal convolutions, chiefly in front of precentral sulcus, for lateral movements of head and eyes, elevation of eyelids, dilatation of pupils. II. At base of first frontal, for extension of arm and hand. III. Occupying upper ends of ascending frontal and parietal convolutions, for complex movements of arm and leg, as in climbing, swimming, etc. IV. In parietal lobule, for movements of leg and foot, as in walking. V. At lower end of ascending frontal, encroaching on ascending parietal and third frontal, for movements of lips (lower facial) and tongue (hypoglossal), as in speaking. VI. and VII. Depression and elevation of angle of mouth. VIII Supination of hand and flexion of forearm; the last three occupy the middle part of the ascending frontal. IX. At lower end of the ascending parietal, for platysma; retraction of angle of mouth. X. Occupies rest of ascending parietal, for movements of hand and wrist. XI. and XII. indicate sites supposed to be occupied by centres of vision and hearing. XIII. The dotted line has been added to mark out the area, *upon the inner surface* of the hemisphere, occupied by Horsley and Schäfer's centres for the trunk and other muscles. C, at the base of the third frontal, marks the speech centre.

tres toward each other; to get rid of the impression of accurate outline given by the circles it is well to group together in one mass the centres for the whole of the upper limb, of the face, and so on.

For many purposes, both of diagnosis and of treatment, it is necessary to know the *relation of the motor area, and of its separate parts, to the surface of the skull* (Fig. 165). As these centres lie grouped around the fissure of Rolando, a line upon the surface corresponding to this sulcus will be our best guide to them. The Rolandic line (Lucas-Championnière) may be thus obtained: its *upper end* lies fifty to fifty-five millimetres (the shorter measurements are for women and small skulls (behind the bregma or meeting-point of the coronal and sagittal sutures. The bregma may sometimes be felt; if not, when the face is looking straight forward, the transverse vertical plane through the external auditory meatus passes through the required spot. The following plan (Broca) is more accurate: fasten two stiff tapes at right angles to each other, fix the point of junction over one external auditory meatus by a small peg pushed into the canal, and carry one limb across the upper lip just beneath the nose, and the other across the vertex;

the bregma will be found in the mesial plane, immediately behind the latter tape. To find the *lower end* of the Rolandic line, with the face looking straight forward, draw a horizontal line, sixty-five to seventy millimetres long, from the external angular process of the frontal, and from the hinder end of this draw upward a vertical line, three centimetres long. The free end of this line marks, approximately, the lower end of the fissure of

FIG. 165.



After Thane, Quain's *Anatomy*. To show the relation of the convolutions to the surface of the skull. *f.R.*, fissure of Rolando; *Sy.*, Sylvian fissure; *Sy.a.*, *Sy.p.*, its interior and posterior limbs; *tr.f.r.f.*, transverse frontal or precentral fissure; *p.o.*, parieto-occipital fissure; *par.f.*, parallel fissure; *m.t.s.f.*, middle temporo-sphenoidal fissure.

Rolando. We can now draw the Rolandic line; as this is straight, whilst the sulcus is curved, the two correspond only approximately. The following rules for drawing the line are simpler: Trace the mid-line from the nose to the occiput; at right angles to it drop lines just in front of the external auditory meatus and behind the mastoid process; from the point at which the latter joins the mid-line, draw a line downward and forward to a point on the anterior line, two inches above the meatus (Godlee, *Trans. Med. Chir.*, 1885).

The relations of the brain to the skull vary a good deal, yet not so much but that the following rules (Lucas-Championnière) for finding the various motor centres, by means of the Rolandic line, hold good within the limits of the crown of a large trephine. In all cases the head must be shaved, and the line traced on the side opposite to the symptoms.

The *speech centre* (Fig. 164, C) lies altogether below and in front of the lower end of the line, 5 cm. along the line from the external angular process, and 2 cm. above it.

The *lower facial centres* correspond to the lower third of the line, lying rather in front of it.

The *upper limb centres* correspond to the middle third of the line, rather more in front of than behind it.

The *lower limb centre* lies beneath the upper end of the line.

The centre for complex movements of *upper and lower limbs* lies beneath the upper third of the line in front of it.

Lesion of the Cortex where Function is Diffuse.—At present a large number, perhaps the majority, of injuries of the cortex escape diagnosis, or are recognized by the sight, by a history of deep penetration of the skull by a weapon, etc., for they affect parts in which function is diffuse. Thus, large quantities of brain-substance from the prefrontal or occipital lobes may be lost, or much of the temporo-sphenoidal lobes pulpified without the occurrence of any localizing symptoms. Such lesions are often discovered post-mortem by chance, or are suspected during life only on account of the gravity and duration of the concussion symptoms (p. 432); and their situation can then be surmised only from a knowledge of the situation of the injury, and of the fact that cortical injuries occur either beneath the point affected or at a point or points opposite. Often such injuries are complicated by a good deal of subdural hemorrhage, and in mild cases are characterized by prolonged somnolence and signs of cerebral irritation, including a position of persistent flexion of all the limbs. Such injuries may give rise to late spasms and paralysis, which are probably due to spread of inflammatory hyperæmia to the motor area.

Lesions of the Motor Area.—When, however, the motor area is injured, symptoms will arise corresponding to the centres implicated; and in considering these, all injuries, whether contusions or wounds, with or without impaction of foreign bodies, may be classed according as they exercise an irritant, depressant, or destructive effect. If they irritate, spasm of the muscles presided over by the affected centre (monospasm) will result; if they compress or otherwise damage a centre, corresponding paresis or paralysis (monoplegia), from which recovery is probable, will follow; but if the centre is destroyed, the monoplegia will be permanent.

From the relations to each other of centres in the cortex, it follows that the spasms or paralyses from one lesion must be grouped in a definite manner—*e. g.*, the face and the arm may easily be affected by a lesion sufficiently extensive to cover their contiguous centres (Fig. 164), but there must be two distinct lacerations to cause simultaneous paralysis of the face and leg. Similarly we shall find that spasms from stimulation of the cortex have a definite march from one centre to those nearest.

Cortical paralysis.—When a centre is destroyed or seriously damaged by an injury, paralysis is of course immediate, though it may not be discoverable in deep insensibility; but in slighter cases the paralysis appears after a few hours, deepens, and perhaps spreads from hour to hour, as is so common in ordinary apoplexy—the progress being due in each case to increasing hemorrhage or to œdema. Usually the extravasated blood collects in the subarachnoid space and presses on the injured and uninjured cortex, but it may occupy a considerable cavity in the brain-substance, and compress fibres of the motor tract descending from cortical centres. Usually cortical paralysis stops short of complete hemiplegia, but face, arm, and leg may be involved, and, as in ordinary hemiplegia, the arm is more completely paralyzed and recovers sooner, though less completely, than the leg. The skin reflexes in the paralyzed side are normal, and the temperature of paralyzed limbs is usually raised. Bergmann says that anæsthesia was present in nearly one-third of the cases he collected, but the point has been neglected in case-taking.

Frequently spasms precede or interrupt the course of the paralysis, but they do not necessarily affect the paralyzed muscles, and may occur even on the opposite side.

Cortical spasms may occur immediately or some hours after an injury, being due either to the irritation of the laceration, or of extravasated blood tearing up the membranes, or they may appear first after some days, and this in cases without wound or any sign of a depressed fracture. The pathology of these later convulsions is obscure, but they are probably due to an active hyperæmia round an injured area; when there is a splinter sticking into the brain we have a cause for the hyperæmia. In septic cases late convulsions are from meningitis. Convulsions from simple cortical lesions are like those which may be excited in animals by stimulating a centre with a current, at first weak, but soon becoming strong. They are of sudden onset, occurring without any warning in a single group of muscles (*e. g.*, lower facial), or those of one part (*e. g.*, the thumb or forearm and hand). They may never spread from the muscles first affected, but, if they recur often, their tendency is always to extend to muscles of which the centres border on that affected by the original injury. Thus an aphasic patient may suddenly be attacked by facial spasms, and to these may be added, sooner or later, convulsive movements of the arm and then of the leg of the same side; in some cases the convulsions become general, when the march of the spasm on the opposite side, if it can be traced, is from the leg up to the face. The fits may last only a few minutes, or continue for half an hour or more. As the case proceeds the fits become more frequent, and the pauses between individual muscular twitches shorter. Consciousness is usually retained in monospasms, but is lost in more general convulsions; the tongue may be bitten and foam appear on the lips; the motions may be passed involuntarily, so the resemblance to an epileptic fit is very close when the spasm is general. These convulsions are often preceded and accompanied by a slight rise of temperature, headache, and some intolerance of light and noise. When frequent, consciousness is not recovered between them; on the contrary, insensibility deepens.

The *diagnosis* of a cortical contusion or laceration requires (1) that the above symptoms shall be immediate or of early onset, certainly within twenty-four hours; and (2) that they shall not be accompanied by signs of compression, in which case they might be due to subcranial hemorrhage.

The convulsions which, rarely, occur in cases of rapid compression (p. 435) are usually general, but may occur only or chiefly on the same side as the hemorrhage. Sometimes convulsions result from injury of parts other than the motor area; these also are said by Bergmann to be general from the first.

Prognosis.—Immediate paralysis, unless due chiefly to compression by depressed bone or foreign bodies, will probably prove permanent, but when paralysis is of later onset, due to spread in a circle of blood or œdema, it will usually pass off. In permanent paralyses the patient will be liable to late rigidity and other signs of descending sclerosis. Frequent general convulsions, deepening insensibility, and failing pulse, render the outlook grave even in simple cases. The possibility of an undetected fracture with depression must be remembered in these cases. In compound cases everything depends upon whether meningitis occurs; if it does, the prognosis is almost, if not absolutely, fatal.

Medullary Lesions.—There have been very few cases of punctured wounds of the medulla which have not proved immediately fatal; extensive unilateral or bilateral paralysis resulted.

Much more important are cases in which medullary centres have been injured, perhaps by the small hemorrhages which Duret (p. 445) describes as frequent in falls on the head. In concussion and compression, medullary centres suffer with the rest of the brain; but if, when the injury causes no general effect or when this has passed off, we find, with full restoration of the higher centres, evidence of abnormal action of one or more situate in the medulla, we may conclude that these latter have been specially damaged. Such symptoms are most likely to accompany fractures of the posterior fossa.

In some cases the *pulse-rate* has been altered either for a few days or for much longer periods. It may become very slow, or frequent with distressing palpitation and giddiness. Persistent *vomiting* has been noted and referred to the vagal nucleus. The *lung-mischief* which so commonly arises before death from head injuries has likewise been attributed to paresis of the vagus; broncho-pneumonia being supposed to result from entry of food, vomit, etc., into the air passages, whilst the low, œdematous, diffuse pneumonia is thought to be connected with the redness and œdema of the lungs which have been seen after section of the vagi. It does not seem necessary to call in any special lesion of the vagal nuclei to get these results in cases fatal from compression, as rise of intracranial pressure alone will produce paralysis of medullary centres (p. 435).

Sugar in the urine is a common result of head injury. It may appear at once, soon after, or not for months. It is sometimes accompanied by paralysis of medullary nerves. The diabetes may be slight and temporary, or permanent and severe. Usually, but not necessarily, the quantity of urine is increased. Simple *polyuria* (diabetes insipidus) has sometimes resulted.

Transitory *albuminuria* is not uncommon.

These symptoms are naturally regarded as due to injury of the floor of the fourth ventricle, where punctures produce similar results, but no lesion has yet been found. Sugar in the urine results from injuries anywhere of the vasomotor tract to the liver.

Treatment of Cerebral Contusion, Laceration, and Wound.—In subcutaneous and apparently uncomplicated cases the indications are: to check bleeding from torn vessels, and to prevent hyperæmia, œdema, and rise of intracranial pressure. To these ends the routine treatment of head injuries—absolute rest of mind, senses, and body, cold to and elevation of the head after any severe shock has passed off, low diet and a purge—is adapted. To combat hyperæmia, freer purgation, occasional cold douching of the head in addition to Leiter's tubes, leeching the head or bleeding from the arm may be employed.

Should subdural hemorrhage occur and cause signs of severe compression, the difficulty in recognizing its seat and its treatment will be found at p. 440.

If, in spite of the above treatment, late convulsions make their appearance or early convulsions become more frequent, extend and are accompanied by deepening insensibility, with signs of cardiac failure, it is obvious that the irritation cannot be overcome by the above remedies. The etiology of these convulsions is little understood, but the irritant may be a splinter sticking into the brain or even pressing on it through the dura mater (Lucas-Championnière, *Sur la Trépanation*, p. 29). A circumscribed splintered fracture over the motor area may well be concealed by the temporal muscle; so, unwilling as we are to sacrifice that best of all antiseptic dressings, the sound skin, yet, in cases where *death is imminent* unless relief is afforded, the bone should be examined over the centre corresponding to those muscles in which symptoms were first manifest (for surface guides, see p. 448), and if a splintered fracture is found it should be treated as usual. But if the bone is sound the only other source of irritation at present suggested is that of tension and pressure from extravasated blood, etc. In a desperate case it would be justifiable to trephine over the point of primary irritation, if this can be localized, to open the dura and even the arachnoid, if there is much subarachnoid hemorrhage, with the object of permitting the escape of blood and other fluid. A recognized depressed subcutaneous fracture with symptoms of laceration would of course be immediately treated (p. 430).

In *compound cases—i. e.*, cases of laceration or wound, accompanied by compound fracture, or wound of the skull)—to the indications for treatment above mentioned the all-important one of rendering and keeping the part aseptic must be added, and that of removing all irritants must be much more frequently acted upon.

To obtain *asepsis* treat as directed at p. 426; any brain-surface must be purified just as thoroughly as other exposed parts, even though some convulsions should result. All *foreign bodies* and *bits of bone*, driven more or less deeply into the brain, must be carefully sought for and removed with forceps; the tracks of bullets, bayonets, etc., may be examined with a rather large-ended probe or soft catheter. But if no definite track can be found probing must be given up at once. In all bullet-wounds, the skull should be carefully examined everywhere for any swelling which might indicate impaction of the ball against the opposite side. If found, cut down upon it and remove the ball, taking great care not to push it back into the skull. Larrey followed a ball across the skull with a catheter, and removed it by trephining on the side opposite to the wound; but Erichsen relates a case in which the ball had rolled from beneath such a swelling into the base of the skull and could not be found.

Lastly, all punctured, incised, and perforated fractures require trephining (p. 430), or enlargement of the aperture by other means, so constantly are fragments of the inner table displaced inwards upon the brain, irritating, lacerating, and acting as foreign bodies. Fractures depressed over a large area are much less injurious. For the treatment of inflammatory complications, diffuse or localized, see next section.

INFLAMMATION OF THE BRAIN AND OF ITS MEMBRANES.

MENINGITIS OR MENINGO-ENCEPHALITIS is the name given to a more or less diffuse inflammation of the pia-arachnoid, which naturally extends to the cerebral cortex; it stands in contradistinction to the circumscribed inflammation of the brain-substance which leads to *softening* (inflammatory) and to *abscess.*

ETIOLOGY.—*Traumatic meningitis* may occur *primarily* as the result of admission of septic organisms to the meninges through some wound or compound fracture of the skull, either vault or base; or it may be *secondary*, and spread to the meninges in one or other of the following ways. 1. Infective thrombosis may spread to veins of the surface of the brain along a vein leading from a wound or focus of infective inflammation; the latter vein usually opens into a sinus, causes infective thrombosis of it, and this process spreads into cerebral veins, but here and there (as at the apex of the temp. sphenoidal lobe from the sphenoidal fissure), veins from the surface join cerebral veins directly. Infective phlebitis and periphlebitis follow upon the thrombosis. 2. Schwalbe's injections have shown that a lymph-current runs from beneath the galea, through the bone and the dura mater to the subdural space; consequently the lymph-stream may bear infective organisms to the meninges or to a subcranial collection of fluid. In the latter case the dura inflames, pus forms, adhesions develop between dura and arachnoid, and inflammation may spread by continuity. When erysipelas of the head causes meningitis its cause probably enters by the lymphatics. 3. Septic inflammation may creep along nerves, especially the facial or auditory; a late neuritis warns us of danger. 4. A traumatic cerebral abscess may cause meningitis when it reaches the surface. 5. Meningitis after wound may be pyæmic.

It would seem therefore that traumatic meningitis is always due to the conveyance to the meninges, directly or indirectly, of organisms; and these find in the vascular lax pia mater, the subarachnoid fluid, and any fluid there may be in the subdural space, a most suitable nidus in which to grow and spread.

Morbid Anatomy.—The first result of irritation is intense injection, perhaps running on to small hemorrhages here and there; then exudation increases and renders milky the subarachnoid fluid; and still later, thick coherent yellow lymph or some substance between it and thin greenish-yellow pus forms. This exudation occupies the substance of the pia and the subarachnoid space, and it appears in quantity first around the veins which course in the sulci between the convolutions, thence it spreads until even the most prominent parts of convolutions may be covered. There may be pus in the subdural space when this has been wounded. The pia mater strips off much more readily than normal; the cortex is too soft and often pinkish, the white substance soft and œdematous, the corp. callosum and fornix especially tearing easily; the puncta cruenta are large and numerous in early stages, but not after exudation has much increased the intracranial pressure. The cerebro-spinal fluid is turbid and much increased. The vessels entering the cortex are surrounded by round cells, and the ganglion cells early undergo granular degeneration (Huguenin in Ziemssen).

As compound injuries, or the points at which injuries are compound, are situate more often in the vault than at the base, traumatic meningitis, starting from the wound, is usually more marked upon the convexity of the hemispheres than at the base, contrasting in this, among other things, with tubercular meningitis. But not infrequently the inflammation starts from a compound injury of the base; and then it does not mount much upon the hemispheres, but extends along the spinal cord even to its end, the exudation being curiously limited to its posterior freer aspect.

The symptoms of these two classes of cases differ in so much as affection of one motor area alone or chiefly will give rise to *unilateral symptoms*, which, whilst developing rapidly, may exhibit that " march " characteristic of spreading cortical lesions; whilst inflammation about the medulla and pons causes only general or bilateral symptoms (except of cranial nerves), and especially retraction of the head, with the characteristic boring of the occiput into the pillow. It is, however, common for inflammation to affect both base and convexity, to be pretty equally distributed on the latter only, or to be very irregular and patchy.

As to time of onset: primary meningitis almost always occurs from the second to fifth day; it has been described as early as the fourth hour (*St. Barth. Hosp. Rep.*, 1875) or as late as the eighth or tenth day. Secondary meningitis may occur during this time, and after the second week meningitis is always secondary (Bergmann). It may be very late in connection with necrosed fragments.

Symptoms of Meningitis of the Convexity.—*First stage, that of irritation.* The onset is more or less sudden, marked by rise of temperature, which is usually moderate (100°–102° F.), and accompanied by chills but rarely by a rigor. The pulse quickens, and is at first tense and hard. Vomiting may occur once or oftener; but headache starting from the neighborhood of the wound and becoming very severe is the chief symptom. It causes great restlessness, there is little or no sleep, and the patient tosses about, pressing his hands to his head, groaning or crying out sharply, and often grinding his teeth. There is marked intolerance of light and noise. The eyes are bright, the pupils small, equal, and at first react; but their movements soon become sluggish. Optic neuritis is commonly present and may be most marked on the side of the wound. The head is hot, the great arteries beat strongly, the face may at first be flushed, but is usually pale. Attacks of clonic spasms often occur, but quite as often there are none; they may be partial and extending, unilateral or general, the sides being equally or unequally affected; there may be but one attack or several, and usually they are quickly followed by paralysis.

So far the symptoms are those of simple acute hyperæmia, such as is believed to occur in cases of simple laceration with subdural hemorrhage, but early in the case delirium, quiet or violent, has set in, consciousness has been gradually lost, and the patient now lies in a state of stupor.

In the *second stage* this stupor deepens until the patient is insensible, and lies quite still with all the muscles lax; the pupils dilated and motionless; the temperature either subnormal or high; pulse very frequent, small, and irregular; respiration superficial, irregular, and gradually failing. Before this state is reached it is often evident that the side opposite to the wound, or certain parts of that side, are paralyzed; often, but by no means necessarily, they have been convulsed, and spasms may at first alternate with paralysis. It is common for the pupils to be unequal in the middle period, that on the most affected side being the larger. The temperature may not rise at all, but be subnormal rather, and the failure of pulse and respiration is gradual.

The great majority of cases die in less than a week.

Symptoms of Basic Meningitis.—At first symptoms of hyperæmia with delirium, fever, and loss of consciousness occur later than where the convexity is affected. Retraction of the head and rigidity of the neck muscles appear early. Convulsions, if they occur, and paralyses are general, unless a nerve has been injured by the fracture, when the symptoms will be early. Paralysis of one or more cranial nerves from neuritis, leading to squint or other symptom, is common; yet often nerves are unaffected though surrounded by pus.

Prognosis.—Once the disease has passed beyond the stage attributable to simple hyperæmia, it is probably invariably fatal.

Diagnosis.—The paralysis of meningitis is easily distinguished by the time of onset from the primary paralysis which characterizes compression or laceration of a motor centre by bone, blood, or other agent. But the diagnosis from hyperæmia and œdema, spreading concentrically round a contusion, is often at first impossible.

The diagnosis is difficult also in cases in which consciousness has not been recovered after the injury before the onset of meningitis, as in cases of prolonged concussion, in which any signs of irritation may be regarded as reactionary; or in cases of subdural hemorrhage in which rise of temperature may be due to absorption of extravasated blood, and attacks of congestion are common (p. 438).

The disease is very variable: thus the temperature may be little affected or subnormal; the first symptoms may be convulsions with loss of consciousness, or a cortical paralysis may appear and spread from day to day. Meningitis at its onset is distinguished from pyæmia by the absence of rigors and characteristic temperature.

Treatment.—At present there is none other than prophylactic, and this is summed up in "asepsis." Hutchinson recommends energetic mercurial inunction; Bergmann (*loc. cit.*, p. 506) has several times "touched the mouth" in twenty-four hours, but he did not cure his cases.

Whether we shall be able to diagnose suitable cases sufficiently early and certainly to treat them as we should similar inflammation elsewhere, even of the peritoneum, by antiseptic incisions into the subarachnoid space through several trephine openings placed round the wound, rests with the future.

INTRACRANIAL ABSCESS.

Circumscribed collections of pus may form between the dura mater and the bone, or in the substance of the brain.

Subcranial suppuration was regarded as a not uncommon result of injuries to the skull by Pott, who gave as its symptoms: the occurrence of rigors some days or weeks after a head-injury, followed more or less quickly by coma; the formation of a "puffy swelling" of the scalp at the point struck if there is no wound, or, if there be one, it becomes pale, smooth, and ceases to discharge, and the pericranium separates, leaving the bone yellow and tending to dry. But in the great majority of cases these symptoms result from osteomyelitis, necrosis, and meningitis, or perhaps cerebral abscess—the formation of pus beneath the bone being quite exceptional (Bergmann). Of seven consecutive cases with the above symptoms trephined at St. George's, pus was found beneath the bone in one only, and in this the dura had been separated by blood.

Cerebral Abscess.—More frequently, though still rarely, abscesses form in the brain, either superficially or well beneath its surface.

Causes.—Cerebral abscess rarely arises without a discoverable cause. The most common is *suppurative otitis media*, which sometimes causes caries or necrosis of the petrous abscess beneath, and adhesion of the dura mater to the temporo-sphenoidal lobe or cerebellum, and spread of inflammation by continuity to these parts; or the dura over the petrous being healthy, the abscess is due to infective thrombosis of veins from the ear to the brain or cerebral sinuses. It is said that an otitis which has not led to perforation of the membrane may cause cerebral abscess, so hearing must be carefully tested (Fagge).

Chronic rhinitis, leading to disease of the ethmoid, is a much less common cause. *Caries* or *necrosis* of any part of the skull, whether induced by injury or by disease, may act similarly.

Pyœmia is a rather common cause, usually giving rise to multiple abscesses.

Sir W. Gull described certain cerebral abscesses as *secondary to some ulcerative disease of lung*, bronchiectasis with putrid secretion being the most common. Septic embolism from a pulmonary vein is regarded as the pathology, and there is usually more than one abscess.

Injury.—An injury which is followed by cerebral abscess has almost always caused a wound of the soft parts, and often contusion or fracture of the bone. Bergmann states that he can find references to only six cases attributed to simple injury, and of these some, at least, are uncertain. Again, very rarely an abscess forms in the hemisphere of the side opposite to that struck (Erichsen, vol. i. p. 710), a fact difficult to understand, as traumatic intracerebral hemorrhages are so rare.

Usually the abscess is on the side of the injury, but it may seem to have no relation or direct vascular or nervous connection with the point struck.

Some traumatic abscesses are *primary*, others *secondary* to some infective wound disease, especially infective thrombosis. Among the primary are certain cases of *diffuse septic softening with central suppuration*, which start at once from extensive compound lacerations such as are common in war; they are always coupled with meningitis. Again, an *acute circumscribed abscess* is not uncommonly found in cases of death from meningitis in the second or third week. Whether the meningitis is primary is doubtful, but the two are almost always associated. Sometimes, however, a bullet track or a punctured wound will drain well for a time through the opening in the skull, the visceral and parietal membranes adhere and meningitis does not occur.

After perhaps months drainage becomes insufficient, bagging occurs, and symptoms arise, perhaps to subside as pus bursts out afresh. This late traumatic abscess is due directly to the injury; but more commonly such abscesses are secondary to infection from a wound travelling along veins, lymphatics, or nerves.

MORBID ANATOMY.—After an existence of six weeks (Meyer) we may expect to find an abscess encapsuled, but it may not be so after years. The pus is greenish, acid at first, mucous and alkaline when old; often very offensive when secondary to disease of bone.

Abscesses may occur anywhere in the brain, but are most common in the temporo-sphenoidal and cerebellar lobes, because these parts are infected from the middle ear (anterior or posterior surface of petrous). They are often as large as a pigeon's or hen's egg, and may occupy the greater part of a hemisphere. They may be single or multiple, pyæmia and lung disease being the causes of the latter, though sometimes two or three abscesses close together, or one in the temporo-sphenoidal lobe and another in the cerebellum, may result from middle ear disease. They may last from a few weeks to, it is said, twenty-six years.

Sometimes it is not evident, post-mortem, to what the fatal symptoms were due; often meningitis is excited by the abscess coming to the surface and even bursting there, though much more often it bursts into the ventricle. A sinus may be found by which a cerebral abscess has drained through a wound in the bone.

SYMPTOMS.—These are very variable, and there is not the slightest doubt that most abscesses are latent throughout much of their course. Their slow increase allows surrounding conducting structures to move aside without loss of conducting power, and in this way Bergmann (*loc. cit.*, p. 107) seeks to explain a remarkable case in which the abscess ran a two months' course; only two days before death, headache and nausea appeared, then drowsiness, deepening into coma, with slow pulse. The abscess occupied nearly all the right hemisphere, and had burst into the ventricle. One can, however, scarcely believe that the fibres of the white substance were simply pushed aside to make room for so large a collection of pus, as the rise of pressure would soon have caused coma: yet it is very difficult to see how otherwise the absence of motor symptoms is to be accounted for, unless upon Hughlings Jackson's view that both sides of the body are represented in each hemisphere.

Acute traumatic abscesses being almost always accompanied by meningitis, their differential diagnosis is impossible, and treatment is of no avail. In chronic cases it is sometimes very difficult to be sure that meningitis has not supervened when the patient is seen.

When a chronic cerebral abscess results from injury, there is a clear interval or period of latency between the primary symptoms of the injury and those of the abscess which quickly (the majority within fourteen days) end in death. The period of latency may be a week, is usually several weeks, and may apparently be many years. It is occupied with the origin and growth of the abscess; but when this affects the cortex of the motor area, or irritates or destroys fibres of the motor tract, from the first some localizing symptoms will be present throughout, and there is no period of real latency.

Following this period vague symptoms may be noted, such as loss of memory, change of disposition, rapid emaciation; the pulse may become very slow, and double optic neuritis is common; with malaise there may be bouts of fever, perhaps with rigors, which may be so regularly repeated as to simulate ague; epileptiform seizures may constitute the first, and for some time (two years in one case) the only, symptoms of abscess. But much more constant than any of these is pain, sometimes agonizing, and usually continuous; sometimes corresponding to the seat of abscess, again being most misleading. Trigeminal neuralgia may be due to abscess.

In a certain number of cases monospasms and monoplegiæ, like those which occur as primary symptoms of injuries of the motor area, or hemiplegia or aphasia occur to localize the abscess. It will be remembered, however, that yellow softening may spread from centre to centre in the cortex, causing exactly similar late paralysis (p. 446); fever, and perhaps rigors, will point to abscess.

When there is a scalp wound, it often assumes the appearance described by Pott, when pus lies in the brain beneath it; but septic meningitis may produce similar change. Sooner or later the final symptoms set in, and quickly end in death from coma, with symptoms of compression (p. 420). This may be ushered in by a severe convulsion during which consciousness is lost once for all, or violent delirium may occur and subside into deepening stupor. Sometimes symptoms of this kind form the first and last indication of cerebral abscess.

Diagnosis.—This includes the recognition of pus and its localization, both of which are often impossible. But when, after attacks of fever, and perhaps rigors, with more or less constant headache, epileptiform convulsions (general or having a march pointing to a cortical lesion) are followed by paralysis on the side opposite to the wound, abscess so placed as to compress or destroy the centres of the paralyzed muscles is most probable. The presence of one of the causes of abscess is very important.

Not uncommonly escape of pus through a wound in the bone has led to trephining.

Treatment.—When the abscess can be localized, trephining and evacuation of the pus are the proper treatment. As a preliminary precaution, Maas has proposed to make an exploratory puncture through the bone with a hollow drill.

On removing a circle of bone, pus may be found beneath it; or the dura may be torn, pierced by fragments, and on removing these pus may escape from the brain; or healthy dura may bulge into the wound. If it does not pulsate it should be opened, for an abscess probably lies beneath; and this is fairly certain should the dura appear inflamed or show a raised central yellow spot (Bergmann). But pus may lie beneath it in the absence of all these signs. Palpation is useless. In case of doubt several punctures in various directions may be made with a small aspirator needle, *only slight suction being made* and no lateral movement of the needle being permitted. If pus is found, pass a bistoury, or, better, a pair of sinus forceps along the needle and open the blades. The pus squirts out forcibly, as a rule, and if near the ventricle the fluid in the latter may burst into the empty cavity, and diffuse meningitis will probably result. A tube should be placed in the cavity and the abscess treated as usual. Hernia cerebri (p. 431) may follow.

AFTER-EFFECTS OF INJURIES TO THE HEAD.

Traumatic Epilepsy.—Certain cases of this class fall into the hands of the surgeon—those namely which seem to be connected with injuries of the head or of injuries of peripheral nerves.

In 783 cases of epilepsy, Echeverria found 63 of traumatic origin. (1) In some cases of epilepsy the aura starts from a tender peripheral scar, pressure upon which may excite the fit; a scar of this kind may result from a wound of the scalp; (2) Contused skull may thicken from inflammation, or depressed fragments may press upon the dura and brain; (3) The dura mater may become thickened and adherent to the brain-surface as a result of injury; or (4) some irritant condition of the cortex may be established. As a rule, fits do not appear for some time, perhaps years, after an injury.

SYMPTOMS.—These are remarkable only when the irritation affects the motor area: we then find that the fits begin on, or are confined to, one side of the body; that the muscles of one part—*e. g.*, the hand or foot—are always first affected, and that the spasm spreads as described at p. 450. The group of muscles first convulsed indicates the point of the brain-surface which is most irritated. In the more limited and shorter convulsions consciousness is not lost. After these fits there is a tendency to paralysis or paresis of the muscles concerned, chiefly of those corresponding to the irritated centre. These cases are spoken of as cortical or Jackson's (Hughlings) epilepsy.

TREATMENT.—Superficial scars may be removed or dissected up (Bryant) in such a manner as to divide all sensory nerves going to them. When any considerable nerve-trunk is involved in a scar, and neuralgia is excited, it should be stretched. When bone which has been injured is suspected, on account of tenderness or from the march of the spasm, as the cause, it should be removed by trephining. Considerable success has followed the operation, but the statistics include many cases observed for only short periods.

Other late effects of head-injury occur: various mental and moral changes, sometimes amounting to insanity and paralysis of various kinds, motor or sensory.

THE OPERATIONS OF TREPHINING AND ELEVATION OF BONE.

INDICATIONS.—1. Simple depressed fractures, with symptoms of compression or laceration. 2. Compound depressed fractures, and all punctured and incised fractures. 3. Penetration of foreign bodies into the skull. 4. Subcranial hemorrhage causing compression. 5. Abscess. 6. Traumatic epilepsy. 7. Cortical tumor. A large-crowned trephine should always be used for indications 3 to 7.

METHOD.—Expose the bone by a V-, H-, T-shaped or crucial cut, so planned that the spot at which it is desired to trephine will be well exposed; carry the cuts right down to bone, and with an elevator raise the periosteum and flaps together. Stop all bleeding. Now cause the centre pin of the trephine to project $\frac{1}{16}$th inch, and fix it firmly. Place the pin on the centre of the disk of bone to be removed—*e. g.*, exactly over the meningeal artery (p. 442), and bore it into the skull by alternate movements of pro- and supination; soon the crown will have cut a groove for itself, and then the *pin should be at once withdrawn* and fixed up. Working on through diploë, if any is present, the sawdust is bloody and progress fairly easy. As the inner table is approached the surgeon stops frequently, brushes away the dust, and feels round the groove with a toothpick for any indication that the bone is penetrated at one point; sometimes the bone is cut through in one place long before it is separated elsewhere, and then the crown must bear only on the latter part. Toward the end an occasional slight side-to-side movement of the trephine will ultimately crack through the inner table, and the disk may then be removed with forceps. Throughout the sawing the forefinger rests on the side of the crown almost touching the bone, so as to prevent the possibility of any sudden jerk into the skull, and pressure must be lightened as the inner table is neared. The smallest piece of bone a trephine will cut out is necessarily somewhat larger than its half circumference. The thin spots of the skull must be remembered; also the facts that skulls vary very greatly in thickness, and that diploë is absent in children and often replaced by compact tissue in old age. It is advised to operate always as though the skull in question were the thinnest known. The work with the hand-trephine is very fatiguing; a trephine worked by a carpenter's brace cuts much more easily and quickly, but requires great care.

When the disk of bone has been removed, and splinters extracted or pus or blood evacuated, the flaps are laid down again, sewn together, free downward drainage being provided. Asepsis is all-important. The aperture does not fill up with bone as a rule, but a very firm scar forms. Macewen breaks the disk of bone into pieces with a chisel and replaces it, leaving gaps for drainage. In two of eleven cases one or two fragments died.

In Germany a chisel and mallet are preferred to the trephine by many. The chisel is less liable than the saw to cause necrosis and those portions of bone alone which it is wished to remove can be acted upon.

Sometimes an overhanging fragment beneath which bone is depressed can be removed by sawing through it with Hey's saw, but whenever there is an aperture large enough to admit a blade of the gouge forceps, no instrument is so convenient for enlarging it.

Results.—Of 709 cases nearly 50 per cent. died (Bluhm). But older statistics are of little value now, and modern are not yet forthcoming. Volkmann has antiseptically trephined 8 cases for fracture with 1 death (fractured base), and of 14 cases in which the skull was opened for non-traumatic causes, 3 died (entry of air into sinus and meningitis from fracture of base). Bergmann reports 6 cases of trephining for diseased bone, all successful. Of 17 cases (14 trephinings and 3 elevations) Macewen lost 3, but no death could be attributed to the trephining; in the 14 successful cases no untoward symptom occurred (*Lancet*, May 23, 1885).

MALFORMATION OF THE HEAD.

Meningocele and Encephalocele.—These terms imply a congenital hernial protrusion, either of the cerebral meninges or of these with a portion of the brain. They occur at special seats; the occipital region (just above the foramen magnum, through the middle of the bone, or at the post. fontanelle) is by far the commonest; others are the glabella, and much more rarely the ant. fontanelle and the inf. angles of parietal; most rarely, through the sphenoid into the nasopharynx.

Symptoms.—The swellings may be as large as a pea or larger than the child's head (occipital); they are covered by normal skin and pulsate with the brain, unless the opening in the skull is very narrow; pressure on pulsating tumors will cause reduction of part of contents, and, if pushed, loss of consciousness and convulsions. A small meningocele—*e. g.*, frontal—may be non-pulsating and irreducible. When very lax a mass of brain may be felt, otherwise the diagnosis of meningocele from encephalocele cannot be made—unless the electric light gave a shadow. In occipital cases the cerebellum and corpora quadrigemina are the most likely parts of the brain to lie in the sac.

Most children with these malformations die during or soon after birth, at least when the swelling is of any size. Very rarely in those that live the bones close, and cut off the sac from its communication with the interior.

Treatment is required only for large increasing herniæ, in which sloughing would ultimately occur. Ligature at the root has scarcely a success to its credit; puncture and injection, as for spina bifida (*q. v.*) is somewhat more promising; removal of the sac and careful suture of its edges is the final resource. In any case the prognosis is very bad.

Diseases of the Head.

Inflammations of the Scalp.—During childhood *scrofulous pustular eczema* is very common, and also *sores* due apparently to the irritation of *pediculi* which so frequently infest the heads of young children. They should be at once treated by softening the scabs with a poultice, picking them off, and applying boracic or salicylic ointment, or ung. hydrarg. amm. dil. for small surfaces, hair having been freely, or, in the case of lice, entirely removed. If unchecked these lesions lead to *abscess* in the substance of the scalp, and especially in and around the occipital glands.

Diffuse cellulitis with subaponeurotic suppuration is chiefly a complication of wounds, and so is *erysipelas*, which may, however, spread to the scalp from neighboring parts. The diagnosis between the two rests chiefly upon the limitation of the subaponeurotic inflammation by the attachments to bone of the occipito-frontalis, whilst erysipelas will probably pass over these; the rash of the latter is often atypical upon the scalp. Their treatment is very similar.

Sinuses in the frontal region may be very troublesome and require fixation of the occipito-frontalis by strapping.

Inflammations of the Bones.—Blows may cause any stage of *periostitis* up to suppuration, with or without necrosis. Congenital syphilis leads to nodes in infants (p. 116), not to be confounded with thickened growing edges of bones in rickets; and the acquired disease, usually in its latter stage, frequently causes gummatous periostitis of the vault, too often resulting in necrosis. Often there is a chaplet of offensive ulcers round the head, each one floored by dead bone. The sequestra are extremely long (years) in separating, perhaps because of slow spread of necrosis at the margin; they may include the whole thickness or only the outer table. They must be left until nature has well marked out their limits, and almost or quite freed them.

A *tubercular*, often perforating, *caries* of the vault is described; it is rare, and should be treated by removal of all disease with the chisel and mallet.

Tumors of Scalp and Bones.—Most varieties occur, but few are common. There is a diffuse hypertrophy of part of the scalp, usually extending to one side of the face—molluscum fibrosum, but ordinary *fibroma*, except of the basilar process of the occipital, is rare; a pedunculated *fibro-lipoma* is sometimes seen. I have removed a *lipoma* from the forehead. *Ivory osteomata* may be multiple, and sessile and fixed to bone; sometimes they grow into the orbit from the roof. *Nævus* is very common in the scalp, and this is the special seat of the somewhat rare *cirsoid aneurism* (p. 377). *Sebaceous cysts* (p. 215) are very common after middle age, the scalp being their special seat. They are very often multiple and give no trouble; rarely one suppurates, leaving a chronic ulcer with irregular base and thick everted edges, which may actually become epitheliomatous. *Dermoid cysts* (congenital) are fairly common at the upper outer angle of the orbit; they occur also behind the ear and over the anterior fontanelle. Here they may be mistaken for a meningocele cut off from the cranial cavity. The removal of the more usual cyst near the ext. ang. process of the frontal may be difficult on account of processes running far back into the orbit and free bleeding, and it has been known to penetrate the skull; therefore, it should not be undertaken lightly. *Meningocele* cut off from the interior, and a collection of serum left by hæmatomata are other "cysts" which may be met with here.

Primary sarcoma of the scalp is very rare; but it occurs sometimes in the bones and in the dura mater, either growing outwards and involving the bone, or inwards and involving the brain. If, in the latter case, the motor area is pressed upon, symptoms will soon appear. In their early stage, sarcoma of the bones may be removed with the chisel and mallet, and deeper structures, including brain, may be attacked if necessary; but recurrence is very probable. *Epithelioma* is uncommon in the scalp, and generally begins in an ulcerated cyst; *rodent ulcer* may extend from the face on to the scalp; either may affect bone and even brain. *Secondary sarcomata* and *cancers* may occur in the skull.

Diseases of the Brain and its Membranes.—*Hydrocephalus.* The surgeon is occasionally asked to tap the lateral ventricle (*Paracentesis capitis*) in cases of this disease. Introduce an aspirator needle, about 2 mm. diameter, through one of the lateral angles of the anterior fontanelle, away from the line of the frontal sinus; after it has entered an inch, *gently* raise the piston of the syringe, and if no fluid comes, push the needle cautiously on; mark for future guidance the depth at which fluid issues. The piston may now be very slowly drawn up or siphon action may be used (p. 82), pressure being maintained upon the parietals; these bones may be caused to overlap, but there is no advantage in withdrawing so much fluid. The object is simply to relieve tension, not to empty the ventricles; several ounces always remain in these cavities after the most complete aspiration possible. A flannel capelline bandage should be applied after the operation.

There is little danger in the operation, which may be repeated whenever tensive pain renders the child cross and restless. As a rule the fluid is yellow, not nearly so limpid as cerebrospinal fluid, and contains a large quantity of albumen, being of inflammatory origin; but cases of distention due to yielding of an unduly soft skull under normal pressure (Huguenin), or to general or partial atrophy of the brain, contain a fluid very like that normal to the part.

Tumors of the Brain.—Dr. Hughes Bennett having diagnosed in a certain man the presence of a tumor (glioma) in the middle of the ascending parietal, extending across the fissure of Rolando into the upper half of the ascending frontal convolutions, and the history and ill success of treatment showing that it was not a gumma, R. J. Godlee trephined the skull freely over the suspected area and opened the dura; an incision into the ascending parietal came upon the tumor almost immediately. It was enucleated with a steel spatula capable of being bent into any shape. Free, general oozing was checked by the galvano-cautery, but Godlee subsequently stated that it would probably have stopped of itself; the cavity was drained. The patient was quite relieved of pain and other symptoms; but almost complete paralysis of the arm was rendered complete. The wound became septic on the third day, a large hernia cerebri formed, and was shaved off twice or thrice, but recurred persistently; ultimately, meningitis spread from the wound to the base, and death occurred a month after the operation. Sepsis was attributed to imperfect cleansing of the scalp, and the hope is justified that, next time, it will be avoided, and that the success, so distinctly promised in the first days after the operation in the above case, will be attained (see *Trans. Med. Chir.*, 1885, p. 243). Macewen had previously localized by its symptoms an abscess in the base of the third frontal, and had trephined over and opened it *post-mortem*.

The chief tumors of the brain are myxoma, glioma, and sarcoma (all kinds) —closely allied forms—of which the latter grows most rapidly and tends to generalize. The first and last often start in the meninges.

The *symptoms* are most variable, according to the seat, size, rate of growth, and nature of the tumor; they are necessarily those of abscess (p. 456), without fever or rigors, and without any of the special causes of abscess, except as a coincidence. On the convexity which is alone accessible to the surgeon, only primary affection of the motor area will enable the seat of the growth to be recognized. Thus in Bennett's case frequent twitching of the left side of the tongue and angle of the mouth, without loss of consciousness, was followed by general convulsions, beginning on the left side of the face, and accompanied by unconsciousness. The local fits occurred daily, the general, once a month. After three and a half years, twitching of the left finger and arm, without loss of consciousness, began to alternate with the facial twitchings; rarely they occurred together. Soon paresis, and ultimately paralysis of fingers, hand, and forearm ensued, with weakness of the shoulder; and finally twitching spread to the leg, and this became weak. The patient suffered from severe paroxysmal vertical headache, frequent vomiting without cause, and double optic neuritis, worse on the right side, yet could read well; sensation was everywhere normal. A reference to Fig. 164 will show why the disease was localized as above stated; the growth was supposed to irritate or compress the facial, tongue, and arm centres.

CHAPTER XXXIII.

INJURIES AND DISEASES OF THE SPINE AND SPINAL CORD.

Injuries.

Concussion of the Spinal Cord.—It has long been the custom to explain by concussion of the cord a number of very obscure symptoms arising after railway and other severe accidents in which there has been no evidence of fracture or dislocation of the spine. Of late years the truth of this explanation has been called in question, and chiefly by Mr. Herbert Page ("Injuries of the Spine and Spinal Cord without apparent Mechanical Lesion").

We must, therefore, consider whether concussion of the cord occurs. Between the brain and cord in regard to their liability to injury there is but little analogy, the latter being placed at a great depth in the centre of a column of bones which nowhere presents to direct violence a large surface, which is surrounded by soft parts, and so constructed that shock from the feet shall be greatly broken in its passage upwards; further, the cord is fixed to the brain above, to the sacrum by the filum terminale and lumbo-sacral nerves below, and laterally by the issuing nerves; and, lastly, it is surrounded by cerebro-spinal fluid, and is free to move within the dura mater. It would, therefore, seem very difficult for a mere shake to act injuriously upon a long light structure thus suspended.

Next, Page finds that very few of the cases cited as examples of concussion of the cord will bear close criticism; in many there *was* evidence of damage to the spinal column rendering local injury of the cord probable, and often accounting for some of the symptoms; or the symptoms present were very doubtfully attributable to the cord. Doubtless many fractures of the spine are unrecognized; but this would not invalidate the diagnosis of concussion unless there were reason to think that the fragments or blood had compressed or lacerated the cord.

Let us next consider a few of the long train of *symptoms* ("litigation-symptoms," Page) which undoubtedly do arise after railway accidents and similar injuries. Confusion of thought, loss of memory of words or places, inability to count, inaptitude for mental exertion or business, greater or less diminution of sensation and motion, numbness, pins and needles, or coldness of one or more limbs, loss of power of various sets of muscles, or inability to harmonize their action, to stand upright or the like, impairment of special senses, optic neuritis, emaciation, general feebleness and sleeplessness, the spine usually rigid, incapable of being bent or turned, often very tender at one or more places—these and many others, variously combined, undoubtedly occur, but whether they are due to spinal cord concussion is quite another matter. Several are obviously brain-symptoms; others are apparently due to the effect of the blow or wrench on the bones, ligaments, and muscles of the spine; whilst those symptoms which do seem to point to the cord, if they are not due to injury of issuing nerves and consecutive neuritis, indicate a local, and not a general, lesion of the cord. But to preserve any analogy with the brain, concussion of the cord must be a general (transverse) affection, if not of the whole, at least of a considerable length, of the cord, characterized by depression of all its functions—motor, sensory, and reflex; and its symptoms must be immediate, not developed in the course of months, as in the doubtful cases of which we are now speaking. If, however, in any case we found signs of a transverse lesion of the cord, we should certainly attribute it to compression by bone or blood; if such occur from concussion, they must pass off simultaneously with the shock of the accident and be consequently unnoticed. Concussion of the cord *may* occur, but we have little or no distinct evidence of it.

Slight contusions, lacerations, and small hemorrhages into the cord may give rise to no immediate symptoms, but degenerative or chronic inflammatory processes starting from these focal lesions—due perhaps chiefly to longitudinal strain of the cord during forced flexion—may ultimately make themselves felt in local paralysis, impaired spinal reflexes, etc. But it is most necessary in these cases to be certain that the symptoms are really of spinal origin—*i. e.*, that they are phenomena met with in ordinary spinal disease. Many are doubtless due to bruising and tearing of muscle and ligament, others to shock, fright, and anxious expectancy, some to the unconscious mimicry of which hysteria affords so many examples, and some, often many, to malingering. Skill in the examination of nervous cases is necessary for the detection of these.

Treatment.—Immediate cord symptoms will necessitate the same treatment as if fracture or dislocation had been detected. In doubtful cases it may still be advisable to treat, precautionally, by more or less prolonged rest; but mental reassurance will be essential. Bruising of soft parts requires nothing special. Bark, iron, cod-liver oil, and similar remedies must be used to combat the effects of worry and confinement.

Wounds of the Cord.—These are generally punctured from stabs, or lacerated from displaced bone or gunshot; and bullets do so much damage that they almost always kill.

Symptoms.—When the dura mater and arachnoid are wounded cerebro-spinal fluid escapes, and may do so for days; this may happen without wound of the cord. Usually the cord is *partially* or *completely divided*.

In partial division no general statement of the symptoms can be made; the student must remember that most of the motor fibres from half the body run up in the cord in the *same* side and decussate at the medulla, whilst the sensory fibres pass over at once into the *opposite* half of the cord. Division of half the cord causes paralysis and hyperæsthesia of the same, anæsthesia of the opposite, side.

Complete division, or *contusion* destroying the physiological continuity of the cord, is almost always due to displaced bone. The symptoms vary with the height of the injury; but we always find paralysis of motion and sensation below the point, so that the seat of injury may be diagnosed by the discovery of the highest nerves paralyzed. Often, from irritation of the lowest unparalyzed nerves, a zone of hyperæsthesia is found round the trunk at the level of the fracture. At first reflexes are abolished below the injury by some inhibitory action, or by shock; but soon they become excessive—*e. g.*, priapism occurs, cerebral control being withdrawn. Of course, when a centre is *destroyed* by the injury the reflex is lost forever; and often no excess is noticed in centres close below the injury. The higher the lesion the more common is priapism; it appears early, and rarely lasts more than two weeks. Loss of control over the bowels and inability to micturate always result from paralysis of the external sphincter and of the bladder; but involuntary defecation is often prevented for some weeks by constipation, and retention of urine may be masked by the overflow of a distended bladder. As a result of the anæsthesia and of the paralytic state of the arteries, the paralyzed parts become pale, cold, congested at extremities, inelastic, and branny from imperfect casting of the epithelium; pressure-spots slough readily, especially over the sacrum and heels; and in the former situation an acute bedsore, perhaps the size of a saucer and reaching down to bone, may form within a few days of accident or later. This is attributed by some to irritation of "trophic" nerves—a pure assumption. Some are inclined to attribute to the same nerves also the ammoniacal decomposition of urine which occurs during the first few days in these cases. But this is invariably accompanied by the appearance of micrococci (*M. ureæ*), which are almost certainly the cause of the fermentation. The difficulty is to account for their entry in cases in which every care has been taken to use an aseptic catheter; it would be well worth while in some of these cases, seen early, to put up the penis in an antiseptic dressing. It has been suggested that the viscid mucus which is produced in large quantity by the bladder wall, acts as a ferment; but this does not explain the constant presence of cocci. Lastly, in some cases, an erythematous or bullous rash appears on the paralyzed parts or more widely distributed; it has been attributed to nerve-influence.

The *effect of the height of the division* is shown chiefly in the extent of the paralysis. If it is in the *lumbar*, or *lowest dorsal region*, the legs are paralyzed and insensitive. As the injury mounts towards the *middle* and *upper dorsal region*, paralysis of the abdominal and intercostal muscles, and loss of sensation over these parts, are added; the abdominal wall bulges unduly with each descent of the diaphragm, the bowels become distended with gas and obstinately confined for the first few weeks; priapism now appears, the penis being in a state of semi-erection. *Above the second dorsal and below the fourth cervical* more or less motor and sensory paralysis of the arms results, appearing first in the distribution of the ulnar; and there is great difficulty in breathing, especially in *expiration*, the trunk muscles being paralyzed, and unable to antagonize the diaphragm; coughing and sneezing are almost impossible; the lungs become much congested and hæmoptysis has occurred. In injuries of the cervical cord the temperature sometimes rises to an extreme height; thus Teale records a case of pyrexia lasting several months, with a maximum of 122° F. (*Lancet*, March 6, 1875). *Above the origin of the phrenic nerve* (*fourth cervical*), the diaphragm is palsied and death instantaneous. This injury results most often from dislocation of the odontoid process, either traumatic or pathological.

The *danger* of injuries dividing the cord obviously increases the higher the lesion is situate.

High up, death is immediate or early from asphyxia; the lower the injury the more possible is recovery, perhaps with permanent paraplegia. Yet a large majority even of low injuries to the cord (usually from fracture) prove fatal, perhaps after months or even years. Death is then due to the development of acute or chronic bedsores, exhausting the patient by suppuration and fever or exciting meningitis (p. 467), to acute suppurative nephritis from extension of putrefaction to the kidneys, or to pyæmia.

Septic meningitis is especially to be feared in cases of open wound of the theca. Gurlt was able to find eight cases of suppuration of simple fractures of the spine.

Fracture of the Spine.—When not due to gunshot violence, fracture of the body of a vertebra is almost always caused by forced flexion of the spine, as in driving under too low an archway, striking the bottom with the head in diving, or falling beneath a too heavy weight placed upon the shoulders. Erosion of vertebræ by aneurism or caries predisposes to and may produce fracture. The arch and processes, especially the spine, are often broken by direct violence and may be driven into the cord. The body is the part broken in more than half of the cervical fractures, $\frac{1}{8}$ dorsal and almost all the lumbar. The injury is uncommon and occurs especially in males from twenty to sixty. Of 286 cases, 108 were cervical, 94 dorsal, 25 dorso-lumbar, and 41 lumbar (Gurlt); more than one vertebra is often broken in the cervical and dorsal regions. The 5th and 6th cervical, 12th dorsal, and 1st lumbar are most frequently broken, and next to them come the bones in their immediate vicinity; they lie at either end of the comparatively rigid rod of the dorsal vertebræ (9th–1st).

Fig. 166.

Fracture of the 11th dorsal vertebra, showing the usual displacement and complete laceration of cord and membranes.

In the body the line of fracture may take any direction, but in the lower vertebræ is almost always oblique, from above, downward and forward (Fig. 166); often the posterior surface is entire, the displacement being that the lower fragment falls backward (Fig. 166), and its upper posterior edge cuts sharply into the cord, though not into the theca as a rule. Comminution is common. Blood is more or less freely extravasated into the muscles, the spinal canal outside the dura, or round the cord itself. The cord may be in no way injured, displacement being slight or absent, but in these cases, at any moment, a movement may cause displacement; or it may be damaged to any degree between slight compression and complete division. Perhaps it is most common to find the cord somewhat flattened and widened, more or less pulpified and broken down by hemorrhage.

Symptoms.—Considerable shock is common; pain at the seat of fracture and often round the trunk at its level—much increased by movement; irregularity of the spine—*e. g.*, separation of two contiguous spines from anterior crushing of one or more bodies, or angular deformity from extensive crushing of the bodies or displacement backward of the lower fragments; perhaps swelling of soft parts round about from hemorrhage; crepitus is unusual, but may be felt by the patient as he is moved. In the great majority of cases of fracture of the body of a vertebra, the cord is implicated and the symptoms detailed under complete division will be present in greater or less perfection. But as even the physiological continuity of the cord is by no means always interrupted in fractured spine, paresis may replace paralysis, sensation especially may remain, and paræsthesia, hyperæsthesia, or pain may supplant anæsthesia, and these symptoms may be irregularly distributed—*e. g.*, one leg or arm may be affected much more than the other, one spot may be hyperæsthetic; spasms rarely occur; the nervous symptoms may not at first reach up to the seat of injury, but may subsequently extend to it or even higher; or temporary paresis or paralysis may occur on the second or third day, probably from œdema; or permanent mischief may result after perhaps a fortnight, owing to late displacement in cases in which the symptoms have been altogether doubtful. Thus Gurlt gives a case in which a man walked for two hours after fracturing the odontoid process and both arches of the atlas; some paralysis developed next day and he died suddenly on the eighth. Of 11 cases of fracture of atlas or axis, 2 died at once, 2 within one hour, and of the rest, 1 lived thirteen days; several died suddenly.

Diagnosis.—Paraplegia and pain at the fracture are the symptoms which usually draw attention to injuries of the spine. In severe shock or when there is insensibility from head injury or other cause, both will be overlooked. Irregularity of the spine might be found in the general examination which should when possible be made after any serious fall; but the possibility of fracture without displacement renders necessary great care in moving cases in which such is likely to be present.

Treatment.—A case of fractured spine should if possible be kept on the stretcher until a water-bed is ready to receive him, this being the best preventive of bedsores. In cervical fractures it is necessary by a sand-bag beneath the nape and others on the side of the head to insure immobility; on *no account* is the head to be moved once it is satisfactorily fixed. In all fractures of the spine the less the patient is moved the better. The patient must be kept lying for at least two months, often more. At first the diet should be very low, as in head injuries. The bowels will generally require aperients at first, and the urine must be regularly drawn off three or four times a day. Too much care cannot be taken as to the purity of the catheter; a silver instrument kept in carbolic is the best. The plan of immediately applying some antiseptic dressing to the penis is worth trial. Tympanites may be relieved by enemata of peppermint or of turpentine and gruel.

When the patient is suffering great pain (B. Hill, *Trans. Clin. Soc.*, 1881), or when there is much displacement, extension may be made, the fracture reduced, and in lower dorsal and lumbar cases, the trunk enveloped in a plaster-jacket. This has usually been done by carefully slinging the anæsthetized patient from Sayre's tripod (Fig. 170); but probably lifting the patient on to a table, making extension and counter-extension from the feet and shoulders, and applying a jacket as advised at p. 478, would be as efficacious and safer. In lifting these patients and endeavoring to reduce deformity, remember that the upper fragment should pass backward, the lower forward; movements in the opposite directions would probably destroy the cord. Good results have been obtained.

When, from the direct nature of the violence and physical signs, it is likely that paralysis is due to a depressed spine or neural arch, and especially if sensation is not lost, it would be right to cut down freely in the mid-line and remove any compressing bone. Of forty cases only three were benefited (Ashhurst), but antiseptics will probably make a difference.

The treatment of fractures of the cervical spine is similar to that for dislocations; but the difficulty in preventing recurrence of displacement is greater.

Pure Dislocations of the Spine are almost always confined to the cervical region, especially the 4th and 6th vertebræ; the occipital may be displaced from the atlas.

Cause.—Extreme flexion from accidents similar to those which produce fracture; the upper vertebra moves forward and downward on the lower till its lower articular processes lie on the pedicles of the bone below, hooked in front of its superior articular processes (*luxation by flexion*, Hüter). Sometimes the force imparts a movement of lateral flexion to the cervical spine; the lower process on the convex side of the spine of the upper vertebra then passes upward and forward on the oblique plane with which it articulates, and finally slips in front of the latter on to the pedicle of the lower bone (*luxation by rotation*, Hüter). Strong muscular effort may cause this. The intervertebral fibro-cartilage often tears off a layer of bone from the displaced body, or slight fractures of processes occur in otherwise pure dislocations.

Symptoms.—In *luxation by rotation* of (say) the right inferior articular process of the 4th vertebra the head will incline fixedly to the left shoulder, the chin remains in the mid-line, the line of the spines seems undisturbed; a finger feels the right half of the vertebra projecting more or less beneath the mucous membrane of the pharynx, and swallowing is somewhat difficult. Usually there are no cord symptoms, but paralysis or pain from pressure of the right inferior process of the 4th upon the 5th nerve is likely to occur.

In *luxation by flexion* the head is much bent forward, the chin in the mid-line, the extensors of the head and neck tense and prominent, often preventing the spines above the gap due to the dislocation from being felt; a finger in the mouth feels a very marked prominence formed by the body of the upper vertebra, and swallowing is difficult or impossible. More or less compression of the cord is almost always present, and often it is fatal; there may be irritation of issuing nerves. The diagnosis from fractures with similar displacement is impossible.

Treatment.—(Hüter.) In *luxation by rotation* bend the head fully down toward the shoulder, then rotate the ear of this side forward, the opposite one backward. Thus in the above example the right articular processes would first be unlocked, and then the upper would be carried back into position over the lower. In *luxation by flexion* convert the case into a luxation by rotation by the above manipulation upon one side; and then by repeating it on the other side complete the reduction. In this way Hüter successfully reduced three cases, of which one lived. Before attempting this treatment the patient or his friends should be told that death may occur during it, especially in luxation by flexion.

The patient should be anæsthetized slowly and carefully for these and similar operations, involuntary movements being carefully guarded against. After reduction the neck should be fixed by a collar of flannel steeped in plaster cream, fixed by plaster bandages which should include the shaven head and pass under each axilla.

Acute Traumatic Spinal Meningitis is rare. *Causes:* septic wounds, the opening of the meninges by a sloughing bedsore or spina bifida, or pyæmia; it may extend from the base of the brain (p. 452) or, on the other hand, extend through the foramen magnum.

SYMPTOMS.—Onset insidious or attended with rigors and symptoms of high fever; more or less intense pain along spine, shooting into limbs and much increased by movement; rigidity of voluntary muscles often causes slight opisthotonos and risus sardonicus, and tetanic spasms may occur. Incontinence of urine and feces usually early. Ultimately spasm gives way to paresis; and pain, hyperæsthesia, and various paræsthesiæ are lost in diminished sensibility. But pain, fever, restlessness, delirium, and progressive paresis of sense and motion may be the chief symptoms. Death generally occurs within a week.

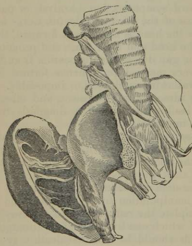
TREATMENT.—As for cerebral meningitis; take special care against bed-sores; watch the bladder lest it become distended.

MALFORMATIONS OF THE SPINE.

SPINA BIFIDA OR HYDRORACHIS. PATHOLOGY.—In this affection the spinous processes and laminæ of some of the vertebræ are cleft or deficient. The spinal membranes deprived of their ordinary support yield to the pressure of the subarachnoid fluid and bulge out, forming a fluctuating tumor in the mid-line of the back.

In the great majority of cases the spinal cord crosses the interior of the sac, and adheres to its posterior wall; the nerve-roots arise from the flattened continuation of the cord in the wall of the sac and pass thence forward, below the emerging cord to gain their proper foramina (Fig. 167). The subsequent disposition of the nerves is normal.

FIG. 167.



Structure of spina bifida. The highest structure crossing the sac is the spinal cord thickened by some nerve-roots which arise from it and run forward applied to its sides; the nerve-roots below arise from the median portion of the sac-wall.

As a rule, the median portion of the sac is not covered with true skin, but by a structure devoid of hairs and glands; elsewhere the sac is formed of the spinal membranes covered by the common teguments. More or less cerebro-spinal fluid is contained in the subarachnoid space. This condition named *meningo-myelocele.*

Sometimes a depression or "umbilicus" exists on the summit of the sac;

this marks the point at which the cord is attached to the sac-wall, but the absence of an umbilicus does not show that the cord is not involved in the sac-wall. The same is true of a longitudinal depression which, if present, marks the line of origin of the nerve-roots from the sac-wall.

The implication of the spinal cord is often shown during life in the paralysis, more or less complete, of the lower limbs with loss of power over the bladder and rectum. Now and then the sac is more or less completely divided by membranous partitions.

This is the usual anatomy of spina bifida, but two other cases demand notice.

In *spinal meningocele* the protrusion consists of the spinal membranes only, the cord and nerve-roots being unconcerned in the malformation. The sac communicates with the subarachnoid space, but the cord and nerve-roots lie in the vertebral canal.

In *syringo-myelocele* the central canal of the spinal cord is greatly dilated, and forms the cavity of the sac; the nerve-roots arising from the expanded cord run in the walls of the sac to reach their foramina.

In their course forward, they lie between the pia mater of the cord and the visceral arachnoid, which last is invested with dura mater and skin, as in the more common form of the affection. (For this account I have to thank S. G. Shattock, F.R.C.S., Curator at St. Thomas's.)

These deformities are connected with imperfect closure of the neural groove in the fœtus. So incomplete may this be that the central canal opens upon the surface of the sac; usually it is closed, but the cord remains adherent to (not differentiated from) its membranes at this spot, and when they are driven by accumulation of subarachnoid fluid through the opening in the laminæ the cord passes out with them (*meningo-myelocele*); lastly, the cord may be differentiated from its membranes before these yield and swell up through the hole in the laminæ (*spina-meningocele*).

The early date at which these malformations occur is shown by the cases of sacral meningo-myelocele; for the cord ceases to occupy the sacral portion of the canal after the third month.

Spina bifida is rather more common in females; it may occur anywhere from the atlas to the coccyx, is most frequent in the lower half of the spine, and especially so in the lumbar region. Many laminæ, or even all, may be deficient. Rarely two tumors are present. The deformity is most common in the first-born, and may be repeated once or twice in a family.

SYMPTOMS.—A swelling as small as a Maltese orange, or as wide across as the back (Fig. 168), sessile (occasionally pedunculated); and it may be covered by normal skin, but usually the central strip (from side to side) of the sac is different in appearance and obviously thinner than the rest; the whole of the strip may be depressed, or only an umbilicus may be present; all may be thin, tense, and bluish, or widely ulcerated. The tension of the sac varies much, diminishing as the pelvis is raised, increasing with crying, straining, or coughing. The contents may be freely or but slightly reducible; fluctuation may be obtained from the swelling to the ant. fontanelle; pressure on the sac may cause convulsions.

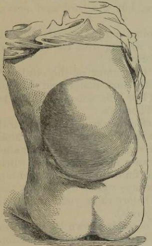
Some sacs are so translucent that the shadows of the cord and nerves may be distinguished; the groove or pit above mentioned shows the attachment of the cord to the sac; but in many cases it is quite impossible to say whether or not the cord is in the sac.

COMPLICATIONS.—Very often paralysis of the lower limbs, talipes (especially calcaneus), or hydrocephalus; much more rarely, idiocy or some other malformation.

Terminations.—*Death:* the great majority die within a year, and most within a month of birth, from rupture and meningitis, marasmus, convulsions, or hydrocephalus. In a few cases *the swelling persists* unchanged, not interfering much with the duties of life. Still more rarely the swelling shrinks and its cavity is obliterated (*spontaneous cure*); this may happen after rupture and suppuration of the sac, perhaps after very grave symptoms of meningitis.

Treatment.—*Support* by collodion, cotton-wool and bandage, or hollow truss, and *repeated puncture* are simply palliative. *Ligature* or *excision of the sac*, with closure of the gap by a plastic operation, is suited only to simple meningoceles. The mortality, chiefly from meningitis, is considerable. *Injection with Morton's solution* (Iodi. grs. x, Pot. iodidi. grs. xxv, Glycerine, ℥j) is now regarded as the best treatment. To perform it, have the child held up rather high with its back downwards; pass a long, coarse hypodermic needle into the sac through the skin, a short distance to one side of the base of the swelling that subsequent oozing may be easily checked; let ʒij–iij of fluid run away, and then inject ʒj of Morton's solution. Keep the child with the swelling dependent for twenty-four hours. Repeat once a fortnight.

Fig. 168.



Showing the appearance of a spina bifida. King's College Museum.

Deformities of the Spine.

Those which will be considered under this head are not the result of caries, and are distinguished from *angular curvatures*, to which this gives rise, by the facts that they affect long lengths of the spine, and produce well-rounded, ill-circumscribed curves.

These spinal deformities are typical of a group as regards their pathology. Some do, though rarely, result from malformation of the bones, but in the great majority of cases the course of events, leading to permanent curvatures, appears to be this. The weight of the head and shoulders should be borne by the whole flat of the bodies of the vertebræ chiefly, but also by the articular processes. In these cases something, either frequently and for considerable periods or permanently, disturbs this distribution of the weight, which is thrown too much upon the bodies, upon the articular processes, or upon one side of the bodies and the corresponding articular processes. Intervertebral fibro-cartilages are compressed on one side, very slightly pressed upon the other; in the former situation they atrophy and perhaps disappear, whilst in the latter they become abnormally thick. Then the bones suffer similarly; they may be very greatly compressed from above down upon the concave aspect of a curve, excessively thick upon the convex, and they tend to develop more fully in other directions upon this side of least pressure. On the concave side the bodies often become sclerosed, and acquire protruding margins from osteophytes, which may blend across articulations and fix the vertebræ. When the laminæ are separated by flexion of the spine they may deepen markedly to close the canal; transverse processes or spines may articulate, and the articular processes may be greatly modified by undue pressure and excessive rotation. By these bony changes deformities, which could at first be corrected by muscular effort, are rendered more or less permanent.

Naturally abnormal pressure produces the greatest effect upon young, growing tissues, and especially upon too rapidly produced tissue, which we may presume to be abnormally soft. Further, in these cases of rapid growth the weight to be borne is unusually great. The result will be practically the same if the bones are softened by disease, or if healthy tissues are made to bear much weight added to that of the body. The addition of a weight, whether borne in the arms, on the head, shoulder, or back, necessarily throws unusual pressure upon some parts of the vertebræ, and must produce its effect if it acts long; but when the weight of the head and shoulders only has to be borne, all probably goes well until the muscles are fatigued, then they cease to take their parts, and the bones glide into faulty positions until checked by ligaments and bony processes, upon which the *whole* strain falls and *for long periods*. Even these yield under such circumstances and the deformity gets worse as above described.

The fifth lumbar may be actually displaced upon the sacrum by carrying weights on the back (see Lane, *Trans. Med. Chir.*, 1884, for the effects of weight-carrying).

One deformity often entails others, and this is nowhere more conspicuous than in the spine; for it is of paramount importance in the upright position to keep the weight symmetrically distributed round the line of gravity, and to enable the patient to turn the face forwards; hence a primary curve which interferes with these is generally corrected by one or two *secondary curves*, the result of muscular action.

Posterior Excurvation or Kyphosis (stooping).—In this the dorsal convexity is increased, and perhaps the lumbar concavity lost or exchanged for convexity. Dorsal kyphosis is compensated by cervical and lumbar lordosis.

Causes.—A slouching habit or occupations requiring constant bending forwards. Simple muscular weakness, seen in young, often rickety, children, after severe illness, and in old age. Rarely, infantile paralysis affects the back muscles; rarely, also, progressive muscular atrophy. Rheumatoid arthritis, which causes ossification of the anterior common ligament or union of adjacent bodies by smooth rounded osteophytes at one or both antero-lateral angles; but simple pressure also gives rise to osteophytes. *Osteitis deformans* (p. 286) affects the spine in this manner and early. A few cases in adults, without obvious cause, have been called *spondylitis deformans*, or, from the fact that bodies have been found ossified (Fagge), *synostosis of the vertebræ*. In these and other cases in which osteophytes occur, they may press on nerves, and cause severe pain, increased by jarring (D. Colley, *Trans. Path. Soc.*, 1885).

Treatment.—Common sense suggests the remedies in cases due to habit, occupation, weakness of muscle. A plaster-jacket may relieve pain and check advance in rheumatoid arthritis or spondylitis deformans.

Posterior Incurvation or Lordosis.—The lumbar spine is usually affected, its convexity being increased.

Causes.—In some it is natural, in others (acrobats) developed. It is compensatory in kyphosis and ankylosis of the hip in a flexed position, and is very characteristic in double congenital dislocation of the hip. Rarely it occurs with lumbar caries.

Treatment.—In hip ankylosis it may be well to divide the neck of the femur and bring the limb down straight.

Lateral Curvature or Scoliosis is by far the most important spinal deformity.

Morbid Anatomy.—Usually we find an S-bend of the spine, the lumbar half being convex to the left, the dorsal convex to the right; in about ten per cent. the curves take the opposite direction (Little). The vertebræ are rotated more or less so that the bodies are turned *towards the convex aspect*, and consequently the spines are turned towards the mid-line from which the lateral curve has taken them. Hence, the sigmoid curve of the spines is usually much less than that of the bodies. The rotation may rarely be so great as to cause the sides of some bones to look forwards and backwards. The changes in fibro-cartilages, bodies, and articular processes due to excessive pressure on one side and to rotation (p. 470) are marked in proportion to the deformity. Looked at from above, a vertebra from the centre of a curve is often obviously asymmetrical; a line through the spine has much more of the body lying on the convex than on the concave side, this increased lateral growth adding to the convexity of the curve without affecting the line of the spine.

Thoracic deformity may be extreme, and results from the connection of the ribs with the vertebræ. The right ribs, like the transverse processes, diverge so that they are more horizontal than their fellows, and the intercostal spaces are wider; their angles project posteriorly, displacing the scapula, and are more acute than normal. The right side of the thorax is flattened, especially anteriorly. The left ribs converge and are depressed, the lowest may be below the iliac crest; their angles are less prominent and more obtuse than natural; the left side of the chest is the wider from side to side, and the left cartilages project.

In severe cases the dorsal curve much exceeds the lumbar, and with the angles of the right ribs projects so strongly as to produce a gibbosity (*kypho-scoliosis*) which may be quite as great as any caused by caries. There may be three, four, or even five short curves instead of the typical two.

The viscera, especially thoracic, suffer much displacement, and the aorta is bent like the spine; usually no symptoms arise.

Symptoms.—The following are usually first noticed: elevation of right shoulder, lessening the hollow between neck and shoulder; projection of right scapula, especially lower angle; projection forwards and outwards of left breast; prominence of left hip, a marked hollow above right. Weakness, often some aching of back; actual pain is rare even in advanced cases, but may be severe from nipping of issuing nerves. Weakness may be so great that on removal of her support the patient will drop, the spine falling into curves. The spinal furrow is serpentine, the line of spines more or less so, the right ribs raised and their angles prominent; this and the resistance due to the dorsal right transverse processes afford much more reliable evidence of rotation than sinuosity of the spines. The patient should stoop a little and cross the arms during the examination.

At first the deformity disappears on suspension or lying down; when bone changes have occurred, no real improvement is thus effected.

Advance may be checked at any stage, but its tendency when untreated is to increase. At first, with a flexible spine, it often makes rapid progress, but is checked by completion of growth. Sometimes the deformity increases again late in life without obvious cause.

The deformity resembles angular curvature only in advanced stages; the *diagnosis* is made by demonstrating rotation of the vertebræ. The humps of most *old* people are due to lateral curvature.

Pathology and Etiology.—This deformity is very rarely congenital, occurs with equal and moderate frequency in girls and boys under eight, and is very common in girls between ten and sixteen, and occasional cases occu in males. It rarely, if ever, begins after twenty. It is very much commone among the well-to-do and sedentary than among the laboring classes. The patients have often "outgrown their strength;" a considerable number, however, appear in good health and muscular.

Congenital cases are usually due to the presence of wedge-shaped pieces of bodies; if not, intrauterine pressure may be responsible. In children under eight, signs of rickets are said often to be present; Adams detects hereditary influence in them, and Birch-Hirschfeld inclines to attribute some to imperfect growth of vertebræ. Contraction of scars, retraction of chest after pleurisy, empyema, and fibroid lung changes may curve the spine. The curve is compensatory in cases of wry-neck or oblique pelvis from shortness of one leg or fixed adduction of the hip. Spasm is a rare cause in girls from ten to twenty, and often hysterical; the curvature, though well marked, disappears if the patient's attention is distracted (Little, Holmes's *System*). But the above causes do not account for the great majority of cases in girls from ten to sixteen. These are probably due to fatigue of muscle, on account of weakness or overloading, and the consequent assumption of a faulty position (p. 470) in which ligaments and bones do duty for muscles. In the upright position, the girl will "stand at ease"—*i. e.*, throw the weight upon the right leg, and let the pelvis drop back and to the left till it is fixed by the ilio-tibial band and Bigelow's ligament. The spine is thus thrown to the left. To place it symmetrically with regard to the line of gravity it is raised by muscles and drawn well over this line, a lumbar curve, convex to the left, being produced. To make the head and neck vertical, the cervico-dorsal spine is drawn back again to or past this line, a dorsal curve, convex to the right, resulting. The cervical spine now ascends in the line of gravity or its upper end reaches this line by a slight curve, convex to the left. These different curves form almost simultaneously, yet the lumbar curve must precede and necessitate the dorsal. In other cases the dorsal region may be first affected, as when curvature is traceable to pleurisy or to prolonged writing, with the pelvis square to the table, the spine being rotated to the right and flexed to the left.

The curves result from the action of muscles on their concave sides, and these (especially the multifidus and ext. oblique) naturally rotate the bodies away from themselves. The dorsal articular processes are suited to this movement, which occurs when the ribs of one side are simply squeezed together; whilst the lumbar are strongly opposed to rotation. It seems likely, however, that the two lateral curves, distinct rotation of the dorsal, and the strong bias in the opposite direction of the lumbar bodies are due to the action of muscles endeavoring to correct the effect of faulty position assumed because of muscular fatigue, of other deformity, or merely as a bad habit. Once formed, the superincumbent weight of head, shoulders, etc., tends to exaggerate both the lateral flexion and rotation; consequently we find the muscles on the convexity of the curves tense in advancing cases, indicating an attempt to check increase. This seems to be the pathology of an ordinary case; but it must be admitted that the problem is a very complex one.

It is usually assumed that, so long as the deformity can be rectified by voluntary effort or by recumbency and extension, there is no bony deformity.

Treatment.—First ascertain what the patient, without or with assistance, can do in the way of rectification; if an apparently normal position can be maintained, even for a few seconds, practically complete recovery is probable; but if it cannot be assumed, perfect cure is impossible.

1. Strengthen the patient by good diet, sea air, steel, cod-liver oil, or phosphate of lime, and cold bathing if it is well borne; early rising and retiring, and the use of a hard mattress. See that no garment fits so as to oppose improvement. Examine for flat foot, and order proper boots and valgus pads.
2. Walking, running, and skipping should be practised frequently, out of

doors, but always stopping short of fatigue. After such exercise the patient should lie, prone or supine, on a flat couch, of which the head-end is raised moderately; if the arms are passed through armlets, some extension on the spine is kept up. Standing still should be prohibited; when unavoidable, the feet should be well apart to avoid the "at ease" position. The patient may sit at a Glendenning's adjustable school-desk, the sacrum and scapulæ touching the moulded back, the desk being at fifteen degrees for writing, forty degrees for reading, and slid up over the thighs, which must not be crossed. All bad positions must be avoided; the patient must lie down before she fails to maintain the spine erect. 3. The back-muscles in particular must be strengthened by douching with cold salt water, friction, and massage; also by suitable exercises from Ling's system (Swedish gymnastics). Thus the patient lying supine on a table, the surgeon raises the trunk to sixty degrees by a hand beneath the neck, the patient resisting; then the patient performs the return movement, the surgeon resisting. Again, the patient lying supine or prone circumducts first one hip, then the other, with help or against resistance according to strength. When fairly strong, the legs may be attached to a table over the end of which the body hangs prone; it is to be raised slowly toward the horizontal. Each movement is gone through eight to twelve times; and about an hour daily is spent upon these and similar ones (Roth, *Brit. Med. Journ.*, 1882, vol. i. p. 691). Especially should that one which brings the spine straight be practised; the position of the arms is often the key to this. Barwell's suggestion that the patient should sit on a seat moderately raised on the side to which the lumbar spine curves, points to an excellent exercise.

Mechanical support should be used only when the above plan has failed, and it becomes necessary to check advancing osseous deformity. The support should be as simple as possible, should support the abdomen, but not compress the chest.

Roth states that the above treatment usually gives a satisfactory result in one month when there is no bony deformity; in three when this is very moderate. But the exercises should be persisted in after this.

Caries of the Spine and Angular Curvature.

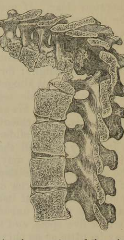
The spine is the commonest seat of ordinary tubercular caries or rarefying ostitis (p. 317), and exhibits typically all its phases. The disease may be excited by injury, though usually there is no distinct history of such. It exhibits its well-known partiality for growing cancellous bone by affecting almost exclusively the *bodies* of vertebræ, the lower, larger, dorsal and lumbar rather than the higher bones; and usually in children from two to twelve years; it is rare in the first year and after the completion of growth, but may occur even after mid-life. Probably the dorso-lumbar region most frequently suffers, though Billroth says the mid-dorsal. Occasionally processes only are diseased, especially the articular in the neck.

Morbid Anatomy and Pathology.—The morbid process (for "Microscopy" see p. 318) is thought to begin usually upon the anterior, upper, or lower surface of the body of a vertebra, in the growing tissue beneath the periosteum or cartilage, and thence to invade the substance of the centrum. The slightly vascular fibro-cartilages may be invaded early, but very often, in advanced cases, comparatively sound disks project between the deeply eroded bodies; the disease rarely, if ever, starts in them. Only one vertebra may suffer or several; the caries usually eats deeply into, or even through, their substance, but may remain superficial; as a rule, there is only one focus of disease, but there may be two distinct foci, or many, scattered on the surface of adjacent vertebræ.

When caries affects merely the anterior surfaces of several vertebræ, no deformity results.

But as granulation tissue replaces bone, the bodies become unable to bear the weight of the head and shoulders, and the vertebræ above the disease sink down toward those below; thus a prominence (*Pott's boss*, Fig. 169) of the spines is produced which is sharp or rounded according as few or many bodies are eroded. Compensatory curves follow (lordosis in unaffected regions) to keep the face directed forward.

Fig. 169.



Angular curvature of the spine. King's College Museum.

The disease may run the course of a "simple" caries—*i.e.*, no suppuration occurs, but the granulation tissue ossifies, and the displaced and mutilated bodies become united by sclerosed bone. In a very large number of cases among the poor, however, either a dry cheesy mass or a chronic abscess results. Healing may still occur and the abscess dry up; but as a rule it increases and presents on the surface. These *cold abscesses* extend along lines of least resistance, usually taking arteries or nerves as their guides, and avoiding strong fasciæ, so that their course may often be foretold. From the cervical bodies pus may form a retropharyngeal abscess, or run into the posterior mediastinum, or, extending outward, present in the posterior triangle. From the upper dorsal bodies, pus either collects in the post. mediastinum or passes back along a dorsal intercostal branch and points in the back. From the lower dorsal, fluid runs beneath the pleura, and enters the sheath of the psoas (*psoas abscess*), as also does pus from lumbar bodies, carious where slips of the muscle are attached, and, destroying the muscular substance, it sinks toward the thigh; it may either pass out into the iliac fossa beneath the fascia, or beneath Poupart's ligament just outside the artery under which it usually turns down and in along the profunda; but it may pass back along the internal circumflex and present on the buttock beneath the lower part of the gluteus max. Pus from the side and front of the lumbar bodies commonly runs along a lumbar artery beneath an arch of the psoas, and passes between two transverse processes into the back, behind the quadratus (*lumbar abscess*); or it may descend along the great vessels into the pelvis and present through the great sciatic foramen or in the perineum, or burst into a pelvic viscus. (For "Morbid Anatomy" see p. 78.)

Abscess connected with a carious process appears in relation with it.

Sequestra from necrotic caries (p. 318) may be locked in among the bodies and prevent union. There is, as a rule, no means of diagnosing their presence.

Not uncommonly, when caries reaches the posterior surface of the bodies, a button of granulation tissue protrudes into the canal and compresses the cord, causing more or less complete paraplegia, followed by signs of descending sclerosis. This is much commoner than compression of the cord by displaced bodies. Issuing nerves may be involved in the inflammation.

SYMPTOMS.—At first a child ceases to run about and play, and walks cautiously with a stiff back; then he seeks assistance from objects of furniture, etc., and, these failing, stoops forward, places his hands on his knees, and supports the shoulders and head with his arms. He fears all jars of the spine, and in lying down or rising places much dependence on the arms. Children rarely complain of pain in the back, but sometimes they suffer from constant bellyache, pains down the legs, or along cervical nerves, or painful constriction of the thorax—symptoms which should always be carefully inquired into.

On examination there may be such projection of spines as renders the diagnosis clear. If not—and it is of the greatest importance to recognize the disease before deformity appears—tapping all down the spines may reveal a tender spot, as also the application of a hot sponge; but these signs are best marked in older patients. Stiffness of the spine is shown by causing the child to pick up something from the floor, or to touch his toes whilst his knees are straight; for the former purpose he will bend knees and ankles fully, he will fail altogether in the latter, and in both it will be seen that he holds a considerable segment of the spine stiff. When laid flat he cannot rise without using his arms; he will not jump freely from a small height on to his heels. Movements of rotation are absent in the affected part. Sudden pressure on the shoulders or rotation or extension of the spine causes pain.

In every case all the seats of abscess (p. 475) should be carefully explored, for abscess may be the first positive sign. It will be noticed that the above symptoms depend upon tenderness of the weight-bearing surfaces of the bones; a focus of disease limited to the anterior or lateral surface would hardly reveal itself, and an abscess springing from it would be regarded as *possibly* unconnected with bone. In this case pus may point at four or five spots, and two or three quarts may be present; and yet there may be little or no curvature.

Adults must be examined like children. They usually suffer more pain and are more sensitive to tapping and heat.

In the neck the symptoms are usually plain. The disease begins almost always in childhood, but may be of long duration. The part is held stiffly, and the whole body is turned to look to one or other side. To lie down or get up, the patient turns sideways and supports the head with one or both hands. There may be dull local pain and some swelling posteriorly. Pain along cervical nerves is very characteristic—*e. g.*, along one or both great occipitals in atlanto-axial disease. Hüter states that the articular processes suffer much more frequently here than elsewhere, and that this is the cause of the wry neck frequently met with in cervical caries. If there is much angular curvature the head is extended and the dorsal convexity undone. Abscess must be looked for. If the movements of nodding and of rotation of the head are free, the disease must be below the axis; caries above this is rare.

DIAGNOSIS.—In the cervical region, muscular rheumatism and wry-necks from the presence of glandular swellings and abscesses may occasion difficulty; also a form of wry-neck not uncommon after rheumatic fever, which is usually cured by blistering. Lower down, difficulty is most often met with in young children, who have an ill-defined curve; evidence of pain, spontaneous or on movement, is here very important. Indeed, any severe enduring pain on one or both sides, running from the spine, should always suggest the possibility of caries. For a long time, especially in adults, there may be no curve, or such prominence as there is may possibly be physiological. For the diagnosis from lateral curvature, which may be accompanied by severe pain, see p. 472.

When an *abscess* presents in any of the ordinary positions of a spinal abscess, it must be regarded as spinal unless this source can be distinctly negatived. Most difficulty is experienced in the groin, where psoas and iliac spinal abscesses present. They may be confused with abscesses of lymphatic glands, hip-joint abscesses, especially that running up beneath the ilio-psoas; enlargements of the bursa beneath the ilio-psoas; abscesses about the cæcum, or arising in the connective tissue beneath the iliac fascia or, it is said, from simple myositis of the psoas; abscesses from pelvic cellulitis or disease of the hip-bone, and rarely with perirenal abscesses, or even empyemata that have gravitated to the groin. Spinal abscess often causes persistent flexion of the hip when it enters the psoas; but the hip is easily shown to be normal.

PROGNOSIS.—*Cæteris paribus*, this is worse after than before puberty. The general health and ability of the patient to carry out treatment are of first importance. If abscess does not form, the outlook is very favorable, general or some other local tuberculosis being the chief danger. When abscess is present, aseptic treatment wards off the extreme dangers of acute septicæmia and hectic; but it must be admitted that many children recover in spite of long, suppurating sinuses. The amount of deformity depends largely upon the treatment and the time when it is begun.

TREATMENT.—In addition to the hygienic treatment necessary in all tubercular diseases of bone (p. 286), absolute rest of the part is essential. There can be no doubt that recumbency best secures freedom from pressure and friction, and the prone position is preferred. But health may suffer under these conditions, and among the poor the necessary attention cannot be given to children. Often, therefore, a support is required, which will give sufficient rest to allow healing to take place, whilst the patient walks about without pain. None is equal to Sayre's plaster-jacket in cases of disease below the mid-dorsal region; when the disease lies higher, the corset does not get a sufficient hold upon the part above effectually to support it. For these latter cases, Sayre introduced the contrivance known as a "jury-mast"—a thin rod of iron, fixed to the back and loins, and bent forward some inches above the patient's head; to a swinging crossbar attached to the point of the upper end, the head is slung by straps, and its weight is thus removed from the spine and carried along the jury-mast to the pelvis; but the movement of rotation of the atlas on the axis is permitted. As a cheap substitute for the jury-mast, the loop of iron shown in Fig. 170 is used at King's College Hospital.

It is obvious that the rest these jackets give is far from perfect; they constrict and prevent the development of the thorax, and throw undue stress upon the abdominal rings, they are liable to rub the patient into sores, and frequently get extremely filthy; yet they are often the best means of treatment at our command, and are much superior to the old spinal supports in cases where recumbency and good air cannot be obtained. The existence of abscess or of sinuses is no bar to their use, for windows can be cut for the latter; or the corset may be made in two pieces, hinged behind, and a dressing can be applied beneath it. In these cases, poroplastic corsets are often employed by those who can afford them.

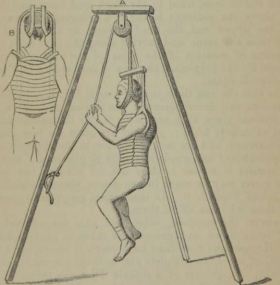
When, however, the occipital, atlas, and axis are affected, the patient must be kept lying down, and precautions taken to prevent all movements of the head. Krohne and Sesemann have recently shown me a splint which would, I think, afford more complete rest to the spine than can be obtained in any other way. It consists of a double Thomas's splint (Fig. 134), and from the upper crescent bars are carried up behind the neck to support a padded plate, upon which the occiput rests, and to which the head may be fixed by an encircling band. The patient must always be kept horizontal, but may be lifted and taken out of doors freely. He must lie upon a feather bed, or air or water mattress. It seems likely that this splint would safely reduce deformity to a minimum, or, if applied early, prevent its occurrence.

The application of a Sayre's jacket.—Sayre, at first, swung his patient as shown in Fig. 170, and rapidly rolled a plaster bandage round him; later, only such traction upon the head and shoulders was made as rendered the patient more comfortable. Now, all such slinging is done away with, and corsets are applied with the patients lying on their backs. The following method is very good:

The child having been well washed, make a close-fitting jersey of boracic lint, fitting well up into the axillæ; lay six or eight layers of a towel over the soft part of the abdomen, as a "dinner-pad," and then draw the jersey tense by a bandage pinned to it and passing under the perineum.

Cut a piece of bandage long enough to reach from the first dorsal spine to the sacrum, one inch above the trochanters, and another one and a quarter the girth of the trunk at its widest; lay them in the shape of a T on a table a little wider than the latter piece. Next soak two to three inch bandages in mucilage (B. P.) diluted one-half, squeeze them slightly, cut them into lengths equal to the one and a quarter girth, and lay them on the table so that each piece shall cover about two-thirds of its predecessor, till the length of the jacket is made up. Then lay over the ends of the slips, on either side, a strip of ordinary bandage, and commence above again to lay down a second set of plaster slips. This is enough for small children; it can be strengthened at any level or throughout by a third layer. All this is done with the aid of an assistant, standing opposite the surgeon, who takes the end of the bandage, unrolls it from the surgeon's hand, and puts it into position on his own side; the surgeon cuts the bandage into proper length.

Fig. 170.



A, tripod for the application of Sayre's bandage; B, iron loop for supporting the head in ditto.

The patient is now laid upon the table so that the longitudinal bandage corresponds to the part of the spine it represents, and the arms are drawn well up over the head to expand the thorax. Starting below, the surgeon and his assistant take the ends of the most superficial slip, draw it tight beneath the back and fold the ends in over the hip-bones and hypogastrium, and so on in succession up to the top. Next, six or eight previously prepared strips of tin are placed symmetrically on the trunk chiefly behind the mid-lateral line; they reach from the pelvis nearly to the upper edge of the jacket, and are held in place by the second layer of plaster slips, which are brought up like the first. Now remove the perineal band, draw out the dinner-pad, mould the case well down over the iliac crests and anterior spines, and leave the patient twenty to thirty minutes to dry. Then cut out the jacket under the arms if necessary, and it is finished. When a jury-mast is used, it is put in instead of the tins, and two layers of slips will be required outside it.

Thus we get such extension as it seems right to use; R. Davy, however, employs hammock-suspension—*i. e.*, puts the patient on his face in a hammock of which the ends are far apart, but which still tends to undo an angular curve, sometimes causing great pain and, no doubt, damage. The hammock is included in the plaster roller and slipped out afterward.

A jacket should wear at least three months.

Paraplegia from spinal caries is of good prognosis if early treated by recumbency. Rarely is an *abscess* met with clinically which is drying up and may be left alone; rarely, also, aspiration suffices to cure. Always examine the cavity with a finger, and if possible touch the diseased spine; in rare cases sequestra have thus been found and removed. Considering the difficulty there is in keeping a freely discharging sinus in the groin sweet, psoas abscess is often best treated by incision here and the passage of a catheter or sound to the upper part of its track to serve as a guide for a counter-opening in the loin; a tube is introduced here, and all pus having been expressed, the first opening is sewn up. It may be reopened and drained two days later if necessary, the first gush of discharge from the large cavity being then over. *Postpharyngeal abscess* has been opened aseptically by an operation like that for tying the carotid, the vessels being drawn out.

In cases of disease with abscess affecting the lumbar or even the 12th dorsal vertebra, Treves suggests (*Trans. Med. Chir.*, 1884) reaching the carious focus by the following operation. Make a two and a half inch cut an inch inside the outer edge of the erector, having its centre opposite the vertebra most diseased; divide the posterior layer of the lumbar fascia and any fibres of latissimus; draw the outer edge of the erector towards the spine; carefully divide the middle layer of fascia close to the transverse processes; divide the quadratus just outside the tip of the central transverse process, and also the anterior layer of fascia. The psoas is now seen; introduce a finger into it, working along the front of the transverse process until the body is reached. An abscess is usually opened long before this. The line of the transverse process is that of safety; a lumbar artery lies above and below it. A sequestrum may be found; direct drainage is established and iodoform may be applied.

The chief *causes of death* in spinal disease are: acute tuberculosis, phthisis, or other tubercular disease, septic wound diseases in connection with open abscesses, and exhaustion from hectic, bedsores, etc.

Syphilitic caries of the spine from gummatous infiltration of the bodies of the vertebræ certainly occurs; its frequency is as yet unknown. But in adults, if there is a history of syphilis, treatment from this point of view should be adopted.

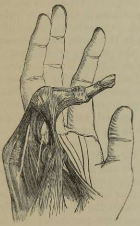
New growths of the spine are generally secondary. They may cause deformity by destruction of bone. Often they are discovered *post-mortem*; but if they press on spinal nerves, they cause excruciating pain.

CHAPTER XXXIV.

DISEASES OF THE HANDS AND FEET, CLUB-FOOT, AND OTHER DEFORMITIES OF THE LIMBS.

WEBBED FINGERS.—Union of fingers to each other even to their tips may be congenital, or caused by burns when it is most intractable. In the former case an incision must be made down the centre of the dorsal aspect of one finger, and down the centre of the palmar aspect of the other, and the flaps towards the web dissected up; the fingers are then separated, and each flap adheres by its base to the finger other than that from which it was taken, and is used as a covering for it. In cases from burns, the scar tissue will not bear transplanting. Mere division of the connecting skin is often of no avail, for the fingers grow together again when the wound heals. To counteract this, a flap of skin may be twisted from the dorsum of the hand to between the fingers (John Wood); or, a perforation may first of all be made in the connecting skin near the roots of the fingers, and prevented from closing by keeping a piece of tube in it till the edges have healed, and then the remainder of the connecting issue may be divided (Liston).

FIG. 171.



Dupuytren's contraction. From a dissection by Mr. Partridge in King's College Museum.

Webbed toes are of little consequence.

CONTRACTION OF THE FINGERS (*Dupuytren's contraction*) depends on shortening and rigidity of the palmar aponeurosis, as is well shown in Fig. 171, and does not depend upon contraction of the tendons nor of their sheath. The contracted fascia passes across like the string of a bow, whilst the tendons in their sheaths lie at a distance along the concavity of the curve close to the bone. It sometimes is accompanied by petty tumors on the fascia.

The disease is very chronic, often increasing steadily for years, usually beginning in the fifth and spreading to the fourth and third fingers. Most common in men. The influence of manual labor is doubtful, though in many cases it seems to be connected with repeated blows upon the part, and rarely with wounds. It is common in the well-to-do, and often seems to be associated with *rheumatoid arthritis* or *gout*.

The skin is closely incorporated with the band in bad cases, and presents numerous puckers where small offshoots are inserted.

TREATMENT.—Mr. Adams recommends—(1) "Subcutaneous division of all the contracted bands of palmar fascia that can be felt by as many punctures as may be necessary; the smallest tenotomy knife being passed under the skin and made to cut backwards. (2) Immediate extension of the contracted fingers, which with the hand are to be bandaged to a splint. (3) The bandage may be removed on the fourth day, when probably the punctures will be healed. But (4) an extension splint must be worn night and day for three weeks, and at night for three weeks more. Motion must be employed every day."

Mr. Adams seems (*On Contraction of the Fingers*, 1879) to have achieved excellent results by this method, as also have others in mild cases. But most surgeons have failed utterly with it when the skin has been closely adherent to the fascia. In these cases Goyrand's operation is the best. Render the part bloodless and make a longitudinal incision over and longer than the band; carefully dissect the skin from it, make transverse incisions in it whereever tight, and straighten the finger; remove any loose bits of the band; oozing from small vessels is generally free, so lay a horsehair drain from end to end of the wound, and unite the edges carefully with continuous horsehair suture. Dress antiseptically with pressure and fix to a straight splint. Remove the drain the next day, and leave the second dressing on for a week. Then the wound is healed; remove the stitches, employ passive movement, and the use of a splint for two or three weeks longer. (Quoted from J. Hardie, *Medical Chronicle*, p. 9, No. 1.)

A *congenital* contraction is sometimes seen in the fifth finger, apparently due to deficiency of skin in the direction of its length. No band is felt, no deep transverse furrows or puckers of the skin are seen. It yields to constant extension for several months, maintained by strapping the finger to a splint fitted to the inner side of the hand with a bar along the outer posterior edge of the finger. Other fingers may be affected.

WHITLOW OR PARONYCHIA is an acute inflammation of a finger, in many ways resembling a boil, probably starting almost always in the fibrous structure of the skin and subcutaneous tissue, and rapidly running on to suppuration and necrosis. It is very frequently due to infection of the cutis by some intense noxa through punctured wounds or fissures, perhaps scarcely noticeable. Thus they are frequent among surgeons, anatomists, butchers, cooks, and others liable to wounds and called upon to handle decomposing materials.

The tissue in which the inflammation is seated is peculiarly dense, especially upon the palmar surface of the fingers, where it is covered by a very thick layer of epidermis. Pus is consequently prevented from extending far laterally; if it reaches the surface it cannot burst through the epidermis but raises it widely into a bulla; but if it originate deeply, it may destroy the periosteum of the last phalanx, and cause caries or necrosis of it, or burst into the tendon sheath. Four varieties are accordingly described: the *subcuticular*, the *cutaneous* or *subcutaneous* (*P. cellulosa*), the *thecal*, and the *periosteal*. It is impossible to get certain information as to the point of commencement of the inflammation, but there seems no reason why an acute suppurative periostitis of the last phalanx, or teno-synovitis should not occasionally be primary.

Thecal abscess or suppuration in a tendon sheath is always grave; for the inflammation may extend widely along the sheath, perhaps to the common sheath of the flexor tendons beneath the annular ligament—a complication which is most likely to occur in whitlow of the thumb or little finger, but may occur by extension from any finger. The most favorable result of this accident is the formation of dense adhesions between the tendons and their sheaths crippling the finger or the hand; the least favorable results are necrosis and separation after long suppuration of pieces of tendons, caries and necrosis of the phalanges, and suppuration in the interphalangeal joints. Necrosis and separation of the sequestrum of course necessitate prolonged suppuration.

Lymphangitis, diffuse cellulitis, and lymphadenitis, simple or suppurative, are frequent complications, especially of the cases due to inoculation from dead bodies. Occasionally a death occurs from septicæmia, pyæmia, or exhaustion from prolonged suppuration and fever.

The SYMPTOMS vary with the depth and situation of the inflammation, being most severe when it is deep on the volar aspect. They are *pain*, often agonizing, throbbing, much increased by the dependent position; extreme *tenderness*, diffuse *redness* and tense *swelling;* the red lines and swollen glands of lymphangitis may be present; there is more or less fever, in the more severe forms perhaps 103°–104°.

The subcuticular is the form which occurs most frequently on the dorsal and lateral surfaces of the fingers, and not uncommonly pus forms beneath the root of the nail and then burrows widely beneath the cuticle.

When the tendon sheath becomes involved, symptoms of deep inflammation spread along its course, and the general state is much aggravated.

TREATMENT.—In the earliest stage of severe cases, rest and vertical suspension, or, if that is impossible, slinging the hand as high as may be; free application of belladonna and glycerine, and envelopment first of the finger then of the whole hand in hot fomentations changed every two hours; frequent bathing of the hand in water as hot as can be borne; a purgative, if necessary, and the administration of aconite.

In the slighter *subcuticular forms*, directly a dark or yellow spot appears beneath the cuticle, this should be removed and some moist antiseptic dressing applied; and when suppuration occurs beneath the nail, the earliest opportunity should be taken of carefully cutting a hole through it and letting out the pus. If swelling and pain continue to increase, remove the nail.

In *P. cellulosa*, if the above treatment does not speedily give relief, incision is urgently called for to prevent extension to the tendon sheath or bone, unless, of course, the pus has burst out beneath the cuticle, when the removal of this may yield sufficient drainage. The incision should be made carefully and not by a plunge into the tendon sheath, which may thus become infected ; but a rapid incision is necessary unless the part can be frozen or gas given. The exact point where the first drops of pus form may be found, if there is any doubt, by seeking the most tender spot with a probe. By the fourth or fifth day a slough is usually present, and its separation may be hastened by boracic fomentations.

Thecal abscess requires free openings and counter-openings into the tendon sheath, the latter made upon a probe, and so placed as to avoid digital arteries; a horsehair drain may be used along with boracic fomentations and boracic hot baths; or boracic irrigation through the sheath may be used. In severe cases it has been proposed even to divide the annular ligament. As the inflammation subsides, passive movement must be used to secure as much movement as possible.

A necrosed phalanx must be removed in pieces or entire when it becomes loose, the sinus being enlarged as may be necessary. When the ungual phalanx is gone the nail usually falls forward into the top of the finger, but a useful tip is left.

When a terminal joint is involved, ankylosis may be tried for; but ankylosis in the metacarpo-phalangeal or next joint is a great nuisance, the finger being always in the way. Excision or amputation must then be done.

The treatment of general complications presents nothing special.

ONYCHIA, OR INFLAMMATION OF THE MATRIX OF THE NAIL, is in no way separated from paronychia, cases of onychia often ending as subcuticular paronychia (P. ungualis). In *onychia simplex*, after a good deal of pain in many cases and symptoms of inflammation, a slight purulent discharge escapes from a fold round the nail, and it is generally found that the latter has been undermined and loosened. In other cases a pale yellow spot is first noticed beneath the nail, indicating the presence of pus. In the first case, overhanging nail should be removed and the part kept dry with iodoform ; in the second an opening must at once be made through the nail.

Fig. 172.

Onychia maligna. From a cast in King's College Museum.

Severe chronic forms, usually due to syphilis — acquired or inherited — or to scrofula, are called *onychia maligna*. A foul ulceration slowly separates the nail, which may long remain attached at one point, acting as an irritant to the granulations and forming a recess in which matter putrefies. The end of the finger often becomes much swollen, so as to look like a drum-stick (Fig. 172). There may be much pain, especially at night, and children chiefly suffer.

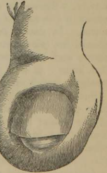
Treatment.—Attention to the general health, especially in the strumous. Removal of the nail or its remains; the application of an antiseptic ointment, especially iodovaseline, or a mercurial ointment in syphilitic cases. An endeavor to reduce the size of the finger-end by firm strapping may be made.

Ulcers about the Nails.—A very common and troublesome affection is that popularly termed "*ingrowth of the nails*," which usually occurs in the great toe. It is not due to any alteration in the nail, as its name would imply, but the contiguous soft parts swell and inflame from constant pressure by tight shoes against the edge of the nail. If this continue, suppuration occurs, and an ulcer forms, with fungous and exquisitely sensitive granulations, in which the edge of the nail is embedded, often producing so much pain as to prevent walking. The pus decomposes, irritates the ulcer, and bags beneath the edge of the nail, which becomes more and more detached from the matrix.

Treatment.—The preventive treatment consists chiefly in the wearing of square-toed boots, to avoid lateral pressure; but a few cases occur in which there appears to have been no error in this direction. It is said, also, that the nails should be cut straight across, the angles being left so long as not to be overlapped by the skin.

If the disease threatens or has just started, complete rest should be given ; soften the nail well by soaking in warm water, and shave it as thin as possible that it may yield before rather than resist lateral pressure; a touch of caustic to any ulcer and then dusting with iodoform will soon bring about healing. In more advanced cases, where pus is burrowing beneath the nail, an almost painless cure may be effected by carefully cutting away just so much nail as is undermined, snipping off granulations, and dressing with iodoform; or painting with strong solution of perchloride of iron acts both as antiseptic and astringent. In the worst cases this is not sufficient, and the nail grows up again before the ulceration has healed ; it is then necessary to remove half or even the whole nail. If the disease still recur, the *whole* of the overlapping fold of skin and granulations must be removed. Some surgeons prefer this to removal of the nail.

Fig. 173.



Exostosis of the toe. See Annandale on "Diseases of the Fingers and Toes," 1865.

Subungual Exostosis.—A fibroma or fibro-enchondroma, which subsequently ossifies, is not uncommon on the dorsal surface of the last phalanx of the great toe (Fig. 173). To cut away a sufficient portion of the nail, and dissect the tumor out, separating it deeply from the phalanx with a gouge, is the only effective treatment.

Genu valgum and Genu varum, or Knock-knee and Bow-knee.—Genu valgum is much the commoner, but genu varum is not rare. These deformities are of two kinds: (1) the *rachitic*, developing in early childhood, and usually in connection with other signs of rickets; (2) the *static*, developing about puberty from standing under too heavy loads. In both cases probably the primary fault is muscular fatigue, from this follows undue strain upon the ligaments and upon the outer or inner half of the joint surfaces; which side shall suffer is probably determined by slight differences in the plane of the knee-joint either original or acquired by curvature of the tibia, etc. The line of weight falls normally from the head of the femur through the centre of the knee and ankle; pressure is therefore equally distributed in the two condyles. If the patient voluntarily throws the knee somewhat in from laziness or sheer fatigue, this distribution is at once disturbed. We commonly meet with G. valgum or G. varum on one or both sides; more rarely with G. valgum on one side, G. varum on the other.

In G. valgum, the lower end of the femur is slightly curved out, the inner side being longer than the outer; and Macewen has shown that the inner condyle is also longer than the outer. As the ankles are widely separated and the planes of the knee-joints remain horizontal, it is obvious that the tibia is affected similarly to, though to a less extent, than the femur; a sharp spine usually develops at the insertion of the internal lateral ligament. To allow the knees to pass each other, the hips are abducted and finally rotated out. A compensatory rotation in of the foot occurs to keep the sole flat on the ground, and the patient gets on fairly well with great deformity; but not uncommonly a talipes valgus develops, greatly aggravating the trouble. The pathology of G. varum is similar.

Treatment of Genu Valgum.—Removal of any obvious cause, and care of the general health. In slight cases the following apparatus may be worn: Let the child lie on his back on a table, and apply padded wooden splints reaching from the iliac crests to the soles of the boots; these should rest on the table, and be nailed to a stout webbing band passed round the splints and pelvis above the trochanters, which is then buckled on one side. The lower ends of the splints are fixed to the feet by Y-straps, the legs passing in front of and behind the ankle. Other bands draw the thigh, leg, and knee toward the splint, that for the latter being broad and four-tailed. Lastly, a flannel or elastic bandage is applied from below up. The child walks in the splints, and, if well used, they will prevent matters from getting worse. In really severe rachitic cases, and early static ones, the patient should be taken completely off his legs; similar splints should be fixed above and below with plaster of Paris, and an elastic bandage used round the knee; it will often be a matter of many months to get the joint straight, which often renders such treatment of adolescents impossible.

Some surgeons prefer forcible straightening in these cases; it is said that they produce slight separation of the epiphyses externally, or infraction of the femur internally, or rupture of the external lateral ligament. The limb is put in plaster afterwards for several weeks. Delore, Billroth, and others have obtained good results; the treatment is said not to damage the joint nor to hinder growth.

Osteotomy should not be done in rachitic cases in children under eight; in time the above treatment will succeed, whilst recurrence often occurs after osteotomy. In static and uncured rachitic cases lack of time and the less yielding or perhaps fully ossified state of the epiphyses often render the operation necessary. Macewen's operation for G. valgum is thus performed: The limb is laid on the outer side with a bag of wet sand beneath the knee. A half-inch incision down to the bone is now made upward from a line one inch above the top of the patellar surface of the femur, parallel to half an inch in front of the tendon of the adductor magnus. A chisel is passed through the vastus internus down to the bone, and used to divide the latter transversely, or to cut it through until fracture is possible. By working the chisel laterally the cut in the bone may be rendered somewhat wedge-shaped; but this is not a desirable movement, as the chisel may break. Bleeding having ceased, the limb is brought into a satisfactory position and a large gauze dressing applied; or a deep dressing and then the limb is laid in a trough of Gooch's splint covered with hat-lining, and thickly padded with salicylic wool. A firm bandage is applied round all, and the part is not disturbed for four or five weeks. There is often some rise of temperature after the operation and a good deal of pain during the first twenty-four hours. The cure may be completed in plaster of Paris. A very few deaths, apparently from septicæmia, have been recorded after Macewen's operation; suppuration and necrosis running a very long course have occurred; at least two cases of wound of the popliteal artery during the operation; and trouble has arisen from primary and secondary hemorrhage from the deep branch of the anastomotic of the femoral. To tie the latter the wound should be enlarged; but if injury of the popliteal is diagnosed, this vessel must be tied by an incision *behind* the adductor magnus tendon, as recommended under "Ligature of Arteries."

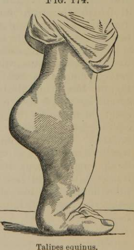
When the deformity is extreme, it may be necessary to divide also the tibia and fibula through longitudinal incisions—the former below the level of the tubercle from a cut along the inner edge, the latter about one inch down (Schede). Most surgeons prefer removal of a wedge having its base at the inner edge of the tibia, to division of both bones. When a wedge is excised, the periosteum must always first be divided, elevated, and preserved.

The treatment of *Genu varum* is conducted similarly. If splints are used inside the thigh for elastic traction, the two must be bracketed together above and below to keep them from riding forwards. Forcible straightening under narcosis may be used; but osteotomy must be done only in patients too old for other treatment.

Rickety deformities of leg-bones when sufficiently marked, and in patients too old to permit the possibility of strengthening by splints, may be treated by excision of a wedge from the tibia and division of the fibula, dressing and splint as for G. valgum.

CLUB-FOOT.—There are four primary varieties of this deformity:

Fig. 174.



Talipes equinus.

1. In *Talipes equinus* the heel is raised, so that the patient walks on the ball of the foot (Fig. 174), or even on the dorsal surface.

2. In *Talipes varus*, which is the common *congenital* form of club-foot, the distortion is much more complex. The heel is raised; the inner edge of the foot is drawn upwards, and the sole twisted inwards—so that the patient walks on the outer edge; or, in extreme cases, on the dorsum and outer ankle (Fig. 175).

3. In *Talipes valgus* the outer edge of the foot is raised, the longitudinal

or inner arch flattened by the sinking of the head of the astragalus, and the patient walks on the inner ankle (Fig. 180).

4. In *Talipes calcaneus* the toes are raised and the heel is depressed, so that the patient walks entirely upon it.

There are also compound varieties, sufficiently described by their names: talipes *equino-varus*, *equino-valgus*, and *calcaneo-valgus*. The first is common.

Each of these deformities may be *congenital*, or *acquired* after birth—*talipes equinus* being almost always acquired.

Causes of the Acquired Form.—The great majority of cases developing after birth are connected with infantile paralysis, and usually commence between the ages of seven months and two years—the ordinary period for the onset of this disease. Usually it assumes the form of *T. equinus*, often with slight, more rarely with marked, *varus; pes valgus*, *calcaneus*, and *calcaneo-valgus*, from this cause are more or less rare. It was formerly taught that certain muscles of the leg remained unparalyzed, or were less affected than the others; these, when deprived of their antagonists, drew the part over to their own side by virtue of their *tone*, and ultimately become short and rigid, fixing the part in the abnormal position. This is the *antagonistic theory*. Hüter and Volkmann object to it, that muscular tone is not able to move considerable portions of limbs against gravity, as would often be necessary; and that the contractions by no means always develop in accordance with this view. For the most severe club-foot may develop with paralysis of *all* the leg muscles; in imperfect but extensive paralysis the calf-muscles may be more completely paralyzed than those on the front of the leg, yet equinus results; when a single group of muscles only is affected, the part may deviate *towards* them; and lastly, severe forms may occur in cases of prolonged confinement to bed for severe disease in which no paralysis or paresis at all exists. The latter observation affords an important clew. The mass of the foot is so unequally distributed round the axis of motion of the joints, that when left to assume its position of rest with the body lying on its back, it becomes extended, slightly inverted and adducted, and the hollow of the sole increases; in other words, the natural position of the foot is one of equino-varus (Hüter), as is seen in sleep and death. In conditions of great feebleness (*e. g.*, in bad typhoid) patients do not use their muscles at all; their feet drop into the above position, they are never raised and everted, the clothes press on them and exaggerate the deformity, and the result is shortening of muscles and ligaments on the flexor side; there is no active contraction about it; they simply shrink and adapt themselves to their shortened state, whilst their opponents are necessarily lengthened. A severe *equino-varus* may thus be established. Now, in cases of paralysis of the anterior or of all the muscles of the leg, in which the patient neither stands nor walks, the foot will hardly ever be removed from its position of rest; consequently the posterior muscles shorten, and a talipes equinus or equino-varus develops. The essential factor is *long, undisturbed rest in one position*. But if the child has already begun to walk, frequent bearing of weight upon the foot causes the passive performance of the movements of flexion and eversion, and prevents shrinking in the opposite directions. If, however, the paralyzed leg is shorter than the other, the ankle will not be fully flexed; for the calf-muscles now contract voluntarily at each step to point the toes and thus lengthen the limb. A *talipes equinus* will be the result.

Sometimes deformity associated with paralysis develops in directions opposite to the above—flexion and eversion. Volkmann noticed that patients suffering from partial or even complete paralysis of the quadriceps extensor cruris were able to walk, using the paralyzed leg simply as a prop rendered rigid by mechanical over-extension at the knee. As a result of this an obtuse angle, open anteriorly, developed at the knee, a *genu recurvatum*, and this was obviously due to excessive strain thrown upon the ligaments, the muscles being no longer able to take their share of work. Inextensible as ligaments are, constant strain will cause them to yield. In this way *talipes valgus* is developed: as a rule there is no paralysis, but either the muscles of the leg are abnormally weak or they are overloaded. The effect of weight placed upon the astragalus is to throw the strain upon the *inferior calcaneo-navicular* and upon the *inter-osseous calcaneo-astragaloid*, and other smaller ligaments which check rotation out of the os calcis.[1]

When these ligaments are unduly strained they yield, the movement of eversion occurs, the navicular and sustentaculum tali separate a little, the astragalus sinks on to the ground, the navicular rises on to the dorsal surface of its neck, the arch disappears, and the inner side of the foot in front of the malleolus lengthens. In early stages the arch returns on raising the foot from the ground, but later the flattening persists, and rarely the eversion may become so marked that the outer margin of the foot is raised from the ground and the dorsum becomes hollowed. Then the dorsal muscles and peronei may shorten and resist replacement. Moderate degrees of this deformity are common in heavy, rickety children, in weakly children and young adults, especially girls, in whom it is often brought on by nursing the baby, whilst in boys it is common among those apprenticed to bakers and blacksmiths, and who have heavy loads to carry and much standing to do. It often leads to secondary genu valgum; or, on the other hand, is secondary to genu valgum.

Paralytic calcaneus is rare, chiefly because the condition which gives rise to it is rare; also because gravity acts against its production. In all cases the calf muscles are paralyzed. In order to gain a firm support the patient throws his foot well forward and puts the back of the tuberosity rather than its under surface on the ground, the tibia slides backward until the physiological (ligamentous) check to this movement is reached. The calf-muscles also are tightened, and the step is rendered as secure as possible. As the ligaments yield the os calcis is pushed further forward, and the front of the foot rises. At first easily reducible, the bones, ligaments, and muscles become adapted to the position of flexion, and complete extension becomes impossible.

Other causes of acquired talipes are scar contractions, after sloughing of skin or abscess in calf, and diseases of joints leading to ankylosis in faulty position.

With regard to CONGENITAL CLUB-FOOT, the student will find an able discussion of its etiology in a paper by R. W. Parker and S. G. Shattock in the *Trans. Path. Soc.*, 1884, together with the results of much careful work upon the subject. The deformities have been held to be due to: 1, *nerve lesions*, leading to paralysis or spasm of certain muscles; 2, *malformations of bones*—astragalus and calcaneum; 3, *mechanical causes*, such as pressure by the uterus, amniotic bands or other parts retaining the foot in one position. In

[1] Doubtless the student knows that the movements of in- and e-version or supination and pronation of the foot take place almost solely in the calcaneo-astragaloid joint; he has only to seize his own heel, and watch the results of passive rotation in and out of the greater process of the os calcis, to convince himself that when it passes down and in it pushes the cuboid and the rest of the foot before it, and the foot becomes inverted; whilst eversion follows its passage out. And he will further notice that if he fixes the heel, he will be unable either actively or passively to produce perceptible rotation in the *transverse tarsal joint*, which was formerly credited with the whole movement; a finger placed on the *calcaneo-cuboid joint* during the endeavors, scarcely detects any movement.

favor of *nervous origin* are advanced the resemblance of congenital to paralytic deformities, and the frequency with which talipes is associated with *spina bifida* and other malformations affecting nervous centres. But, as shown above, the association of talipes and paralysis is quite accidental, the antagonistic theory not holding good; there is usually no clinical evidence of nerve lesion in cases of congenital club-foot, the limbs being muscular and warm; the electrical reaction of the lengthened muscles will be found normal; and lastly, no lesion of the nervous system has been demonstrated, but on the contrary, it has appeared to be perfectly healthy, as also the muscles. It is most probable that spina bifida and club-foot, as suggested by Parker and Shattock, are connected in some other way than as cause and effect. *Deformity of bones*, and especially of the astragalus, were described by Mr. Adams in 1852 (*Trans. Path. Soc.*, p. 455), and by most authors since; some have considered that they are the cause of the malposition (Hüter), but it seems much more probable that *they are its results*, as Adams supposed. The bones seem to have been normally developed, and then unusual facets appear in consequence of prolonged pressure by displaced bones, and the direction and length of processes may be altered by long traction upon them.

With regard to *mechanical causes*, there are a few cases recorded of fœtuses still in their membranes showing club-foot from the effect of position in utero. Thus, in a case figured by Cruveilhier the feet were fixed beneath the chin, one in a position of varus, the other of valgus; one knee was bowed out and back, and the hands were turned over the radial borders of the forearms, having been compressed between them and the legs; but it is not often that such a specimen can be obtained. Next, it is not uncommon to find that there was remarkably little liquor amnii at the birth of a talipedic child. Sometimes the feet bear distinct signs of pressure, such as atrophy of the skin over the outer part of the head of the astragalus which projects, and development of a bursa beneath it. Similar deformities of other joints arise when they are kept long fixed in one position; thus the hips may be flexed and the knees extended, the feet lying by the head, and after birth it is found that a condition of permanent *genu recurvatum* has developed from shortness of the extensor and anterior ligaments; secondary changes in the joint-surfaces may appear, and extension of the hip too may be limited. It is fair to assume that the same result would follow fixation of the foot. We therefore again find that prolonged rest in an abnormal position and adaptive shortening of certain soft parts are probably the immediate causes of most cases of congenital as of paralytic club-foot. Upon this view it does not seem possible to explain the fact that occasionally a healthy woman will bear talipedic children to a club-footed father.

The limbs develop from the body-wall as buds of mesoblast covered by epiblast. At first their surfaces look out and in, but the lower limbs early and without obvious cause rotate in at the hip till the surfaces become anterior and posterior. In the fifth or sixth week the feet cross and meet over the lower part of the abdomen; they are markedly inverted, whilst the hip and knee are flexed. Later the rotation in of the hip goes further, the feet lose their inversion (though retaining power of full inversion) and become flexed—*i. e.*, change from *varus* to *calcaneus*. During the later months the hip, knee, and ankle are usually flexed; and Hüter has pointed out that extension of these joints in the newborn child is always imperfect. It is gradually acquired after birth; but a tendency to inversion remains until it is overcome by walking. Parker and Shattock think that T. calcaneus results from pressure fixing the foot in the dorsal flexion, natural late in pregnancy; and the more severe T. varus results from similar pressure whilst the foot is naturally inverted. Doubtless one of the slighter forms of varus may develop from its being forced into a position of inversion, and so fixed during the later months of fœtal life; but, the *earlier* the foot is fixed, the *more severe* the case (Parker and Shattock).

In rare cases talipes may be due to congenital deficiency of the lower end of the tibia or fibula. It is said by some writers that spasmodic cases, comparable to spasmodic wry-neck, also occur.

TREATMENT.—In paralytic cases, means should always be taken to cause an afflux of blood to the part and to stimulate the muscles. These consist in cold douches to the limb twice daily, followed by rubbing with a coarse towel till the skin is bright red; then ten to twenty minutes should be spent in massage—pinching and thumbing the muscles. Once a day, or every other day, the limb may be well brushed over with a large rheophore, a constant current strong enough to cause marked reddening of the skin being used. The patient must be encouraged to exercise any muscles over which power remains, and for this purpose appropriate exercise with a gymnastic machine will be useful. By these means steadily carried out for several months, together with good diet, etc., Dr. T. Barlow has had some astonishing results in severe cases of considerable duration. The need, in cases of infantile paralysis, for at once instructing the parents to take steps for the prevention of deformity—*e. g.*, passive motion or the use of an accumulator—is very obvious.

In slight cases forcible stretching under chloroform may be tried, followed by the application of a plaster-of-Paris boot. This should extend up to the knee, and until it is dry the foot must be held. The stretching must be repeated every two or three weeks. Some surgeons appear to treat even severe cases in this way, Ogston stating that he has used sufficient force to fracture bones.

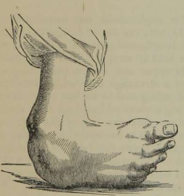
A very neat and efficient plan for slight cases was introduced by Mr. Barwell (*Med. Times and Gaz.*, 2, 61), viz., the use of India-rubber accumulators to act along the line of the lengthened muscles. Thus, in varus, a light splint of gutta-percha or thin lead is strapped over the anterior leg muscles. Two holes are bored at its upper end and a small loop of wire put through them. To this is tied a drainage tube which reaches down almost to the ankle, and has a bit of string tied to its free end. Round the foot, a broad piece of strapping, having a piece of half-inch tape sewn to the middle of its outer surface, is fixed, so that the end of the tape lies just internal to the first metatarsal. The tape is to be carried across the sole and again fixed by a stitch to the strapping below the base of the fifth metatarsal. Lastly, the tape is to be tied to the string left hanging on the tube. The strapping round the foot should be wide enough to project beyond the first metatarso-phalangeal joint, or its free edge will cut in here. Mothers soon learn to manage the apparatus, and very good results are obtained. It is generally recognized that these methods fail as a rule to correct shortening of the calf muscles.

In the more severe cases, and those which do not yield to the above treatment, *subcutaneous tenotomy* is had recourse to; and, needless to say, the earlier treatment is adopted the better. The operation is thus performed: The tendon is put upon the stretch or left lax, as may be most convenient, and a sharp-pointed tenotome is passed through the skin on one side of it, having its flat toward the tendon; the latter is now strongly stretched, the edge of the knife is turned toward and pressed against it by raising or depressing the handle, and made to cut its way through with as little actual to-and-fro cutting as possible. Whoever is rendering the tendon tense must be prepared to slack off pressure *immediately* the division is complete. Some surgeons pass the knife under the tendon and cut toward the skin; others do the reverse. The latter is certainly the safer plan for the tendo Achillis, and whenever important parts beneath the tendon would not be endangered. When the division is complete, more or less of a snap is heard, and a distinct gap is felt in the tendon. The knife is then withdrawn and the small puncture closed with a small wisp of wool steeped in collodion. Formerly, the foot was now placed in the same position as before the operation, and, after four or five days, apparatus was applied to stretch gradually the bond of union and bring the part into shape; but the practice of at once fixing the part in the best attainable position by means of plaster of Paris is rapidly gaining ground. It may, of course, be necessary to employ traction by apparatus still further to improve matters; the point is that good union occurs when the ends of the divided tendons are separated by putting the part in position at once, when this can be done. This union is effected by the formation of granulation tissue and its transformation into fibrous; at first adherent to surrounding parts, this splice which has been let into the tendon soon works loose.

A most important part of the treatment of club-foot consists in the employment of systematic passive motion. In a bad case of varus it will be necessary to keep them up for at least a year, the tendency being to relapse unless much care is taken.

Talipes Equinus.—All degrees are found, from slight raising of the heel to that shown in Fig. 174. When pure it is probably always paralytic; but it constantly occurs with congenital varus.

Fig. 175.



Talipes varus. From King's College Museum.

Fig. 176.

Pes varus: outer side of leg (Adams).

Treatment.—Division of the tendo Achillis. The patient should be prone, the tendon should be divided from the skin, and the surgeon can make pressure on the foot with his own thigh. In bad cases of equino-varus, the post. tibial artery is not far from the edge of the tendon. Afterward put the limb in plaster for ten days, at a right angle, or as near to it as may be; then, if further flexion is required, fix the leg in a hollow back-splint, cut out at the heel, and having hinged to it a foot-piece; India-rubber accumulators must be arranged constantly to draw the foot-piece upward and thus to flex the ankle. The patient may walk in the splint with advantage as soon as he will do so.

Talipes calcaneus is the reverse of *equinus*, the ankle being more or less fully flexed. It is usually congenital, rarely paralytic (p. 487). In the former the trochlea is prolonged forward almost to the navicular facet, and the facet for the internal malleolus runs on to the neck of the bone. The congenital form seldom if ever requires more severe treatment than stretching and splints. In the paralytic form, division of one or several of the anterior tendons at the ankle may be necessary to bring the foot down. This, as before explained, leaves the tread insecure; and Walsham has recently conferred considerable benefit on three patients by excising half an inch of the tendo Achillis through a short vertical wound, suturing the ends and putting up the foot in a position of complete extension.

TALIPES VARUS AND EQUINO-VARUS.—Varus and equino-varus are the most serious forms of talipes and the most common; they may be either congenital or acquired. The deformity is shown in Fig. 175. A prominence in front of and below the external malleolus probably marks the head of the astragalus projecting externally.

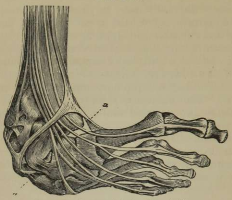
Pathological Anatomy.—This is best seen in congenital cases. The first movement appears to be one of extension of the ankle, so that much of the trochlea of the astragalus projects from beneath the malleolar arch and the tuberosity of the os calcis is more or less raised (Fig. 177, after Adams,

FIG. 177.

Pes varus: sole of foot and back of leg.

Trans. Path. Soc., 1855). Then the greater process of the os calcis is rotated in beneath the astragalus, and thus the foot becomes inverted and its inner border shortened. The more complete the rotation is, the more does the outer side of the os calcis and its greater process sink, and come to form the lowest part of the foot upon which the patient walks, and the further the navicular bone is pushed up beneath the internal malleolus, against which it may actually rest. During life it is often extremely difficult to feel its tubercle. Pressure apparently forces all the more distal parts of the foot toward the inner side; and constant tension on the external calcaneo-cuboid ligament may cause lengthening of the greater process of the os calcis. As a result, the outer or lower border of the foot is convex from the heel to the toe (Figs. 177, 178). The head of the astragalus is divided by a vertical ridge into an outer part, which projects subcutaneously and is generally covered with loose connective tissue, and an inner, perhaps at right angles to it, upon which the navicular rests; the neck of the bone is much more oblique forward and inward than normal, and often elongated. In some cases, presumably of recent origin, the astragalus is quite normal; proving that bone changes are unnecessary to talipes. The outer part of the posterior joint-surface of the os calcis may be unoccupied on account of extreme

Fig. 178.



Pes varus: dorsum of foot and front of leg.

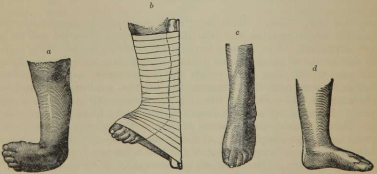
rotation in of the bone. Walking on the foot much exaggerates the displacements, and may narrow the transverse arch of the metatarsals (Fig. 175).

The *ligaments* behind the ankle, on the inner side of the foot, and in the sole, are shortened; elsewhere they are lengthened. In treatment it is most important to remember the shortening of the inferior calcaneo-navicular, and the anterior and middle fasciculi of the internal lateral ligament of the ankle. The plantar fascia is often shortened.

The *muscles* shortened are the *Tibialis anticus, posticus,* and *Flexor long. digitorum;* the ends of the two former muscles especially are approximated in proportion as their insertions are carried upward, inward, and backward.

Treatment.—In the cure of *Talipes varus,* the practical rule is to divide the treatment into two distinct stages, and to accomplish the objects of the first stage thoroughly before commencing the second.

Fig. 179.



a, talipes varus; *b*, the bandage applied after division of the tibialis tendons; *c*, the distortion reduced to simple equinus; *d*, restoration complete (Adams).

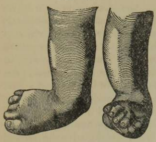
In the *first* stage the *inversion* of the foot is to be overcome by division of the *anterior* and *posterior tibial tendons,* and perhaps that of the *flexor longus* *digitorum,* also of any tight bands of *plantar fascia.* The anterior tibial is usually divided in front of the ankle, the posterior 1 inch above the malleolus; but it seems to the writer that the latter, together with the *middle and anterior bands of the interior lateral ligament* of the ankle, may be best divided through a puncture below and in front of the malleolus by a knife made to cut down to bone from just inside the tibial artery, *immediately* below the malleolus, to a point in front of the posterior tendon, whilst a strong attempt is made by an assistant to rotate out the foot and thus separate the sustentaculum and navicular from the malleolus. Then put the foot in plaster or bandage it to a straight splint extending to the knee, placed outside the leg (Fig. 179, *b*). For an infant the splint should be one and a half inches in width, and made of wood or sheet-iron, softly padded. When, by this means, the foot forms a straight line with the leg, and does not exhibit any disposition to turn inward upon the removal of the bandage—when, instead of *varus,* a state of simple *equinus* has been produced—the *second* stage may be commenced. This consists in dividing the *tendo Achillis,* and subsequently bringing down the heel, as previously recommended (p. 490); or, in slight infantile cases, the foot may be bandaged to a bent splint applied in front of the ankle-joint.

In severe adult cases, and where the deformity is extreme, and accompanied with much rigidity, the same principle is to be followed. The treatment of these cases by tenotomy and splints is usually unsatisfactory. From the pathological anatomy it will be seen that a cure necessitates a radical modification of the facets on the astragalus and os calcis chiefly, but, to a less degree, probably on every bone in the foot. The points of pressure have been so abnormal that certain portions of joint surfaces have been hindered in their growth whilst others have grown abnormally, the result being that the planes or general inclination of the facets are such as to render extreme inversion the natural position, and eversion all but impossible. If after division of muscles and ligaments and the use of considerable force the foot is more or less everted, the tendency of every bone still is to glide back from the insecure to the secure position, and every undivided fibre of soft tissue will tend to pull it back. Consequently it is only by the most prolonged and careful attention to detail that success can be attained; by the division of *every tight band* that can be felt, of such ligaments as can be got at and as may reasonably be regarded as shortened, by maintaining to the full, by careful fixation of the foot, the advantage gained, and by increasing the advantage by passive movement and the skilful application of constant traction by some apparatus like Scarpa's shoe. The difficulty of obtaining a good hold upon a small malformed foot is very great, as also the danger of producing sloughing by pressure.

Among the well-to-do, skill and patience have effected much, but in hospital practice the treatment of severe club-foot in old children and adults is eminently unsatisfactory. Some more speedy method of treatment has accordingly been sought. Some surgeons practise excision of the *astragalus,* and this is the only operation which permits the os calcis, and with it the foot, to be brought into proper position. Others excise the *cuboid,* and twist the anterior part of the foot up and out, leaving the os calcis and astragalus unaltered; and others again excise a wedge-shaped piece, having its base at the calcaneo-cuboid joint, from the tarsus, without any regard for the particular bones cut through (Davies-Colley). These operations appear to involve little risk, and to leave feet upon which the patients can walk fairly well; nothing has yet been ascertained about their effect upon the growth of the feet when they are done during childhood.

Weak ankle, Flat-foot, and Talipes valgus, form as regards deformity a progressive series (p. 487); they may occur on one side only. Weak ankles and flat feet in heavy, rickety children or anæmic girls, must be treated by attention to the general condition, by cold douching, rubbing, and massage of the leg muscles, and by systematic active and passive inversion of the foot. Meanwhile the deformity may be prevented from increasing by wearing a so-called "surgical sole," or an India-rubber or cork valgus-pad to fit inside a boot which laces high, and is stiffened up the inner side. In healthy patients overloading will generally be discovered.

Fig. 180.



Pes valgus (Adams).

In cases of talipes not thus remediable, and in which it is necessary that something shall be done to render the foot useful, Ogston has performed with much success the following operation, which has for its object ankylosis of the astragalo-navicular joint after restoration of the arch: An incision is made parallel to the sole and over the joint on the inner side of the foot, the joint opened, the cartilage-covered surfaces removed, the arch restored, and the bones pegged together. The foot is kept in plaster for three months. Should tendons (peronei) on the outer side of the foot offer resistance to replacement, they should be divided.

In a unilateral case, in a healthy boy, after long soaking of the foot in 1 to 20, Stokes excised a wedge (base upward) of the neck of the astragalus, and restored the arch, the wound healed quickly, and then Dupuytren's splint was applied for two weeks, and later a plaster splint; six months later the result seemed excellent. Like Ogston, Stokes comments on the uselessness of ordinary treatment in marked cases (*Trans. Acad. Med., Ire.*, vol. iii. p. 141).

Contraction of the Toes.—One of the toes is often permanently elevated, and rides over its neighbors, from the habitual use of narrow boots; and its upper surface being peculiarly exposed to friction, is generally covered with corns; it may be so painful as to necessitate amputation. Or the last two phalanges may be strongly flexed, the proximal somewhat extended —*hammer-toe*. Division of the extensor tendon (or of the flexor, in the hammer-toe variety) and forcible straightening, will sometimes prevent the necessity of amputation.

Bunion (a swelling over the metatarsal joint of the great toe) is a disorder which presents many varieties, viz.: 1. A recent bursal tumor, thin, and easily burst under the skin by pressure, which is the proper treatment. 2. A thickened bursa in the same place, filled more or less with effusion, somewhat tender and inflamed. The treatment of this kind is rest, fomentations, and anti-arthritic remedies. 3. The same kind of bursa in an indolent state; thickened, but not tender; best treated by iodine paint or *empl. hydrarg.* 4. The same in a state of suppuration. This is to be treated, like any other abscess or fistula, according to its condition. Not uncommonly suppuration involves the great toe joint. Bony ankylosis in this situation is very inconvenient; so if this seems to be the only mode of recovery possible, or if burrowing of pus and caries of joint-surfaces have rendered recovery impossible, subperiosteal excision of the joint should be done through a short wound on its inner aspect. Fibrous ankylosis must be tried for. The whole head of the metatarsal should not be removed. This is much to be preferred to amputation, especially with removal of the head of the metatarsal, which lames the patient greatly. 5. Often added to all these or occurring alone is a distortion of the foot, in which the great toe is thrown outward, while the head of the metatarsal bone projects and forms a swelling on the inner side of the foot (*hallux valgus*). This affection depends on alterations induced by age, labor, and badly fitting shoes, and by gouty enlargement. Square-toed boots, close-fitting the instep, and division of any tendon or band which pulls the toe outward, with forcible straightening and fixation, may be tried, but is not satisfactory. Simple hallux valgus is best treated by osteotomy of the neck of the first metatarsal from the inner side with "redressement," as suggested by C. Hoar, of University College Hospital.

CHAPTER XXXV.

INJURIES OF THE ORBIT AND ITS CONTENTS.

The entry of a foreign body into the orbit may be followed by the most disastrous consequences; the orbital walls may be fractured and the cranium entered; the eyeball may be dislocated and pushed out of the orbit, wounded, ruptured, or with some of its structures irretrievably disorganized; the optic nerve may be severed, leading to absolute loss of vision, or branches of the third or other nerves may be divided, causing paralysis of the muscles they supply. Gunshot or explosive injuries are followed by even more serious and often fatal results.

Fractures of the Orbit, implicating the cranial cavity, are extremely dangerous, on account of the damage to the brain or membranes which is usually associated with them. Fracture of the roof occurs, of course, in all cases of fracture through the anterior fossa of the base of the skull, being then but a part of a more general injury. Localized fractures of the orbital walls are not very infrequently met with, as the result of a prod with some pointed instrument, the ferrule of an umbrella or walking-stick, for instance.

If the fracture extend to the nose or communicating sinuses, emphysema of the orbit and eyelids may follow; and in all cases there is an effusion of blood, sometimes in large amount, causing proptosis, impaired mobility of the eye, and loss of vision due to pressure upon the optic nerve, together with ecchymosis and swellings of the eyelids. A blow on the face not violent enough to cause a fracture of the orbit may be followed by effusion of blood with attendant symptoms of pressure on nerves; implication of branches of the third, for instance, with partial ptosis, paralysis of accommodation, and partial dilatation of the pupil, is a not very uncommon effect of a blow upon the upper lid. Orbital abscess, the result of orbital cellulitis, periostitis, caries, or necrosis of the orbital walls, may be the direct or indirect consequences of injuries to this region.

Treatment.—Incised or punctured wounds of the orbit should always be most carefully examined, with a view to the detection and subsequent extraction of a foreign body, if such be present. Occasionally very large foreign bodies have been allowed to remain lodged in the orbit of patients who have been quite oblivious of their presence. Effusions of blood and collections of air (emphysema) in the orbital tissues usually become absorbed if not interfered with. Pus should invariably be evacuated as soon as possible; in doubtful cases an exploratory incision with a narrow-bladed knife through the skin, or, if practicable, through the conjunctiva, is advisable.

The diagnosis of compound fracture of the orbital roof must often remain uncertain. Any case in which such a complication of a wound might possibly exist should be treated antiseptically, just like a compound fracture elsewhere.

INJURIES TO THE EYELIDS.—*Bruising* or *ecchymosis* of the lids is common as the result of a blow or fall. The discoloration consequent upon the rupture of a small vein or veins into the lax areolar tissue of the lids, is known as a "black eye;" it usually comes on at once or within a few hours of the injury, whereas that resulting from the gravitation of blood into the parts, due to a fracture of the orbital walls, appears after a much longer interval, and shows itself first of all beneath the conjunctiva, extending secondarily to the lids (p. 429). The immediate application of a cold water compress with a firm bandage will limit the amount of extravasation, whilst at a later period, warm fomentations, combined with a compressive bandage, will do much to hasten absorption. The swollen parts should never be pricked or punctured, as a way is thus opened to infection.

WOUNDS OF THE EYELIDS, unless carefully treated, often give rise to much deformity. Every effort should be made to induce union by first intention; the cut edges therefore should be brought into accurate coaptation by means of fine silk sutures. It should be remembered that the least deviation from the normal of the puncta lachrymalia will be followed by an overflow of tears. When the canaliculus is cut across in the wound, the openings should be found, and a fine director passed along the canal into the sac; the canaliculus should then be slit open from end to end, in the usual manner.

BURNS AND SCALDS OF THE EYELIDS should be treated like those of other regions. Every endeavor must be made to avoid adhesion of the tarsal edges of the lids (*ankylo-blepharon*) or of the palpebral to the ocular conjunctiva (*symblepharon*) if the latter be involved. Where there has been loss of substance of skin, deformity may be to some extent prevented by the transplantation of a piece of skin, freed from all subcutaneous fat, and of suitable size and shape, into the granulating gap.

In all cases of injuries to the eyelids, the globe should be examined and the fundus explored, lest a deeply seated injury be overlooked.

INJURIES OF THE CONJUNCTIVA.—These are generally of a mechanical or chemical nature. Foreign bodies on or in the conjunctiva give rise to more or less severe irritation, such as spasmodic contraction of the lids, more or less severe conjunctivitis, photophobia, lachrymation, and a feeling as of "grit" in the eye or under the upper lid. The conjunctiva and cornea should be carefully scanned, the lids being gently separated and the patient directed to look down. If the foreign body, as it very frequently is, be lodged in the conjunctiva of the upper lid, particularly in the loose folds of the retrotarsal region, the upper lid should be everted. This is easily done by placing a probe horizontally across the lid just above the tarsus; then, catching the lashes between the forefinger and thumb, the lid should be gently drawn downward and forward, whilst at the same time the probe is pressed firmly downward, so that the lid may be turned up over the latter, thus exposing its ocular surface. Particles of coal dust or metal, if lying on the surface of the conjunctiva, may be removed by means of a little roll of blotting paper; if embedded, by the aid of a fine needle or spud. *Injuries from lime* are of very common occurrence; every particle should be removed by syringing with warm water or the use of the scoop, the upper lid being everted and the conjunctiva thoroughly cleansed. In the case of burns from *caustic alkalies* or *acids* no time should be lost in searching for a neutralizing solution, although such should be used if ready to hand, but a stream of lukewarm water from a sponge or syringe should at once be applied to the conjunctival surfaces. The irritant, whatever it may be, having been removed, a little castor or olive oil should be dropped into the eye, and a moist compress and bandage applied. The resulting inflammation must be dealt with according to circumstances: if the conjunctiva alone be affected, astringent lotions, such as a solution of boracic acid, should be frequently used, and vaseline or other lubricant applied to the tarsal edges of the lids, to prevent them from sticking together during sleep or when the compress is being worn. If the cornea is or becomes implicated, belladonna fomentations and atropine lotions must be resorted to, and strong astringent solutions discarded. A five per cent. solution of boracic acid in warm water, however, may be advantageously employed as a wash.

Abrasions or *wounds of the conjunctiva* occurring independently of the presence of foreign bodies, and without implication of deeper structures—as from a scratch—rarely give rise to more trouble than a slight degree of conjunctivitis. Treatment as above.

Injuries of the Cornea.—*Foreign bodies*, such as particles of metal or stone, when impacted in the cornea, give rise to symptoms of severe ciliary irritation. They are generally easily detected if the cornea is turned sideways to the light, or examined by oblique focal illumination. In the case of a very minute or light colored particle, the search may be facilitated by dilating the pupil with atropine, the foreign body being thus thrown into relief by the dark background of the pupillary aperture.

Before attempting its removal, a solution of cocaine may be dropped into the eye, so that the cornea may be rendered anæsthetic. The patient should be seated in a chair, or recumbent upon a couch, facing a good light, the surgeon standing behind the patient's head. The latter should be requested to fix his gaze upon some distant object, and in such a direction that the particle is clearly visible to the surgeon. The eyelids are held apart by the fore and ring fingers of the left hand placed over the temple or nose, and the eyeball steadied in the required position by the middle finger. If the foreign particle be merely stuck on the epithelial layer of the cornea, it may readily be removed by a little roll of blotting paper. If embedded more deeply, it can be picked out by a needle, many varieties of which have been devised for the purpose; often a certain amount of corneal tissue must be scraped away before the particle can be got at. Particles of iron which have been left in the cornea for two or three days usually give origin to a brown rust-staining of the corneal tissue immediately surrounding them; this need not be interfered with, since it is thrown off in the natural course of repair.

When a chip of iron or other substance lies so deeply that it touches or partially penetrates Descemet's membrane, a broad needle should be passed into the anterior chamber, and its flat surface pressed lightly against that portion of the innermost layer of the cornea in which the particle lies; the latter can then be removed from the front with a needle, spud, or forceps, without danger of its being pushed onwards into the anterior chamber, an accident which may readily occur if the procedure described be not adopted. In some cases particles of metal may be drawn out of the cornea by means of an electro-magnet, that of Snell being, perhaps, the most convenient for all purposes. After the foreign body has been extracted, a little castor or olive oil may be dropped into the eye and a light compress applied. Should any degree of congestion or photophobia result, atropine and warm fomentations must be employed.

A *foreign body lodged in the anterior chamber* should always be removed, except in cases of old standing, unaccompanied by any symptoms of irritation. The original wound of the cornea should be utilized, when possible, for the purpose, and the electro-magnet may be employed in suitable cases. As a rule, the damaged portion of the iris on which the particle lies should be excised.

BURNS, or injuries from *quick-lime, molten lead*, and other chemical agents, should be dealt with as described under "Injuries to the Conjunctiva."

WOUNDS. (*a*) *Non-penetrating.*—These may vary from a mere needle prick or abrasion to an incised or lacerated wound of considerable dimensions. The pain, photophobia, lachrymation, and other symptoms of ciliary irritation are often more marked in the case of a simple abrasion than in that of a clean-cut incision; a fact easily explicable by the multitude of nerve-fibres and endings which ramify in the corneal epithelium—the intra-epithelial plexus—a larger number of which would be damaged by an injury of the former than of the latter kind. Simple incised wounds or abrasions usually heal without difficulty; a permanent leucoma or nebula may, however, remain.

The *treatment* in such cases is simple. The conjunctiva should be washed, preferably with some antiseptic solution such as boracic acid, two or three drops of a half per cent. solution of atropine dropped into the eye three or four times a day so long as any pericorneal injection exists, and a light compress worn. In the presence of a purulent discharge from the lids, as in granular conjunctivitis, or from lachrymal canals, or when accompanied by much bruising of the corneal tissues, as may happen from a blow with a blunt instrument, suppurative inflammation may ensue, leading to destruction of the cornea to a greater or less extent, hypopyon, and perforating ulcer. Contusions of the cornea are specially liable to be followed by these untoward consequences in old or enfeebled subjects—pauper stone-breakers for instance. Treatment directed toward the improvement of the general health should therefore be adopted, and, locally, hot belladonna fomentations, atropine drops, and antiseptic lotions assiduously employed. In some cases of this kind atropine fails, and eserine drops (gr. iv ad ℥j aq.) are recommended. If there be much pain, a couple of leeches may be applied to the temple or an opiate given. Should hypopyon occur, the pus ought to be evacuated by paracentesis of the anterior chamber, and the puncture opened daily until pus ceases to collect.

(*b*) *Penetrating* wounds are of grave import as regards the integrity of the eye, since the iris, lens, or both these structures are often implicated, resulting in severe iritis and traumatic cataract; in any case, the anterior chamber is of necessity opened, the aqueous humor escapes with a rush—unless the injury be in the form of a mere needle-puncture—and the iris is carried forward, not unfrequently being caught between the edges of the wound or protruding through it, where it generally becomes incarcerated by inflammatory adhesions (*anterior synechia*). Hence the pupil is displaced and altered in shape, vision being proportionately interfered with; at the same time the inclusion of the iris in the wound is liable to be followed by iritis, destructive irido-cyclitis, and sympathetic ophthalmitis of the other eye.

Treatment.—It is of the greatest importance to ascertain whether or not a foreign body be present in the eye; the nature of the injury, therefore, should be thoroughly investigated. In all cases, efforts should be made to subdue the resulting symptoms of irritation and inflammation. To this end a 1 per cent. solution of atropine should be used every four or six hours, the eye should be closed by a cold-water compress, and if there be much pain, leeches should be applied to the temples. The conjunctiva should be frequently cleansed by a week antiseptic solution. If the iris be entangled in the wound, an attempt may, in recent cases, be made to reduce it, the most convenient instrument for the purpose being a curette, or blunt-pointed caoutchouc spatula; or an endeavor may be made to attain this object by the instillation of a 1 per cent. solution of eserine every four hours.[1] Some authorities recommend that eserine and atropine should be used according as the wound is central or peripheral, with the object of drawing the pupillary margins of the iris away from its vicinity. It should be remembered, however, that eserine does not produce a contraction of the pupil in the unclosed anterior chamber. When the iris has become adherent to the edges, any protruding portion should be cut off with iridectomy scissors, close to the surface of the cornea; subsequently a compress and bandage should be worn, atropine or eserine employed, and measures taken to lessen the inflammatory symptoms, as already described.

Injuries to the Iris.—Injuries to the iris commonly involve the lens and other structures. A blow on the eye, however, from a foreign body such as the cork of a soda-water bottle may rarely rupture or lacerate the iris, most frequently at its circumference, tearing it away from its ciliary attachment (*coredialysis*) without damaging the lens. Clean-cut wounds of the iris are not generally followed by iritis, as proved by the operation of iridectomy. Accompanying all such injuries, there is usually more or less effusion of blood into the anterior chamber (*hyphœma*).

Traumatic iritis should be combated by the instillation of a 1 per cent. solution of atropine, belladonna fomentations, and the application of leeches to the temples. If a foreign body be impacted in the substance of the iris, the usual practice is to perform an iridectomy, including that portion on or in which the particle lies. Splinters of iron or steel may be conveniently removed through a corneal incision, or through the original corneal wound, by means of the electro-magnet.

Injuries to the Lens.—The lens may be loosened from its attachments by a blow, or partially or completely dislocated; the injury is often accompanied by hemorrhage into the aqueous and vitreous humors. When dislocated into the vitreous, which is the more common situation, the iris will be observed to be tremulous as the eye is moved in different directions, whilst the anterior chamber is somewhat deepened; when into the aqueous, the anterior chamber will be found to be much deepened, and the iris cupped. The edge of the displaced lens can usually be easily detected in its abnormal position by ophthalmoscopic examination, unless the parts are hidden by the effused blood. Rarely, the lens may be found beneath the conjunctiva, having made its way thither through a rupture or wound of the sclerotic. As a rule, a partially displaced lens eventually becomes opaque and cataractous, in which case it may be moved by extraction; if it remain transparent and permanently fixed in its new position, vision is sometimes improved by a judiciously placed artificial pupil. When it lies in the anterior chamber, it may be removed by "needling" and solution in the case of young children, in adults by the method of linear extraction, during the performance of which it should be fixed by a needle, lest it slip backward into the vitreous. When dislocated into the posterior chamber, its removal is attended with great difficulty, and usually involves the loss of a large quantity of the vitreous, followed by shrinking and wasting of the globe. The pres-

[1] Juler, Ophthalmic Science and Practice, p. 105.

sure and irritation of a displaced lens are very apt to occasion glaucomatous symptoms, iritis, irido-cyclitis, or sympathetic ophthalmitis of the other eye; in either case, it should be at once removed by one or other of the above methods. If it lie in the posterior chamber, as a rule the globe must be enucleated.

A Wound of the Capsules of the Lens is always followed by an opacity which, if the perforation be extremely small, such as may have been produced by the prick of a needle, may be limited to the portion injured. If the wound be larger, the action of the aqueous fluid upon the lens-fibres causes them to swell rapidly and to become opaque. The lens thus swollen presses upon the iris and ciliary body, leading to glaucomatous symptoms, traumatic iritis, or irido-cyclitis. In children, these complications are less to be feared, the lens being softer and absorption more rapid. Injuries produced by foreign bodies, bits of iron or steel, for example, which have either become impacted in the lens, or, having passed through it, are lodged in the deeper structures of the eye, are exceedingly dangerous, being prone to light up destructive inflammation of the globe and sympathetic ophthalmitis. A blow on the eye may occasion traumatic cataract in the absence of other damage; in the larger number of these cases, a small rupture of the lens capsule probably exists, often at the periphery of the lens.

The *treatment* of traumatic cataract must vary with each individual case. In young people, if the wound be of slight extent, the lens may be left to the natural process of absorption, the eye being kept thoroughly under atropine, so long as there are no inflammatory symptoms other than slight ciliary injection. If the wound be large, or if glaucomatous or inflammatory symptoms arise, the lens should be at once removed by the operation of linear extraction; or should the nucleus or larger portion of the lens remain firm, a large iridectomy may be performed and absorption allowed to proceed, the attendant risks of swelling being avoided by providing increased space. In other cases where the swelling of the lens is great and accompanied by increased intraocular tension, or severe inflammatory symptoms, it should be removed by extraction with or without the aid of the scoop. When a foreign particle is embedded in the lens, both may be removed together by introducing a scoop behind the latter and lifting it out with the foreign body. A foreign body having passed through the lens, may be lodged in the deeper structures, vitreous humor, choroid, or retina, and a large amount of blood may be effused into the vitreous; in this class of cases, plastic or purulent cyclitis may follow, often leading to destruction of the globe. Under such circumstances, if the lens be much swollen, it should be removed by linear extraction, a large iridectomy being made in the hope of lessening the amount of inflammation; the foreign body, however, being left in the globe is a source of continual irritation, and may at any time light up fresh inflammatory troubles or sympathetic ophthalmitis. The eye, therefore, should be carefully watched, and excised without delay should symptoms of sympathetic inflammation, or even well-marked sympathetic irritation arise. Nettleship advises excision in every case when there is a wound in the ciliary region with traumatic cataract, " whether or not the eye is causing sympathetic symptoms or is in itself especially irritable." In all cases the globe should be excised if the extent of the injury involves a great, and probably permanent, impairment of vision, and when a foreign body is lodged in the vitreous, or deeper structures, and cannot be extracted therefrom.

Injuries to the Sclerotic.—*Ruptures* and *wounds* of the sclerotic are dangerous, insomuch as they are generally accompanied by an escape of the contents of the globe, intraocular hemorrhage, and irreparable damage to the choroid and retina, and may be followed by panophthalmitis and disorganization of the eyeball.

RUPTURE may result from a blow with a blunt instrument, and generally takes the form of an irregular wound or rent, which tends to run concentrically with, and is situate about two millimetres outside, the corneal margin, thus involving the ciliary region. Through this the lens, with a part or even the whole of the iris wrenched from its ciliary attachment, may be extruded, and a large quantity of vitreous may escape. The retina is usually detached over a larger or smaller area, and copious intraocular hemorrhage takes place. Such injuries usually result in shrinking of the globe.

Treatment.—When a rupture traverses the ciliary region, the globe should be excised; if the ciliary region be but slightly encroached upon or if the tension of the eyeball be not lowered in marked degree, and the extent of the damage to the deeper structures cannot be gauged by reason of a hemorrhage into the vitreous hiding the parts from view, temporizing measures may be adopted, such as rest to the eyes and the application of cold compresses. Then, if after the lapse of a few days vision is almost or completely lost, or panophthalmitis set in, the globe should at once be enucleated.

WOUNDS OF THE SCLEROTIC vary in importance with their extent, the damage done to internal parts, and the presence or absence of a foreign body in the eyeball. If it be inconsiderable in size, its edges may be brought together with one or two firm sutures; if a portion of the iris or vitreous be prolapsed, it should be cut off close to the surface of the sclerotic, cold compresses applied, and means taken to prevent, or to subdue, any resulting inflammation. When the wound is extensive and involves the ciliary region, and so much damage has been done to the deeper parts that all hope of restoration of useful sight is lost, or if irido-cyclitis has commenced, the globe should be excised. Another class of cases occurs in which, though the wound involve the ciliary region, *a fair amount of vision remains*, and inflammatory complications have not arisen. Under these circumstances it is of the greatest importance to determine whether a foreign body is present in the globe, its nature and situation; if it be of iron or steel, an attempt should be made to remove it with an electro-magnet, either through the original wound, which may be enlarged for the purpose, or through an incision judiciously placed at the spot where the foreign body is, or is thought to lie. If it cannot be extracted, or if decided symptoms of sympathetic irritation manifest themselves owing to inclusion of the iris or ciliary body in the seat of the wound, or if subsequently to the extraction of the foreign body panophthalmitis is threatened, the globe should be excised.

INJURIES OF THE VITREOUS, CHOROID, AND RETINA.—A *foreign body* may be arrested in the vitreous, generally giving origin to destructive inflammation which may spread to surrounding parts, causing panophthalmitis. The foreign body may, however, become encysted and remain quiescent for a long time, in which case the cloudiness of the vitreous may clear up and sight be more or less completely restored. Even though it has lain dormant for many years, ultimately inflammatory symptoms or sympathetic ophthalmitis may be occasioned. *Hemorrhage* may take place into the vitreous as the result of a blow, the blood being derived from the veins of the ciliary body, choroid, or retina.

RUPTURE OF THE CHOROID AND DETACHMENT OF THE RETINA resulting from a blow on the eyeball are also generally accompanied by bleeding into the vitreous. The presence of blood in the vitreous may often be detected, on focal illumination, by its red color, but in other cases it can only be inferred from the opacity of the vitreous and the absence of any reflex, the fundus appearing quite dark when observed with the ophthalmoscope.

Permanent opacities frequently remain, the blood being imperfectly absorbed.

The *treatment* of such cases consists in resting the eyes, the use of cold compresses, atropine, and leeches to the temples if inflammatory symptoms supervene.

Sympathetic Irritation and Sympathetic Ophthalmitis.—Sympathetic irritation is the name given to certain functional disorders excited in an eye by a morbid condition of the other eye; sympathetic ophthalmitis to a destructive form of inflammation similarly occasioned. Sympathetic ophthalmitis may be preceded or accompanied by symptoms of sympathetic irritation; but generally the inflammatory symptoms set in suddenly without any such prodromata. The terms "sympathizing eye" and "exciting eye" explain themselves.

Etiology.—The exact nature of the morbid influence transmitted from one eye to the other is unknown; by some it is referred to irritation of the ciliary nerves of the exciting eye, by others to the transmission of an infective organism from one eye to the other by way of the lymphatics or blood-vessels. In all probability both hypotheses are true, the functional trouble in the sympathizing eye being in part due to conduction or reflection of nervous irritation from the exciting eye, the inflammatory lesion to the transmission of infective matter in one or other of the ways mentioned, most likely by the lymphatics.

Sympathetic irritation and inflammation are in the majority of cases determined by a perforating wound of the ciliary region of the exciting eye; the presence of a foreign body within the globe; corneal wounds or ulcers in the scars of which the iris has become entangled (anterior synechia); and in some non-traumatic morbid conditions of the exciting eye, such as chronic irido-choroiditis, ciliary staphyloma, glaucoma, etc.; or in cases in which the globe is disorganized and shrunken.

Symptoms.—The *exciting eye* is often the seat of intense neuralgic pains, and exhibits symptoms of inflammation in the form of ciliary injection, photophobia, watering, and impaired vision. If it has excited inflammation in the sympathizing eye, the whole uveal tract is inflamed and iritis is always present.

In the *sympathizing eye* sympathetic irritation is manifested by intolerance of light, lachrymation, failure of accommodation, disordered or suspended retinal function, as evidenced by temporary obscurations of sight or sensations of darkness, and often neuralgic pain in or about the globe is complained of. Such symptoms may continue for an indefinite period, and may subside without the supervention of actual inflammation. They cease, as a rule, with the removal of the exciting eye.

Sympathetic ophthalmitis, in the majority of cases, is a severe form of irido-cyclitis. In the mildest cases the earliest signs of the disease are those of a serous iritis. The pupil is noticed to become sluggish, the iris discolored, the aqueous cloudy, whilst a number of dotted opacities, often very small, make their appearance on the back of the cornea, and there is a certain degree of ciliary injection. In more severe and advanced grades the iris, assuming a buff or yellowish-red tint, becomes much thickened from inflammatory infiltration, and large turgid veins are seen ramifying on its surface; large quantities of lymph are poured out between the lens and the posterior surface of the iris, leading to the formation of extensive posterior synechiæ and occlusion of the pupil. The ciliary region is intensely congested, often tender, and the seat of neuralgic pain, which may be reflected along various branches of the fifth nerve.

If the vitreous can be observed, it will be found to be cloudy and to contain floating opacities, sometimes masses of lymph, and the lens may ultimately become opaque. The anterior chamber becomes shallow, and the intraocular tension increased; subsequently, however, the eye becomes soft, and in the end may shrink. If, however, the disease subside, the tension may regain the normal standard, and the condition generally may greatly improve. The onset of the symptoms is frequently very insidious, ill-marked, and painless, the patient imagining that he is suffering from a slight cold in the eye, and so taking but little notice of the affection, or failing to seek advice until it is well advanced; this is especially true of children, and it is said that they are more liable to the affection than adults. The duration of the disease usually covers some months, but it may extend to a year or longer. The prognosis is exceedingly grave; in a large number of cases vision is almost or altogether lost; in mild cases recovery takes place, but with more or less impairment of sight. The interval of time which elapses between the damage to the exciting eye and the outbreak of inflammatory symptoms in the sympathizing eye is extremely variable; it is seldom less than three weeks, but may be many years.

Prevention and Treatment.—An eye which is permanently useless for visual purposes, by reason of injury or disease affecting its anterior segment, should, as a rule, be removed, for at any time it may prove the starting point of a sympathetic inflammation. The necessity for its excision is emphasized if it be tender or irritable, or if it contain a foreign body; or if symptoms of sympathetic irritation have already developed in the other eye. When the vision of the damaged eye is, or is likely to be, preserved in a greater or less degree, but the condition of the globe is such that it may at any time give origin to sympathetic ophthalmitis, the question of excision is often one of great difficulty, and the surgeon must be guided in his judgment by a number of considerations which cannot be discussed in this work. It is obvious that means should be taken to allay the inflammation and irritability of the injured eye; and with a view to the prevention of sympathetic irritation and inflammation, complete rest should be secured to the eye by keeping the patient in a darkened room for a lengthened period. In all cases the patient should be warned of the nature of the danger affecting the sound eye, and told to seek advice immediately, should sympathetic symptoms manifest themselves. Occasionally, sympathetic inflammation has arisen after the removal of the exciting eye, and in rare cases after an interval of several weeks has elapsed. If sympathetic ophthalmitis has already commenced, the exciting eye should not be removed, unless all hope of retaining any useful degree of sight is lost, since in the end it may prove the better eye of the two for visual purposes. The treatment of the sympathizing eye consists in the maintenance of rest and exclusion of light, the frequent use of atropine (one per cent. solution), the application of leeches or counter-irritation to the temples, and the administration of tonics with a due supply of proper nourishment. No operative treatment either of the sympathizing or the exciting eye is permissible until the inflammatory symptoms have entirely disappeared.

Excision of the Eyeball.

An anæsthetic should be administered. The surgeon stands either in front of or behind the patient's head, as may be most convenient. The eyelids should be kept apart by a stop spring speculum. The conjunctiva is divided with scissors around the whole circumference of the cornea, as close to its margin as possible, leaving only a sufficient hold for the forceps. The capsule of Tenon is then opened, and by means of the strabismus hook, the tendons of the recti muscles are picked up in turn and cut through between the hook and the globe, the fascia in connection with them being at the same time severed. The surgeon now presses the speculum backward into the orbit, a manœuvre which causes the globe to start forward; he then passes curved scissors—either from the inner or the outer canthus and with their concavity towards the globe—backward close to the sclerotic until the optic nerve is felt, by the resistance it offers, to be grasped between the open blades. Having divided the nerve, the operation is completed by cutting through the oblique muscles and any remaining tissues as close to the sclerotic as possible. The resulting hemorrhage is easily stopped by stuffing a small carbolized sponge into the orbit and maintaining pressure for a few minutes; then it may be removed, a light compress of moist sponges overlaid with cotton-wool being applied and kept *in situ* by a bandage for six or eight hours. The most important points in connection with the operation are to remove as little of the conjunctiva as possible, and to avoid damaging unnecessarily the orbital tissues. Sometimes a little difficulty arises when the globe has contracted tough inflammatory adhesions to surrounding structures, or when it is shrunken or ruptured. In a few cases of enlargement of the eyeball by reason of myopia or malignant disease, it may be found necessary to divide the outer canthus.

Artificial eyes consist of a thin scale of enamel, or celluloid, colored to imitate the natural eye. The false eye is of service in the removal of deformity—in keeping the lids in their natural position; placing the puncta in a more natural position for conveying away the tears; acting as a defence against intruding bodies (which are apt to get within the lids and produce irritation): and keeping the cavity free from collections of lachrymal secretions.

After any disease which has rendered the eyeball shrunken and sightless, if the patient objects to the trouble and expense of an artificial eye, it may be convenient to divide the levator palpebræ, in order that the lids may remain permanently closed. This may be effected by making a transverse incision in the upper eyelid just below the orbit, and seizing the belly of the muscle as far back as possible. Then a piece should be snipped out of it with scissors.

New Growths of the Conjunctiva and Eyeball.

Conjunctiva and Cornea.—*Pedunculated warts* or *polypi* are occasionally met with, springing from the ocular or palpebral conjunctiva and subconjunctival tissues; they are usually small, flattened, and not unlike those so often found growing from the mucous membrane of the glans penis. They may bleed spontaneously, or cause annoyance by impeding the movements of the lids, or by covering a part of the pupil. They should be removed, together with the portion of conjunctiva to which they are attached, with curved scissors.

Dermoid tumors take the form of little smooth elevations, about the size of half a lentil, the surface of which is sometimes covered with hair; they are always seated on the corneal margin and adjacent portion of the sclerotic, lie in the line of the palpebral fissure, and are often accompanied by other congenital anomalies such as coloboma of the eyelids. Treatment consists in excision; if a portion of the tumor has grown into the substance of the cornea, this should not be attacked lest the cornea be perforated; the removal of the extra corneal portion will induce obsolescence of that remaining.

Cysts of the conjunctiva or subconjunctival tissue may be congenital, due to lymphatic dilatation or cystic degeneration of a nævus, or acquired from obstruction of a duct of the lachrymal gland (*dacryops*).

EPITHELIOMATOUS GROWTHS may spring from either the conjunctiva or the epithelial layer of the cornea, or may involve these structures secondarily.

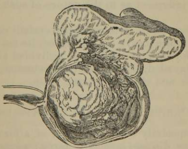
SARCOMATA, sometimes pigmented, generally growing from the sclero-corneal junction, are sometimes encountered; they are subconjunctival in origin. These growths must be diagnosed and treated on general principles; if they are fixed to the globe, enucleation, as a rule, should be performed without delay.

INTRAOCULAR TUMORS.—The commonest intraocular tumors are GLIOMA OF THE RETINA and SARCOMA of the CHOROID or of the CILIARY BODY.

GLIOMA OF THE RETINA is a disease of infancy or childhood; it may be congenital, but is not known to occur after the twelfth year. It appears in some cases to be hereditary, and several children of the same parents may be affected. The growth may fill the eyeball, burst through the cornea or sclerotic, and infiltrate the orbital structures; or it may extend backward by way of the optic nerve to the brain, meninges, and cranial bones. Sometimes the other eye becomes affected, but apparently not by direct extension. Secondary foci of growth in the viscera are rare.

The growth rarely comes under the notice of the surgeon in its earliest stages, by reason of the youth of the patient, the absence of external signs, and the painless character of the affection. At this time, if the eye be examined with the ophthalmoscope, the growth may be recognized by the appearance of white shining patches in the retina, which are more or less elevated. Later, the eye becomes blind, and the pupil is dilated; the patches or foci of growth coalesce, giving rise to a bright, glistening, yellowish-white reflection, which is often noticeable at a distance. Increasing in extent, the growth can be distinguished by focal illumination as a yellowish-white nodular prominence, projecting into the vitreous, its surface being beset with vessels. Still later the lens becomes opaque, the cornea steamy, the intra-ocular tension greatly increased, and severe pain with inflammatory symptoms obtains. When the growth has filled the cavity of the eyeball, the coats of the latter give way—generally at the sclero-corneal junction—and the orbit is invaded (Fig. 181). Its rate of progress then becomes extremely

FIG. 181.



Giloma of the eyeball.

rapid, and, finally, it may give rise to a fungating mass—fungus hæmatodes—protruding between the eyelids. The course of the disease to such a termination may cover but a few months.

Glioma is simulated by a condition known as *pseudo-glioma*, a state of things brought about by inflammatory changes in the vitreous, with detachment of the retina, giving rise to appearances not very unlike those of the former disease. The presence of iritic adhesions with a history of antecedent inflammation, together with a state of *minus* tension of the globe, will point to the latter affection.

Sarcoma of the Iris is so uncommon that it can merely be mentioned here.

Sarcoma of the Choroid and Ciliary Body.—The majority of choroidal sarcomata are of the pigmented or melanotic variety: the non-pigmented are generally developed in connection with the ciliary body. The constituent cells may be fusiform or round, the former kind being more common in the posterior part of the uveal tract, the latter in the anterior.

The round-celled varieties are the softer and more malignant. Sarcoma of the choroid may occur at any age, but by preference, in middle life or subsequently. Usually the growth fills the cavity of the eyeball and extends to the orbit by bursting through the sclerotic or cornea, as in the case of a glioma; but sometimes it makes its way out along the sheaths of the blood-vessels, perforating the sclerotic, forming large extraocular masses, even when the intraocular portion is of small extent. Secondary embolic foci may be deposited in the viscera, especially the liver, although the primary growth be limited to the globe; the neighboring lymphatic glands are not affected.

The *diagnosis* of a sarcoma of the ciliary region is not difficult, the appearance of a rounded prominence in the pupillary area, the surface of which is vascular and of a grayish or marbled aspect, in the absence of inflammatory symptoms which always accompany the development of a gumma in the same region—with which alone it is liable to be confused—is sufficiently characteristic. When the tumor arises in the equatorial region, or further back, it causes an extensive detachment of the retina, which, completely veiling the subjacent growth, may render a correct diagnosis impossible for the time being. In other cases it may be recognized as a nodule projecting into the vitreous, the retina around it being detached, or the vessels ramifying on its surface may be visible through the retina covering it by the aid of a strong illumination. Later on the intraocular tension is greatly increased, inflammatory complications arise, and the eye becomes glaucomatous; at this stage the condition may be mistaken for that of simple glaucoma. The numerous indications which may assist the surgeon in forming a correct judgment as to the nature of such cases must be sought elsewhere.

The *treatment of glioma and sarcoma* of the eyeball consists in enucleation of the globe; if the optic nerve be infiltrated, its cut end should be seized with forceps, drawn forward, and the nerve redivided as far back as possible. When the orbit is invaded, the whole of its contents should be extirpated by means of the knife and chloride of zinc paste.

Orbital Cellulitis and Abscess.

Causes.—Injury, especially with impaction of a foreign body; erysipelas or some other infective disease, especially farcy; sometimes no cause is discoverable, and it is attributed to cold.

Symptoms.—Considerable general disturbance, fever, and perhaps rigors; much pain; swelling of the lids and conjunctiva, protrusion and immobility of the globe, but the cornea remains clear until the pressure and chemosis become very marked; it is difficult or impossible to distinguish fluctuation. These symptoms develop rapidly.

Treatment—of cellulitis is usual. If suppuration is suspected, an exploratory puncture should be made through the conjunctival fold, where the symptoms seem most marked, and carefully enlarged by Hilton's method (p. 79) if pus is found. Early evacuation of pus is most important, for, besides destroying sight, these acute inflammations may lead to infective thrombosis of cerebral sinuses or to meningitis.

Chronic abscess forms slowly; its symptoms depend upon its bulk and position, and its chief cause is carious or necrosed bone.

Orbital Tumors.

Tumors of all kinds may be met with in the orbit, either as primary growths, or spreading thereto from neighboring regions. Sooner or later they cause a protrusion of the globe (*proptosis oculi*) with or without lateral displacement, and generally this is one of the first signs of their presence to which attention is called. Not only is the globe displaced and its movements interfered with, but blindness commonly ensues, owing either to pressure upon or actual involvement of the optic nerve by the growth. It should be remembered that intraocular sarcomata, while yet of small size, may give origin to large extraocular orbital masses. In all cases, a careful examination should be made of the eyeball, as well as of the adjacent cavities —pharynx, mouth, nose; the functions of the cranial nerves should be inquired into, and a search made for enlarged lymphatic glands, with a view of determining the primary seat, extent, and character of the growth in question.

Of solid orbital tumors, lipomata and fibromata are very rarely met with.

Exostoses are generally of the broad-based ivory variety, and therefore difficult or impossible to remove. The cancellous or pedunculated exostosis sometimes occurs, and may be removed, though not without danger of opening up the cranial cavity with all its attendant risks, if attached to the roof of the orbit.

Sarcomata of various kinds are the most common form of orbital tumor. Carcinoma may occur primarily in connection with the lachrymal gland. These growths, if amenable to operation, should be promptly and completely extirpated. If the orbital walls are affected, chloride of zinc paste should be applied, with the hope of getting beyond the infiltrated structures. Bleeding may be arrested by pressure, the thermocautery, or by means of perchloride of iron.

Cystic tumors are of two kinds: *hydatid* or *congenital dermoid*. A free opening should be made into the former; the latter, if possible, should be completely removed.

Distention of the frontal sinus may give rise to a fluctuating swelling at the upper and inner angle of the orbit, which may be mistaken for a soft growth, or, before the bony walls are absorbed, for an exostosis. The treatment is directed to the establishment of a new communication with the nose, the swelling being freely incised, and a drainage tube passed into the nose from above.

In the diagnosis of orbital tumors the possibility of the presence of a *chronic abscess* or *syphilitic* growth must be considered. Exploration with a grooved needle, trocar, or narrow-bladed knife, may be adopted as a means of diagnosis. Collections of pus in the orbit, whether the result of an *acute idiopathic cellulitis*, or of *injury*, or *chronic inflammation*, should always be evacuated through a free incision, and adequate drainage established.

Pulsating tumors of the orbit are generally the result of a communication of the carotid artery with the cavernous sinus, pulsation being thus propagated to the ophthalmic vein and its branches; such a condition may be caused by a fracture of the bone of the skull involving the sinus, or by a wound of the artery, or its spontaneous rupture as it passes through the sinus. The carotid has been ligatured with success in these cases. Aneurism of the orbital arteries is very rare.

Nævoid tumors, as a rule, exhibit no marked pulsation. They may be dissected out.

Proptosis may be a marked symptom of the disease known as Graves's or Basedow's or Exophthalmic goitre, and is then usually accompanied by enlargement and pulsation of the thyroid gland, and other signs of vascular and nervous disturbance. In the absence of the latter symptoms, the proptosis may be wrongly referred to other causes, such as tumor.

CHAPTER XXXVI.

DISEASES AND INJURIES OF THE EAR.

Examination of the Ear.

Examination of the Meatus.—This canal is about an inch and a quarter long in the adult. Its direction is inward, with a slight curve forward; the floor describes also a slight curve with its convexity upward, and this convexity produces a narrowing of the canal about the middle. The walls of the outer half (or somewhat less) are formed by a prolongation from the cartilage of the auricle; for the remainder of the distance it runs in the petrous portion of the temporal bone. Internally it is bounded by the membrana tympani, owing to the obliquity of which the floor of the meatus is somewhat longer than the roof. The canal is lined by a prolongation of the external skin, which differs in character in different parts of the meatus and forms the outer layer of the membrana tympani. It is at first studded with hairs and sebaceous glands, and loosely connected with the subjacent cartilage. In the central, narrowest part of the canal, about three-eighths of an inch in length, are found the seruminous glands secreting the ear-wax; the subcutaneous tissue is here denser and scantier. The skin lining the osseous portion is very thin, free from glands and hairs, and closely adherent to the bone; in health it is dry, white, and shining.

The membrana tympani separates the meatus from the cavity of the middle ear. It is placed obliquely, looking downward and forward, and forms an acute angle (55 degrees) with the floor of the meatus. It is slightly concave externally, owing to the direction backward and inward of the handle of the malleus. In health the handle can be seen through the membrane, running from the circumference above and in front to a point a little behind and below the centre; below this is seen a bright point due to reflection of light from the concave surface. These appearances are altered in disease.

In children the external meatus is relatively as well as absolutely much shorter than in the adult. The osseous part of the canal is absent at birth and is formed subsequently. The membrana tympani is nearly vertical in infants.

The bony part of the canal and the membrana tympani can be satisfactorily seen only by inserting into the meatus a funnel-shaped silver tube, known as an ear-speculum; into this the light from a window or an artificial source is thrown by reflection from a laryngoscopic mirror. To insert the speculum, draw the auricle upward and backward with one hand, so as to straighten the cartilaginous canal, and with the other hand gently insert the speculum. By slightly moving the large end from side to side, a stream of light from the mirror may be made to play on the deepest part of the meatus. It is well to remember that some persons are very intolerant of the presence of a speculum, even in a healthy meatus; a dry cough is common, and faintness or even fainting may result.

Affections of the External Ear.

Affections of the auricle call for no special consideration here. Eruptions, tumors, etc., require the same treatment as elsewhere. Imperfect development of the auricle is apt to be associated with congenital mental deficiency.

In the treatment of affections of the external meatus, injections in one form or another play so important a part that it is well to begin with directions as to the best method of using them. For ordinary injections use a syringe, holding at least two ounces, and having a fine nozzle which will not block up the meatus, but allow easy reflux of fluid. Avoid the injection of air-bubbles by seeing that the piston fits well. The water should be of a comfortable temperature, and that already injected should be allowed to flow away into a separate vessel. In the case of an obstructing substance, direct the stream along the upper posterior wall of the meatus, in the hope that the fluid may pass beyond the body and drive it forward. Dry the meatus, after syringing, with absorbent cotton, and insert a drop of oil or glycerine and a piece of cotton. Vigorous syringing must be used cautiously, as it may lead to inflammation of the membrana tympani if unprotected by wax. When it is desired to introduce a gentle continuous stream into the ear, a Higginson's syringe is better than an ordinary syringe. For applying lotions use a small elastic bottle.

Foreign Substances in the Ear.—Children not infrequently push bits of slate-pencil, peas, glass beads, etc., into the passage of the ear. As an indispensable preliminary to treatment, satisfy yourself by inspection, through a speculum if necessary, that the foreign body complained of is really present. Any such body should be removed, as quickly and as gently as possible, by syringing the ear with warm water. If it cannot be thus removed, it should, as a rule, be allowed to remain. Probably it will after a short time fall out, or a repetition of the syringing, at short intervals, may be successful. Foreign bodies have remained in the meatus for years without inflicting permanent injury. Except in the case of soft fibrous bodies, or substances lying just at the entrance of the passage, instruments seldom succeed and almost invariably do harm, by driving the foreign body against the membrana tympani.

If used at all, instruments must be in all cases directed by sight, and so applied that any force used acts on the foreign body from within outward. A very fine-pointed steel hook, a snare of silver wire, or a rod tipped with glue by which traction may be made, offer the best chance of success. For children, chloroform is necessary.

Accumulation of wax, mixed with hair and cuticle, is a common cause of deafness, usually of sudden onset, often intermittent. The patient may complain of loud noises, and sudden giddiness even without defect of hearing. An examination should be made with the speculum, when the wax will be seen. It may generally be removed at once by syringing; but if two or three efforts do not bring it away, the meatus should be filled with oil, stopped with cotton-wool, and left for twenty-four hours. Then the syringe may be used again. Concretions may sometimes be advantageously removed by the fine steel hook.

Small FOLLICULAR ABSCESSES often form within the meatus. They are exceedingly painful, and very apt to recur. They are common in persons subject to styes of the eyelids. The constitutional condition should be looked to. Fomentations as hot as can be borne, leeches, and the local application of opium, give great relief. A small dose of morphia at night is sometimes desirable. An early puncture is the only thing which relieves the intense pain promptly and entirely.

CATARRHAL INFLAMMATION OF THE LINING MEMBRANE OF THE MEATUS.—This is usually dependent on constitutional causes, and is most frequently met with in ill-nourished children during dentition, or as a sequel of the exanthemata or any exhausting illness. It is a diffuse inflammation of the integument lining the external meatus, including that covering the tympanic membrane; the pinna may also be affected. It occurs usually in a chronic form with acute exacerbations.

The *symptoms* in the acute stage are earache, redness and swelling of the external meatus, which may be nearly occluded, and more or less fever. They are relieved on the appearance of a thin discharge, which persists as the chief characteristic of the chronic stage. In severe acute cases, inflammation may extend through the substance of the membrana tympani to the middle ear.

In the acute stage, leeches and fomentations, and general antipyretic measures are indicated; in the chronic, mild astringent injections, especially lead lotion, cod-liver oil, tonics, and good food. In both, the maintenance of local cleanliness by syringing is of the first importance.

ECZEMA OF THE EXTERNAL MEATUS always extends to it from the auricle. In the acute and subacute forms it induces a condition closely resembling that of catarrhal inflammation. Diagnosis depends on recognition of the eruption elsewhere. Avoid watery injections and cleanse with olive oil. Apply boracic ointment in the acute stage, and later ung. hydr. nitr. mit. Cod-liver oil, tonics, and good food are often indicated.

In the chronic form of eczema, the integument lining the meatus and covering the membrana tympani becomes thickened and scaly. It may cause impairment of hearing. Apply strong ung. hydr. nitr., or a strong solution of silver nitrate; arsenic internally is sometimes useful.

POLYPUS.—In rare cases small fibrous pedunculated tumors spring from the periosteum lining the osseous canal, probably as the result of some irritation. They may cause impairment of hearing. They are readily removed, and, if the base is cauterized, rarely recur. The general subject of aural polypi is considered under the head of "Diseases of the Tympanum."

EXOSTOSES sometimes form in, and almost occlude the meatus, leading to an accumulation of wax behind them. The entrance of water into the meatus by syringing or otherwise is to be avoided, and accumulations of wax must be removed by the fine hook or other means. When hearing is much impaired, the exostoses may be removed by means of a dental drill.

SEBACEOUS TUMORS occasionally prove fatal in early life by perforating the bone and pressing on the brain. They give rise to few symptoms. If discovered, lay open and remove the cyst.

Mucous tubercles are occasionally met with in the external auditory meatus. Sprinkle with calomel, and employ appropriate internal remedies.

Affections of the Tympanum.

The tympanum is a roughly cubical cavity, separated from the intracranial cavity above by a thin plate of bone only. Externally it is bounded by the membrana tympani; on the inner wall are the fenestræ communicating through thin membranes with the labyrinth. The chain of ossicles extends across the tympanum from the membrana tympani to the fenestra ovalis. Posteriorly the cavity communicates directly with the mastoid cells, which are in close relation with the lateral sinus. Anteriorly, the Eustachian tube passes forward to open in the pharynx, forming the only connection with the external air.

Except when the membrana tympani is ruptured, direct treatment of the tympanic cavity can be effected only through the Eustachian tube. The methods most commonly in use for driving air into the tympanum are based upon the fact that the slit-like opening of the Eustachian tube, though closed when in a state of rest, is rendered patent by muscular action during the act of swallowing, and also by inflation of the pharynx. By Valsalva's method the patient makes a forcible expiration, with the mouth and anterior nares closed. By Politzer's method, one end of an elastic catheter is passed into one nostril, and the anterior nares closed upon it: the patient swallows a mouthful of water, and at the same moment the operator forces a jet of air into the pharynx from an elastic bag attached to the catheter. By either of these methods air can usually be made to pass from the pharynx into the tympanum.

The Eustachian catheter is a shortly curved silver tube, which is held in the right hand and passed quickly, point downward, along the floor of the meatus till it strikes the spine; it is then withdrawn about half an inch and its point turned outward and rather upward, when it catches in the mouth of the Eustachian tube. The left hand now holds the catheter steady, and the right injects air with a small fine-pointed ball-syringe which fits the catheter. When the otoscope shows that air enters the tympanum a few drops of fluid may be run into the catheter and blown into the tympanum. It is now rarely used for the purpose of simple inflation, but it is the most convenient method for fluid injections. Its use is not without danger in unpracticed hands.

The otoscope is a flexible tube, of which one end is placed in the patient's external meatus, the other in the surgeon's. When the tympanum is inflated, the air can be heard by the auscultator to enter, while moist sounds indicate the presence of fluid in the cavity.

Obstruction of the Eustachian Tubes, owing to extension of catarrh from the pharynx, is one of the most common causes of deafness—hence known as "throat deafness." Owing to the obstacle to the admission of air, the balance of pressure on the inner and outer sides of the tympanic membrane is disturbed, its own pressure on the ossicles is ill-adjusted, and the transmission of vibrations to the labyrinth is interfered with.

The obstruction may arise from simple acute catarrh, when it usually subsides spontaneously, or requires at most a few inflations of the tympanic cavity.

More commonly one of the following conditions is present: 1. Chronic catarrh of the pharynx, arising from exposure, alcohol, or one of the exanthemata, and leading to the state known as "granular pharynx." 2. A thickened state of the membrane in strumous children, associated with enlarged tonsils, and often accompanied by "adenoid growths" in the upper part of the pharynx. These growths consist of soft lymphatic tissue, and may be so abundant as to occlude the posterior nares.

The symptoms are those of acute or chronic catarrh with more or less deafness, which is usually bilateral. The concavity of the membrana tympani is increased, but its appearance is otherwise healthy.

Both conditions require constitutional treatment. In addition, inflate the tympanum at intervals while the deafness lasts; apply astringents to the pharynx with a curved brush, and use weak alkaline nasal injections. In strumous children examine digitally for adenoid growths; if present, remove with forceps, or with the nail, or a curette attached to the finger. Removal of the tonsils may be indirectly beneficial.

Catarrh of the Tympanum is frequently a further stage of the preceding affection, the inflammation travelling up the Eustachian tubes. It sometimes commences independently in the tympanum. The rheumatic and gouty diatheses are said to predispose to it. It is apt to be recurrent.

The symptoms are usually not very marked. There is impairment of hearing, slight pain in the ear, and sometimes tinnitus. On examination the membrane is found opaque, and the lower part of the meatus rather inflamed. Moist sounds are heard through the otoscope during inflation. Perforation of the membrane is rare. After repeated attacks the mucous membrane of the tympanum becomes permanently thickened, and inspissated mucus hampers the movements of the ossicles; in some cases the ankylosis occurs between them, or between the stapes and fenestra ovalis. There is a dry chronic form of otitis media.

Treat the constitutional condition and any morbid state of the pharynx. Inflate the tympanum periodically. Mild astringent injections into the cavity may be used. In the most chronic form, injection of warm soda solutions and the vapor of ammonium chloride have been recommended. If rupture of the membrane is threatened, or if there is good reason to suspect accumulation of semi-fluid mucus, make a small vertical incision in the lower posterior part of the membrane. By means of Valsalva's method the cavity can be emptied. The incision heals in a few days.

Otitis Media Purulens Acuta, or acute purulent catarrh, most often occurs in children in the course of scarlatina; less often in connection with one of the other exanthemata or idiopathically.

The idiopathic form is the most typical. It commences with violent pain in the ear, more or less deafness and tinnitus, and fever, often high. The meatus is red, swollen, and tender; the membrane dull, opaque, and vascular; syringing causes great pain. The inflammation usually goes on speedily to suppuration, and unless exit is afforded to the pus by spontaneous rupture of the membrane or by its incision, disorganization of the tympanic cavity takes place with necrosis of varying extent of the small bones. Inflammation may spread to the mastoid cells and to the petrous bone, leading to caries or necrosis. It is sometimes accompanied by facial paralysis. Death may occur either immediately or after years of chronic discharge from the supervention of meningitis, pyæmia, or abscess of the brain. When the membrane ruptures spontaneously, perforation and a chronic discharge from the ear (otorrhœa) usually persist.

Treatment.—If seen early, apply leeches behind and below the ear, followed by fomentations, purgation, and low diet. Occasionally suppuration is prevented and the attack subsides.

More often suppuration occurs and the fever and pain increase. When this is the case, at once relieve tension and secure drainage by a free incision in the lower posterior part, in the absence of any sign of pointing elsewhere. Apply hot fomentations and syringe frequently with warm boracic lotion. The patient should, if possible, empty the cavity by the Valsalvan method. The cut tends strongly to close, and must be kept open, if necessary, by the insertion of a special bead.

If there is pain in the mastoid process, with redness and œdema, even in the absence of definite signs of pus in the tympanum, make a free vertical incision down to the bone. If pus is not reached, break into the mastoid cells with the scalpel, or, if necessary, with a drill, so as to allow free exit to the discharge which is almost certainly present. The mastoid cells may be emptied by Valsalva's method of inflation, after closing the external meatus on each side. If the membrane is perforated, the cells may be washed out through the tympanum, by using a syringe with a nozzle accurately fitting the meatus. The treatment of intracranial complications—indicated by rigors, headache, delirium, convulsions, or coma—is simply prophylactic, and consists in local cleanliness and free drainage.

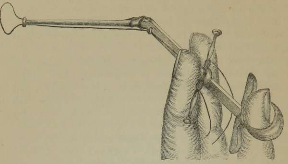
Perforation of the Membrana Tympani may result from (1) laceration by violence. It often accompanies fracture of the petrous bone; but it may be caused also by blows on the head, or a box on the ear; by violent blowing of the nose; throwing a forcible current of air through the Eustachian tube; by violent syringing, which may easily rupture a thinned and dry membrane; by descent in a diving-bell; by the introduction of foreign substances; and lastly, by loud noises, especially the discharge of cannon. Sense of shock in the ear, bleeding, and deafness are the immediate symptoms of this accident. (2) Perforation is most commonly the result of acute otitis, and suppuration within the tympanum. (3) Chronic inflammation may cause it, but more often predisposes to it.

The symptoms of aperture in the membrane are: deafness; hemorrhage—from laceration, discharge and sudden cessation of pain—from perforation; escape of air through the ear on blowing the nose forcibly; or the taste or perception in the throat of substances applied within the meatus. On examination with the speculum, the aperture may generally be seen; or if the tympanum is inflated, air bubbles and mucus issue from it. The deafness accompanying perforation probably depends less on the size of the opening than on the amount of accompanying morbid change in the tympanic cavity. In the case of rupture by violence, the deafness is usually roughly proportional to the violence, and is probably due as much to injury of the nervous apparatus as of the membrane. As perforations usually heal, unless kept open by the passage of irritating secretions, they are almost invariably accompanied by a discharge from the ear, which in chronic cases is often fetid. This is the usual cause of polypus. Should there be any obstacle to the free exit of discharge, the mastoid cells and petrous bone may become involved at any stage, and *caries* or extensive *necrosis* result.

The objects of treatment are to prevent the accumulation of secretion in the tympanic cavity, to restore its lining membrane to a healthy state, and to improve hearing by restoring the requisite support to the chain of ossicles. To fulfil the two former indications, syringe twice daily with warm boracic, quinine, or sulphate of zinc lotion, washing through from the meatus to the nose, if possible. If fungous granulations are present, blow in gallic acid in powder, or touch with silver nitrate fused on a probe, and apply iodoform. The latter indication is fulfilled by the use of an artificial membrane composed either of vulcanite, or of a moistened pellet of cotton-wool. The latter is applied daily by the patient, and should not be sufficiently large to occlude entirely the external meatus.

Polypus is, as a rule, simply a further stage of the fungous granulations mentioned above. Polypi are pedunculated, and consist when young, of ordinary granulation tissue, and when older of fibrous tissue of varying degrees of firmness. They constitute a mechanical impediment to hearing and

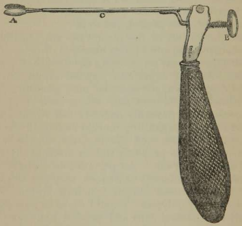
FIG. 182.



Sir W. R. Wilde's snare for polypi.

lead to retention of discharge with its attendant evils. After removal by forceps or a snare (Figs. 182, 183), they recur obstinately. Their sites should be touched daily with some strong caustic (chloracetic acid) unless

FIG. 183.



Avery's lever forceps for polypi.

there are no further signs of growth. At the same time the ordinary treatment for perforation of the membrana tympani must be assiduously carried out.

AFFECTIONS OF THE MEMBRANA TYMPANI are rare as independent affections. Primary inflammation of the membrane may occur as the result of local irritation, such as violent syringing; in these cases it usually spreads to the tympanic cavity.

Collapse of the membrane is generally a sequel of chronic catarrh of the tympanum, needing treatment by astringent injections, etc. There is impairment of hearing, improved by inflation, but rapidly returning as the membrane sinks back towards the promontory.

EARACHE (*Otalgia*).—This term ought to be restricted to signify *neuralgia* of the ear. Genuine *neuralgia* of the ear—occurring in fits of excruciating pain, shooting over the head and face—may be distinguished from *otitis* by the sudden intensity of the pain, which is not throbbing—does not increase in severity—is not attended with fever, and comes and goes capriciously. Its causes are those of neuralgia elsewhere, including decayed teeth. It is by no means common; what is popularly called earache is usually of inflammatory origin.

The pain may be temporarily alleviated by the application of liniment of aconite; croton chloral may be administered internally. Tonics and iron are generally indicated, and decayed teeth should be seen to.

AFFECTIONS OF THE INTERNAL EAR AND AUDITORY NERVE.

The internal ear or labyrinth contains the ultimate ramifications of the auditory nerve, and it is here that auditory impressions are received for transmission to the brain. Symptoms of nervous origin may be due to changes in the labyrinth, in the auditory nerve or its nucleus, or in the part of the brain receiving impressions from it. With very rare exceptions these symptoms are not amenable to treatment of any kind, and the chief practical importance of their diagnosis is the prevention of the patient's being harassed by the useless application of local remedies to the middle ear.

The chief *symptoms* resulting from nervous changes are deafness, tinnitus, and vertigo—all met with in affections of the middle and outer ear.

Intrinsic deafness is apt to be increased during nervous fatigue or exhaustion; it is not relieved by inflating the tympanum. If a vibrating tuning-fork be placed on the vertex it is heard least in the deaf ear; the reverse is the rule in extrinsic deafness.

Tinnitus from intrinsic causes is usually, though not invariably, of an aggravated form. Tinnitus is apt to be associated also with those affections of the middle and outer ear which cause increased pressure of the stapes upon the fenestra ovalis.

Each attack of vertigo of intrinsic origin is usually followed by further diminution of hearing which is not recovered from.

DEAFNESS FROM VIOLENCE, such as a blow on the head or an explosion, may occur with or without rupture of the membrana tympani. There is generally tinnitus; and both it and the deafness are independent of rupture of the membrane. They may in time improve or be completely recovered from.

OTITIS ACUTA INTERNA is an acute illness attacking children suddenly with symptoms of meningitis. On recovery there is complete and permanent deafness, and for some time a tumbling gait. It is supposed to be due to pus in the labyrinth, probably from extension of inflammation from the meninges.

INHERITED SYPHILIS is a cause of deafness, generally coming on between the age of five and fifteen. It is almost invariably bilateral, often extreme, and usually rapid. It is permanent and not amenable to treatment.

MÉNIÈRE'S DISEASE is supposed to be due to some affection of the semi-circular canals. The symptoms are vertigo often with vomiting, and tinnitus, at first intermittent, afterward in severe cases continuous; with these is increasing deafness. The attacks may cease, the impaired hearing remaining stationary; or they may cease only when complete deafness is reached. Quinine, pushed to cinchonism, is said to have been beneficial.

Besides the above fairly well-marked varieties, deafness may occur as a symptom of various intracranial lesions; it may also come on in the course of acquired syphilis and pass off under treatment. Occasionally complete deafness follows mumps, and may be permanent. In some families there seems a predisposition to deafness from slight causes.

Sir W. B. Dalby's *Diseases of the Ear*, 2d edition, has been freely consulted.

CHAPTER XXXVII.

INJURIES AND DISEASES OF THE SOFT PARTS OF THE FACE.

INJURIES of all kinds may affect the face, the most serious, on the whole, being gunshot wounds and burns. Gunshot and other wounds of the part are frequent, and, even though bones are shattered and considerable portions carried away, the prognosis as regards life is good if there is no fissure extending to the base of the skull. In the face more than in any other part is deformity of importance, and this may be extreme from actual loss of parts and from scar-contraction; the mere presence of a scar may be very unsightly. Ectropion and eversion of the lower lip are common, closure of the jaws a rarer result of scar-contraction.

TREATMENT.—Owing to its vascularity, the face tends strongly to heal by first intention and resists sloughing. Consequently, flaps, no matter how injured, must be carefully cleaned, and brought into the *most accurate apposition*, by a continuous horsehair or other fine suture, the needle being no larger than the thread necessitates. Where there is some loss of substance, but the wound can still be brought together, choose that line for the scar in which its contraction will have least effect upon the eyelids, ala of nose, or angle of mouth; at right angles is the best if it is possible, and attention must first be paid to the lids. Asepsis should be obtained when no mucous membrane is involved, and wool-dressings are the best. Bleeding stops after short compression or a suture will include the points. In perforating wounds involving skin and mucous membrane, a fine continuous suture should include the skin; another may take the mucous membrane, and perforating sutures of support may be used, if required by tension. Failure of primary union often means a muco-cutaneous fistula. This (*salivary fistula*) is especially frequent when the parotid duct has been opened.

In cases of loss of substance from incised wounds, it is right at once to adopt such plastic measures as are best adapted to the case; but fear of sloughing prevents this in lacerated and contused injuries.

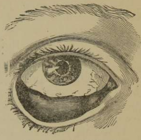
When bones are fractured and easily displaced, they should be wired.

DEFORMITIES from injury or disease are very frequent.

EYELIDS.—*Ectropion*, or eversion of the lower lid, may be due to paralysis of the 7th, or to hypertrophy of the palpebral conjunctiva, and require excision of some of the latter membrane, or, in the latter case, light pencilling of the surface with mitigated caustic. But the worst cases are due to scar-contraction. The lid may then be drawn far down on the cheek, the eye cannot be closed, the conjunctiva is chronically inflamed, and tears often run down the cheek; for the punctum does not touch the globe.

Treatment.—Rarely a V-shaped cut with its point downward and upon the scar will allow the lid to be dissected up, placed in position, and kept so by approximation of the lower margins of the cut. More commonly the lid has been dissected up, placed in position, and the resulting wound filled by a suitable flap twisted in from the temple. But Wolfe's operation seems to be much better than this. Having dissected up the lid, he keeps the eye closed by two or three silk sutures through the lids, and then fills the gap with a bit of skin, free from fat, taken from the front of the forearm and fixed by sutures when all bleeding has ceased. A moist boracic or a wool dressing is used.

Fig. 184.



Ectropion caused by scar.

Entropion, or inversion of the lids, may be spasmodic, especially in children with photophobia. Contractile collodion on the lids may prevent it, or division with scissors of the outer canthus (ciliary part of orbicularis) be required. The lax lids of old people may be turned completely in by muscular contraction; here removal of a strip of redundant skin generally cures. The worst cases are from scar-contraction of the conjunctiva in cases of chronic inflammation. The cartilages, chiefly the upper, become incurved. Expose it and excise a wedge-shaped slice along its whole length and reunite the skin by sutures. Should this not succeed, split the cartilage and remove the outer half with the hair-bulbs.

Congenital or otherwise irremediable *Ptosis* may be relieved by excision of a strip of skin.

NOSE.—A part or the whole of a nose destroyed by disease or accident may be restored by transplantation of skin from an adjoining part; but when the loss is due to scrofulous, lupous, or syphilitic ulceration, at least a year should elapse after healing before any plastic operation is done, lest the disease should recur.

Total Rhinoplasty.—The whole nose is best replaced from the forehead by the *Indian method.* Cut a piece of brown paper to the shape of the nose spread out flat, and one-fourth too large for the patient; from this trace the outline on the forehead, the stalk of the pear-shaped flap being rather long, and wide enough to reach from beyond the mid-line of the nose on one side to the eyebrow on the other; the flap may incline a little to one side. Pare the margins of the nose thoroughly by a knife held parallel to the mesial plane; and if there is any of the ala left, split it off from the rest by a cut in the groove above it. Dissect up the frontal flap, taking everything down to the periosteum, and making the knife incline slightly to the mesial plane as the sides are cut; a wider surface which fits the nasal margins well is thus obtained. Bleeding is free, and requires sponge-pressure on the frontal wound. Twist the flap into position, lengthening the cut near the eyebrow but *not* turning it in toward the nose, and continuing the other cut down the mid-line of the nose, thus forming a groove for the stalk of the flap to lie in. Fix the flap in position by a close continuous horsehair suture, and sew the remains of the alæ to the lower margin of the flap, to which they form the most natural border. The columna may be formed, now or later, by a strip from the forehead, brought down with the flap, or from the upper lip. Now bring together the three angles of the frontal wound with harelip sutures; the skin is so movable that little raw surface need be left. Lastly, support the nostril with a little antiseptic wool, to be removed next day, and cover the whole nose with wool to keep it warm. If it become blue and cold from venous obstruction, look carefully to the pedicle; if nothing can be done there, the loosening of a suture, or pricking the flap freely, may prove beneficial. The danger, of course, is that more or less sloughing may occur. The flap shrinks much as time goes on. The stalk may ultimately need paring to make it lie smooth. The result is often such a hideous deformity, that it is questionable whether a celluloid noose, held on by a spectacle frame, is not to be preferred.

To restore the septum or columna it is best to cut a strip, a quarter of an inch wide, from the centre of the upper lip. The incisions run in the convexities on either side of the median groove, and below they turn sharply in to the middle, along the line of the red, and then through this. Divide the frænum well, and turn up the strip; split its end a little, and attach it, spread out, to the vivified edge of the nose; the mucous surface will soon become pale and skin-like. Now bring in the side of the lip, first making short cuts up and out from the base of the central strip, that it may not be constricted, and secure the halves as in harelip. The saved bits of prolabium restore the central prominence of the lip, and the result is very good.

When only *one ala nasi* is destroyed, skin may be measured out on the cheek, and raised to supply the defect. But if both are lost, or the cheeks spare and thin, it is better to supply their place from the forehead. The slip which connects the engrafted portion with the forehead will be long and thin, and to maintain its vitality, a groove may be made to receive it on the dorsum of the nose. When union has occurred, this connecting slip may be raised and cut off, and the groove closed by sutures.

Depression of the apex may be remedied by restoration of the columna. If more is necessary, separate the alæ and cheeks widely from the upper jaws, by a narrow knife passed between the lip and jaw, and draw the cheeks in toward the mid-line by Lister's button-sutures—one passed from one naso-labial fold to the other, one or two between the grooves separating the alæ from the cheeks. In seven to ten days the cheeks have united in their new position, and push forward the nose.

For *Depression of the Bridge* there is no satisfactory remedy. Improvement may result from cutting a mesial groove, and implanting a division of frontal flap. We are not aware that division of the septum, as in Rouge's operation (p. 525), and forcible elevation of the bones with rubber-sheathed forceps has ever been tried.

Deviation of the septum may obviously block a nostril and turn the tip of the nose to the opposite side. By cutting off the apex of the prominence, freely scoring the cartilage in a radiating manner, bending or breaking it into place, and keeping it there with antiseptic wool plugs, relief may be given.

CHEEKS.—*Muco-cutaneous fistulæ* must be treated by paring and bringing together the edges, or by twisting or gliding a flap or flaps to cover.

Salivary fistula sometimes forms when the parotid or submaxillary duct, or, rarely, the gland, has been perforated by a wound or ulcer; then saliva dribbles out on the cheek.

Treatment.—First, a good passage must be established from the duct into the mouth, by passing a probe through the buccal orifice of the duct into the strictured part, and gradually dilating it; or, if this cannot be done by puncturing the mouth through the fistula in two places, passing a piece of flexible wire through the apertures, and securing the two ends in the mouth by a twist. When a sufficient opening into the mouth has been established the edges of the fistula may be pared, dissected up, so that they may be shifted, and brought together in a straight line. In slight cases a fine cautery may be passed round the edge to make it contract. If these fail, the aperture may be covered with a flap of skin raised from the adjoining parts.

LIPS.—*Eversion of the lower lip* commonly results from burns of the neck and chin, and the lower teeth are forced outward into a horizontal position by the tongue. Syme's operation (p. 195) is the best.

Contraction of the oral opening may necessitate its enlargement by a cut at either end, mucous membrane being sewn to skin to prevent reunion.

MALFORMATIONS.—The face is formed thus: in the fifth to sixth week the fronto-nasal process grows down from the base of the rudimentary skull, between the nasal pits on the ends of the anterior cerebral vesicles; it overhangs the mouth, and forms the nose and central portion of the upper lip, whilst in a process from the base of the skull behind it, the nasal septum and intermaxillary bones, each bearing two incisor teeth, develop. Below, the mouth is bounded by the first visceral or mandibular arch, which reaches the skull at either end, and gives rise to the lower jaw and lip. From this arch, near the skull on either side, a plate (maxillary) grows horizontally inward below the eye, and ultimately blends with the fronto-nasal process, completing the orbit, cheek, and upper lip. The maxillary process produces the upper jaw, and from its inner surface the palatine process grows toward the mid-line.

Macrostoma, or prolongation of the angle of the mouth upward and outward, results from arrested union between the maxillary and mandibular plates. A slight *degree* is not uncommon, and gives a good-humored look; marked examples are rare, and may be remedied by paring the edges, and bringing them together as far as need be.

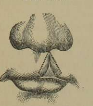
Harelip is by far the most important deformity of the face. It may be *single* or *double*, according as the maxillary fails to join the fronto-nasal process on one or both sides. Single harelip varies from a slight notch in the red border to a cleft running through the lip into the nostril, and is almost always to one side of the mid-line, a median fissure being possible only when the fronto-nasal process is absent below; in double harelip, the clefts are almost always complete into either nostril, and between them is the *lunula*, or part of the lip developed from the fronto-nasal process, resting upon a rounded bony nodule—the *intermaxillary bones*—attached to the mesial septum of the nose. Often the intermaxillary process projects greatly, being attached to the columna of the nose. In these cases there is always complete cleft of the palate, which often accompanies single complete harelip also. This and other malformations are often attributed to maternal impressions; usually these occur too late to have any effect, for the lips and palate are complete about the tenth week.

TREATMENT.—Infants have been operated on successfully a few hours after birth; but as they bear even slight losses of blood ill, it is best to wait till the third to sixth week, or later if they are weakly. As in all other plastic operations, a good state of health and freedom from all local trouble (thrush, ulceration, etc.) are essential to success. Very rarely a child dies after an operation for harelip, previous starvation, aided by broncho-pneumonia, being the usual cause.

Chloroform should be given, and the surgeon either stands above the head, or sits opposite the nurse and takes the head upon his knees.

In *single harelip*, complete or almost complete into the nostril, first detach the lip *freely* from the bone on either side of the cleft; then pare the edges. Seize one lower corner of the cleft with artery forceps, stretch the edge of the cleft, pierce it with a narrow knife just under the nose and cut downward; proceed similarly on the other side, and, lastly, vivify the notch in incomplete cases. It is better to remove too much of the margin rather than too little, and the knife should describe the segment of a small circle as it travels from above down, turning sharply in below, rather than the straight lines shown in Fig. 185; thus a bit of red border will be saved inferiorly, and the edges, when brought together in a straight line, will deepen the lip. During the paring, bleeding is controlled by the fingers of an assistant pinching the thickness of the upper lip, or preferably, by bull-dog forceps applied near the angles. To bring the edges together, one or two harelip sutures (Fig. 45) are usually employed, the first pin being passed through the skin one-third inch from the raw edges, and beneath the cut ends of the coronary, care being taken as to the fit at the free border; one or two fine silk stitches are passed through the edges of the prolabium, and then a continuous horsehair suture (passed with a fine needle) holds the skin edges together. Lastly, paint round and across the wound with contractile collodion, seeing that none enters it. The pins are removed after forty-eight hours, the silk and collodion being left undisturbed. In many incomplete cases, pins are unnecessary and their scars may be avoided; and, where sutures of support are required, many prefer a small button suture, introduced an inch from the cleft. In any case the retracting action of the zygomatici should be met thus: cut two figure-8 bits of strapping, quite narrow, centrally; fix one end of each on to a cheek; pass the free end of one through a slit in the centre of the other, and by pulling on the ends draw the cheeks down and in, and pucker the lip; make the centres rest on the point of the chin and fix the free ends on top of the attached ones. Linen may be similarly used with collodion.

FIG. 185.



Single harelip, incomplete; showing paring of edges.

If union fails, the pins may be reinserted, or the edges may be kept together by strapping as above and across the lip; union by granulation gives a less satisfactory scar. Every endeavor must be used to prevent crying during healing; sucking is permissible.

The following modifications must be noted. Nélaton treated a notch in the lip by cutting a Λ above it, everting the Λ, and sewing the raw edges together. Some preserve part or all of the parings of the edges, turn them down and sew them together. In many cases one side of the cleft is vertical, the other oblique; it is then a good plan to pare the former, as shown in Fig. 185, without making the little cut at the end, but to remove the red border completely from the latter; it will then be found that when the edges come together a raw surface is left on the free border of the oblique side which accommodates the paring from the straight side.

The result cannot be regarded as good unless there is, not only no notch in the free border, but an actual prominence; for the scar contracts and does not grow with the rest of the lip, so that ultimately a notch forms. It may be remedied by Nélaton's operation.

When the *harelip is double* many more difficulties arise—the gap is wider, the intermaxillary bones projecting, the nose more flattened on the face.

First, as to the *intermaxillary process:* Fergusson used to cut it off, finding that, if bent back, the incisors would not align with the other teeth; but it is well to preserve it, as it gives a better shape to the upper jaw and supports the lip. To bend it into position between the maxillæ, make a one-inch cut along the lower edge of the septum, behind the process; with an elevator raise the periosteum and both naso-palatine arteries from the septum; with scissors cut out a wedge of the septum having its base below and wide enough to permit the necessary movement of the process.

Next, is the *lunula* to be used in the lip, or to make a columna? If the side pieces will come together fairly without it, dissect it up, fashion it into a columna and fix its free vivified margin between the side pieces; thus the tip of the nose will be fairly raised. But if material is scanty, pare the lunula into a square, the columna occupying the fourth side; cut and preserve a rather wide paring from the side pieces; secure the side pieces by pins and sutures to the side of the lunula and unite the parings below its lower border. The nose will be much depressed.

Lastly, *flattening of the nose* cannot be avoided if no columna can be made; but the alæ should be dissected up freely from the maxillæ, the clefts pared to the very top, and the alæ slid in and sewn to the columna. The tip rises to a certain extent subsequent to the operation.

HYPERTROPHY OF THE NOSE.—The nose is specially liable to irregular general increase of its soft coverings, which form tuberous masses that grow slowly and painlessly. The organ is red, small veins are dilated, and the sebaceous follicles are enlarged and secrete profusely. There is usually a history of free living.

Treatment consists in first cutting down to the cartilage in the mid-line, and then shaving the morbid tissue off close to the cartilage, whilst an assistant distends the nostril with his finger and warns the surgeon against a too near approach to the interior. Bleeding may be free, and must be stopped by ligature, pressure, or hot water. The part granulates and skins over smoothly.

INFLAMMATIONS of all kinds may affect the face and reach any degree of intensity. Certain occur with special frequency. Thus patches of *scrofulous eczema* and *impetigo contagiosa* are very common, and often lead to infection of glands; removal of scabs, and antiseptic ointment, and attention to the general health soon cure. The upper lip is the special seat of *herpes febrilis;* and *herpes zoster* may occur along the branches of the fifth, especially the supra-orbital and infra-orbital. *Cellulitis* and *acute abscess* usually result from wound; *chronic abscess* in connection with diseased bone. *Erysipelas* may seem to arise in the face without wound (p. 151). *Facial carbuncle* has been described (p. 212); also *malignant pustule* (p. 208), which is specially common here. *Syphilis* may occur as a *primary sore*, especially on the lip, by infection from mucous tubercles in kissing, and on the lids in babies, from women with mucous tubercles, using their saliva to remove scabs or discharge; *secondary rashes* are frequent, and often choose the forehead, near the hair; *tertiary ulcers* form in debilitated subjects and may destroy extensively, the nose and its cartilages most commonly suffering. The diagnosis must then be made from *Lupus*, of which the face is the special seat (p. 212), and *scrofuloderma*.

NEW GROWTHS AND CYSTS.—Many forms occur on the face, if the bones are included. Simple connective-tissue growths are not common; *fatty tumors* are the most so, and then *ivory exostoses*. Primary *sarcomata* are common in the bones, but not in the soft parts. *Nævi*, superficial and deep, are specially frequent, sometimes growing rapidly in the most awkward places, as the eyelids or lip. Hairy *moles* are often connected with these. *Warts* are common, and small *sebaceous adenomata* occasionally occur. *Sebaceous cysts* are frequent, and also *molluscum contagiosum* (p. 215). The *cancers* of the face are squamous *epithelioma* and rodent *ulcer*. For particulars of the tumors, see Chapter X.

Certain retention-cysts—MEIBOMIAN CYSTS—of the eyelids demand special notice. These small cystic tumors are very common, and often multiple; they arise in connection with the Meibomian glands of either lid, owing to obstruction of the ducts. They form firm, spherical, painless tumors, fixed to the tarsus, the skin being freely movable over them, and contain a thin fluid or a soft gelatinous or caseous mass. Not infrequently they suppurate, bursting through the conjunctiva, but occasionally externally. They generally possess no distinct wall, so cannot be dissected out.

Treatment.—The lid should be everted, a small crucial incision made into the tumor through the conjunctiva, and the contents removed with a small scoop or curette. The cavity fills with blood, which in a few days is absorbed, and the swelling disappears.

Rodent Ulcer, the anatomical relation of which to epithelioma is so very close, finds its special seat upon the *skin* of the face; it may occur with epithelioma of the lip or other mucous surface. For its clinical history, see p. 142. Complete excision is the proper treatment; only when this is possible should recourse be had to caustic pastes (p. 147), which must be freely applied.

Epithelioma of the Lip.—Occasionally a growth upon the *skin* of the face has not only the structure (p. 144) but also the clinical course of epithelioma; but it is upon the mucous membranes, and especially upon the *lower lip*, in this region that typical epithelioma occurs. Men are affected much more often than women (1 female in 61, v. Winiwarter); but women are said to suffer much more often in Ireland, where many smoke short, unprotected, clay pipes. The irritation of these certainly seems an effective cause, but non-smokers often suffer. It affects the lower rather than the upper classes, and countrymen rather than townsfolk. The upper lip is very rarely attacked; I have seen a wart upon it in a cornet-play, on whose lower lip was an epithelioma, which had begun as a wart. Hüter saw no case among more than 100, and this is the experience of most; yet v. Winiwarter records 5 cases among 62.

Symptoms.—The disease begins as an indurated crack or ulcer, as a wart or superficial hardness, upon the prolabium (Fig. 186), or where this joins the skin. The patients are usually past mid-life, but cases are recorded as early as twenty-one, and such are, as a rule, very malignant and of rapid course. Often, in older patients, the growth remains for a long time almost stationary or slowly progressing, covered with a scab of epithelium and discharge, which is occasionally cast. In its spread it may involve the whole chin and upper lip, the jaw and floor of the mouth, by direct extension; and, sooner or later, the submental and submaxillary glands swell, and finally the cervical; generalization is rare. Pain, difficulty in taking food, and cachexia destroy life.

Fig. 186.

Epithelioma of the lower lip.

Diagnosis.—Rarely a *slightly* indurated simple fissure is met with in the aged; it must be treated with an antiseptic ointment and anxiously watched. The chief difficulty is with primary syphilitic sores of the lip, before any secondary symptoms develop. If the symptoms are uncertain, mercury must be pushed, and if it fail to do good in two or three weeks, excise.

Prognosis.—This is more favorable than in epithelioma of any other mucous surface, especially in cases of slow progress, excised freely before glands are involved.

Treatment.—Excision, as early as possible, together with half an inch of apparently healthy tissue all round, no regard being paid to the patient's appearance. The cuts usually form a V, or three sides of an oblong. The sides of the V can often be brought together by wire or harelip sutures; if not, curved cuts down and back, from the angles of the mouth to below the jaw, and dissecting up of the flaps, will permit their approximation (Jaesche).

The square excision is more difficult to make up for; two oblong flaps may be twisted down from the naso-labial fold (Langenbeck), or a modified Syme's operation (p. 195) may be done.

Enlarged glands must be carefully sought with one finger in the mouth and others outside. Enlargement must not be attributed to "irritation;" it is much more probably epithelioma, and delay is fatal. The surgeon may think fit to extirpate apparently healthy glands. The submental are easily reached; but those (three or four) between the submaxillary and the jaw are troublesome, because close to the facial artery and vein; glands on both sides may be affected. If the jaw is invaded, or a gland is adherent to it, the piece should be excised; even when a case has gone so far as this, a good result *may* be obtained.

Affections of the Nasal Cavities.

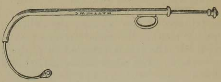
Foreign Bodies may be removed from the nose by a small scoop or bent eye-probe, either through the nostrils, or by pushing them back into the throat. The removal should be effected as early as possible.

Epistaxis, or Hemorrhage from the Nose.—*Causes:* (1) injury; (2) ulceration, often seen in scrofulous and syphilitic ozæna; (3) chronic Bright's disease, with hypertrophy of the heart; (4) cirrhosis of the liver with jaundice; (5) splenic leukæmia; (6) acute infective fevers, especially typhoid; (7) all hemorrhagic diseases, and especially scurvy, purpura, and hæmophilia; (8) it may be vicarious, occurring especially at puberty or the menopause—sometimes in pregnancy. But the majority of cases are not accounted for by the above; a single attack with a congestive headache, or the onset of a cold in the head is common. In other cases epistaxis is "habitual," the patients being sometimes very anæmic, at others plethoric; and in the latter it often relieves feelings of fulness in the head. The blood is thought usually to escape from varicose veins on the turbinate bones, but the varix at least is doubtful.

Symptoms.—Blood, usually bright, drops or flows from one or both nostrils, but even in the latter case proceeds, as a rule, from one side passing round the septum behind; the quantity lost may be very large, causing even fatal syncope, or the attacks may be less severe, but frequent, producing extreme anæmia and exhaustion. Much of the blood may be swallowed when the patient is lying asleep, and be either vomited or passed by stool; it is possible that *none* may escape from the anterior nares.

Treatment of an Attack.—Try the following methods in succession. Let the patient sit up, if not fainting, hang the head a little forward, and raise the arms above the head for a time. Sponge the face with iced water and apply ice to the nape of the neck whilst the feet are in a hot mustard bath. Irrigate the nostrils with iced water, and *afterwards* with water containing a little liq. ferri. perchlor., alum, or tannin (ʒj of each ad ℥j). Cause powdered tannin to be snuffed up, after all clot has been washed out. All blowing of the nose and muscular effort must be forbidden. These means failing, see if pressure on one or other lateral nasal cartilage will arrest the bleeding; if it does, plugging one or both anterior nares well with a narrow strip of boracic lint may stop it. If not *plug both nares* upon the bleeding side only, if this can be recognized by the history or otherwise. It is best done by inflating a Howard's India-rubber bag introduced collapsed upon a probe (*British Medical Journal*, December 3, 1881). If no bag is at hand, pass *Bellocq's canula* (Fig. 187), or an elastic catheter—either bearing a short loop of string—through the nose into the pharynx, seize the loop in the mouth and attach to it by a rather long double string a piece of sponge measuring one and one-quarter by two-thirds of an inch. Withdraw the instrument, and by means of the string and a finger in the naso-pharynx, place the sponge in the posterior naris. Next plug the nostril with cotton or lint, tie the two strings over the plug in a bow, and leave all undisturbed

FIG. 187.



Bellocq's Canula.

in severe cases for two days. For the posterior plug, the strings should be passed through the sponge and tied on each side, so as to constrict it less centrally; and one of the posterior strings should be left long and hanging from the mouth; by it the plug may readily be withdrawn. In doing this, it is wise to attach to an anterior string a fresh thread and to leave it *in situ*, if a second plugging is likely to be required.

Kidney, liver, or general disease must be treated according to the methods of medicine. Tincture of hamamelis deserves a trial in all habitual cases.

WATERY DISCHARGE.—Rarely, profuse discharge of watery fluid, lasting many days or months, occurs from one nostril, and in two cases (Paget, *Trans. Clin. Soc.*, vol. xii.) polypi in the antrum have been found *post-mortem*. Astringent lotions and inhalations of iodine are used.

RHINITIS, or inflammation of the nasal mucosa, is often spoken of as *coryza*, from the discharge which forms a prominent symptom. *Acute coryza* usually arises from a "cold in the head," and its symptoms are but too well known. It appears to be an infective inflammation to which some are specially liable. This tendency may sometimes be removed by a course of Turkish baths; one will often stop an attack, or sweating may be induced by homely methods and a full dose of pulv. ipecac. co. Small doses of quinine often relieve; and sneezing may be stopped by painting the mucosa with cocaine (five per cent.). Other causes are measles, diphtheria (nasal), farcy (p. 103), gonorrhœa, and hay-fever, which is due to the irritation of the pollen of flowering grasses (Blackley). Antiseptic douches form the treatment, and hay-fever may be guarded against by a respirator of several folds of crape.

Chronic Rhinitis occurs at all ages, and is usually tubercular, syphilitic, or traumatic; some cases are attributed to gout, and a few to arsenic in wall papers, etc. Adenoid growths in the naso-pharynx may cause a nasal discharge. The mucous membrane thickens much, and the lower turbinate is seen as a red mass blocking the nostril; polypi may form; ulcers are often present, and they may cause caries or necrosis. The most extensive destruction of the superficial and deep parts of the nose may thus be produced both in struma and syphilis, congenital or acquired. Primary affections of the bones also occur, leading to perforation of the septum or hard palate, or necrosis of single bones. *Treat* any general state, for this is the most important part. Antiseptic and astringent douches, similar ointments applied with a brush, powders blown in with an insufflator, or iodine or creasote inhaled, form the local treatment. Adenoid growths must be removed; also sequestra.

OZÆNA is a name given to a group of cases characterized by fetid breath and fetid, occasionally bloody, discharge from the nostrils—symptoms sometimes sufficiently marked to debar the sufferer from all society. Among its *causes* are struma, syphilis, injury causing necrosis, and the presence of foreign bodies; but often none can be discovered. In many cases, the fetor depends upon the presence of dead bone; in others, swelling of the mucous membrane may perhaps lead to retention and putrefaction of discharge, rarely to its inspissation and calcification (*rhinolith*); but the cases which most deserve a special name are characterized by atrophy (subsequent to rhinitis?) of all nasal structures, and the smell seems connected with drying of the secretion in the nose; perhaps some special organism is at work. These cases are practically incurable. The *treatment* is that of any general morbid state coupled with douches of all kinds of antiseptics, preceded by a lotion of carbonate of soda (grs. iv ad ℥j), to remove crusts and mucus. Any foreign body must be removed. If there is reasonable ground to suspect necrosis, though no bone can be felt bare, and especially in cases of injury, the nose may be opened by dissecting the upper lip and alæ from the bone and cutting the septal cartilage so as to allow the parts to be raised (Rouge). The interior can then be well examined and dead bone removed if found; according to Rouge it is very frequently present, but if the cribiform plate is affected, manipulation may set up meningitis. The operation is slight and leaves no deformity.

NEW GROWTHS.—*Mucous polypi*, having the structure of œdematous and very lax fibrous tissue are by far the most common; all mucous surfaces show a greater or less tendency to form such outgrowths, especially when they are chronically inflamed. In the nose polypi are single or very numerous; they may spring from any part of the interior on one or both sides, but are much most common upon the middle and upper turbinates near their anterior and posterior ends, and tend to project through the anterior and posterior naris. At first, small, hemispherical, and sessile, they gradually become large, pedunculated, and pear-shaped; they are smooth, yellowish or grayish, and slightly streaked with vessels. Occasionally they are *cystic* from degeneration of contained mucous glands; or largely *glandular* from excessive growth of these structures; rarely, vessels may render them quite *cavernous* (Birch-Hirschfeld).

Symptoms.—Sense of obstruction of the nose and more or less constant mucous catarrh, with frequent sneezing, and sometimes epistaxis; all symptoms much increased by damp weather. The patient is obliged to breathe through the mouth, the voice becomes thick, and smell is impaired or abolished, as obstruction becomes complete. Their pressure ultimately causes change in the shape of the bridge, displacement of the septum, blocking of the lachrymal duct, or deafness by closing the Eustachian tube.

Diagnosis.—Often polypi can be seen through the nostril without a speculum when the patient expires forcibly; still more often with a speculum. They are distinguished from the swollen inferior turbinate by their pallor, mobility, and the presence of a distinct neck; and from fibrous and malignant growths, not only by these signs, but also by the firmness, tendency to bleed, offensive discharge, and rapid infiltrating growth of the latter. Polypi hanging into the pharynx are detected by a finger above the soft palate or by posterior rhinoscopy.

Treatment.—Seat the patient before a good light. With a probe feel for the neck of the polypus, seize it with slightly curved forceps having slender but rigid serrated blades, and twist or tear it from its attachment. Often no guide can be obtained other than touch through the forceps, with which the nose must be cleared; the patient blows his nose strongly between the introductions of the forceps and forces down fresh growths. Bleeding is checked by iced and astringent douches. When polypi hang in the naso-pharynx, they may still be extracted, or at least detached, by forceps through the nose, aided by a finger behind the palate; but it may be necessary to surround them with the noose of an écraseur. Some surgeons always use the galvanic écraseur; it gives little pain and avoids bleeding.

A day or two after the removal of polypi, Haward recommends the application of strong liq. ferri perchlor. on a bit of lint to the interior of the nose; and an astringent douche should be used for some time.

Polypi very often recur or fresh ones present, and the treatment may have to be repeated several times. In bad cases Rouge's operation may be performed and the growths removed with the tissue whence they grow.

Papillary growths covered by columnar epithelium are rarely met with; and a *columnar epithelioma* occasionally starts in the nose. Very vascular *fibromata* and *sarcomata* spring from the basilar process or from the anterior common ligament of the vertebræ, block and invade the posterior nares and push down the palate; and tumors, especially sarcomata, of the upper jaw frequently project into the nasal cavity (p. 532). Sarcomata arising in the cranium may fungate through the ethmoid.

Warts must be treated like polypi. Epithelioma requires resection of the bone on which it rests. Nasopharyngeal growths may be attacked with an écraseur, by letting the head hang down and splitting the soft palate (Nélaton) or by osteoplastic resection of the upper jaw. Hemorrhage is very free and Paquelin's cautery-knife should be used.

Affections of the Jaws and Antrum.

Cleft Palate.—The development of the palate is referred to at p. 519. In some cases the uvula merely is fissured; in others, the cleft extends forward through the soft and hard palates, and may be combined with a harelip. The fissure in the hard and soft palates is invariably in the mid-line, but when it extends through the alveolus it diverges to one side of the intermaxillary bones. In a few cases the fissure is double in front and may be compared to the letter Y, the two lines in front having the premaxillary bones between them. This affection, when extensive, necessarily causes great difficulty in sucking and swallowing; and subsequently, very serious impediment to distinct articulation.

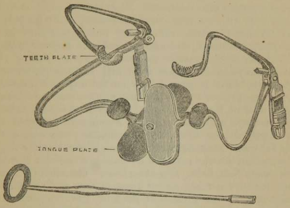
Etiology.—The only facts known are that a lioness at the gardens in Dublin gave birth to cubs with cleft palates when fed on meat without a sufficient quantity of bone; and that it is occasionally hereditary.

Treatment.—When combined with harelip, the latter should be treated as soon as possible, but the cleft of the palate should be left until teething is well over—*i. e.*, till the child is three years old or thereabouts. For infants bear loss of blood ill, the alveolar and palatal processes grow together considerably in three years, and the success of this operation depends very largely upon a healthy state of the part concerned and of the patient. In particular the surgeon should see that the teeth and mucous membrane are healthy, and that there is no cough.

The child should be under observation for some days before the operation, that its good health may be an ascertained fact; and during this time some direct that a finger shall be frequently passed into the fauces, that they may become accustomed to manipulation which otherwise causes free secretion of mucus, hawking, and swallowing. Every precaution must be taken to prevent chloroform vomiting, and an important one is to keep the pharynx well sponged out during the operation and prevent the swallowing of blood and mucus.

Operation.—The patient may be placed in one of three positions: upon the back, with the shoulders raised and the head extended; upon the back, with the head hanging over the end of the table, completely inverted; or upon the left side. The first is generally chosen as most convenient to the surgeon; the last is least so, but is probably that in which blood gives least trouble, as the cheek forms the floor of the cavity; in the second, venous bleeding from the valveless veins is free, and it is hard to expose the soft palate well, but blood is not easily swallowed. The light must be good and directed fully on the cleft; small electric lights are quite as good as daylight. The child being anæsthetized and position and lighting being satisfactory, a gag must be introduced. T. Smith's (Fig. 188) is most often used, or Wood's

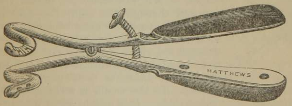
Fig. 188.



Smith's gag and tongue-depressor, with key.

modification of it; they take their bearing on the molars and tend to slip forward, so must be held by a nurse standing above the head; for, if strapped on, there may be delay in removing them. Whitehead's gag is better when the incisor teeth, upon which it holds, are present, for it is self-retaining. Mason's gag (Fig. 189) must always be held, and opens the mouth asymmetrically.

Fig. 189.

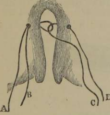


Mason's gag.

trically. An assistant with stick-sponges stands on the left, the anæsthetist on the left or above, and the surgeon on the right. Quick, efficient sponging at the right moments is most important. Free bleeding necessitates waiting and the use of pressure; and if the anæsthetist is not very skilful he must be allowed a few minutes to himself occasionally. Junker's tube or a wide-spreading Skinner's inhaler saturated with chloroform and held at a distance from the mouth gives the best results.

The *operation* when *the cleft runs forward to the teeth* is performed as follows: 1. *Pare the edges.* With long tenaculum forceps seize by its tip and stretch half the uvula, transfix it with a narrow knife parallel to the margin of the cleft and at such a distance as to make sure that all mucous membrane shall be removed; first cut back to the tip of the uvula, and then, stretching the paring, cut forward into the angle in front; leave the paring adherent here and repeat the process on the opposite side; the removal of a V of mucous membrane insures that the whole angle is raw. 2. *Raise mucous and periosteal flaps from the hard palate.* Opposite the middle of the cleft of the hard palate and midway between it and the margin of the gum make a puncture with the knife down to the bone; into this press the point of an *open-curved* aneurism needle and work it through beneath all the structures of the palate into the cleft. Now withdraw the needle, following it up from the cleft with an open-curved elevator, and with this raise all the structures of the hard palate—out to the puncture, forward to the teeth, backward to the junction of hard and soft palate. Repeat upon the opposite side. 3. *Divide the mucous membrane passing from the floor of the nose to the upper surface of the palate.* This is done with scissors curved on the flat to a right angle; one blade is passed between the flap and the bone, the other above the upper surface of the palate, and the mucous membrane is snipped through to the wall of the pharynx below the Eustachian tube. The flaps now hang down more and can be drawn considerably toward the mid-line, especially in high palates, which are consequently the easiest to mend. 4. *Introduce the sutures.* Most surgeons use fine silver wire for the hard palate and silk or horsehair for the soft and uvula, some use silk throughout; wire and horsehair seem best, being non-absorbent. Generally T. Smith's hollow needle is used for wire stitches, and it answers very well; but it is expensive, its needles are larger than solid ones need be, and the palate may be torn and bruised in the endeavor to pierce the second flap. The older plan is free from these objections, and by it the stitches can be more accurately passed with regard to the edges. With a fine rectangular or nævus needle carry a loop of silk through the edge of the flap, one-eighth inch from the cleft, seize the loop (AB, Fig. 190), draw it two or three inches into the mouth and remove the needle. Do this on the other side and, if silk sutures are to be used, draw *one end* (C, Fig. 190) of this loop into the mouth and pass it through the loop AB. Withdrawal of AB will carry the thread CD across the gap and through the right flap (Avery). But if wire is to be used, CD must be drawn into the mouth as a loop, passed through AB and then brought through the right flap; the wire is next hooked on to CD and by its withdrawal carried through both flaps. The thing is done more quickly than described. In the uvula a rectangular needle easily carries a horsehair from side to side. It is best to begin with uvula and soft palate and so far as possible to tie the horsehairs. Then start in front with silver sutures and pass all before tying any, placing them one-eighth to three-sixteenths inch apart and one-eighth inch from the edge. Next tie with a reef knot the wires in front where the edges come together with little strain; but where they gape tie the first half of the knot only, so as to make the flaps slightly tense. It will now be evident where the flaps must be freed in order that they may meet easily. 5. *Make lateral incisions, midway between the edge of the gum and margin of the flap, long enough to relieve all tension.* These are most needed at the junction of hard and soft palates,

FIG. 190.



Passing a palatine suture.

always the point of greatest difficulty. It is possible to cause sloughing by too long cuts, but they are much oftener made too short. 6. *Tighten and tie the last stitches and again feel that there is no tension upon them.*

The only serious *accidents* are hemorrhage and entry of blood into the trachea; both very rare. When hemorrhage not speedily stopped by pressure occurs, try to insure that the bleeding vessel is completely divided; it is usually the posterior or anterior palatine artery. Then try either prolonged digital pressure or expose and plug the canal whence the vessel issues.

Practice varies in several points. Many begin the second step by making free lateral incisions before they know how long they should be, and with the result that they get all the bleeding during, instead of after, the operation. Then as to the position of the incisions; some place them far out on the inner surface of the alveolus in the endeavor to preserve the great palatine artery in the flap. But it seems that this must usually be cut, for its entry is no doubt one of the main obstacles to the gliding in of the flaps at the back of the hard palate removed by snipping with the scissors. In the incision given, little regard is paid to the palatine artery.

After paring the edges, some bore two or three fine holes through the bony palate near the cleft, and pass wires through them; then make lateral incisions, bore through the palate several times and finally fracture it with a chisel along these lines; the wires then draw the fragments with the adherent mucous membrane together in the mid-line (Fergusson's operation, modified). This may be useful when the palate is covered with scar-tissue.

When the *cleft is less extensive* there is no real difference in the treatment; but shorter lateral cuts will do. In the soft palate it is of most importance to divide the levatores.

After-treatment.—A young child should be kept on milk for a fortnight; if meat is thought necessary it should be rubbed down and forced through a fine sieve. In the act of swallowing, the flaps are brought together by the *superior constrictor;* afterwards they are drawn apart by the *levator* and *tensor palati* and *palato-pharyngeus* (Fergusson). Crying, coughing, retching, and the like acts must be carefully guarded against; it is, therefore, better not to look at the mouth for a week. The stitches need not be removed for weeks in successful cases—until union is quite firm.

Results.—Frequently the operation is more or less of a failure, sometimes entire, again only at the junction of the hard and soft palates; rarely, the flaps slough. Several operations are often required, and it may be that ultimately success is wanting or that the palate is unpleasantly tight. After a nasal tone of voice has been acquired, successful closure effects but little improvement in this respect; if done before the child begins to talk the result is usually fair. Careful training is necessary.

Obturators are now so well made that they give results as good as, often better than, those of operation; but they are expensive. Syphilitic or tubercular perforations of the palate are best treated thus: no operation should be undertaken unless they have been soundly healed a year or two.

Closure of the Jaws may be *spasmodic* and very enduring, being almost always connected with faulty eruption or retention of the wisdom teeth. I have known the spasmodic closure of tetanus in a young man at first referred to this cause. It usually occurs about twenty, but may appear in quite old people in whom a wisdom tooth has not been cut. The *treatment* is to anæsthetize, open the mouth with a screw-gag and extract the third molar if it can be seized, or the second molar to make room for the third; or, if this does not succeed, to open the alveolus with a chisel and remove the retained, and usually misdirected, tooth.

Permanent closure arises from rigid scars of mucous membrane, or of the whole thickness of the cheek from sloughing after noma, mercurial stomatitis, or extensive necrosis of the jaws with burrowing abscesses. No treatment will *prevent* this contraction. Another cause is *ankylosis* of the jaw on one or both sides, the result of rheumatoid arthritis or of arthritis after acute fevers, usually occurring in children, perhaps by extension from the middle ear.

When the mucosa only is affected, Heath (*Inj. and Dis. of the Jaws*) states that success may follow repeated division of the scar tissue and the wearing of silver plates, fitting the teeth, which maintain a groove between the cheek and alveolus; but the treatment is uncertain, difficult, and painful. Probably mucous membrane from a distance might be transplanted to the raw surface, according to Wolfe's plan. *Esmarch's operation* of excising a wedge (apex at alveolus) from the jaw in front of the scar, and thus freeing the other side, is more often practised; but bony union may occur in spite of free excision. *Fibrous ankylosis* of the jaw has been relieved by division of the fibrous tissue with a tenotome and subsequent passive movement (Spanton), also by excision of the head; *bony ankylosis* by removal of the neck.

Necrosis may affect any part of the jaws—the alveoli most commonly, and the lower jaw more often and more extensively than the upper. The *causes* are mechanical injury, salivation, syphilis, struma, destruction of soft parts by noma, alveolar abscess; in children from three to eight (Salter) alveolar necrosis occasionally follows six to eight weeks after scarlatina, measles, and typhoid; lastly, phosphorus-fumes *acting through carious teeth* and for long periods, as in matchmakers, excite a periostitis which more or less rapidly suppurates and causes necrosis perhaps of the whole jaw, maxilla, and rarely of other face-bones also, with much sloughing of soft parts. In the upper jaw there is little or no callus thrown out, but in the lower a complete arch forms along the lower edge and acts as a mandible even when the condyles come away. Often, however, it atrophies in the course of years.

Symptoms.—These vary with the extent and acuteness of the periostitis and may be very severe. They are: More or less constant toothache, sense of elongation of the teeth, swelling and lividity of the gums, and often more or less œdema of the face, escape of pus between gums and teeth, through the gums or skin, recession of the gums, dropping out of the teeth, and exposure of a discolored sequestrum, which slowly loosens. The breath is offensive and large quantities of fetid pus are swallowed daily.

Treatment.—In the earliest stage, free vertical incisions through the gums and thickened periosteum; when necrosis has occurred, antiseptic lotions freely used; meat beaten to a pulp, and other nourishing food; sequestra to be removed as soon as detached.

Suppuration in the Antrum. Causes.—Almost always infection from dental caries and alveolar abscess; rarely blows and injuries on the cheek.

Symptoms.—Constant aching and uneasiness of the cheek, with intermittent nasal discharge and bad smell, perceived by the patient only, followed in exceptional cases by acute throbbing pain, fever, and rigors, as tension rises and swelling closes the opening into the nose; and, if an opening is not made, by slow general enlargement. This, if permitted to increase, causes bulging of the cheek, protrusion of the eye, obstruction of the lachrymal duct, depression of the hard palate and teeth, and closure of the nostril. The parietes of the cavity then become so thin from distention, that they crackle on pressure like parchment. Sometimes the pus escapes continuously or intermittently, in certain positions, by the nostril; sometimes through the cheek, through the mouth, outside the gum, along a tooth, or, rarely, inside the lower lid through the floor of the orbit.

Treatment.—Make a free aperture into the cavity. If any tooth—molar, bicuspid, or canine—be carious, extract it, and push a trocar into the antrum. If all the teeth are sound, or absent, make an incision through the outside gum above the alveoli of the molar teeth, pierce the bone and remove an oval piece of it with strong curved scissors. Syringe the cavity frequently with an antiseptic lotion to clear away the matter, which is sometimes thick like putty. Do this daily. Search with probe or finger for necrosed fangs or loose pieces of dead bone, and remove them without delay.

Dropsy of the antrum was formerly supposed to be due to catarrh of its mucosa from slight neighboring irritation, coupled with closure by swelling of the often small opening into the nose. But *cysts* of the mucous membrane have been found in the antrum, and Wernher thinks that these account for all cases.

The *symptoms* are those of distention of the antrum (given above), and slow absorption of its wall in some direction, without any sign of inflammation. The *treatment* consists in removing a piece of the antral wall as above, and regular injection till discharge ceases.

Dentigerous cysts are accumulations of serum, rarely pus, around an impacted tooth, which is almost always a permanent one. They are rare, may occur in either jaw, and when in the upper, may extend into and "expand" the antrum. They are seen chiefly in young adults. A non-erupted permanent tooth, or a persistent milk-tooth, is the chief aid in diagnosis; but the cyst may be round a supernumerary tooth. Excise part of the wall, extract the tooth, and plug with boric lint.

Mucous polypi of the antrum are not uncommon. They may cause no symptoms, or may fill the cavity and project into the nose. They have been found associated with watery discharge from the nose.

Many other *new growths*, simple and malignant, are found in the antrum, but their point of origin is doubtful.

Tumors of the upper jaw present themselves in great variety. The following are met with: 1. *Fibroma*, springing from the periosteum, usually of the alveolus or antrum, and sometimes reaching a great size. 2. *Chondroma*, which is rare; also fibro-chondroma, ossifying and calcifying chondroma. 3. *Osteoma*, either cancellous or, less often, ivory-like. With this may be mentioned certain rare cases of *diffuse hypertrophy* (*leontiasis ossea*), usually symmetrical, often referred to blows, often involving many other facial and cranial bones, and causing extreme deformity; it most often begins about puberty. 4. *Nævi* are very rarely met with. 5. *Sarcomata* of all kinds occur, the myeloid, round, and spindle-celled being common, the first usually beginning in the alveolus, the two latter in the body. 6. *Epithelioma: squamous* when starting from the gums, whence it not uncommonly invades and fills the antrum (épithéliôme térébrant); or *tubular*, when it starts from the glandular lining of the antrum. 7. *Dentigerous cysts*. 8. *Multilocular cysts* of epithelial nature, supposed by Eve to originate by ingrowth from the gum (*Brit. Med. Journ.*, Jan. 6, 1883); usually they run a simple course.

Setting aside for the present new growths of the alveoli and gums, we have to diagnose those of the body of the upper jaw, and so far as possible to ascertain their nature. *Symptoms*, even in the malignant forms, are usually absent until the tumors involve skin, displace neighboring parts, or project into adjacent cavities and obstruct them, perhaps giving rise also to some discharge.

Diagnosis.—To detect a tumor of the body of the upper jaw, it is necessary in all cases to look carefully for displacement of either eye or any asymmetry of the face; to examine the line of the teeth, the palate, and the outer surface of the antrum; to test the patency of the nasal passages, and to pass a finger into the nasopharynx. In advanced cases, most horrible deformity may be present; and widely distant parts, perhaps including the brain-cavity, be involved; the order of appearance of the symptoms may then show the starting-point of the disease.

Abscess and cyst of the antrum, and nasopharyngeal growths causing displacements of the jaw as a whole, must be eliminated. The question of fluid may be decided by thrusting a fine trocar and canula into the antrum; tumors may cause œdema, redness, and eggshell crackling. Necrosis of the hard palate may *look* very like epithelioma.

For the general differences between malignant and simple growths, see p. 126. No one symptom should be too much relied upon—*e. g.*, the firmness which is characteristic of some simple growths may be equally shown by most malignant osteosarcoma. Rapid growth, infiltration of the structures of the cheek, fungation, and hemorrhage are the early signs of malignancy most to be relied on. A piece may often be snipped off for examination. Remember that giant-cells are common in chronic inflammation as well as in myeloid sarcoma.

Treatment.—For all these tumors early and complete extirpation is the remedy; but small, stationary, simple growths may be left alone. Some of them necessitate removal of the whole, others only of part, of the upper jaw.

Removal of the whole upper jaw.—A good light on the face is essential. Usually the patient lies on a rather low table with the head and shoulders slightly raised. In this position it is easy for blood to enter the larynx in quantity, and a sense of this causes the surgeon to hasten his steps and to fear hemorrhage. Some, therefore, perform a preliminary tracheotomy and plug the pharynx with a sponge—a plan which answers better than that of using Trendelenburg's tampon-tube, and which renders it possible to work carefully and thoroughly; moreover, if the tube be kept in until the discharge is no longer putrid, the danger of septic broncho-pneumonia is much diminished. Others do not administer chloroform fully, that the patient may cough—and struggle. Others, again, operate with the head hanging, an excellent method but that it increases venous bleeding. Macewen, in similar cases, has passed a tube through the glottis and plugged the pharynx round it.

First extract the central incisor of the jaw to be removed. Then make an incision from the lower external angle of the orbit, along its lower edge to the line of the lachrymal sac, down in the angle between the nose and the cheek and accurately in the groove round the ala to the mid-line, and then vertically through the lip; or the cut may start here. Only small twigs of the facial are cut. Rapidly reflect the flap from the bones to behind the tuberosity of the jaw, dividing the infraorbital vessels and nerve; infiltrated skin may be subsequently cut out freely. Raise the contents of the orbit from the floor and protect them with a broad retractor. Pass a narrow saw with a movable back into the nose and cut through the hard palate and alveolus of the incisor removed; then notch the base of the nasal process of the upper jaw, and divide the malar into the spheno-maxillary fissure. With large bone forceps acting upon each of these cuts in reverse order, start the jaw from all its attachments. Cut the soft palate free from the bone; put the lion forceps on the upper and lower surfaces of the latter, and wrench it out, cutting all adherent structures. Often the bone breaks through the tumor and has to be removed piecemeal. The hole is at once plugged with a sponge, and the vessels are secured as this is raised. Compression of the common carotid may be of service. The cautery is often necessary to check oozing from pterygoid veins, etc. When the bleeding is controlled a most careful examination should be made of the depth of the wound, and pieces of new growth freely removed with curved scissors. The wound must be washed with chloride of zinc lotion, and well powdered with iodoform; it may then be filled with boracic lint or gauze. Lastly the flap is accurately fixed in position and covered by a wool dressing.

For some growths, projecting very much down and out, a cut up and out from the angle of the mouth toward the malar must be made; the facial should be held on either side and tied at once.

If the palate only is involved, sufficient room is given for its removal by a cut through the mid-line of the lip into the nose; if this is extended to the lachrymal sac, the face of the antrum is exposed; and an incision below the orbit and down the nose gives access to the upper half of the bone. Horizontal saw-cuts are made in these cases of partial extirpation, which, in malignant disease, are of very doubtful value.

Shock after these operations is considerable, yet patients recover well from them, and with surprisingly little deformity when an obturator is fitted. Septic disease and septic broncho-pneumonia are the great dangers, and are to be guarded against by the use of the above dressings. Feed for the first few days by rectum or rubber stomach-tube.

Tumors of the Lower Jaw.—The same forms occur as in the upper; but central myeloid growths and multilocular cysts are more frequent and are hard to diagnose from perfectly simple growths. Usually, however, free removal cures them. Simple growths may often be removed by sawing and nipping without breaking the arch of the jaw; so also early epithelioma, spreading from the gum. Cysts must be broken into freely and any projection like a tooth removed. In the multilocular variety the bone around must be gouged; in case of recurrence, removal of a segment of the jaw may be necessary.

Operations.—Any portion or even the whole of the bone may be taken away without cutting the margin of the lip; but this is not important if the mid-line can be used.

The first step is always to remove a tooth or teeth where the jaw has to be divided; then the incision is made along the lower or hinder border of the bone of sufficient length to expose the tumor thoroughly when the flap, containing all healthy soft parts, is raised. If the facial vessels are cut, they must be at once secured.

Removal of half the jaw.—Draw an incisor tooth. Make a curved incision from the zygoma along the jaw to the chin and then up in the mid-line to the groove between the lip and chin. Dissect up the flap so formed and the masseter with it; saw vertically through the bone in front, seize and draw from its fellow the diseased half and detach with a knife the mucosa and mylohyoid, keeping the edge toward the bone. Then depress the end strongly and dissect the temporal muscle from the coronoid process; the internal pterygoid muscle and other internal attachments are then to be divided, and finally the ligaments of the joint and external pterygoid. Whilst doing this the point of the knife should be kept close to the inner side of the bone, to avoid wounding the external carotid or internal maxillary artery, and the condyle dislocated by depressing the bone strongly and twisting it outward. After bleeding has been restrained, the wound is to be closed by sutures, except at the middle, where an aperture should be left for drainage. The salivary ducts and facial nerves divided in these operations may be left to themselves; the muscular power of the face is usually recovered, and the saliva finds a channel into the mouth. Treat the wound as advised under the upper jaw.

If the disease involves the *symphysis and mid part of the body*, the incision must be made along the lower border, the *chin* divided in the mid-line; next, the bone may be laid bare, sawn half through on each side, and then divided completely by forceps—one blade being passed upon the inner side of the bone, and the other placed in the groove made by the saw. Bleeding from the inferior dental may be stopped by plugging with catgut or gauze, or a touch with a hot wire. Lastly, the digastric, mylohyoid, geniohyoid, and geniohyoglossus muscles must be divided. When these are cut, care must be taken not to let the tongue fall back suddenly on the glottis and cause suffocation. To prevent this a ligature should be passed through the tip of the tongue, by which it may be held forward during the operation and afterward. If the stumps of the geniohyoid and genioglossus can be sewn to any fixed point this should be done and the patient should lie on one side with the string round the pinna or fixed by strapping to the cheek.

Union of the two fragments ultimately occurs by dense fibrous tissue, and a useful mandible results. It is well to fix the ends, at a suitable distance for apposition with the upper teeth, by a stout wire suture.

Cases of undoubtedly simple tumor may be removed subperiosteally, when a bony arch may form.

If the *angle or ascending ramus* is to be removed, the incision extends from in front of the masseter to the condyle; and both this and the coronoid process should be removed, or they will be inconveniently displaced by the temporal and ext. pterygoid muscles.

If the disease is confined to the *alveolar border*, a horizontal portion of the base may be saved, which will prevent the chin from falling in after the operation. To effect this saw the bone downward for half its depth on each side of the tumor, and make a horizontal cut below it with Liston's "sugar-nipper" forceps on a narrow saw which will cut in a curve. The gouge forceps are often useful.

In all these operations careful revision of the soft parts should be made after removal of the bone; they should be left above suspicion. Access to the submaxillary glands is easy.

Affections of the Teeth.

Fracture and Dislocation of Teeth.—If part of a tooth is broken off, without exposing the pulp-cavity, the exposed surface should be filed smooth, and then probably no inconvenience will follow. If it is snapped off at the neck, and the pulp-cavity is exposed and very painful, it should be touched with lunar caustic, and the mouth be frequently bathed; and when pain and tenderness have ceased, an artificial tooth may be fastened by a pivot to the stump. If, however, the root of the tooth is loosened by inflammation, it had better be extracted at once. If a tooth is loosened by a blow, it should be fastened by silk to its neighbors. If entirely driven out, it should be replaced as soon as bleeding has ceased, and fastened in by silk; no food should be allowed that requires mastication, and inflammation should be combated by leeching the gum.

Painful and Difficult Eruption of Wisdom Teeth.—The wisdom teeth cause trouble in eruption much more frequently than any others, and the symptoms may last years and be referred to many causes other than the right one. Owing either to their appearance earlier than usual before growth of the jaws is complete, or to imperfect lengthening of the jaws, these teeth may be unable to rise to the surface fully or in an upright position. In the *upper jaw* they generally protrude backward against the coronoid process or outward toward the cheek, causing much pain and ulceration. Extraction is the *treatment*. In the *lower jaw*, usually only the front cusps of a vertical tooth appear, the rest being concealed by dense gum and perhaps bone at the base of the coronoid process, and the raised soft parts are bruised by every closure of the teeth. Less often, the third molar may grow forward against the second, causing absorption of its neck or roots or death of the tooth. It may not erupt at all. This gives rise to greater trouble than the upper wisdom, causing more or less radiating pain and swelling of soft parts, not uncommonly running on to suppuration, perhaps localized beneath the gum, but in other cases leading to wide burrowing, the sinuses opening even as low as the clavicle, or as high as the zygoma, with great disfigurement. It looks like a case of necrosis, and there may be some. But in many cases cure follows at once upon treatment of the tooth. *Persistent tonic spasm* of the masseter (p. 529) is a not uncommon symptom. *Treatment.* Dense covering gum may be freely cut away to expose the whole crown, and further elongation of the jaw awaited in young people. In older patients, extract the third molar if it can be reached, unless the second is diseased, when it should be removed in preference. When suppuration has occurred, the third molar must be removed for cure.

Retention of wisdom as of other teeth sometimes causes dentigerous cysts (p. 531) to form.

Irregularity of the permanent teeth results from short development of the jaws. In slight cases and early much may be done by pressure; but often it is necessary to remove a projecting canine or, better, a bicuspid, when the canine will fall into place.

Caries of the Teeth.—This begins especially in the furrows in the crowns of molars, and where teeth press closely on each other. In both places the enamel is not infrequently either absent, thin, or imperfectly calcified. Not uncommonly, fissures are found elsewhere in enamel.

The first sign of decay is opacity of the enamel at one of these spots; then it becomes brownish, friable, and disappears, exposing the dentine, which becomes still more widely brown and more or less rapidly decalcified. On the surface of the pulp cavity new dentine may be laid down over the carious focus. Sooner or later ulceration gains the mastery and the pulp is exposed. The whole tooth may thus be destroyed. At a carious point the dentine tubules are varicose and filled with micrococci, as one would expect in the mouth.

The *etiology* is complex. Developmental defect is evidently very important from the frequency with which bad teeth are found running in otherwise healthy families. The effect of rickets on the milk teeth, and of congenital syphilis on both sets, is very marked, as also that of general ill-health during the development of teeth. Next, caries begins commonly during pregnancy, nursing, or after serious illness, though how these act is uncertain. The effect of softening acids, even used as drugs, upon enamel, the common association of dyspepsia with bad teeth, the frequency with which caries starts between teeth or where teeth are overlapped by gum, and where, consequently, food is often retained for long periods, and the fact that dead teeth used as artificial ones may undergo caries, strongly suggest the view that acids developed in the mouth cause softening of the enamel, and, naturally, they act chiefly where it is the thinnest, or still better upon exposed dentine. Once cocci gain access to the tubules of the latter, the products of their action doubtless assist largely in causing decalcification.

Treatment.—The *whole* of the decayed portion should be gouged out, and the cavity rendered aseptic and filled with gold, or an amalgam of silver and mercury, or of silica and gutta-percha (F. 334). To keep saliva from the cavity during filling, an India-rubber apron should be fitted round the tooth. If decay has opened the pulp-cavity, it may be necessary first to use some application, under which the pulp may heal and close over by bone, or cease to yield discharge; it is of no use to stop a tooth if there is any secretion of purulent matter from the pulp underneath. The best application seems to be creasote, inserted into the pulp-cavity on a little bit of cotton-wool, and over that another bit of cotton-wool dipped in mastic varnish (F. 334). This must be changed once in two or three days, till all discharge ceases. But if the pulp continue irritable, tender, or bleeding, it will be necessary to deaden it with a little fragment of nitrate of silver, or to destroy it by a minute quantity of arsenic mixed with morphia. After this, which is not painful, the cavity may be again stopped by creasote, till it ceases to discharge. Then it may be filled with gutta-percha and silica; and, lastly, a fine hole may be bored through the *gum* into the pulp-cavity. Should any discharge form, it will drain out of this aperture; and thus a tooth with the pulp destroyed may continue useful for years.

A great deal may be done to abridge the sufferings of children by looking after *caries of the milk-teeth.* These should be stopped with varnish on wool, or gutta-percha, to protect them from the food.

There is a prejudice against extracting any of the first set of teeth in children, however carious, on the supposition that the jaw might become contracted, and the permanent teeth crowded. Tomes says this fear is groundless. These teeth certainly should not be extracted needlessly: but it is better to do so than to allow them to cause much pain, or gumboils; or to tempt the child to bolt his food from the pain of chewing it.

Every case in which teeth decay with rapidity should be looked upon as requiring medical treatment, and tonics (F. 25, etc.).

COMPLICATIONS.—The chief are inflammation of the pulp (q. v.) and of the periosteum of the root, the latter often leading to alveolar abscess (q. v.) —toothache being a prominent symptom of either.

GUM-BOIL (*alveolar abscess* or *parulis*) is a small abscess commencing in the socket of the tooth, and discharging round the tooth or bursting through the alveolus and gum, or sometimes through the cheek. It is usually caused by irritation of a carious or dead tooth. In neglected cases, extensive necrosis of the bone may follow; but, without this untractable sinuses with pouting mouths may form widely in the face and neck. Therefore, in all such cases, look carefully to the teeth.

From the upper incisors pus may burst into the nostril, and the case is liable to be misunderstood; more often pus forms behind these teeth, perhaps causing necrosis of the hard palate; rarely the abscess may be far back on the palate and appear unconnected with the front teeth, one of which will be found carious (Salter, *Holmes's System*, vol. ii.).

TREATMENT.—At first, when signs of periostitis of the root only are present, fomentations and washing of the mouth with water as hot as can be borne; leeching the gum and a purge. If the tooth is very carious remove it at once; if stopped, remove the stopping first. So soon as pus forms incise freely, with the knife edge towards the bone. This cut should be the more free in cases threatening to burst externally, and the skin over the abscess should be painted with collodion. In spite of incision, a discharging sinus almost always persists and requires removal of the tooth for its cure. The sac often comes away with the fang.

NECROSIS OF TEETH may be caused by violence tearing the pulp-vessels or by suppurative periostitis; it may also occur quietly and without obvious cause, remaining in the jaw perhaps for years with the gum somewhat receded. Such teeth are opaque, and may become black and unsightly. Extract if inflammation or other inconvenience arise.

TOOTHACHE. 1. *Inflammation of pulp.*—When the tooth-pulp is bare, it is liable to injury from food forced into its cavity or from hot or cold or acrid liquids; and will inflame from cold and other causes. The pain is agonizing; the tooth becomes exquisitely tender and loose, rises in its socket, from swelling of its periosteum; the gum swells, and if the case goes on, an alveolar abscess forms. If the tooth is useless, extract it at once; if likely to be useful, the cavity should be cleared of foreign substances, and then be treated with creasote as above. If the patient is feverish and the tongue foul, a purge, broth diet, and warm fomentations will do good; so also will washing out the mouth with a tumbler of hot water containing a teaspoonful of bicarbonate of soda; leeching; an incision on either side of the tooth, down to bone; solution of tannin in ether, or of camphor in chloroform, applied on a very small plug of cotton-wool to the cavity.

2. *Inflammation of the dental periosteum*, causing the teeth to rise in their sockets, is common from cold; and *necrosis of the alveolus* (p. 530) begins with obstinate toothache from periodontitis.

3. *Irritable gum.*—The gum between a decayed tooth and its neighbor may become spongy and swollen, and excessively sensitive, giving rise to a very wearing kind of toothache, and causing excruciating pain if a portion of the food happens to be pressed down upon it. This may be relieved by an incision through the swollen gum, and the use of tannin-gargle, of pellitory chewed, and aperients.

4. *Neuralgia* may affect the dental nerves of healthy teeth or may be excited by irritation of a dental filament. It occurs paroxysmally (p. 418).

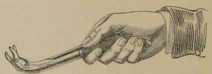
5. *Thickening of the fangs of teeth* is usually secondary to caries; but may arise spontaneously in an apparently healthy tooth and cause severe neuralgia. When the tooth is removed, the disease often spreads to others and no permanent relief may be obtained till all the teeth of both jaws have been extracted.

EXTRACTION OF TEETH is an operation which is easily performed by any one who has the proper instruments, and uses them with ordinary care; but

FIG. 191.

Extraction of lower incisor. Mode of using the forceps in removing teeth from the lower jaw.

FIG. 192.



Extraction of upper molar. Mode of using the forceps in removing teeth from the upper jaw.

FIG. 193.

FIG. 194.

if unskilfully performed, it may lead to very serious results and much suffering. The surgeon should study well the construction of the instruments, and practise with them on the dead body before he tries on the living.

1. *The forceps* should be made with sharp edges, that it may pass between tooth and gum, and seize the tooth by its neck, close to the alveolus. For this purpose, also, the jaws of the instrument should be made to incline towards each other, so that they may slip up and embrace the neck of the tooth accurately when the handles are pressed together; and they should be ground to fit accurately the shape of each tooth. For this the surgeon will require seven sets of instruments: One for the left upper molar (Fig. 195), and another for the right (Fig. 194), because of the peculiar

Fig. 195.

Fig. 196.

Fig. 197.

conformation of those teeth; one for the lower molars of either side (Fig. 193), one for any single-fanged tooth of the upper jaw (Fig. 197), and one for any single-fanged tooth of the lower jaw (Fig. 196). Stumps in the upper jaw may be extracted with the instrument Fig. 198, and those in the lower jaw with Fig. 199. The instruments depicted were devised by Mr. Tomes, and were made by Evrard.

In extracting teeth with forceps, there are two things to be done—first to loosen the tooth, and then to pull it straight out. In extracting the incisors

Fig. 198.

Fig. 199.

and canines of the upper jaw, they may first be loosened by giving them a gentle twist, combined with a slight rocking motion, and then they may be pulled perpendicularly downward with a slight inclination backward. The incisors and canines of the lower jaw are to be loosened by giving them a firm but gentle motion backward and forward, and then pulled straight up. The bicuspids and molars are to be loosened by moving them from side to side, so as to make the alveolar process yield a little, and then pulled perpendicularly upward or downward, as the case may be. "Hawk's-bill" forceps are now more commonly used for lower molars. The operator should grasp the forceps firmly, in such a manner that it may move altogether with his hand—but yet not so forcibly as to run the risk of crushing the tooth.

2. The *elevator* is highly prized for stumps and for old straggling teeth. The point is to be thrust firmly down between the tooth and its socket; and then, by bringing the instrument into a horizontal position, and making a fulcrum of the edge of the alveolar process or of the adjoining tooth, or of the operator's fingers, the tooth may be lifted out. The stump-forceps are easier to use where they can be employed.

HEMORRHAGE AFTER EXTRACTION OF TEETH.—This operation may be followed by dangerous hemorrhage, which sometimes comes from the dental artery at the bottom of the socket—sometimes from the gums, when they have been long diseased. All clot must be removed; syringe with cold water, or dry and mop the gum with a bit of wool in weak solution of chloride of iron. Should this not answer, plug the aveolus. Dry the cavity, and press into it, so as to come into contact with its very bottom, one end of a long shred of lint, which may be steeped in solution of chloride of iron, and force in the remainder, in successive portions, till the socket is filled to the level of the gum. Then place a compress on the part, thick enough to be pressed upon by the antagonist teeth, and firmly close the mouth by a four-tail bandage .Instead of this a hot wire may be passed into the socket.

TARTAR is earthy matter, chiefly carbonate of lime, mixed with epithelium and *débris* of animal food and swarming with organisms, deposited on the teeth from the saliva. It is most abundant on the upper molars and lower incisors, because they are nearest the orifices of the salivary ducts. If suffered to accumulate, it causes inflammation and absorption of the gums and gradual loosening of the teeth.

TREATMENT.—Prevent deposit by cleaning the teeth twice a day with a soft tooth-powder (precipitated chalk) and a little soap, and by the use of a quill toothpick. The hairs of the toothbrush should be soft, and not too closely set, that they may penetrate the better between the teeth.

When any quantity of tartar has accumulated, remove it with *scaling instruments*. Introduce the edge or point of the instrument between the concretion and the gum, and detach the former in flakes; meanwhile press a finger or thumb, guarded with a towel, firmly on the cutting edges of the teeth, that they may not be loosened by the necessary force. Sometimes a bit of tartar is found in the orifice of a salivary duct, causing much irritation. It may easily be removed.

AFFECTIONS OF THE MOUTH, GUMS, AND TONGUE.

INFLAMMATION.—*Acute Stomatitis.* The early SYMPTOMS are soreness, redness, heat, swelling, and dryness of the mouth, the latter two soon yielding to excessive thin secretion with some subsidence of swelling. Heat and corrosives killing the epithelium produce a dead white surface at first. Then the spots most affected become very red, tender, and smooth, the superficial epithelium being cast—best seen on the rough tongue. Next, small superficial ulcers appear, most commonly upon the gums, and may increase to a considerable size and depth. More or less salivation is usual.

The CAUSES are numerous. Scalds, burns, and chemical injuries do not usually excite more than the first degree, which soon subsides. In *congenital syphilis* stomatitis is common and is usually slight, but Hutchinson has seen ulceration causing necrosis of the alveoli. In *acquired syphilis* mucous tubercles are very common at the angles of the mouth and small ulcers upon the cheeks and lips. *Thrush* is a slight stomatitis excited by the growth of the oïdium albicans in the epithelium, and the redness of inflammation is soon mottled by curdlike spots, and then concealed by a membrane formed by their blending; the saliva is always acid. It may extend down the gullet, and sometimes appears on the vulva and lower end of the rectum; whether it occurs in the stomach and intestines or air-passages seems very doubtful. It is very common in infants, especially if weakly or syphilitic; in older patients it usually occurs in states of exhaustion from phthisis or acute fevers, and is therefore of ill omen. Attend to the general health and apply mel boracis, solution of sulphurous acid, or other antiseptic. *Mercury* now rarely causes more than spongy gums with a dark red line along the teeth, œdematous tongue, foul breath, and salivation; but among quicksilver workers extensive ulceration of gums and cheeks with loss of teeth, and even necrosis of bone may still be seen. Treat by chlorate of potash and astringent washes, iodide of potash in small doses, Turkish baths, and nourishing diet. In *ulcerative stomatitis* or *putrid sore mouth* numerous ulcers form on gums, cheeks, and, to a less extent, on palate and tongue, after two or three days of slight feverishness, and either die away in seven to fourteen days or become chronic. Over any large ulcer the cheek will be swollen. The picture is like that of severe mercurial stomatitis and is uncommon after puberty. Chlorate of potash internally and locally is specific. *Erysipelas* rarely spreads to the mouth, causing much swelling. *Diphtheria* may extend from the fauces.

Rarely, *chronic stomatitis, buccal and lingual leukoplakia* are excited by minor irritants—excessive smoking, chewing, dram-drinking, hot spices, irritation of sharp teeth or tooth-plates, and syphilis. *Psoriasis* and, when highly developed, *ichthyosis linguæ* are other names of this disease upon the tongue. At first, red smooth areas form, the superficial epithelium being cast; but after a time epithelium thickens, and blue, white, or yellowish, thin but rigid patches appear, surrounded by some injection so long as they are increasing; they cause no pain, but there may be slight ptyalism. These plaques are much most common in men (101 to 9), and on the tongue; then on the cheeks, lips, and palate, in order. They may appear on other mucosæ, as the vulva. Such white patches are common in early syphilis, but they disappear under treatment, in the course of weeks or months. Cases, however, occur—and to them the name "leukoplakia" is more especially applied—in which the patches are extremely chronic, and resistent to all known treatment. Their causes are very doubtful, but syphilis and smoking seem to rank high; sometimes psoriasis, eczema, or ichthyosis of the trunk is present. The interest of these cases is that in many epithelioma supervenes, after an average duration of the plaque, in twenty-nine cases, of about fourteen years—fifteen months to forty years being the extremes. The plaques appeared between sixteen and sixty-nine (Barker in *Holmes's System*, vol. ii.).

TREATMENT.—Removal of the cause and antisyphilitic remedies in suspicious cases. Barker recommends locally a wash of sod. bicarb. (gr. xx ad ℥j) used often; others employ hydr. bichlor. gr. ss, or ac. chromic. gr. j ad ℥j. Caustics should not be used. The patient should be impressed with the necessity of watching the patch very carefully, and of showing it to a surgeon upon the appearance of any irritation, ulceration, or induration, when an operation should at once be undertaken.

CANCRUM ORIS, NOMA OR WATER-CANKER, is a gangrenous affection of the cheeks and lips, occurring almost exclusively among ill-fed, dirty children of large towns; the vulva may be similarly affected. It often follows scarlatina and other acute fevers or exhausting illnesses. Lingard has described long bacilli as the probable cause.

Symptoms.—A spot on the inside of the cheek usually becomes livid, and the cheek swells and hardens over it; quickly an ulcer forms within and spreads, its base being covered by a brown or ash-colored slough, sometimes like diphtheritic membrane. The breath becomes fetid, blood-stained saliva dribbles, hardness of the cheek increases, the skin over it becomes dull red, then a bloody bulla rises centrally, bursts, and leaves a black patch of gangrene which spreads widely, preceded by a broad margin of inflammatory infiltration. In the worst cases it is said that the parts around remain pale, waxy, and little swollen. Within the mouth gangrene is much more extensive then externally, the connective tissue of the cheek being like wet chamois leather far around the perforation, and horribly fetid; large portions of the jaws necrose from destruction of the soft parts, and teeth drop out in numbers. The child dies exhausted, or perhaps one should say poisoned; there is little or no pain, and consciousness is retained until the end, when stupor often supervenes. Fever is slight or moderate. The glands are not swollen. Recovery is rare, and fearful deformity results from sloughing and scar-contraction.

The diagnosis from sloughing mercurial stomatitis has now rarely to be made. *Noma* is at first unilateral, begins almost always at one spot, is circumscribed, and does not affect the tongue. *Mercurial stomatitis* affects the whole mouth.

Treatment.—(1) If it appears possible to get beyond the disease, anæsthetize the child, expose the gangrenous focus—thoroughly splitting the cheek if necessary—cut slough away with scissors until a bleeding surface is everywhere reached, then cauterize this deeply, and, lastly, soak the eschar in chloride of zinc (p. 156) or 1 in 500 perchloride of mercury, and powder it with iodoform. A hole should be cut in the cheek without hesitation. Afterward the surface may be dusted daily with iodoform and painted every two hours with 1 in 1000 sublimate lotion. Apply boracic fomentations externally. Repeat the operation *at the first sign* of recurrence. (2) Remove the child from its unhealthy surroundings. Use the most nutritious diet and give wine freely. Quinine and mineral acids internally are recommended. The prognosis is very bad.

New growths commencing in the floor of the mouth or on the inner surface of cheeks or lips are rare; *warts* and *epithelioma* are the commonest. No cheese-paring operations should be done for the latter.

Cysts are much commoner. *Mucous cysts* from degeneration and dilatation of a mucous gland may occur at any part, especially on the lips; a bit should be excised. *Ranula* is a cyst of glairy fluid in the floor of the mouth, usually on one side of the frænum; it may sometimes be due to dilatation or wound of Wharton's duct (Erichsen), but usually this is free, and the pathology is then doubtful. When ranula has existed long, it may form a tumor of considerable size, pushing the tongue over to the other side, or upward, interfering seriously with speech, deglutition, and respiration; not allowing the mouth to be closed, projecting under the jaw, and even reaching down between the sterno-mastoid muscle and trachea to the clavicle (Mayo, *Lancet*, 1847, vol. i. p. 667). A seton may be passed through the cyst, or a piece be cut from the sac; or a V-flap may be cut in the wall, and its apex sewn into the interior of the cyst (Barker). It may be necessary to wipe out the interior with some irritant, after which submaxillary cellulitis may arise. *Dermoid cysts* are rarely met with in the floor of the mouth lying in the mid-line between the genioglossi; as a rule, they do not enlarge until adult life. A grooved needle may bring away a little cheesy *epithelial* débris. Incise from the mouth freely in the mid-line and by drawing on the wall, and, tearing or cutting bands of connective tissue, endeavor to pull out the cyst; this failing, dissect out from below. A *bursa* between the genioglossi and geniohyodei may enlarge; it projects most in the neck, but should be incised from the mouth in mid-line, and a tube inserted with a stitch. *Hydatids* have been found in the tongue; incise.

Inflammatory softening and absorption of the gums, vulgarly called *scurvy*, generally affects middle-aged or elderly people, and may be a consequence of the accumulation of tartar, or of severe dyspepsia. The gums are swollen, spongy, exceedingly tender, subject to constant aching pain, and bleed on the slightest touch. If the disease proceeds, they separate from the teeth; the alveoli are gradually absorbed, the teeth loosen, and at last fall out. These consequences are sometimes speedy, and are attended with suppuration in the alveoli; but more frequently they are slow, the teeth dropping out one by one in the course of years.

Treatment.—Cleanliness, astringent washes, and close attention to the digestive organs. Free scarifications of the gums. Nitric acid and bark usually act well.

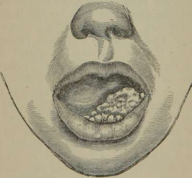
Hypertrophy of the gums is rare, and appears at or soon after birth. The soft parts are much swollen, lobulated, firm, and but slightly sensitive; the teeth are more or less covered over. The hypertrophy often begins at a point and spreads thence. It is said to start from the periosteum within the margin of alveoli, and consequently requires for its cure removal not only of the soft parts, but also of the edge of the bone. Mental defect, overgrowth of cutaneous epidermis and hair have generally been noted in these cases.

Polypus of the gum is due to inflammatory thickening of the septum between two teeth, and is usually excited by caries. The latter must be treated and the little mass removed.

Warts occur on the gums, especially in warty subjects. Rarely, the papillæ are very long (villous). Remove freely.

Epithelioma commencing on the gum is rare and ulcerates early. Secondary infiltration is common. The appearances are characteristic, and free removal is required.

Fig. 200.



An epulis which had lasted many years, interfering with mastication, and causing great emaciation.

Nævus may affect the gum alone or with the lip and cheek. A young woman under Heath had vascular hypertrophy of the gums on one side, together with port-wine stain of the cheek and neck. These growths bleed easily, and should be cut away and the bleeding checked by the cautery.

Epulis means simply "on the gum" (ἐπὶ οὖλον), and to it should be added an adjective expressive of the nature of the tumor—*e. g.*, myeloid. Practically the word alone has come to signify a fibrous or sarcomatous growth, usually myeloid, starting from the periosteum of an alveolus, or from the soft bone around it. It usually appears between two teeth in close relation to one, which is the more displaced, but may show first on the labial or deep surface of the gum. It forms a hard or soft, rounded, irregular, usually sessile tumor, of reddish aspect, covered by mucosa (Fig. 200); it may grow very slowly or rapidly, involving much of the alveolus, displacing many teeth, and ulcerating speedily. These growths should all be removed early together with the bone whence they spring (see p. 534), those of rapid growth very freely. Quite small tumors may come away with the tooth to which they are related. The prognosis after fair removal of fibrous or myeloid epulis is good.

Wounds of the tongue may be attended with severe hemorrhage, and young children swallow the blood. If the bleeding orifice cannot be tied, pass one or more deep sutures with curved needles to close the wound, and constrict the bleeding vessel; or the cautery may be applied.

Children sometimes inflict very severe bites on their tongues, almost biting off the end; unless bleeding, leave them entirely to nature. They rarely require sutures.

Tongue-tie means congenital shortness of the frænum binding the point down and even rendering it slightly bifid. It is much more often complained of than present. Let the child lie on its back, the head toward the surgeon; raise the tip of the tongue with two fingers, make tense the frænum, and snip the thin white band through with blunt pointed scissors, cutting toward the floor of the mouth to avoid the ranine vessels. The fingers easily widen the gap.

Makroglossia is an enlargement of the tongue evident at or within a year or two of birth. It occurs chiefly in cretins and imbeciles. At birth the tongue is merely rather large, if anything wrong is noticed. Sometimes one or more attacks of glossitis seem to cause the enlargement. As it grows it protrudes from the mouth, more or less constantly, and its epithelium becomes horny. If retracted, great fulness of the floor of the mouth results. The lower teeth and alveoli become horizontal from constant pressure; the teeth often cause ulcers on the tongue, and saliva dribbles away. On section, increase of the fibrous tissue, chiefly in the mid-line and beneath the dorsal mucosa, is found; and sometimes distinct spaces—dilated lymphatics—are visible here; they may even form translucent pearls on the under surface. The swelling is variously regarded as due to a cavernous lymphangioma, obstruction of lymphatics, or chronic interstitial glossitis. The submaxillary glands may be swollen and hard. The lips may be similarly affected (*makrocheilia*).

Treatment.—Pressure has caused but little benefit and is hard to apply. Therefore, in any marked case, excise a V-shaped piece with scissors and suture the wound. Union by first intention is common.

Acute and chronic superficial glossitis were considered under stomatitis, and the importance of the chronic form, "leukoplakia lingualis," with regard to epithelioma was pointed out. The *red glazed tongue*, in which more or less of the organ is smooth, red, and shiny, and perhaps in an early stage of glossitis (p. 540), is similarly dangerous.

Acute interstitial glossitis results from wounds, wasp-stings, mercurialism, and rarely in the course of specific fevers; often the cause is obscure. The tongue swells rapidly and greatly, and becomes firm from inflammatory effusion into its substance, is deeply impressed by the teeth, and perhaps protrudes from the mouth, furred and livid, or dry and brown. It causes salivation and dyspnœa, in part probably by œdema about the glottis, and there is often a good deal of pain; temp. 100°–101° Fahr. An abscess may form in the base and must be carefully sought for with a finger, a symmetrical swelling, softness, and perhaps fluctuation being its chief signs. Cases have proved fatal, in spite of active treatment, from diffuse suppuration, sloughing, or pneumonia. Evacuation of pus at once arrests the swelling; if no pus can be found, make a long cut into the submucous tissue on either side of the mid-line, and rinse the mouth well with hot boracic lotion. On no account give opium, lest, in deep sleep, the tongue fall back on the glottis.

Chronic interstitial glossitis renders the tongue very hard without producing much increase in size. It is generally syphilitic.

Acute abscess may form in the tongue, especially the base, in acute interstitial glossitis; sometimes also under the tongue. Even less common are cases of *chronic abscess*, which arise without obvious cause and are certainly recognizable only by puncture. They feel like tense cysts in the substance of the organ.

Ulcers on the tongue arise from many causes and are usually grouped as *simple*, *syphilitic*, and *tubercular*.

Simple Ulcers are chiefly such as arise from injuries, especially from sharp teeth, bites, etc.; and with them must be placed ulcers in mercurial and ulcerative stomatitis (p. 540), and scurvy. *Aphthous ulcers* also, which occur in dyspeptic subjects as small white or gray based spots with red margins about the tip, edge, and under-surface of the tongue, cause smarting pain, especially when salt touches them. A little borax soon cures an ulcer, but recurrence must be checked by attention to the digestion.

Syphilitic Ulcers are of three kinds: (1) the primary sore; (2) ulcers due to the breaking down of superficial patches of infiltration, corresponding to secondary papules upon the skin, and (3) those due to breaking down of a gumma in the substance of the tongue.

The *primary sore* usually occurs under thirty, and must be recognized by its general characteristics (p. 112), and by the onset of secondary symptoms.

In the first year or two of acquired syphilis the tongue is so commonly affected that a chronically or frequently sore tongue is one of the points in its history; in accepting it, however, we must remember aphthæ. *Leukoplakial patches* are the result of the mildest irritation acting continuously; mingled with these come *smooth, red, slightly swollen parts* where the surface-epithelium is gone from more intense irritation; and next superficial *ulcers* and *fissures* form, usually on the dorsum and margins. These three conditions, separately or variously combined, make up the tongue of early syphilis: there may be but a leukoplakial patch or two, or the whole tongue may be red, or the red is largely mottled with ill-circumscribed blue-white patches, dotted with ulcers, seamed by fissures, or puckered by scars. Sometimes these ulcers erode rather deeply; but as a rule their scars are slight and all trace of the early syphilitic lesions is commonly lost. The above lesions may occur at any period of syphilis; there is no induration about any of them. Typical *mucous tubercles* are not common, but they do occur in both the congenital and acquired forms.

The Gummatous Ulcer begins as an indefinite soft swelling in the body of the tongue, over which the mucosa is somewhat raised, and becomes red and smooth; then the swelling bursts upon the dorsum, and a deep, ragged, soft-edged cavity, which gapes with certain movements of the tongue, is left after escape of the slough. Without treatment, healing may be very slow; and it seems certain that the walls may indurate and epithelioma supervene upon a typical gumma. After healing, a soft, puckered scar marks the site of the ulcer.

TREATMENT.—That of syphilis in general, and locally black wash, lotio hydr. bichlor. or bicyanidi (gr. ij ad ℥j), or a powder of gum acacia and hyd. c. cret. (āā) with iodoform ʒj ad ℥j. Mercurial fumigation of the mouth is useful in very obstinate cases. For obstinate leukoplakia, see p. 540.

TUBERCULAR ULCERS have been generally recognized only of late years. Occasionally, they seem to be the primary manifestation, but usually they occur subsequently to obvious tubercle of lung or larynx. They are much commoner in men than in women, probably occur at all ages, and usually appear upon the edge or near the tip, next upon the dorsum, and least often on the under surface. There may be but one ulcer, or several may form round the first. They begin either as a red pimple or small submucous nodule which ulcerates and exposes a grayish or yellowish slough, through which, when spread is slow or absent, pale granulations project. If spread is rapid there is little or no induration, but usually extension is slow, and the thick, firm, elevated edge of the tubercular ulcer develops; sometimes it is undermined; the floor is rarely sunk more than a quarter of an inch. The ulcer may be extensive, but is usually well under a square inch. The palate may be simultaneously affected, especially with dorsal sores. The SYMPTOMS are irritation and soreness, usually not amounting to pain, and, perhaps, ptyalism; the lymphatic glands do not enlarge until quite late, if at all, and then are said not to feel hard. Microscopically the edge and base consist of inflammatory infiltration, containing usually distinct gray granulations, and often numerous tubercle-bacilli; by degeneration of the granulations ulceration spreads. (*Trans. Path. Soc.*, 1883–84–85.)

TREATMENT.—When the patient is dying of phthisis or laryngitis, and suffering little inconvenience, do nothing operative. When the ulcer seems primary, it should be destroyed by the sharp spoon and cautery, or excised with a wedge of tongue substance, the wound being sutured.

NEW GROWTHS.—*Fibroma, lipoma,* and *enchondroma* are all very rare in the substance of the tongue; they would shell out. Fibroma may form a pedunculated mass. *Sarcoma* is equally rare.

Nævi may occur anywhere, on the surface or deeply; they are uncommon and cause inconvenience by their size and danger by bleeding. Treat as usual (p. 399 *et seq.*). *Warts* occur.

EPITHELIOMA of the tongue is one of the most terrible of cancers, being usually very painful, and rapidly fatal. It is of the *squamous* form. A sharp tooth, irritation of a pipe or tooth-plate and the like are regarded as CAUSES; the disease may supervene upon leukoplakia, glazed red tongue, simple warts, or gumma. It is commoner in some districts than in others. It is much commoner in men and between the ages of forty-five and fifty-five; but may be met with at any age after twenty-six. The edge is its seat, but no part is immune. When not preceded by one of the above conditions, a hard pimple or fissure forms and quickly ulcerates, whilst induration extends into the tissues, binding the tongue to the floor of the mouth and jaw. The edges are hard and irregular, the base is sloughy, but where clean, presents epithelial granulations and looks warty; there is widespread surrounding induration; pain, local and radiating over the branches of the fifth is usual, and not uncommonly there is aching in the occipital region; ptyalism is constant; difficulty in taking food may be extreme. The submaxillary glands, and those at the base of the carotid triangle, are early involved. The sputa are often bloody, and rarely profuse hemorrhage may occur.

The DIAGNOSIS in early stages may be very difficult. From a *simple wart,* induration at the base is the distinctive point; but a wart developing in mid-life, or even persisting, should certainly be removed by a free snip with curved scissors. From a *chronic gummatous ulcer* with hardening edges the diagnosis may be impossible; a bit should be excised and examined without delay. From a *primary sore* also there may be much difficulty; if mercury does not act quickly, examine a bit; the sore *usually* occurs before, the cancer after, thirty. From a *simple ulcer*, indurated from constant irritation of a sharp tooth, the amount of hardening in proportion to its duration, the character of the surface, and rapid improvement after removal of the tooth must be relied upon.

TREATMENT may be *curative* or *palliative*. The sole hope of *cure* lies in complete removal of the disease. This can be effected only by early and very free operation, dealing with the nearest lymphatic glands in all cases, whether or not these can be felt enlarged. They are not easy to discover at first, as they lie between the jaw and the submaxillary salivary gland, and even in the substance of the sublingual; the glands at the base of the carotid triangle are also often affected in tongue cases, even before the submaxillary. Naturally, one feels much more hopeful in attacking disease which appears limited to the tongue than that which extends to the floor of the mouth, tonsils, palatine arches, palate, or jaw, and which is accompanied by swollen, more or less fixed glands. But if any operation is to be curative it must be planned and carried out in the above-expressed belief.

It has been acted upon much more conscientiously in Germany than in England; yet of 170 cases, including the best German statistics, only 17 were alive and healthy after periods of one year and upward, and only 42 such cases could be found recorded (Barker, in *Holmes's System*, vol. ii.). This point does come out, however—that those surgeons who always perform radical operations show the best results; for the actual mortality from these operations with scientific after-treatment has scarcely been greater than that from milder septic measures.

In cases of cancer apparently limited to the edge of the tongue, many think it sufficient to remove half the tongue and leave the glands alone; yet these are the very cases wanted for radical treatment, and recurrence and early death are almost constant under any other. With regard to preservation of half the tongue, it seems to be of little value for speech or feeding; and the addition of an incision below the jaw for the removal of glands, which may be used for preliminary ligature of the lingual artery, seems to have but little effect upon mortality.

In operating upon the tongue, hemorrhage and danger of asphyxia from blood constitute the chief difficulties; there may be great difficulty in reaching diseased parts, or these may closely approach very important structures.

There are many *ways of preventing hemorrhage* and consequent asphyxia. A good *light*, a good *gag* that will not slip, and a *thread through the tip* of the tongue (or through either side when half is to be removed), by which it can be drawn forward, are very important.

Strangulation of parts is now never employed, and the mortality after the *galvanic écraseur* or other *cautery* is high from septic disease and secondary hemorrhage on separation of the putrid eschar. The *wire-écraseur* leaves a less sloughy surface; but neither this nor the galvanic is a guarantee against bleeding. The former constantly drags out in its loop the untorn vessels, and these must be tied before being cut. Whitehead has shown that a tongue-wound may be kept almost dry if it is made by successive short snips with the *scissors;* many vessels do not then bleed—even the lingual may not; but *any vessel which does not stop bleeding after a few moments' pressure must be twisted* or *tied* (with some of the surrounding tissue on account of the softness of the part) *before going on.* Trouble arises only from venous bleeding, often caused by blueness from the anæsthetic. A sudden gush of blood covering the surface of the wound may be at once controlled by *passing a finger well behind the root of the tongue, on the bleeding side, and pressing it forward and against the opposite side of the jaw* (C. Heath). Bleeding may be absolutely prevented by passing a loop of whip-cord from just above the hyoid in the mid-line to just in front of the epiglottis, drawing the loop into the mouth and dividing it; passing the well-curved needle through the neck into the glosso-epiglottid pouch, a little above the corner of the hyoid, on either side, and withdrawing it threaded; then tie the ligature pretty tightly upon each half. The parts pierced are very thin, and the needle on entering the mouth should be received by a finger-point in front of the epiglottis (J. Lloyd, *Lancet*, January 23, 1886). If the lateral puncture goes too close to the cornu, it will be below the lingual, if too high up it may go through the facial vein, if too far back through the external carotid. A better fastening than a knot could easily be devised. Lastly, a *preliminary tracheotomy* may be done and the pharynx plugged; this does not add much to the danger of the operation apparently, but opinions differ greatly as to its advisability.

Treatment of Wound.—If the operation is borne, the chief dangers are septic broncho-pneumonia, septicæmia, and pyæmia; secondary hemorrhage is now rare. These have been met in Germany by attempts to obtain asepsis; and Barker and Kocher simultaneously suggested allowing the patient to continue breathing through a preliminary tracheotomy wound until the mouth was healing well. The best antiseptic for the mouth seems to be iodoform, Wölfler having found that its admixture with septic fluids prevented them from exciting broncho-pneumonia when injected into the tracheæ of rabbits. This is usually dusted on the surface daily; but Billroth and Wölfler pack the wound closely with an iodoform gauze which adheres to it for six to eight days, and the patient can take food over the solid cake. Chloride of zinc might be first applied. An antiseptic dressing covers any skin-wound.

After-treatment.—There is always slight oozing for a few hours. In case of hemorrhage or asphyxia a ligature should be kept through the stump of the tongue in all cases in which the genioglossi are cut from the jaw. The patient is best kept on one side. In septic cases or those dusted with iodoform, the patient should not swallow food, mingled with discharge and iodoform, but should be fed by rectum, or with a soft rubber tube passed halfway down the gullet, until the wound is granulating. The patient should be encouraged to spit out the ropy saliva which is usually freely secreted at first; and if a mouth-wash is required, Condy's fluid diluted is the best. The patient must write and not talk.

Operations for Removal of the Whole or Part of the Tongue. (1) Through the Mouth. *Removal of half tongue by écraseur.* (M. Baker.)—Pass a thread through each half, make the tongue tense by them and score it deeply with a scalpel in the mid-line, dividing it completely in front of frænum; then with the thumbs tear the two halves asunder sufficiently. With scissors snip the mucosa and muscles close to the jaw on the diseased side, pulling on the ligature, until well behind the growth; pass one or two needles through the organ here, slip a wire or stout whip-cord loop round behind them and cut through. The whole tongue may be similarly removed without splitting the organ. In difficult cases, with disease far back, Baker splits the cheek from the angle of the mouth to the masseter. He records forty cases with five deaths, one being from diphtheria (Butlin, *Diseases of the Tongue*, p. 363).

Whitehead's method of removing the whole tongue.—Draw the tongue forward and upward and snip through the mucosa all round close to the jaw and the anterior pillars of the fauces; next snip through the muscles on a level with the lower edge of the jaw back to the epiglottis, at once stopping any bleeding that may occur (p. 546). Whitehead records fifty-eight cases with nine deaths (Butlin).

For removal of glands, a preliminary operation in the neck must be undertaken.

2. Division of the Jaw. *Sédillot's operation.*—Incise through the mid-line of the lip and down to the hyoid; then bore a hole through the jaw on either side of the mid-line and place a plug in each; next divide the jaw at the symphysis; divide the insertions of the genioglossi and the mucosa on either side; draw the tongue forward and divide its base with écraseur, scissors, or knife, dividing one half before the other. Bring the jaw together by wire through the drilled holes, the soft parts by sutures, and drain in front of the hyoid.

The mortality is very high after this operation, which seems to be required only where the symphysis is involved and requires removal. Access to glands, except submental, is not afforded.

When the body of the jaw is infiltrated at a spot away from the mid-line, the soft parts may sometimes be split in the mid-line and a flap reflected to allow the removal of sufficient bone; again, it may be more convenient to divide them from the angle of the mouth, but this leaves an ugly scar.

3. By Incisions below the Jaw. *Regnoli's operation.*—An incision is made below the arch of the jaw from one facial artery to the other, and the flap bisected by a cut from the symphysis to the hyoid, the flaps are reflected, the digastrics and mylohyoids, geniohyoids, and genioglossi detached from the jaw, the mucosa divided along the whole length of the wound. The tongue is drawn out on to the neck by a thread through its tip and removed where desired. The flaps are sewn together and drained in front of the hyoid. Access to the glands is not given.

The submental method has undergone many modifications. Thus *Billroth* omits the median cut, prolongs the semilunar one backwards, ties one or both linguals, and extirpates glands before opening the mouth. *Kocher's operation* is the most radical yet introduced. A preliminary tracheotomy is performed and the pharynx plugged with a carbolized sponge on a string. Kocher operates under the spray, but this is doubtfully beneficial. Cut on to the anterior edge of the sterno-mastoid from the mastoid to the level of the hyoid, then forwards horizontally to the union of cornu and body, and up along the digastric to the jaw. Raise the flap, tie and cut the facial vein, and go on as for ligature of the lingual behind the hyoglossus. During this, tie the facial artery, remove the three or four glands between the submaxillary and the jaw, and also the submaxillary and sublingual glands, and if the whole tongue is removed Kocher ties the lingual on the far side; all connective tissue back to the carotid sheath is to be dissected away, and the upper glands upon the sheath should be removed. The mylohyoid and mucosa are now opened freely and as much of the tongue as may be necessary removed, partly through the mouth, partly through the wound. Should there be reason to suspect glandular infection upon both sides, this operation must be bilateral. No sutures are used. The wound and pharynx are packed with gauze in carbolic lotion one in twenty, and drained into an antiseptic dressing—all changed twice daily. Respiration goes on through the tracheotomy tube for several days, and the patient is fed by a stomach-tube at the dressings and by rectum.

Of 14 cases 1 died from secondary hemorrhage from the tracheotomy wound; in 8 the disease recurred; 1 died a year after the operation from pneumonia, and 4 were well after 14 months, 5, 5, and 6½ years (*Deutsch. Zeitsch. f. Chir.*, 1880, Bd. xiii. S. 147).

These are by far the best results yet obtained. The most perfect access to glands is given, the tongue at its base and one side of the floor of the mouth can be removed, and, by dividing the flap, parts of the jaw can be taken away.

CHOICE OF OPERATION.—Whitehead's method appears to be the best when it is not intended to remove glands and the floor of the mouth is not affected; under other circumstances Kocher's, modified to suit the case, is to be preferred. The surgeon must decide for himself whether or not to do a preliminary tracheotomy, and how he will treat the wound. There are obvious objections to the frequent carbolic dressing.

PALLIATIVE TREATMENT.—Removal of a painful tongue is justified, even though it is certain that glands must be left; relative euthanasia, or a period of ease, may thus be secured. In other cases the lingual nerve may be divided (p. 420); it should be hooked up, and half an inch cut out to prevent reunion. Morphia, when it does not disagree, may be used freely.

Hemorrhage from a cancer must be checked by local treatment—pressure, styptic, cautery—if possible. Ligature of the lingual is the next best remedy; and, if this is impossible on account of large matted glands, the common carotid must be tied.

DISEASES OF THE SALIVARY GLANDS.

Inflammation affects the parotid most commonly, then the submaxillary, and least often the sublingual.

ACUTE INFLAMMATION is usually a symptom of a febrile, infective disease—mumps. As a rule one parotid first forms a doughy, tender, aching swelling, of characteristic shape; and later, often as the first is subsiding, the other gland swells and runs a similar course. Suppuration is very rare. The submaxillary alone may be affected, and the swelling may be very slight and painless. Surgically, the disease is interesting as a cause of so-called "metastatic" orchitis, which often leads to atrophy of the testis, and of ovaritis, about which much less is known. There are many lymphatic glands on and in the substance of the parotid, which, when they enlarge rapidly, produce a swelling shaped like the gland; in parotitis, however, the *socia parotidis* upon the masseter is almost always to be felt—not so in glandular swellings.

Other occasional causes are: Passage up duct of a foreign body, mercurialism, many infective diseases—*e. g.*, pyæmia, scarlatina, typhoid, pneumonia, and rarely tuberculosis and congenital syphilis. Very often these cases end in abscess, which may open after a long time into the mouth, on the face, or into the ext. meatus, for the gland is enclosed in strong fascia. A salivary fistula may remain. Cellulitis of the neck, wide burrowing, destruction of the gland, necrosis of bone, or death from pyæmia, may result.

The TREATMENT of parotitis is that of any inflammation. Pus is hard to discover deep beneath œdematous cheek and parotid fascia; but it should be evacuated as soon as possible.

CHRONIC INTERSTITIAL PAROTITIS usually follows on the acute. Cases of chronic enlargement of the glands soon after birth are probably syphilitic.

NEW GROWTHS.—A *mixed tumor* is characteristic of the parotid. It consists of fibrous, mucous, cartilaginous, sarcomatous, and glandular tissue—all or some—variously combined, and usually forms a circumscribed rounded growth, movable over deep parts and projecting externally; rarely it is diffuse. *Mucous cysts* may form. The submaxillary is much less often affected. The circumscribed growths shell out easily; the incision may usually be vertical, as they lie over the facial nerve, but great care should always be exercised in dealing with the deep parts of the tumor. It may be impossible to avoid dividing some of, or all, the facial; so the patient should be warned. Local recurrence is common, but not general. The diffuse simple growths are usually best let alone.

Tumors of single tissues—*fibroma, chondroma, sarcoma*, and *cancer*—are very rare, but *lymphoma* of the glands in this region is fairly common. *Sarcoma* occurs chiefly as fibro-sarcoma, usually encapsuled. *Cancer* is of the acinous variety.

In cases of malignant growth the parotid has in a few cases been carefully dissected out, the structures passing through it being cut. The prognosis is bad.

CALCULI (salivary) of phosphate and carbonate of lime sometimes form in the ducts of *Steno* and *Wharton*. They must be removed by incision through the mucosa.

DISEASES OF THE FAUCES, TONSILS, AND SOFT PALATE.

ACUTE TONSILLITIS. CAUSES.—There may be no obvious cause; again, cold and wet. When several cases occur in a house, look for an escape of sewer-gas; hospital atmosphere is often to blame. Early syphilis and scarlatina are common causes. Acute tonsillitis occurs chiefly in children, and is often recurrent.

SYMPTOMS.—Sudden onset with temp. 102°–105°, chills, and often rigors, accompanied by all the symptoms of fever (p. 57), and by soreness of the throat increasing rapidly, until swallowing may be impossible. The soft palate, palatine arches, and especially the tonsils, are bright red and swollen; often dotted with white spots of follicular secretion; tongue foul, bowels confined; glands at the angle of the jaw are enlarged and tender. The tonsils, uvula, and palatine arches may almost close the fauces. The surfaces may ulcerate or slough superficially.

Often an *abscess* forms (*Quinsy*) in one tonsil, which is chiefly affected from the first, and becomes much swollen, very red, and tense-looking, yet soft to touch; it rises up behind the palate and its anterior pillar. Sometimes an abscess forms in the soft palate or outside the tonsil. *Œdema glottidis* and *diffuse cellulitis in the neck* are serious and fortunately rare complications.

TREATMENT.—First, give a sharp purge; aconite ♏j, every half hour till the pulse is affected, may relieve. Order either fomentation of the neck and inhalation of steam, or a cold compress and constant sucking of ice. Gargles (F. 201) should be frequently used. If abscess is suspected, at once push a Paget's knife into the tonsil and cut in toward the mid-line; evacuation of pus here or elsewhere gives immediate relief. The pus is usually fetid. The patient is often left weak and anæmic.

CHRONIC ENLARGEMENT OF THE TONSILS is a frequent sequel of repeated or chronic catarrh in scrofulous children. The parts are usually pale, pitted, and scarred, but are liable to frequent subacute inflammation; deglutition is impeded, the voice is husky or hoarse, the respiration noisy and laborious, especially during sleep; the diseased state is liable to be continued into the Eustachian tube, causing throat deafness, and to lead to impairment of the delicate structures in the tympanic cavity. Suffocation even has been caused by viscid mucus entangled between the swollen glands.

TREATMENT.—Tonics, especially the iodide of iron, bark, cold-liver oil, and sea-air. Contraction must be promoted by astringent gargles (F. 203

et seq.), and by swabbing the throat once a day with arg. nit. gr. xx., aq. dest. ℥j, or liq. iodi; or, more often, with glycerine of tannin or liq. ferri perchlor. and glycerine (āā).

Inhalation of vapor is of great efficacy when the mucous membrane of the fauces and tonsils is flabby and swollen; as well as in catarrhal rhinorrhœa, in throat-deafness, and in coughs attended with copious expectoration. To inhale effectually, put a pint of boiling water in a jug, add to it any desired drug, put the mouth close to the jug and cover both jug and head closely with a towel. Siegel's spray played into the mouth is better; but to apply remedies to the naso-pharynx and posterior nares or to the glottis, a hand-spray with a long curved nozzle should be used.

The most efficient vapors are evolved from hot water to which ♏xxx ad ʒj of creasote, or of tincture of iodine or of benzoin, have been added.

Usually, when hypertrophy is well established, time is only wasted in the above treatment. The child's face acquires quite a characteristic appearance; the chest often becomes deformed, especially if rickets coexists—the lower parts sinking in because of the obstruction in the fauces to entry of air; and deafness makes the child backward and dull. The tonsils should therefore be excised after a short unsuccessful trial of the above remedies. The child faces the light with the head thrown somewhat back and resting in the hollow of the nurse's shoulder. The surgeon *standing behind*, bends over and seizes the *right* tonsil with hooked forceps, and then shaves off a slice with a curved probe-pointed bistoury, cutting upward parallel to the pillars of the fauces. The left tonsil is at once similarly treated, the surgeon standing in front. The nearest half of the blade should be wrapped in strapping to prevent the lips being cut. All the tonsil need not be removed, as it shrinks from scar-contraction. Mackenzie's guillotine renders the operation easier. The surgeon stands in front for both tonsils, and uses the left hand for the right gland; with his free fingers he grasps the patient's neck and presses the tonsil in through the ring of the instrument. The pain is slight, referred to the middle ear. If both tonsils are to be removed, it should be done at one operation, especially in children. Cocaine may be painted on the part.

Hemorrhage, not checked by ice or an alum wash, is very rare; it comes from tonsillar arteries. The carotid is not in danger if either of the above operations is properly done; for it lies *behind* the tonsil, in the angle between the vertebræ and the pharynx. A thrust back and *out* through the tonsils with a pointed knife would wound it. Prolonged digital pressure can be kept up on the tonsil, and a styptic may be pressed on to it; a visible bleeding point might be touched with a cautery. Most difficulty arises in hemorrhage from sloughing tonsils in scarlatina; here the common carotid has been successfully tied by Pepper. The uncertainty of origin of the vessels which supply the tonsil, and the presence of swollen glands at the angle of the jaw are against tying the external carotid.

Enlargement of the uvula produces cough and expectoration by tickling the larynx. If it does not yield to nitrate of silver, it should be stretched and steadied with a pair of hooked forceps, and be cut through the middle with a pair of long, blunt-pointed scissors.

Gangrene of the fauces, apart from diphtheria and scarlatina, occurs rarely in other severe infective diseases, and in very weakly patients.

The fauces are almost always affected by congestion, superficial ulceration, and mucous tubercles in *secondary syphilis*; and later in the disease *gummatous ulceration* not uncommonly perforates the soft palate or destroys it and much of the mucosa round about. *Tubercular ulceration*, often with lupus of the face, may also commit great ravages. Scar-contraction may greatly constrict the pharynx.

NEW GROWTHS.—In the *soft palate* the commonest is an adenoma which shells out on incision of its capsule. *Warts*, and *mucous* and *glandular polypi* occur; very rarely *epithelioma* is primary here. In the *tonsil, lympho-sarcoma* sometimes develops, *epithelioma* very rarely. Removal is difficult, and offers little hope.

THE SURGICAL TREATMENT OF DIPHTHERIA.—Although its cause is not yet known, there is every reason to believe that diphtheria is an infective disease of local origin, and that the general symptoms are due either to the absorption of ptomaines, or of organisms, from the primary focus. In the former case, everything will depend upon local antiseptic treatment; and, even if general infection has occurred, analogy with malignant pustule would lead us to hope that local treatment may be beneficial.

It would, therefore, seem right that this disease should be transferred to surgeons, that the treatment may be, to a certain extent, "operative" from the first. Obviously, if antisepsis is to have a chance, it must be begun early. The first step is carefully to remove, with forceps and a sharp spoon, all the membrane that can be seen, and then to rub well the slightly raw surfaces, and the whole fauces, with some strong antiseptic, such as corrosive sublimate, 1 in 500. An anæsthetic should be given to children, and the treatment carried out most thoroughly, neither time nor trouble being spared. Great care should be taken not to let detached pieces of membrane fall into the throat; and everything coughed up or removed should be placed in sublimate solution. Recurrence requires immediate repetition of the treatment. As a gargle every hour or two, sublimate lotion (1 in 1500–2000) is probably the best, but unfortunately it is intensely disagreeable; strong Condy comes next. The throats of young children must be painted with these lotions, or with glycerin of carbolic, but such treatment is unsatisfactory.

Next, as to *tracheotomy*. This operation is at present done for obstruction to breathing from spread of the disease to the larynx. All are agreed that if done at all, it should be done early—as soon, in fact, as *retraction of the lower ribs is evident;* otherwise, a child becomes slowly asphyxiated and exhausted by its struggles, parts of the lungs become collapsed, and infective particles are sucked into the bronchi and excite broncho-pneumonia. In young children the glottis is so small that dyspnœa soon follows change or loss of voice, and croupy or aphonic cough; but in adults there may be no dyspnœa, even when the membrane has run down the trachea, perhaps even to the larger bronchi, and it is well known that they usually die of asthenia, and not of asphyxia. In the great majority of cases, hoarseness or aphonia will tell that the disease is involving the cords; rarely, it may pass below without affecting them by inhalation of a bit of membrane. The question therefore arises, whether a prophylactic tracheotomy might not with advantage be done. As in so many cases, especially among adults, the larynx does not become affected, one would hardly like to open the trachea in every instance. Yet breathing over the diseased surface would thus be avoided, the advancing edge of the membrane could be watched for in the larynx, and there would be no difficulty, when swallowing is impossible, in feeding by an India-rubber stomach-tube, which so often excites spasm of the glottis. But whatever may be thought of this, it would seem better to take the slightest hoarseness or croupiness of cough, rather than dyspnœa, as the sign for operation; and this should be the division of the cricoid and three or more upper rings of the trachea. No tube should be introduced, but the edges of the trachea should be held apart by a dilator, bent into hooks. If the tracheal mucosa is normal, the advantages will be those enumerated above, and the larynx must be frequently examined from below, that the spreading edge may be treated immediately, should it appear. If the edge of the membrane can be seen—a laryngoscope mirror or electric light being used if necessary—it should all be torn off, and the surface treated as advised for the tonsil. It would be justifiable to open the trachea for two inches or more to reach the spreading edge.

If the membrane has passed even into the main bronchi, it may be sucked out with Parker's trachea-aspirator, or removed with a small umbrella-probang; then bichloride solution must be applied with a feather, but, necessarily, accuracy is entirely lacking.

The recurrence of dyspnœa demands a fresh examination of the mucosa, the removal of any recurrent membrane, and reapplication of the antiseptic.

Between times the nurse wipes away and disinfects in mercury lotion everything that is coughed up into the wound; if a feather is passed into the trachea, it should be moistened with bichloride solution (1 in 2000). Every two or three hours one ounce of alkaline solution (sod. carb. iv; aq. ad ℥j) may be sprayed into trachea.

In *nasal diphtheria* little can be done beyond using a douche of corrosive sublimate frequently.

A warm (60–65° F.), moist atmosphere should be preserved in the room, and the inhalation of steam is usually grateful. All unnecessary furniture should be removed from the room, and a good supply of fresh air should be provided. From the first, all possible nourishment should be given by mouth, stomach-tube, or rectum, and stimulants must be freely, though carefully, administered.

Injuries and Diseases of the Lower Part of the Pharynx and of the Œsophagus.

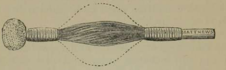
Foreign bodies, when fixed in the pharynx or the œsophagus, may produce immediate suffocation from impaction over the glottis; or much pain or discomfort, inability to swallow, and fits of suffocative cough from spasm of the glottis which may prove fatal. If the foreign substance remains impacted, it may produce dysphagia, ulceration of the parts, attended with exhausting cough, dyspnœa, and profuse fetid expectoration, or sudden hæmoptysis from an œsophageal vessel or the aorta.

Treatment.—The patient should be seated in a chair, with the head thrown back, and the mouth wide open. The surgeon should then introduce his finger, and should pass it swiftly into the pharynx, and search the whole of it thoroughly. When the substance is felt, it may perhaps be entangled in the point of the nail, or curved forceps may be guided to it by the finger. But in cases of suffocation, laryngotomy or tracheotomy should be at once performed, and the body pushed up from below, if over the glottis and not otherwise removable.

Pins and fishbones are often entangled about the pillars of the fauces, or in the folds of mucous membrane between the epiglottis and tongue. The surgeon must be careful not to mistake an abnormally elongated lesser horn of the hyoid bone for a foreign body. If the patient has false teeth, he should take them out, and the surgeon may then pass his finger in another inch.

If the body has passed into the œsophagus, and it is small and sharp (a fishbone, for instance), it may be got rid of by making the patient swallow a good mouthful of bread. If large and soft (as a lump of meat), it may be pushed down into the stomach with the probang; but large hard bodies, especially if rough and angular (such as pieces of bone, glass, or false teeth, etc.), should be brought up if possible. If the stomach is full a dose of tartar emetic dissolved in a very small quantity of water or apomorphia subcutaneously may be administered in the hope that when the contents of the stomach are vomited they may bring up the offending substance with them. This failing, the ordinary "coin-catcher," if at hand, and the expanding probang (Fig. 201) are better than improvised instruments such as a piece of whale-

Fig. 201.



The umbrella probang.

bone armed with a flat blunt hook or with a skein of thread, so as to form an infinite number of nooses. The use of these instruments for pulling up sharp bodies is not without danger, two or three cases having been lately recorded of fishbones thrust into the pericardium—fatal pericarditis resulting. For the removal of bodies in the upper third of the gullet long curved forceps may be used. A foreign body immovably impacted in the cervical or upper thoracic part of the gullet should be removed by œsophagotomy; when fixed lower, every effort must be made to extract it or push it on into the stomach, whence, if its passage through the intestines is much to be feared, it can be removed by gastrotomy. But ordinarily, if a foreign body has got into the stomach, the patient should eat plentifully of porridge, rice, potato, pudding, and oil, so that it may pass through shielded.

When a copper coin, or other poisonous metal, is forced into the stomach, diet as above, give plenty of oil and allow no acids. Watch the stools carefully.

For Wounds, see "Injuries of the Neck."

Diseases of the Œsophagus: General Points.—The great symptom of disease of these parts is *dysphagia*—difficulty in swallowing—which may be induced in several ways; thus, soreness and pain may prevent swallowing, the gullet may be paralyzed or in a state of spasm, strictured by a scar or new growth in its walls, or by pressure from without, or dilated or sacculated. It may be of sudden or gradual onset, constant, remittent or intermittent, slight or extreme, most marked with either fluids or solids. With dysphagia there is often a sense that the bolus sticks at a certain point, often behind the cricoid or in the suprasternal notch, and actual pain may be referred to these or other spots, usually on the anterior surface of the body; but, unfortunately, these symptoms are of little localizing value. Food may regurgitate either immediately, before any starch is changed into sugar, or after a considerable interval, when perhaps putrid; unless rejected by vomiting, the ingesta contain no gastric juice, and are alkaline and sodden, or putrid. They may be mixed with blood or pus.

Our means of examining the tube are: (1) Palpation of the cervical part, by which compressing tumors, distended diverticula—rarely, growths in the wall of the gullet—especially on the left of the trachea—and swollen glands secondary to such growths may be felt. (2) Examination of the pharynx by the finger; a long one will reach to the cricoid cartilage and often detects a foreign body. (3) The passage of a bougie (gum-elastic). This is really a long finger, and should be used *to feel*, not to overcome all obstacles. To pass it, let the patient sit up with the head a little flexed and poked forward as much as possible to undo the convexity of the cervical spine. Soften the bougie in warm water, grease it with glycerine, and bend its point slightly, pass the left forefinger into the pharynx, and along its under surface push the bougie, point downward. The finger prevents the point from turning up into the naso-pharynx; the tendency of the instrument to uncurl keeps the point against the spine away from the glottis. These manœuvres must be rapidly performed, as they usually excite much retching; yet the hand must be prepared for a check quite early, as stricture is common just about the cricoid. Some education of touch is necessary to decide when the point of a bougie is in a stricture and may be gently pushed on, and when it is in a *cul-de-sac*. Blood may easily be drawn or the tube perforated in malignant cases. (4) *Auscultation* of the back and neck during swallowing of liquid sometimes reveals a point at which the sounds indicate its passage through a narrow orifice; but it is not of much value. (5) Very rarely is dilatation or sacculation so great as to yield dulness on *percussion* of the back. (6) Mackenzie's *œsophagoscope* is hard to use, and of little value.

Spasm of the Œsophagus (*spasmodic stricture*) occurs in sudden fits. The patient at a meal finds himself unable to swallow, and the attempt to do so produces spasmodic pain and sense of choking. The obstruction can usually be overcome when it is insisted that medicine, for example, shall be swallowed. The *diagnosis* between this and *organic* or *permanent stricture* is founded on the suddenness of its accession, its intermittent nature, and the fact that the bougie either meets with no obstruction or with one that easily yields. A foreign body must also be excluded.

This affection may last years. The patients are usually hysterical or hypochondriacal, and a reflex connection with some other disorder may exist. Thus Brodie relates a case that ceased on the removal of bleeding piles, and Mayo another that was cured by relieving chronic disease of the liver.

Treatment.—Tonics, antispasmodics, and alteratives, especially iron with aloes and galbanum at bedtime; exercise, the shower-bath, warm and cold bathing; great attention to diet; care not to swallow anything imperfectly masticated or too hot. The passage of a bougie is rarely of use.

Palsy of the Œsophagus may follow diphtheria, or depend on medullary disease or poisoning from lead or alcohol. It occasions painless dysphagia. So long as the pharynx acts, food is pushed like a rod through the gullet into the stomach; when it sticks, it is rejected after a time by coughing or vomiting. Solids are often swallowed better than fluids. The latter are heard to pass slowly down the tube, and to enter the stomach with a loud noise. A bougie meets with no obstruction. The *diagnosis* is difficult from general dilatation, and may be impossible in old-standing cases unless other paralysis is present. The patient should be fed by the stomach-pump, by nutrient enemata (F. 211), and by pushing soft food down the œsophagus with a probang. The palsy has sometimes been relieved by electricity to the œsophagus.

Dilatation of the Œsophagus (ektasia) is usually the result of obstruction, commencing immediately above a stricture and gradually extending upward. Ulcers, scars, and a warty state of the mucosa may also be found, and some of the scars may yield and form small diverticula. More commonly there is no ektasia above a stricture, but hypertrophy of muscle. In rare cases dilatation of the gullet is *congenital*, in others apparently *acquired*, without any obstruction, as a result, perhaps, of inflammatory softening or of fatty degeneration of muscle. Some cases of late appearance and doubtful cause may be congenital, but remain long without symptoms. The dilatation may be enormous—*e. g.*, twice the normal length and six inches across, the course of the tube being sinuous.

SYMPTOMS.—In stricture cases, regurgitation of large quantities of œsophageal contents is added to the signs of narrowing. In the second group, dysphagia, rejection of quantities of sodden food—perhaps hours after ingestion—owing to the pressure of the œsophageal collection on the trachea exciting dyspnœa and cough; dulness near the spine has been found and referred to lung-disease. A bougie may pass easily, and free movements of the point may show dilatation; but it may also fail to pass some bend and lead to error. The symptoms may, it is said, disappear, even for years.

The TREATMENT consists in proper feeding.

DIVERTICULA OF THE ŒSOPHAGUS.—Small funnel-shaped protrusions, *traction diverticula*, usually from the anterior wall in the neighborhood of the trachea, are not uncommon from the dragging of scar tissue, due usually to inflammatory destruction of a bronchial gland. They cause no symptoms, but there is danger that they will ulcerate, often from lodgement of a foreign body, and perforate the mediastinum, pleura, pericardium, or some great or small vessel.

The so-called *hernial diverticula* (Zenker) are rare, and almost always start from the mid-line, behind, of the pharynx, at a very weak spot, just above the junction with the gullet, where it is formed by inferior constrictor only. Zenker thinks that this predisposes to the hernia, and that an external injury or impaction of a foreign body is the exciting cause. König (*Deutsche Chirurgie*, No. 35) regards the constancy of their point of origin as evidence that some malformation—deficiency of inferior constrictor, a shallow fossa or actual diverticulum—is their real cause, the mucosa being pushed out by force from within. Heron Watson and others associate these diverticula with a brachial cleft which opens into the pharynx about their point of origin, for it sometimes occurs with a congenital fistula. The largest specimens are pear-shaped, bulging on either side of the gullet and reaching down even to the bifurcation of the trachea; and they consist of mucosa covered by a fibrous adventitia with a few muscular fibres round the neck.

SYMPTOMS in hitherto described cases have not appeared till after thirty, and have lasted many years (even forty-nine, Rokitansky)—ultimately proving fatal in a large proportion of the cases. Food enters and gradually distends the sac, and the larger this becomes the more does it come to lie in the axis of the pharynx and to displace and compress the gullet; consequently the symptoms increase steadily. They may be slighter in some positions than others, and patients sometimes find that by pressure at a certain spot they can direct some food into the gullet. The neck swells on one or both sides during a meal, and pressure in the sac will elicit gurgling, and force gas and food into the mouth. Many patients do this and become regular ruminants (König). Dyspnœa may result from the filling of intra-thoracic sacs. Sooner or later, by coughing, vomiting, or other movements, the food is rejected in various stages of salivary digestion or of putrefaction. A bougie passes usually into the sac and moves freely in it; now and again by a lucky chance the gullet may be entered and the stomach easily reached.

TREATMENT.—It is usually impossible to feed by the stomach-tube, but enemata may be given in addition to what the patient can get into the stomach—often after hours of struggling. Such a state certainly justifies gastrostomy; and if the patient is not satisfied with a gullet outside his body, Kluge suggests that through an œsophagotomy wound the neck of the sac should be cut off, the œsophageal margins inverted and sewn up with catgut, the sac drawn out (possible?), the cavity drained, and the whole operation done antiseptically.

SIMPLE STRICTURE OF THE ŒSOPHAGUS may rarely be congenital, the central part of the gullet being absent or solid. The small superficial ulcers in *acute* and *chronic œsophagitis* are not known ever to cause trouble. *Thrush* may completely block the tube, and has thus killed young children (Virchow). *Diphtheria* scarcely ever affects the part. *Phlegmonous œsophagitis* is not known to have caused stricture, but may leave cavities, in which food collects, from the mucosa not healing down after the pus has burst through it. *Tubercular* ulcers have been described, and *syphilitic* are said not to be very rare; the latter do cause stenosis, and the former would do so if they healed. *Variolous* ulcers cause only superficial scars. Yet among the above we must look for the causes of a few simple strictures. In the great majority of cases, stricture results from the *swallowing of caustic* fluids, of which sulphuric acid is the worst, and strong solution of soda or potash the most common. This causes sloughing and violent inflammation of the whole or part of the mucosa — the whole depth of the mucosa being often, the thickness of the wall of the gullet sometimes involved. It is surprising with how little injury the gullet may escape when such fluids pass rapidly through it. In the worst cases death results; in the slighter, more or less of the mucosa, and other parts perhaps, are thrown off, the parts granulate, swallowing becomes possible; then contraction sets in, narrowing the tube, often in several places or even throughout its length, and with it come the symptoms of stricture. These are increasing, almost unvarying, difficulty in swallowing: more or less anxious gulping and straining being required, together with mouthfuls of fluid, to wash down a bolus. Pain may be caused. If the stricture becomes blocked, food will of course collect above; it is regurgitated at once from a high stricture, either at once or after a little time from obstructions low down. A bougie meets an obstruction at a certain distance from the teeth, and perhaps passes through it into the stomach, or meets with one or more lower strictures, which may require smaller instruments. Ultimately the stenosis in severe cases becomes impassable.

FIG. 202.

Simple stricture of the œsophagus. (Middlesex Hosp. Museum.)

Simple stricture is said to be most common at the commencement of the gullet and at the cardiac end—two narrow spots.

TREATMENT.—The diet must be carefully selected—well moistened, and no lumps should be present. Everything that has been done for stricture of the urethra appears to have been done here also. *Dilatation by the daily passage of bougies* is always first tried, and if successful the patient learns to use one; the dangers are perforation of the wall and the excitation of acute phlegmonous œsophagitis. Krishaber recommends the *sonde à démeure*, a tube introduced through the nose, used for feeding, and replaced as it loosens. *Internal œsophagotomy* (Trélat) killed three out of twelve patients and placed two in jeopardy—from peri-œsophagitis and bleeding. *Forcible dilatation*, with cone-headed bougies running on a whalebone guide, has recently been practised with marked success by MacCormac (*Lancet*, Jan. 30, 1885).

When no bougie can be passed through a cervical stricture *external* *œsophagotomy* is recommended by some, and Hüter thinks it justifiable low in the neck, if from it a thoracic stricture might be reached by the finger and dilated. But the difficulty of maintaining a passage is so great that, in most of these cases, *gastrostomy* is done, or *œsophagostomy*—the establishment of a fistula in the gullet below the stricture, a more difficult and less satisfactory operation.

Squamous Epithelioma occurs usually after forty, chiefly in men and in dram-drinkers, being sometimes due perhaps to continued irritation of a catarrhal ulcer. It may occur anywhere, but is most common in the lower, least so in the upper, third; the back of the cricoid, the point of crossing of the left bronchus and the cardia are said to be seats of election. The growth is almost always annular and may have a villous surface, but it is usually ulcerated, and its prominent edges present an "os uteri" aspect when seen from above or below; it may be very limited or very extensive. Mediastinal and cervical glands are not uncommonly affected; in twenty-five of forty-two cases metastasis had occurred, and in twenty-seven perforation of the trachea, bronchi, or lung, causing septic broncho-pneumonia, or of the pleura, pericardium, or surrounding connective tissue. Death from perforation of a large vessel is rare. Two years is the extreme duration, and eight months is said to be the average (Mackenzie).

Symptoms.—Those of stricture. The age of the patient, the absence of the chief cause of simple stricture (corrosive action), the presence of a swelling on the left of the trachea, moving with the gullet, the presence of enlarged glands here, blood in rejected food, and easy bleeding on introducing a bougie are the points of *diagnosis* from simple growth.

Treatment.—Radical treatment is possible only in the neck. Billroth suggested and Czerny successfully carried out *resection of the gullet* (one and a half inch), the woman being well and at work five months after the operation, feeding herself through a fistula. The operation began as for œsophagotomy, the growth was felt, the œsophagus containing it separated easily from the trachea and spine, and cut through above and below the mass; the stomach-end was sewn in the wound. No glands were involved. This case, it will be seen, was singularly favorable; yet, as König says, the result was so good that further attempts should be made. Then, should extirpation be found impossible, a fistula below the growth can be established.

Usually careful feeding, the use of enemata as aids, and the occasional passage of a bougie are persevered with until they become all but impossible; then, when the patient has suffered almost all the pangs of starvation, *gastrostomy* is done. The results of this operation and of *œsophagostomy* for cancer are consequently very bad. By performing one or other, and preferably the former when resection is impossible, as soon as the patient has real difficulty in obtaining sufficient food by mouth, the results would greatly improve, the patient would be saved a great deal of suffering, he would not die of hunger, and growth of the cancer would not be stimulated by the irritation of food and bougies.

As an alternative, C. J. Symonds passes through the stricture and leaves in a gum-elastic tube, ending above in a small funnel, which rests on the face of the growth; it is drawn out by an attached thread. It gave rise to abscess in a case of Barwell's (*Brit. Med. Journ.*, Jan. 17, 1885).

Simple Tumors of the œsophagus are very rare and mostly *polypoid*. The commonest are mucous and adenoid; myoma has been seen.

Diagnosis of Stricture.—The symptoms of the various diseases of the œsophagus above considered are so similar that the differential diagnosis is often difficult. If we put aside the drunkard's catarrh, *stricture*, fibrous or epitheliomatous, is by far the commonest disease of the part; and the points of distinction between the two forms have been given. *Spasm*, even in a first attack, can hardly be taken for either, though impaction of a bolus may be the first sign of stricture. *Palsy, dilatation*, and *diverticulum* are all very rare. The bougie, apart from collateral evidence of nervous disease, distinguishes *palsy* from stricture; also *dilatation* unless this is very great, and the instrument always hitches in a bend; and *diverticulum*, where the symptoms are typical, should present little difficulty.

But before diagnosing "stricture," *it is necessary always to examine the whole length of the tube for evidence of any external pressure* on the œsophagus —by goitres, tumors, and enlargements of the cervical glands, retropharyngeal abscess, aneurisms of the aorta or great vessels, or enlargement of the bronchial or mediastinal lymphatic glands. Aneurisms and abscesses have been burst by bougies; before passing one, therefore, the chest should be carefully examined, and signs of embarrassed circulation or respiration must be looked for.

Œsophagotomy may be required (1) for the removal of foreign bodies, not merely from the cervical, but also from the upper thoracic region; (2) for the division of a simple stricture or dilatation of one below the opening; (3) for the examination of an epithelioma with a view to *resection* or to *œsophagostomy* below it; (4) for the direct treatment of a diverticulum (page 556).

If a foreign body projects on one side, operate on that side; otherwise choose the left side and turn the face slightly to the right. Make a cut on to the sterno-mastoid edge from the sternum to one-half inch above the cricoid; draw the muscle well out and divide the fascia in the line of the wound; draw the omo-hyoid in or out according to the height at which the gullet must be reached; free the lateral lobe of the thyroid body, tying the inf. thyroid if it is divided. If more room is wanted, divide the sternal head of the sterno-mastoid. Stop all bleeding as the operation goes on. Draw the thyroid body and depressors in, the sterno-mastoid and carotid sheath out, working with forceps and the handle of the scalpel, and the œsophagus will be seen as a red, longitudinally striated, flattened tube; open it longitudinally, between two sharp hooks (König), a few lines from the œsophago-tracheal groove, that the recurrent laryngeal may be spared. A foreign body may be cut upon directly. The œsophageal wound should be closely sewn up with catgut, and the wound treated antiseptically. If a fistula is wished for, sew the edges of the œsophageal cut to the skin. If resection is intended, the incision must probably reach to the hyoid.

Gastrostomy.—One finger's breadth below the left ribs make a one and a half inch cut, having its centre opposite the tip of the tenth rib cartilage, and divide successively, by light sweeps of the knife, the fat, some fibres of the ext. oblique and of the sheath of the rectus, the margin of the rectus, the tendon of the int. oblique, and the muscular fibre of the transversalis beneath it; the latter in thin subjects must be picked up with forceps and divided with great care by a knife held on the flat, for the peritoneum may be quite close to it, though, ordinarily, one finds and tears through a thin fascia transversalis and some subperitoneal fat before reaching it. Tie all bleeding vessels. Pick up and notch the peritoneum, and slit it up to the full length of the wound. If the stomach does not present at once, pass two fingers into the abdomen, touch the edge of the liver, and glide beneath the left lobe as far back as possible; the viscus then beneath the fingers is the stomach and must be drawn forward. It is thick, quite smooth, having no bands, and has a wide surface. Hold a piece in the wound with ring-forceps, or by means of two threads passed through the outer coats; these may be left in till the stomach is opened. Attach it all round by closely set fine silk stitches passed through the serous and muscular layers of the stomach, the parietal peritoneum drawn out from beneath the muscle and the skin; the mucous membrane slips easily from between the finger and thumb when the wall is gently pinched. The object is to secure a large surface-contact between the stomach and parietal peritoneum, and not to open the viscus. Pass all the stitches before tying any. The skin-wound may be shortened by a stitch at either end. Dress antiseptically and feed by rectum for four days, if the patient is not too weak; then make a puncture with a tenotomy-knife, held quite short, and insert a small corked tube until a fistula is established. Such an opening is closed by the mucous membrane. If a large opening is made, the gastric juice always escapes—it may do so through a small one—and digests the epidermis of the abdomen, which must be protected by an ointment.

At first only milk and egg beaten up should be introduced; later mince, mashed bread, etc. In a case of fibrous stricture, operated on by Trendelenburg, the boy masticated his food and blew it down a tube into his stomach, thus enjoying his food, and obtaining the advantage of salivary digestion.

Of 103 gastrostomies for cancer, 50 lived more than 1 week, 37 less than 3 months, 3 for 3 months, 4 for 4 months, 3 for 6 months, 1 for 7 months, 2 for 8 months (Blum, *Arch. Gén. de Méd.*, Nov. 1883). The later results show improvement from earlier operating and safer methods.

USE OF THE STOMACH-PUMP.—The tube is introduced in the same manner as the œsophagus bougie. In order that the tube may not be bitten, it is usual to place a gag, having a hole for the tube to pass through, in the mouth of any resisting patient. The tube has been passed down the trachea, and the lungs injected. Before pumping out the contents of the stomach, one or two pints of water should be injected, and all should not be pumped out or the mucosa may be torn to shreds. (Sir T. Watson, "On the Abuse of the Stomach-pump," *Lond. Med. Gaz.*, vol. xvii.) Pumping water in and out should be repeated till it returns colorless.

A soft rubber tube with a bulbous end is much safer than the gum-elastic; when pushed into the pharynx, it is carried down by deglutition. The stomach can be filled through a funnel, and washed out by siphon-action when the funnel is lowered.

INJURIES AND DISEASES OF THE LARYNX.

The LARYNGOSCOPE consists of two parts: (1) the *reflector*, a circular mirror of about nine-inch focus, eccentrically connected by a ball-and-socket joint to an elastic band round the head, so that it can be worn upon the forehead or brought down in front of either eye, when the observer looks through a central aperture in it; (2) the *throat-mirrors*, varying from one inch to one-half inch across, and attached at 45 degrees to long-handled stems.

Mode of Use.—Bright daylight, or light from a good lamp with a condenser, may be used. The patient sits with the light behind, or to one side, facing the surgeon, who reflects the light into the patient's throat. The surgeon now warms the throat-mirror to a little above the temperature of the body, testing it upon his hand, that the breath shall not condense upon it. Then the patient protrudes his tongue, the surgeon wraps the tip in a napkin and holds it forward whilst he introduces the warmed mirror, raising with it the soft palate and uvula, without touching the pharynx, which excites retching. Light from the reflector is directed on to the throat-mirror and thence on to the parts below it, and the surgeon thus gets a view of the back of the tongue, of the epiglottis, and at last of the rima glottidis. It is essential to study the normal glottis, its movements in breathing and in uttering the broad A.

The laryngoscope is used not only in diagnosis but to guide the application of remedies and to enable certain operative procedures to be undertaken. For these purposes the surgeon requires both hands—so the patient must hold his own tongue; it is then possible to seize with endolaryngeal forceps, and to extract some foreign bodies, to scarify œdematous parts, to apply lotions and powders to the glottis with a brush bent at an angle, to remove polypi with forceps or snares, or to apply galvanism.

Rhinoscopy.—By drawing forward the uvula with a hook and introducing a mirror with its face upward, a view of the posterior apertures of the nares, turbinated bones, and adjacent parts may be obtained. It is useful in the diagnosis of polypi and ulcers of the nasal cavities and of the Eustachian tube; but rhinoscopy is not easy.

Foreign Bodies in the Air-passages.—Occasionally when a sudden inspiration is made, or when swallowing is carelessly performed, and especially in patients suffering from impairment of sense or motion about the glottis, a foreign body floating in the air, or in the mouth, on being swallowed, may be drawn through the open glottis. The bodies thus entering are very various and include pieces of soft food, pins, coins, nutshells, and other hard, and often angular, substances. Bourdillot found that of 166 cases 80 were in the trachea, 35 in the larynx, 26 in the right, and 15 in the left, bronchus. The reason why bodies usually enter the right in spite of its being the less oblique of the two bronchi, is that the spur between it and the left lies to the left of the mid-line of the trachea.

Foreign bodies may become impacted at some point, or may remain free, changing their position from time to time in consequence of movements of the body, or of coughing and forcible respiratory movements. They, of course, obstruct the entry of air in proportion to their size—perhaps at once and completely, perhaps imperceptibly; but they obstruct also by causing spasm of the glottis, which may prove fatal at any time, and will be the more severe when the body is hard, angular, and lodged in, or strikes against, the larynx than under other conditions. This spasm is indicated by croupy symptoms—difficult, whistling, or whooping inspiration; fits of hard, metallic coughing, accompanied by much distress and obvious signs of dyspnœa. The local irritation of the body causes increased secretion of mucus, which necessitates cough; thus, with even small, soft bodies, a violent fit of coughing usually follows any prolonged sleep and consequent accumulation of mucus. When impacted, fixed pain often indicates the situation of the body—pain meaning injury to the tissues. Sooner or later, if a body remain in the air-passages it causes ulceration and the formation of a cavity, in which it may become encysted and remain quiescent for years; but finally suppuration usually occurs, and the patient dies with signs of phthisis, broncho-pneumonia, or bronchiectasis. The foreign body may be expelled even after years, but it may be too late to save life if serious lung symptoms exist.

The *results* according to Durham are: (1) Expulsion, at once or later, when the case usually ends in recovery. (2) Death from asphyxia, at once or later, from hemorrhage from the innominate or some pulmonary vessel, from œdema glottidis, ulceration of larynx, ulceration of lung, or empyema from spread of ulceration to pleura. (3) A body has rarely escaped through an abscess pointing on the surface of the thorax. (4) Recovery or death may follow an operation for removal of the body.

The Diagnosis of Foreign Body may be difficult in young children, or when it has entered during a fit or some accident or other distracting occurrence. Always inquire in cases of sudden onset of laryngeal symptoms whether the patient had anything in his mouth ; sudden onset and intermittent character of symptoms, and absence of fever and of general symptoms, point strongly to foreign body, as also does expiratory dyspnœa, that of laryngitis being inspiratory. Similar symptoms may arise from impaction of a foreign body in the œsophagus (p. 553). Dysphagia would then be present and a bougie would find an obstruction.

(*a*) *Foreign Body in the Larynx.*—Sometimes a person who is busily laughing and talking during a meal, suddenly rises from table, attempts to put his finger into his throat, speedily turns blue in the face, and then drops down dead. A piece of food has become impacted in the upper opening of the larynx or in the *rima glottidis*—a thing liable to happen if a sudden inspiration be made through the mouth when filled with food. The surgeon rarely arrives in time to do any good ; but, if on the spot, he should rapidly search the pharynx with his finger and remove the obstructing substance if possible ; and if not, he should open the larynx immediately, and pass a probe up through the wound, so as to push the substance back into the mouth.

In less acute cases, the entry of a foreign body usually causes much distress and coughing for an hour or two ; it then subsides, to recur at more or less frequent intervals. It is now shown to be *in the larynx* by fixed pain there, frequent spasmodic cough, breathing usually croupy with more or less constant sense of suffocation, hoarseness, or aphonia, and absence of lung-symptoms ; sharp laryngitis often supervenes. The body may be seen with the laryngoscope. The symptoms are less urgent when the body is in a sacculus than when in the cavity of the larynx.

(*b*) When *the foreign body is impacted in the trachea*, or even across the cricoid, the distress may be slight for some time—fixed pain and tenderness, with wheezing breathing, heard best by a stethoscope at the spot, being the chief symptoms.

(*c*) The *foreign substance may be loose in the trachea*—especially if it is a button, pebble, or other smooth body. The violent coughing and sense of suffocation caused by its entry soon subside ; but every now and then there are violent fits of coughing and spasmodic difficulty of breathing, during which the substance may be heard by means of the stethoscope, or perhaps may be felt by the finger to be forcibly impelled against the upper part of the larynx.

(*d*) If *a body lies free in a bronchus or one of its main divisions*, the entry of air to the corresponding lung will be prevented or impaired, the movements will be diminished, the note over the part remains resonant, vesicular breathing is feeble, absent, or concealed by sibilant breathing through the obstructed tube. The body may be coughed up against the larynx, and may on returning enter the opposite bronchus.

TREATMENT.—The symptoms may be so urgent as to necessitate the immediate opening of the windpipe ; but usually there is no such urgency. The patient may indeed present few or no symptoms. We know, however, that at any moment the foreign body may be displaced, coughed up into the larynx, and there become impacted, causing perhaps fatal spasm before relief can be afforded. On the other hand, if the body is firmly fixed and remains so, we know that this will almost certainly lead to ulceration and probably death. On both counts soft bodies, such as bits of apple or carrot, must be regarded as much less serious than hard angular ones ; nevertheless they are too serious to be left to the chance of spontaneous expulsion. The reason why this does not more commonly occur is that the entry of a body into the larynx at once excites spasm of the glottis. The main treatment of these cases is, therefore, opening the windpipe that a way out for the body may be provided. The advantage of this treatment appears from Durham's figures: of 271 cases *not* operated on, 156 recovered and 115 died; of 283 operated on, 213 recovered and 70 died—12 cases of inversion and 3 of direct extraction being included among the latter. Moreover, after tracheotomy the body escapes by the wound much more often than by the glottis.

Before opening the windpipe, however, an attempt may be made *to remove the body through the glottis* if it can be seen and the surgeon is skilled in endolaryngeal work; cocaine should be used to deaden sensation.

If this cannot be done, give *chloroform fully, invert the patient, shake and strike him on the back;* this is especially likely to succeed with a heavy body like a coin or button, but it must never be attempted unless everything is ready for immediately opening the windpipe should the body become impacted in the glottis.

Should no favorable result ensue the windpipe should be opened. In many cases the urgency of the symptoms or the size and weight of the foreign body—*e. g.*, a coin or a piece of tracheotomy tube—leave no doubt as to the propriety of this procedure; but in many others, especially when the body is a small bit of food-stuff movable in the trachea or bronchus, and the symptoms are not urgent, the justification of this measure rests upon statistics such as those above given; they show the chance of expulsion and of recovery to be very decidedly greater when the windpipe has been opened. The surgeon may, however, think it right to delay operation, especially in hospital, where it could be speedily performed in case of sudden dyspnœa. The patient should then be kept quietly in bed under the influence of bromide of soda to diminish the sensitiveness of the larynx. Instruments for immediate operation should be kept ready.

Choice of Operation.—When the body is loose in the windpipe, crico-tracheotomy, or high tracheotomy, is the best operation. Usually the body is expelled at once, or soon after the opening, coughing being always excited and air entering freely. If not, and it is in the larynx, it may perhaps be at once extracted through the wound; or inversion and succussion may now be tried without danger from spasm. The wound must be kept open by a dilator. If after two or three days the body is still lodged, the trachea should be explored.

When the body is impacted and its situation known, the opening should be made just below it if possible, that it may not be sucked in by the air first entering. Thus, if it be in the larynx, laryngotomy, or preferably crico-tracheotomy, should be done, the body felt for with a probe or seen after illumination of the larynx with a reflector or small electric light, and extracted with forceps. If this cannot be done thyrochondrotomy must be performed.

If the body be fixed in the lower part of the trachea or bronchi, the lowest site should be selected for the operation, so as to be as near as possible to the impacted foreign body. The body must then be sought for as above said, and an instrument suited to its nature selected for its extraction. A bit of wire variously bent is frequently most serviceable. Thus, in a case in which a tracheotomy tube broke from its shield and became impacted in the right bronchus, Mr. Hulke employed successfully a stout piece of copper wire slightly curved to the right and bent at the end into a narrow elongated hook, which passed through the tube and became fixed upon its lower edge (*Trans. Med.-Chir.*, 1871). Mr. Durham has invented an ingenious flexible forceps for the same purpose.

These endolaryngeal operations are very difficult. The introduction of instruments even under chloroform excites violent cough, but painting with cocaine will probably prevent this. If they fail there is nothing to be done except to maintain an opening for a week or two in the hope that the body may be expelled; then, if expulsion does not occur, the wound must be allowed to heal.

Scalds of the Glottis usually occur in young children who try to drink out of a kettle, and inhale the hot steam or actually get some hot water to the back of the throat. Corrosive fluids may act similarly.

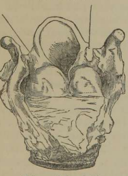
The *symptoms* of œdema glottidis—suffocative cough and extreme dyspnœa, chiefly inspiratory—come on more or less suddenly, though perhaps not for some hours.

Treatment.—Leeches, ice to the throat, free scarifications, opiates cautiously to tranquillize, and high tracheotomy, or laryngotomy in adults, if required.

Fractures of the Os Hyoides, Thyroid or Cricoid Cartilage are rare accidents, produced by blows or falls on, or squeezes of, the front of the throat. The *symptoms* are pain; displacement of the fragments; dysphagia from pain; early dyspnœa from displacement, spasm, blood, or later from œdema glottidis or emphysema; often loss of voice; hemorrhage from the mucous membrane, which may be lacerated: or emphysema. The *treatment* must depend on the urgency of the symptoms, which may be but slight; but the accident is usually serious, fifty of sixty-two cases dying; every case in which the cricoid was broken died (Durham). Attempts to reduce displacement may be made from the mouth, from a tracheotomy wound, or with a fine hook passed through the skin. Ice may be applied outwardly if hemorrhage is free or inflammation violent. The trachea must be opened at once for urgent dyspnœa from any cause, and a stomach-tube or enemata used if the patient cannot swallow.

Acute Laryngitis.—Causes: Cold and wet, wound, fracture of hyoid or larynx, steam, hot water, flame or hot air, irritant gases or chemicals, and the poisons of some acute specific diseases—especially scarlatina and diphtheria, less often measles, smallpox, erysipelas, and syphilis. It may arise also by extension from other parts—*e. g.*, the trachea or the fauces. As a result, the loose tissues about the upper opening of the glottis become red and swollen, perhaps to such an extent as to conceal the cords (œdema glottidis); mucus or mucopus is formed in moderate quantity, and in diphtheria the surface is covered with the characteristic membrane. The arytæno-epiglottid folds are always the parts most swollen, whilst the true cords suffer little, their mucosa being thin and closely adherent; hence they form a considerable barrier to spread of inflammation from the upper to the lower part of the larynx.

Fig. 203.



Œdema of the glottis.

The symptoms are: Some dryness or soreness about the fauces, rendering swallowing painful, and tendency to keep clearing the throat; some pain and tenderness about the thyroid; hoarseness or aphonia; painful cough, at first croupy then aphonic; breathing may be easy, but usually there is some dyspnœa and wheezing, especially in inspiration, and if œdema supervenes, or spasm, the dyspnœa may be extreme and cause sudden asphyxia, or insensibility and more gradual death.

The great and often sudden swelling of the folds about the entry to the larynx, spoken of as *œdema of the glottis* (Fig. 203), is usually of inflammatory origin; but it is much predisposed to by the presence of Bright's disease, or of cardiac insufficiency; it may, however, in these cases be only part of a general dropsy; and as a simple dropsy it may result from pressure on the cava superior.

TREATMENT.—Forbid talking. A moist atmosphere and an equable temperature of 60° to 65° should be obtained; the frequent inhalation of steam alone, or containing benzoin, creasote, or conium; mustard poultices to the throat, hot mustard baths to the feet, a purge, a dose of pulv. ipecac. co., and ordinary means to promote sweating. Should the dyspnœa become urgent, scarify the swollen parts, or at once do laryngotomy or high tracheotomy. For the treatment of diphtheria, see p. 552. An acutely inflamed throat in early syphilis requires the administration of mercury, and the use of a mercurial gargle or the application of calomel in vapor to the glottis.

CHRONIC LARYNGITIS may be a sequel of the acute form, or it may be chronic from the first, arising from cold or from over-use of the voice (aphonia clericorum), usually, in states of depressed health, from syphilis, tubercle, and leprosy. In each form the history is of great importance in diagnosis, and in syphilis, tubercle, and leprosy, corroborative evidence must be looked for. Usually *tubercular laryngitis* is distinctly secondary in time to ordinary phthisis. It begins insidiously and slowly, causes aphonia, frequent cough with mucous, purulent, or blood-stained expectoration, dyspnœa, and dysphagia. At first the arytæno-epiglottid folds form two large, pale, pear-shaped swellings, their stalks diverging toward the sides of the epiglottis; later, gray-based ulcers form and destroy not only the soft parts, but also the cartilages, portions of which are expectorated. Abscesses and sinuses form, and hemorrhage occurs from small, and sometimes from large, vessels. Swallowing may now be impossible from food passing into the larynx, and hectic supervenes. The disease is probably always fatal.

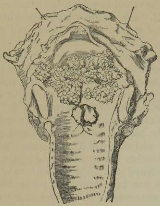
In secondary *syphilis*, injection, swelling, and mucous tubercles with superficial ulcers may appear; but in late syphilis, gummata form in the submucous tissue, break down and form deep ulcers. Here the epiglottis suffers first and is often destroyed. Necrosis and expectoration of cartilage are also common, and destruction is more rapid than in tubercle or in malignant disease. The palate and pharynx are often ulcerating simultaneously. When healing occurs, there is much scar-contraction, and often stenosis of the larynx.

TREATMENT.—Simple chronic laryngitis requires rest of the voice, the avoidance of exposure, and attention to the general health. Locally astringents—tannin, iron, nitrate of silver (grs. v ad ℥j)—must be frequently applied, and alum gargles should be used. Frequent or constant (by iodine) counter-irritation is beneficial.

For *tubercular laryngitis* one has only to treat symptoms by sedatives in vapor or fluid form locally, but also taken by mouth. *Syphilitic laryngitis*, in addition to ordinary antisyphilitic treatment, requires mercury locally as above advised. In either form laryngotomy may become suddenly necessary on account of œdema or the impaction of a piece of cartilage in the glottis. Bryant has proposed tracheotomy in severe cases simply to give rest to the parts. In tubercular disease the tube will probably be retained to the end, and in syphilitic it may be that stenosis consequent upon healing will necessitate its retention.

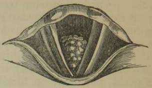
NEW GROWTHS.—By far the commonest is *papilloma*, consisting of multiple warty growths covered by scaly epithelium, and usually springing from the true cords or from the root of the epiglottis; considerable cauliflower masses result (Fig. 204) which often recur after removal. They may result from chronic catarrh, and commonly begin in children. A firm or soft sessile or pedunculated *fibroma* (Fig. 205) occurs commonly on the cords and parts above them; rarely on those below. *Mucous polypi* really belong to this class, but are infrequent. The *symptoms* are hoarseness and loss of voice, if the tumor be situate near the chordæ vocales; cough of a croupy, suffocative character; dyspnœa, gradually increasing with the growth of the tumor, coming in suffocative fits, at last fatal—the tumor, if within the trachea, being driven up between the chordæ vocales by expiration, or, if

FIG. 204.



Warts of the larynx, for which laryngotomy has been performed. Middlesex Hosp. Mus.

FIG. 205.



Laryngeal polypus, as seen with the laryngoscope.

attached to the epiglottis, drawn down by inspiration. The most distinctive symptom is a valvular flapping sound, heard or felt when the tumor moves during respiration. In more than one case the tumor, or a portion of it, has been torn off and coughed up, or has fallen into the trachea, the patient dying suffocated. Other simple tumors are very rare, *lipoma, myxoma, adenoma*, or *chondroma* starting from the cartilages. Small *mucous cysts* occasionally occur.

Sarcoma is rare and generally spindle-celled.

Epithelioma (squamous) is the cancer of the larynx; is not very uncommon, and affects men chiefly. It usually begins on or between the true and false chords. The mucous membrane appears thickened at a certain spot whence infiltration spreads. The surface may be papillary from the first; but it often ulcerates widely, destroys the cartilages, and invades the pharynx and the parts superficial to the larynx. The *symptoms* are: Hoarseness, rarely complete aphonia, pain, cough—ultimately with thin, bloody expectoration and foul breath—perhaps dysphagia and dyspnœa. Involvement of glands is always late, six to twelve months or later.

TREATMENT.—Simple growths should be dealt with by endolaryngeal methods—*i. e.*, by the introduction of forceps or other instruments, through the glottis if necessary, under guidance of the laryngoscope—the patient having been trained to manage his tongue and to tolerate instrumentation. It is possible also thus to apply nitrate of silver or some other astringent, or to incise a cyst. Special practice is, however, required. Repeated removal of recurrent papillomata may be necessary. Should the method fail or be inapplicable, and symptoms demand relief, the choice lies between thyrochondrotomy, for removal of the growth, and extirpation of the larynx. The latter, of course, would not be thought of, except in serious cases; and the results of the former are not so satisfactory as to justify recourse to it lightly; for papillomata not uncommonly recur after it, and aphonia may be permanent.

Operations on the Larynx and Trachea.

These are *laryngotomy, tracheotomy, thyro-chondrotomy,* and *extirpation of the larynx*—the two former being by far the most common. For all a good light should fall on the neck, the shoulders should be slightly raised, and the head allowed to fall back over a sandbag beneath the neck.

Laryngotomy.—Make, down to the cartilages, a one-inch incision, having the crico-thyroid membrane as its centre; and then, whilst retracting the edges, make a free transverse cut in this, which is felt as a soft depression between the cartilages, in the adult, about one inch below the pomum Adami (Fig. 211). Care must be taken not to operate in the thyro-hyoid space, and in opening the membrane the knife must be held short, like a pen. A laryngotomy tube, flattened from above down, is now inserted. This operation can be done literally in two cuts, but it is advised, in cases of great urgency, to use only one—to thrust a knife at once through skin and crico-thyroid membrane. This, perhaps, gives rather greater openness of the wound when the patient throws up his head from dyspnœa; but there is a greater tendency to aërial fistula. The danger of bleeding from the crico-thyroid arteries is very slight.

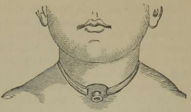
Tracheotomy may be performed above, through, or below the isthmus of the thyroid ; the last, or low operation, is necessary only for foreign bodies impacted in, or pressure low down upon, the trachea, and as a prophylactic measure in laryngectomy; but a high tracheotomy may require extension downward in diphtheria (p. 553).

This operation is always an anxious one when done for dyspnœa, and in children : the need for haste, the vascularity and congestion of the parts, the up and down movements of the trachea, and frequently the shortness of the neck and depth and small size of the trachea, often render even the high operation extremely difficult—much more so the low.

At least two trustworthy assistants should be present. One, whose duties are most important, stands above the patient, a double blunt hook in each hand ; he retracts the tissues as the operator divides them, and by making equal traction upon either side, keeps the cleft in which the surgeon cuts exactly in the mid-line. His own guides to this are : The chin of the patient, kept vertical by a hand and forearm on either side of the head, and the suprasternal notch. The other stands opposite the operator, sponges with his left hand, whilst with his right he quickly clamps any vessel that may be cut or in the way. The chloroformist stands above the operator.

High Tracheotomy : Crico-tracheotomy.—The skin being steadied and stretched by a finger and thumb on either side of the trachea, make a free one and a half to two inch incision in the mid-line, downward, from the cricoid cartilage, avoiding, if possible, any visible vein. The skin and fat are retracted, and the interval between the sterno-hyoids is then usually seen in the mid-line; the deep fascia is opened here throughout the wound, and the muscles retracted ; the red, rounded thyroid isthmus now appears below; pick up the fascia which binds it to the trachea a little below the cricoid, and divide it transversely and freely. When the upper ring of the trachea is bare, put the handle of the scalpel into the wound, push down the isthmus till two or three rings are clear, and let the second assistant take it with a hook ; next, with the left hand, fix a sharp hook from below up into the trachea a little to the right of the mid-line ; now hold the knife like a pen, three-quarters of an inch from its point, and resting the fourth and fifth fingers on the neck, divide from below up two or three upper rings, of which the cricoid may form one if convenient. Usually the outer part of a bivalve canula is now taken, and, its limbs being squeezed together, passed into the trachea through the slit, opened by traction on the sharp hook; the inner tube is introduced within the bivalve, the sharp hook removed, and the canula tied in with tape passing round the neck (Fig. 206). When a canula

FIG. 206.



Tube tied in.

other than the bivalve is to be used, it is well to cut out a small ring from the front of the trachea, before making the slit in it, to facilitate introduction; this, or a long incision, is absolutely necessary with the larger tubes. Immediately the trachea is opened air is heard entering, coughing occurs, and tracheal contents—blood, mucus, membrane, or foreign body—are often expelled in spite of the very general immediate insertion of a tube as above described. To permit this desirable expulsion it is much better to hold the tracheal slit widely open for several minutes with hooks or a dilator; and in diphtheria (p. 553), membrane should be carefully searched for and extracted thoroughly with forceps, brush, or feather, before any tube is introduced.

TRACHEOTOMY THROUGH THE ISTHMUS.—If there is any difficulty in drawing down the isthmus of the thyroid, divide it in the mid-line, between two pairs of artery forceps clamped on to it. It is said sometimes to give rise to troublesome hemorrhage, but this does not seem common; after the above section the cut ends might be tied easily.

LOW TRACHEOTOMY.—The incision must be a free one, proportioned to the depth of the trachea; in children it must begin not far below the cricoid, and end in the suprasternal fossa. Below, a transverse branch between the two ant. jugular veins will perhaps be divided. The skin and fat being retracted, a narrow muscular interval between the sterno-hyoids is seen in the mid-line and opened; these muscles diverge below, and when they are separated the sterno-thyroids are seen, close together below, but soon diverging; the fascia between these is picked up, notched, and slit up. The front of the trachea, crossed above by the thyroid isthmus, is now exposed, and descending upon it are the large inferior thyroid veins, freely communicating with each other; these must be separated, any requiring division being clamped first. The trachea is then opened as above directed.

Difficulties.—The thyroid veins form a chief difficulty in this operation, when they are much congested, so that every little branch bleeds; it is wise not to spend time trying to secure small twigs, but open the trachea as soon as possible, and introduce the canula; bleeding will probably cease as the asphyxial state is relieved. The tube and trachea may fill with blood; if it is certain that diphtheria is not present, no better means than sucking can be found to empty them: but it does not seem right to run the really great risk of diphtheria when the chance of saving life is so poor. W. R. Parker's trachea-aspirator should be kept at hand by everyone likely to do tracheotomy. Other difficulties in low tracheotomy arise from the occasional presence on the front of the trachea of a considerable artery, the thyroidea ima, usually from the innominate; from the crossing of the trachea *above the sternum* by the innominate artery, a right carotid springing from the aorta, or the left innominate vein; and lastly from the meeting of the thymus and thyroid bodies.

If a child does not breathe after introduction of the tube, it may be that artificial respiration is necessary, or that the tube is not in the windpipe, or it has pushed a flap of membrane before it, perhaps into the bronchi, or the tube is full of membrane or blood.

In all these operations it is essential to keep to the mid-line; in the absence of a good assistant, the forefinger, feeling the trachea, must act as guide. It is said that the carotid has been wounded.

Other difficulties and dangers will arise if the trachea be not fixed with a sharp hook and opened with a knife guarded by the finger, and if the tube be not introduced as described.

Other modes of operating.—Dr. Edwards fixes the trachea by a sharp hook, grooved along its back like a director, inserted in the mid-line below the cricoid; a scalpel is run along the groove into the trachea, and if the thyroid isthmus or any vessel is in the way of a cut downwards, a probe-pointed bistoury is entered at the puncture, steadied against the end of the groove, and made to divide the rings from within, in subcutaneous fashion. The soft parts are then dilated to admit the tube.

Trocars have been invented for the performance of tracheotomy; certainly they should never be used on the soft and yielding trachea of children, but they might be for laryngotomy in the adult. They would, however, add little to the speed with which the operation can be performed.

When a very hasty, unpremeditated tracheotomy is called for in a child, the high operation should be done. The best position possible should be hastily obtained, the head being well thrown back. With the fingers of the left hand the surgeon should steady the larynx, stretch the skin over the crico-tracheal region, and maintain this action whilst he rapidly cuts down upon the trachea, opens it, and puts the handle of the scalpel, or some equivalent, crosswise into the trachea until other means of keeping the wound open are found.

When suffering simply from lack of assistants, a spring eye-speculum, or Parker's automatic retractor, may replace the first assistant, and by spending more time, the surgeon can himself perform the duties of the second.

Varieties and choice of a tube.—The tube selected should as nearly as possible fill the air-tube; air should pass through it without whistling (Trousseau). For laryngotomy an oval tube, wide from side to side, and curved on the flat; for tracheotomy, a round one.

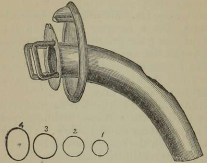
The ordinary form is Fuller's bivalve (Fig. 207), the bivalve outer part rendering introduction very easy. But *unless the slit in the trachea is seen and opened*, as above directed, the pointed bivalve is apt to be pushed into

FIG. 207.

Bivalve tracheotomy tube.

the loose tissue in front of the trachea. Another form consists of one tube sliding easily within another and kept in place by a small button on the collar (Fig. 208). This is more difficult to introduce than the bivalve. In both these forms the inner tube projects one-eighth of an inch beyond the outer (Obré), so that any dry mucus upon its end and inner surface, blocking the aperture, may be removed by withdrawing it, soaking it in boiling water containing carbonate of soda, and cleansing it with a pipe-brush. It is well to have an aperture on the convex side of the tubes, that the patient may be able to test his ability to breathe through the glottis and to speak, by closing the outer opening with a finger. To allow of this, only one wire ring should be attached to the collar of the tube upon the left side, an arrangement which renders the removal of expectorated substances much more easy than do the plans shown in Figs. 207 and 208. The surgeon should have three or four sizes. Fig. 208 shows the exact size of No. 4.

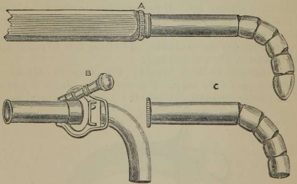
FIG. 208.



Double tracheotomy tube, No. 4. The smaller sizes (1–4) are shown in section.

The chief objection to both the above tubes is that they are curved so as to form about one-fourth of a circle. Now, as the trachea in descending recedes rapidly from the surface, this curve causes the lower end of the tube to press against the anterior wall of the trachea, and its convexity often presses against the posterior wall. From this irritation results, and ulceration may

FIG. 209.



Durham's canula. A, conductor; B, outer tube with movable shield; C, inner tube.

open some tracheal vessel, the innominate artery or vein, or the œsophagus (John Wood, *Path. Soc. Trans.*, vol. xi.). This fault is to some extent remedied by Roger's movable collar, which permits the tube to rise somewhat and to move with the trachea. But it is obviated completely only by the angular form adopted by W. R. Parker in his canulæ, the angle being that which the trachea forms with a transverse horizontal plane, and the shield being jointed to the tube; or by Durham's "lobster-tail" canula (Fig. 209). In this the outer tube B is unsplit, long, and straight till near its deep end, when it suddenly curves down for a less distance than shown in the drawing; upon the straight part moves a collar, which can be tightened upon the tube at any point by a screw, and this is articulated to a movable collar; thus the tube can be accurately adapted to either a deep or a superficial trachea. To facilitate its introduction, the handled conductor, A, is used, the pointed extremity of the latter projecting through the end of the tube. The inner tube, C, like the conductor, is "lobster-tailed;" it can thus pass easily along both the straight and curved portions of the outer tube, and its deep end projects beyond that of the latter. These "lobster-tail" tubes must be well made, or the joints will become loose and fall into the trachea; again, the joints may be so thick and clumsy as greatly to diminish the calibre.

All danger of ulceration is avoided by the use of Morrant Baker's red-rubber tubes, which may, in case of difficulty, be introduced upon a Durham handle. They do not give the same lumen in proportion to their size as silver tubes, are difficult of introduction through, and liable to compression by, a slit-like aperture; and being, moreover, single, they are not used until the early free expectoration is over and a distinct track has been formed. Changing this tube excites very little irritation; but it is liable to become fragile and break off after being worn for a while, and under violent inspiratory efforts the shield-piece may yield and permit the tube to be drawn into the trachea. A suspicious tube should never be worn. Even silver tubes may become detached from the shield and fall into the trachea.

Any one getting tracheotomy tubes would be well provided with a set of Parker's or Durham's; soft ones can be got at short notice. For the single case of tracheotomy for compression of the trachea by a retrosternal goitre, König's four-inch flexible tube is essential.

There are some important objections to all tubes in certain cases. When a foreign body is not at once coughed up, its chance of escape through a tube, hanging free (as it should do) in the lumen of the trachea, is not nearly so good as it would be through the wound held open: and the same remark applies to diphtheritic membrane. In the case of diphtheria especially—and it is in this disease that the great majority of tracheotomies are done—no examination for a membrane can be made without withdrawing both inner and outer tubes, the reintroduction being often difficult; and the removal of the inner for cleaning may be frequently necessary, and cause a good deal of irritation. Yet it is not altogether easy to dispense with tubes; for a short time hooks held by hand may be employed; hooks fastened by elastic behind the neck are very easily displaced from the trachea; in an emergency, a stitch may be passed through the trachea on each side of the slit, and fastened together behind, or, better, a circle may be cut out of the trachea, and the soft parts be held back by stitches (Dr. S. Phillips). Lastly, some kind of dilator may be used, made upon the principle of Fränckel's nasal speculum or of an eye speculum—Golding-Bird's (*Lancet*, 1881, vol. i. p. 407) is as good as any. He claims as its advantages that one instrument does for patients of all sizes; once fixed, it need never be touched even for days; it gets embedded in granulations, and holds even more firmly; in only one case has he known it cause even a superficial ulcer on the mucosa; it gives foreign bodies, blood, membrane, and mucus the best possible chance of escape; it cannot, like a tube, get blocked or closed by a flap of membrane, and patients can therefore be left with more confidence to a nurse's care; opportunity to examine the trachea, and to remove membrane or other foreign body, is provided without the removal of anything. Among eight cases, Golding-Bird reports no slipping or other mishap, and the points claimed in favor of the dilator are certainly very great desiderata.

To introduce a double tube, stand facing the patient; hold the outer tube by both ends of the shield, so that the lower edge of the latter touches the neck, whilst the end is in the wound; the end must now be pushed in by a movement of rotation, the shield being raised into position over the wound. To withdraw a tube, the rotation movement must be reversed.

In cases in which there is nothing to be expelled from the trachea there is no objection to introducing a tube at once; and a tube is always used when an aperture has to be permanently maintained. In the latter cases a Jeffrey's respirator should always be worn over the tube.

When to withdraw a tube or dilator.—It will be advisable to keep the wound open for twenty-four hours, even when a foreign body has escaped at once, if it has excited much irritation, lest some inflammatory swelling of the glottis ensue. After tracheotomy, to prevent blood entering the trachea during an operation, or to obviate suffocation from blood, tumor, or other substances blocking the glottis, the tube may, as a rule, be withdrawn as soon as the difficulty is overcome.

In cases of acute œdema and laryngitis, especially membranous, it is much more difficult to decide when the tube may be removed. All expectoration of membrane must have ceased, and the discharge should be only thin mucus in moderate quantity—not muco-pus. When the tube has an opening on its convexity, the outer opening may be stopped lightly by a finger to see whether the patient can phonate, or breathe comfortably through the glottis; but it is more satisfactory to try this experiment after removal of the tube.

In cases of ulceration and new growth, cure of the former without stenosis, or removal of the latter, must precede closure of the aperture.

For the *after-treatment* in all cases, see p. 553.

Healing of the wound is usually rapid, the cartilages being united by fibrous tissue. If a mistake has been made in leaving out a tube, reintroduction may become difficult within twenty-four hours; a catheter should first be passed into the trachea to clear the way. Rarely a *fistula* remains, and must be closed by a flap. Also rarely a pedunculated granulation-tumor develops from the margin of the tracheal wound, or from a pressure sore, and when the tube is removed it acts like a valve, and necessitates replacement of the tube; its removal may necessitate a preliminary low tracheotomy.

COMPLICATIONS AFTER TRACHEOTOMY.—The most common are bronchitis, broncho-pneumonia, pneumonia, and pleurisy—the commonest causes of death after these operations. In diphtheria, membrane may extend to the finer tubes and cause suffocation, tracheotomy having simply prolonged the agony.

Connected with the wound, the chief complications are *diffuse cellulitis* —sometimes extending from the neck along the trachea into the mediastinum—and *diphtheria of the wound;* the former is extremely serious, the latter does not seem to increase the danger. In both cases antiseptics must be freely used, and cellulitis will require fomentations with a hole for the tube, and the usual treatment. *Secondary hemorrhage* from the wound, or from an ulcer in the trachea, may occur; also perforation of the œsophagus (p. 570). The vessel must be secured in the first case, and the two latter accidents should be prevented by the use of proper tubes.

Indications for Laryngotomy or Tracheotomy.—It is obvious that laryngotomy is by far the easier and more quickly performed operation; but it is only after development of the larynx at puberty that the cricothyroid space affords sufficient room for the introduction of a tube. In the absence of any special indication to operate lower (p. 567), laryngotomy is the operation in the adult to combat or prevent dyspnœa from obstruction of the glottis. In children its place is taken by high tracheotomy or crico-tracheotomy, the low operation being done only for some special reason.

The windpipe may be opened (1) *prophylactically* to prevent blood entering it during an operation, and foul fluids, etc., later; or in anticipation of spasm, of impaction of a body in the rima, or of spread of membrane down the trachea; (2) for the *extraction of a foreign body*, including blood, membrane, etc.; (3) for *spasm of the glottis*, from foreign body in the larynx or gullet, or due to pressure on the recurrent laryngeal by aortic aneurism or other tumor, or coming on in the course of inflammatory disease, perhaps induced by any attempt to swallow, and preventing feeding; (4) for inspiratory dyspnœa due to *laryngeal paralysis;* (5) for *œdema glottidis*, due to Bright's regurgitant heart disease, or pressure on the great veins of the neck; (6) for *inflammatory œdema* acute or chronic; (7) for *diphtheria* and obstruction by membrane as well as œdema; (8) to give rest to a *tubercular* or *syphilitic*, ulcerated *larynx* (Bryant); (9) for *laryngeal or tracheal stenosis* consequent upon the healing of syphilitic, rarely of diphtheritic, ulcers; (10) for *compression of the trachea*, especially by goitre; (11) for *dyspnœa due to new growths* of or overhanging the larynx.

Thyrochondrotomy.—A preliminary tracheotomy should be done, if possible a week or more previous to the operation, that the patient may be used to breathing through a tube. A tampon-tube being inserted, make an incision from above the pomum Adami down to the cricoid; make a small transverse cut into the larynx just below the thyroid in the mid-line, and pass a probe-pointed bistoury, one blade of strong scissors, or a fine saw in the adult or aged person, between the cords, and divide the cartilage accurately in the mid-line. The halves may now be separated sufficiently to remove a foreign body; but for the excision of *new growths* it may be necessary to detach the thyrohyoid and cricothyroid membranes from more or less of the borders of the cartilage. The halves of the cartilage must be most accurately sutured, as also the superficial parts, the tracheotomy-tube being worn till healing is assured. This operation should not be undertaken till endolaryngeal methods have failed. Of 48 cases, 8.3 per cent. died, 31.2 per cent. had to wear a tube permanently for persistent dyspnœa, 14.5 per cent. recovered fully (Mackenzie).

Extirpation of the Larynx.—After a preliminary low tracheotomy and the insertion of a tampon-tube, make a mesial cut from the hyoid to the trachea, and at either end of this a cross cut to the sternomastoid; raise the skin-flaps; separate the muscles from the oblique lines of the thyroid; free the cricoid from the trachea, and plug the latter with a large tampon-tube, through which chloroform is to be given; fix a sharp hook in the cricoid, and drag it strongly forward separating the gullet from its posterior surface. The thyroid must next be dealt with, and it is necessary to keep the knife as close as possible to its posterior borders and thus to shell it out from the lateral masses of the thyroid body—dividing the muscles and sparing the superior thyroid arteries. If the surrounding parts are at all infiltrated, the healthy parts must be separated from the sides of the larynx as a first step. The upper section must depend on the extent of the growth, the epiglottis and part of the pharynx being excised, if necessary. The carotid may be bared on either side, by raising the sterno-mastoid, and suspicious or affected glands removed. Hahn, Schede, and others have lately recommended doing thyrochondrotomy first, in early cases, with a view to removing only half the cartilage—which hardly seems a step in the right direction, though epithelioma of the larynx rarely generalizes (1 in 37, Fauvel) and affects the glands only late. If healing occur, a small hole remains in the pharynx through which an artificial larynx must be fitted. The patient can then swallow food and drink after practice, the artificial glottis being covered by the tongue as heretofore.

The operation has been done twice successfully for recurrent papillomata; five times for sarcoma—twice with great success, 1 death from phthisis, and 2 from recurrence. Of 60 cancers, 15 recovered, 42 died, 3 ?. Of the 42 cases, 15 died of pneumonia and broncho-pneumonia, 12 of recurrence, 9 of collapse and exhaustion. The difficulties in the after-treatment are not yet overcome, and many of the cases were too advanced for operation.

HANGING destroys life: (1) Most usually, a drop being given, by dislocating the neck; (2) by compressing the trachea and suspending respiration: (3) much less commonly by compressing the jugular veins, and inducing apoplexy.

TREATMENT.—Artificial respiration, bleeding from the jugular vein if the face be turgid, dashing cold water on the face and chest, and a current of galvanism passed from the nape of the neck to the pit of the stomach, so as to excite the diaphragm.

TREATMENT OF DROWNING.—Turn the body on the face and let the head and chest hang down for a *few seconds* that water may run from the nose, mouth, and lungs; then turn the body on the back with the head and shoulders raised, wipe out the mouth and throat, draw forward the tongue, and turn the face well to one side that the tongue may not fall back; hastily strip off wet coat and vest, and set artificial respiration going (Silvester's, *q. v.*) at once. Meanwhile let others tear off and remove all other wet garments; dry the body by friction with warm towels, wrap it in warm blankets, and apply hot bricks or bottles, or warm clothing from bystanders; give an enema of brandy or inject ether. Warm drinks may be given as soon as the patient can swallow. Minor means of exciting respiration are alternate affusion of hot and cold water on the chest, and tickling the nose and fauces to induce sneezing, coughing, or vomiting.

A case is related in which the most persevering friction was kept up for eight hours before the humanity of the surgeon, Dr. Douglass of Havre, was rewarded by a return of respiration (*Med. Gaz.*, December 23, 1846).

SURGICAL AFFECTIONS OF THE EXTERNAL PARTS OF THE NECK AND THROAT.

WOUNDS OF THE THROAT are generally suicidal, and may be incised, punctured, or gunshot; each variety may be accidental or homicidal. Suicidal wounds are the most common in civil practice, and are usually incised, transverse, and made from left to right, unless the subject is left-handed. They vary from mere scratches to complete section of all the parts on the front of the spine, the vertebræ being notched. When other than superficial, they are extremely dangerous, both from the importance of the parts affected, and from the despondency of the patient—the latter condition being often accompanied by a tendency to diffuse inflammation and sloughing, especially in the aged.

WOUNDS NOT OPENING THE AIR- OR FOOD-PASSAGES.—Unless punctured or gunshot, these wounds rarely involve the important structures on either side of the larynx; they often score the thyroid cartilage deeply. The chief dangers are *hemorrhage* from superficial veins, *entry of air*, and, later, *diffuse cellulitis;* rarely *œdema glottidis* suddenly supervenes. All vessels must be secured, both ends of veins being dealt with, and their cardiac ends should be compressed at once, lest a deep inspiration causes air to enter. Careful asepsis, drainage, and suture should then be practised, gentle and uniform compression with an elastic bandage applied over the dressing. *In all wounds of the throat* the patient is most comfortable with the shoulders well raised; and the head must be kept strongly flexed by bandages passing from each side of a close-fitting cap to a band round the waist.

Wounds of the great vessels must be treated as usual—by ligature at the spot—if the case is seen in time for any treatment, as is not uncommon in punctured and lacerated wounds. A few cases are recorded of non-penetrating wound of the carotid; ligature above and below should be practised. Any large wound of the jugular must be similarly dealt with, but the vein-wall round a mere puncture may be picked up and tied. During these manipulations, bleeding must be restrained by digital pressure or by clamp-forceps.

We have it on the authority of Billroth that section of the vagus in man may have no immediate effect upon the pulse or respiration; it almost always proves fatal, however, within a day or two from pneumonia, as also does section of the phrenic.

Wounds involving the Air- and Food-passages.—Of 158 suicidal wounds (Durham, *Holmes's System*, vol. ii.), 11 were above the hyoid, 45 through the thyrohyoid membrane, 35 through the thyroid cartilage, 26 through the cricothyroid membrane or cricoid cartilage, and 41 through the trachea.

A wound *above the hyoid* causes severe hemorrhage from the linguals and facials; the base of the divided tongue may fall back on the glottis, and power of swallowing is lost; 9 of 11 cases died. When the knife passes *through the thyrohyoid space*, it may cut off the tops of the epiglottis or arytænoids, and these may fall over the glottis; there may be sharp bleeding from the superior laryngeal vessels, and the internal laryngeal nerve may be cut. The *thyroid cartilage* generally protects all large vessels, but they are easily reached through the *cricothyroid* or *cricotracheal space.* Hemorrhage is free when *the trachea is wounded* from the many veins about it, from the thyroid or from the great vessels; the recurrent laryngeal nerves may suffer. The *œsophagus* may be wounded or divided, in which case much displacement of the ends of the trachea may take place, and soft parts may fall across and obstruct the lower; the great vessels are almost always injured when the trachea is divided.

Treatment.—In the first place *hemorrhage* and the danger of *entry of air* must be met as above directed; unless *asphyxia* be urgent and hemorrhage less so, when the former will take precedence in the matter of treatment. It may be due to dropping back of the base of the tongue; draw it forward and suture it to the anterior part. Seek for and remove any part of the epiglottis, or other cartilage, impacted in the *rima.* If blood is filling the windpipe suck it out with the mouth and a large catheter. If there is general oozing and blood keeps entering the windpipe, introduce a large tube into it, and plug the wound around for a short time. Bleeding being checked, the wound must be treated, remembering (1) that the wound cannot be kept aseptic, and is therefore likely to *inflame and slough;* (2) that if the soft parts prevent the free escape of air it will pass into the subcutaneous tissue and cause more or less extensive *emphysema*—a complication which is usually not dangerous, even though extensive, but which may become so by entering the mediastinum or the submucous tissue of the larynx; (3) that in any of these wounds near the glottis *sudden œdema* may close the latter. To meet these points some recommend tracheotomy below and accurate suture of the wound in the trachea and soft parts; but the great probability is that they would not heal *per primam*. The more usual practice is, therefore, to close and drain lateral parts of wounds, but to leave the central portions open that air may pass in and out freely; in all cases the head is kept flexed. Should œdema glottidis come on, introduce a large tube through the wound, slitting the trachea upward and downward if necessary. This may be done from the first in patients living at a distance from help. When *the trachea is divided* a few stitches must be put in to prevent wide separation and displacement; Hüter recommends continuous suture of the mucosa. When *the œsophagus is wounded* sew it up carefully with catgut, the mucosa first and then the muscle.

Treat the wound with chloride of zinc and with iodoform to prevent as far as possible the dangers of sepsis—*e. g.*, cellulitis, perhaps extending to the mediastinum, and septic broncho-pneumonia—the commonest cause of death in these cases. Warm and moisten the air as directed after tracheotomy (p. 553) to prevent bronchitis, pneumonia, etc.; and lastly, feed the patient with the most nutritious diet and a judicious amount of stimulant from the first. Where there is difficulty in swallowing, a small stomach-tube must be passed gently; enemata may also be used. This difficulty may arise from wound of the tongue and section of the elevators of the larynx, removal of the epiglottis, loss of sensation or motor paralysis of the glottis, and wound of the pharynx or gullet.

As these wounds heal, excessive granulation may occur, cause dyspnœa, and perhaps stenosis: nitrate of silver, or removal, are the remedies.

Affections of the Thyroid Body.

This body is but rarely diseased if we except the group of enlargements classed together as *goitres*. It may be congenitally absent as a whole—usually in acephalous monsters, rarely in idiots—or in part; congenitally large, as a whole or in part; the isthmus may be very deep, and from it a middle horn may ascend to the hyoid, or it may cross between the gullet and trachea; the whole gland may be placed too high, as it often is in cretins (*submaxillary goitre*), or a process may lie between the trachea and sternum (*substernal goitre*); lastly, accessory thyroids are rarely found in its neighborhood, perhaps enlarged (Pollard, *Trans. Path. Soc.*, 1886). A very large majority of cretins are goitrous, and it is probable that in all the thyroid is so diseased as to be functionally inactive.

Hyperæmia is frequent, and often causes swelling of the gland in the female during menstruation and pregnancy, sometimes apparently leading to hypertrophy. One form of goitre (*exophthalmic*) is characterized by great enlargement of the vessels of the gland.

Inflammation is very rare; it may end in resolution, fibroid overgrowth, or abscess. Abscess is often large and circumscribed, with cheesy contents which may calcify; but it sometimes extends, and bursts into a neighboring canal or cavity, or through the skin. The whole gland may necrose as a result of septic inflammation in pyæmia, typhoid, etc.

Goitre or *Derbyshire Neck* is an enlargement of the thyroid gland, of which there are two chief varieties—the *common* and the *exophthalmic*.

(1) Common Goitre is in the great majority of cases due to the action of endemic causes, and is often called "endemic goitre;" but sporadic cases also occur. Its *causes* are still obscure, in spite of much research. It is much commoner in women than in men; may be congenital, but then rarely

enlarges much before puberty; it appears with special frequency just before puberty, and rarely if ever begins after mid-life. After fifty, common goitre ceases to grow, but it may be the starting-point of malignant disease. Its homes are widely scattered over the world, and are usually situate in hilly districts; but it is the inhabitants of the sunless valleys here that chiefly suffer. It is common in Derbyshire, Nottinghamshire, Yorkshire, Hampshire, and Sussex; and much more so in the Alps, Savoy, Black Forest, Punjâb, Himalayas, and many other places. Many of these places are upon magnesian limestone, and the water is extremely hard; but equally hard water is drunk with impunity in non-goitrous districts, and goitre is not co-extensive with mountain limestone. Other peculiarities in water—the absence of iodine, the presence of various metals, even iron—have been blamed. Klebs, of course, suspected an organism, and found and cultivated from the water in Styria a navicula, which gave goitre to dogs who drank it or into whose necks it was injected; there has been no confirmation of the observation. Strangers coming into goitrous districts are liable to the disease; improvement follows removal from the district; and though many of the children of goitrous parents become goitrous, this is so only so long as they remain in goitrous districts. The children of goitrous parents are also liable to be cretinous.

Morbid Anatomy.—1. *Simple hypertrophy* is often spoken of, but exact microscopy shows that it is uncommon to find a goitre quite of the structure of normal thyroid. Usually the original vesicles give rise to budding tubes of epithelial cells which do not all develop into vesicles, and thus we get an atypical epithelial growth, the position of which in an anatomical classification might take it far from its clinical allies. Wölfler calls such cases "adenoma." 2. *Colloid hypertrophy.* The vesicles in a goitre of the above structure may become distended with colloid material, forming small cysts. Parts of a goitre may undergo the colloid change, swell, and render the mass very irregular. 3. *Cystic goitre* is due to the blending of several small cysts at one or more places in a goitre; the contents become more fluid, some

Fig. 210.

Section of a calcified goitre. (Middlesex Hospital Museum.)

Fig. 211.

Enlarged thyroid gland. (King's College Museum.) The œsophagus is pushed to the right side by the tumor.

hemorrhage often occurs into the cyst, and sometimes papillary growths project into it. But a cyst may form in an otherwise healthy thyroid. 4.

In *fibrous goitre* the stroma is greatly thickened. 5. Much of the stroma may *calcify* (Fig. 210), especially in the neighborhood of old cysts, and here even *plates of bone* may be found. 6. Distinct *circumscribed tumors* form, often in or near the isthmus; they may be cystic.

This is the best place to note that Cohnheim, H. Morris, W. Haward, and a few others, have recorded cases of apparently simple goitre in the adult, in which secondary growths, having the structure of normal thyroid, appeared elsewhere, chiefly in the bones. How to explain this malignancy is a difficult question (*Path. Soc. Trans.*, vol. xxxi. p. 259, and vol. xxxiii. p. 291).

SYMPTOMS.—A swelling, having the situation, and often the form, of the whole or part of the thyroid body—in the latter case affecting the lateral masses, and especially the right, much more often than the isthmus. Even when the whole gland is involved, the swelling may be of very unusual shape and bossy (Fig. 211). It is rarely tender, and the skin over it is not discolored. Increase of fibrous tissue and calcification render the thyroid very firm, or of stony hardness; other forms are moderately soft and may seem to fluctuate; cysts usually project and fluctuate, but they may be deep, or even burst into the trachea or gullet. A point of chief importance is that thyroid swellings, unless very large, rise and fall with the trachea in swallowing. Usually such swellings are smaller than a cocoanut, but they may be so large as to reach the thighs. Beyond their weight and inconvenience, these very large growths do not give rise to serious symptoms, viz., dyspnœa and dysphagia, whereas small ones frequently do so, an enlarged nodule occupying some point of vantage—*e. g.*, the isthmus passing between the trachea and gullet, the lateral lobes growing in between these parts, or a nodule lying behind the sternum. Naturally dyspnœa is much more common than dysphagia; at first it appears only on exertion, and is due to side-to-side or antero-posterior compression of the trachea; the cartilages may disappear under pressure, and the lumen be almost obliterated. The more rapid the growth, the more severe the symptoms; dyspnœa in its turn causes asphyxial congestion and greater swelling of the gland. Both air- and food-passage may be displaced to one or other side; rarely one goes without the other (Fig. 211).

At any time an attack of hyperæmia may come on, causing rapid increase in the size of the swelling and of the dyspnœa. A goitre is more liable than healthy thyroid to acute inflammation running on to abscess and sloughing (Kocher).

TREATMENT.—Removal from any place where goitre is endemic to the seaside or some high mountain-climate where pure, soft water is to be had, is most important. All drinking water should be boiled and filtered. "Burnt sponge," in powder or lozenge, has acquired a reputation in the treatment of goitre, and its success has been attributed to the iodine which it contains. Consequently liq. iodi, and more often iodide of potash, have been given in large doses; whilst the skin over the mass is painted with tinct. iodi, or rubbed with the ointment. This treatment very often fails. *Injection of tinct. iodi* (♏xv ad ʒj, twice a week) is next to be tried, a Pravaz syringe with platinum needle being used. Stick the needle *well into the substance* of the mass, and *see if any blood escapes* through it; if it does, alter the position of the point, as it is probably in a vein; then make the injection, withdraw the needle, and rub the skin about the puncture between the finger and thumb to prevent escape of iodine. A cure may require many months. Sudden death has occurred from this treatment, and is usually attributed to entry of air into a vein, but the quantity would be too small; Horsley suggests that it is due to cardiac thrombosis, which he caused by injecting 15 c. c.—a large amount—into the ext. jugular of a dog. This injection is said to be useless in fibroid and colloid cases (Wölfler). The natural variations in size of some goitres, as also the fact that some disappear entirely, especially those markedly connected with menstruation or pregnancy, must be remembered in estimating the value of treatment.

The presence of a cyst is always favorable, as treatment of it is likely to prove successful. Draw off the fluid with a trocar and canula—pure blood will often flow at the end—and at once fill the cavity with liq. ferri perchlor. ʒij, aq. ad ℥j. Plug the canula and leave it in. On the third or fourth day, when suppuration is established, replace the canula by a drainage tube. An alarming rise of temperature usually follows this treatment, but it subsides as pus forms. Drainage must be continued as the cyst shrinks: it takes one to six months. *Incision* often leads to bleeding, which it is very hard to stop.

In cases of *rapid enlargement of goitres*, with urgent dyspnœa, one may, if there is time, try such remedies as purgatives; hot foot, or general, baths; aconite to depress the pulse; tartar emetic in nauseating doses, or bleeding from the jugular. In cases of great urgency, high tracheotomy and the passage of König's canula past the obstruction is the best treatment. Multiple punctures of the goitre, which may bleed excessively, and incision of the capsule, are also recommended. If there is more time, curative measures—division of the isthmus, or removal of part of the gland, may be undertaken at once.

In *cases of steadily increasing dyspnœa* from compression of the trachea, not checked by the above methods, the first remedy to try is *division of the isthmus*. This is accomplished between two silk ligatures, and "is invariably followed by shrinking of the goitre" (S. Jones). If the goitre is *substernal*, or success should not follow division of the isthmus, high tracheotomy and the insertion of König's four to five inch canula, or tracheotomy through the isthmus, may be best. Usually, removal of *part of the gland, or of a circumscribed tumor*, is preferable. Many operations for the removal of the whole thyroid have been done; but recent researches have shown that the functions of this body are most important to the economy, and that its *complete* removal leads to death of the patient from myxœdema (Horsley, Brown Lecture, *Brit. Med. Journ.*, Jan. 17 and 31, 1885). It is doubtful, therefore, whether it is justifiable even in early malignant disease. The method of removing the whole gland is followed in the extirpation of any part. A long median incision generally suffices; and the infrahyoid muscles can be sufficiently retracted to expose the mass; its capsule being bare superficially, the isthmus is to be divided between ligatures, or by the cautery, and the half to be removed is carefully raised, the finger or some blunt instrument being used, until the upper or lower angles where the arteries enter are reached; a silk ligature is tied round these points, being passed with an aneurism needle, and the piece is then removed. In the last step every care must be taken to avoid including the recurrent laryngeal in the groove between the trachea and gullet, or injuring the great vessels, especially the jugular, to which the thyroid may be adherent. Every bit of connective tissue about the gland should be torn with two forceps rather than cut, and obvious veins should be double ligatured or clamped before division. The operation is difficult, and the dangers of septicæmia and mediastinitis, in the absence of antiseptics, great. If some of the gland is left it hypertrophies, and myxœdema does not ensue.

Circumscribed tumors usually shell out without much difficulty or bleeding.

2. EXOPHTHALMIC GOITRE occurs chiefly in young women, occasionally in men of nervous temperament. Not uncommonly some severe illness, strain, or strong excitement, is assigned as the *cause;* valvular disease of

the heart may be present. The complex of *symptoms* is usually regarded as due to paresis of the cervical sympathetic; but some of the signs of this are wanting. In a fully developed case we find slight or moderate enlargement of the thyroid, which pulsates with the heart, and prominence of both eyeballs, which may be so great that the sclerotic is visible all round the corneæ, and the lids cannot meet; but before these appear the patient generally suffers from distressing palpitation, anæmia, disordered menstruation, and often from hysteria. All these symptoms—especially palpitation and prominence of the goitre and globes—are apt to increase at the menstrual periods. The goitre may occur without proptosis and *vice versâ* (p. 508). It is due primarily to enlargement of the vessels, but increase of the thyroid tissues may follow on this; the carotids are said often to be enlarged. The thyroid rarely reaches such a size as to require special *treatment*, but it is said in a few cases to have compressed the trachea. Injection of ergotin into the connective tissue *over* the goitre has been favorably spoken of; injection of iron into the mass is too dangerous to be practised. Attention must be paid to the general health, and especially to the uterine and digestive functions; and steel with aloes, conium, valerian and nerve-sedatives, with a good diet, prescribed. The *prognosis* is very doubtful; in the course of years the disease may become less marked, but it rarely disappears. On the other hand it very rarely is directly fatal.

Sarcoma and cancer rarely affect the thyroid. Kauffmann has recently collected seven cases of the former and twenty-three of the latter. Cancer may be either encephaloid or scirrhous, and in the latter case may shrink a good deal, thus causing stenosis of the trachea. The softer sarcomata and encephaloid may form huge, rapidly growing tumors. Fixity of the parts to the skin and adjoining structures, often dark discoloration of the skin, involvement of the recurrent laryngeal and paralysis of the abductors of the cords, origin after mid-life with rapid growth and cachexia, are the diagnostic points. The disease is probably always fatal; early and complete removal would apparently end only in death from myxœdema.

Cysts and Tumors in the Neck.

Cysts and tumors occur in great number and variety in the neck.

Cysts.—1. *Congenital fistula and cysts of developmental origin.*

The mandibular is the first of a series of five *visceral arches* which grow from above downward and forward to form the lower jaw and the neck by their union in the mid-line. Between them lie four *clefts—branchial—*generally obliterated early in fœtal life. All start from the neighborhood of the ear; the first runs between the jaw and the body of the hyoid bone; the second between the styloid process, stylohyoid ligament, and small cornu, on the one hand, and the great cornu on the other; the third between the hyoid bone and thyroid cartilage; and the fourth lies along the anterior borders of the sterno-mastoids, reaching down to the interclavicular notch. Sometimes these clefts do not close completely; and this is by far most frequent in the fourth. We then find, low down in front of the sterno-mastoid, a small opening from which a mucous or a puriform fluid may now and again be pressed; a probe runs up and in for a varying distance; generally the channel is narrow and ends blindly, but it may open in the pharynx or trachea. It is lined by a mucous membrane, and, rarely, the outer opening is mesial. These fistulæ are rare, often hereditary, give little trouble, and may be let alone. In a boy who wished to become a trumpeter, Hüter followed one, between the carotids, to the pharynx and destroyed the mucous lining.

Unilocular Serous Cysts: Hydrocele Colli.—These, when situate near the angle of the jaw in deep relation with the styloid process, between the larynx and sterno-mastoid, or very rarely in the position of the usual cogenital fistula, appear to arise in connection with the second, third, and fourth clefts. Serous cysts in the subclavian triangle occur, but must have a different origin. These cysts are not usually present at birth. Tapping, injection with iodine, or drainage, are the remedies.

Multilocular Serous Cysts: Congenital Cystic Hygroma: Lymphangioma Cysticum.—These tumors may be of great size at birth, or only the rudiments, which grow more or less rapidly, may be present. They consist of cysts, varying in size from a pea to an apple, the walls of which may be so thin as to seem endothelial only, or they are thickened by the addition of connective tissue, and sometimes of fat containing considerable vessels, or even of cartilage and bone. Papillary growths may project into the cysts, and they contain fluid which is clear and serous usually, but may be chocolate, from blood, or viscid.

These multilocular cysts are thought to be due to dilatation of lymphatics, and even of the lymph-sinuses of glands; by a process of constriction cysts are formed. Naturally, such growths occupy primarily the great areolar planes, but secondary cysts penetrate everywhere, pushing aside muscles, between vessels, between spine, gullet, and windpipe, up to the base of the skull, to the face, to the floor of the mouth (when they may be combined with the makroglossia), or down into the axilla or thorax. Chains of cysts may penetrate into any chink. Parts pressed upon may atrophy.

Their favorite seat is the front of the neck, especially the submaxillary space; they may be unilateral or bilateral, meeting in the mid-line in the latter case, growing down in front of the windpipe to the sternum. They occur also between the jaw and the ear, in the subclavian space, and just below the occiput as a large cyst on either side of the lig. nuchæ. They may be superficial and spread superficially, their lobulated character, fluctuation, and even translucency, being apparent; or they may originate deeply and lack these characters, whilst they cause lividity and œdema of the face, varix, dyspnœa, and dysphagia—symptoms rarely due to a superficial cyst. Children commonly die starved and exhausted, many others as a result of operation, very few recover spontaneously. The *diagnosis* is difficult only in deep cysts, and then chiefly from deep fatty tumor, hydrocele colli, and behind from spina bifida.

The *treatment* consists in setons of fine single threads, left in till suppuration occurs (T. Smith); repeated incision through one another; or injection with iodine or chloride of zinc solution. This may be followed by rapid swelling and asphyxia. Extirpation can be done at so early an age only in small and isolable tumors.

2. Deep Dermoid cysts are very rare and may be met with at any spot in the neck, but the carotid sheath is the seat of election; to it, and to the great vessels, they may be closely adherent; they often do not enlarge till adult age. They may have the structure of simple atheromatous cysts, or contain hair, teeth, cartilage, and bone; and they originate from invaginations of epiblast or from the branchial clefts. Sometimes they may be drawn out easily through an incision; at others the dissection is most difficult and has been abandoned.

3. Bursal cysts in the neck arise usually from the *thyrohyoid* bursa between the thyrohyoid membrane and the back of the hyoid. The *prethyroid* on the pomum Adami is inconstantly, and the *supra-hyoid* (p. 542) rarely, present (Gruber). Collections of fluid in these situations lead to the *diagnosis*. *Treat* by injection of iodine. Incision without cauterization or ex-

cision often leaves a chronic fistula. These bursæ must be remembered as being occasionally the starting-points of cellulitis.

4. BLOOD CYSTS.—Ordinary *hæmatoma* seems to be very rare in the neck, which is, however, the special seat of the so-called "true blood-cyst." Such tumors may be congenital or appear later, and are most common in the supraclavicular fossa; they occur also in relation with the sterno-mastoid. Growth is usually slow, but may be very rapid, and the swellings attain a large size. The skin is normal but for varicose veins, and other pressure-symptoms may of course develop. Some can be emptied by pressure, being in direct communication with a vein; others are quite irreducible. The former contain blood, and are due either to a congenital malformation (dilatation) of a vein, to degeneration of a nævus which has by pressure opened a communication with the vein, or to limited and great varix of a branch. The latter may contain fluid blood and coagula, but sometimes serum first issues, and is followed by blood, which is often bright, and seems to issue by general oozing from the cyst-wall. Their pathology is very doubtful. Spontaneous cysts containing bloody fluid are met with, which give no trouble; they are probably *serous* cysts into which hemorrhage occurred. *Treatment* is extremely difficult, yet something must be done in advancing cases. Aspiration will very likely be necessary for diagnosis; and, the cyst being emptied, pressure may be tried; but this cannot be repeated often or anæmia will be induced. Injection of iodine after emptying has been successful, and has also killed. Extirpation is the only remedy when the cyst obviously opens into a vein, and is the best in other cases when it can be practised. Hüter removed the greatly dilated lower half of the internal jugular, and speaks of such operations as "among the most difficult."

5. HYDATID CYSTS (p. 201) rarely occur in the neck, and are recognized by the results of tapping.

6. CYSTS CONTAINING AIR.—*Hernia bronchalis* or *goitre aërien*, is a very rare tumor, formed by a protrusion of the mucous membrane through the cartilages of the larynx or the rings of the trachea, and caused by violent exertions of the voice. Larrey (*Clinique Chirurg.*, 1829, tome ii. p. 81) met with instances of it in French officers, and in the "muezzin" who call the people to prayer from the minarets in Mahomedan countries. Some cases depend on congenital defect. The tumor is soft and elastic, can often be made to disappear by pressure, and is increased by any exertion.

Hernia of the lung into the subclavian fossa or through an intercostal space is even more rare. A pear-shaped, resonant swelling rises up with expiration toward the larynx, whilst in inspiration the finger sinks into the pleura (Cockle, *Medical Times and Gazette*, 1873, vol. i. pp. 6 and 30). The only available *treatment* is moderate support.

7. THYROID CYSTS, cysts in the rare *aberrant thyroids*, and cysts in tumors, especially sarcomata, need only mention here.

SOLID TUMORS.—All tumors of the skin and subcutaneous tissue occur in the neck, especially *fibroma, lipoma, sarcoma, nævi*, and *sebaceous cysts*. *Fatty tumors* may occur beneath the deep fascia and send processes somewhat widely. *Large masses of veins form*, usually in the supraclavicular fossa, and spread so as to fill the posterior triangle, reach the wall of the pharynx, and so forth. All gradations are found between these masses and cavernous nævi, from which the former may start. They form in early life or are congenital. *Treatment* should be undertaken by electrolysis, cautery, or excision. Calcified sebaceous adenomata (Malherbe) have been described as "bony tumors" in the cellular tissue of the neck; they are rare. Sometimes a *bony mass* forms in the scalenus medius, uniting one or two lower transverse processes and the first rib, and perhaps causing intense neuralgia by pressure on the brachial plexus; remove completely. A *cervical rib* is also sometimes met with attached to the seventh transverse process; the subclavian often crosses it.

The *congenital tumor of the sterno-mastoid* is a firm swelling usually about the middle of the muscle, especially the right, noticed a few days after birth. It often seems to be merely the callus uniting some fibres ruptured during birth, especially in breech-presentations. In some cases the swelling seems to be gummatous. It is said sometimes to lead to wry-neck, but it certainly disappears harmlessly in the majority of cases.

The neck is *par excellence* the seat of tumors of the *lymphatic glands*, even setting aside the ordinary scrofulous and syphilitic swellings. *Lymphoma* (p. 134) and *sarcoma*, of all degrees of malignancy, are the *primary* growths. *Cancer* is always *secondary* to some epithelioma of the head and neck, or to acinous cancer of the breast, which may involve the glands along the subclavian and the lowest along the jugular.

Thyroid tumors have been dealt with.

The differential *diagnosis* of these tumors and cysts is sometimes a matter of difficulty or impossibility; inflammatory swellings and aneurisms (p. 386) have often to be eliminated. Among the cysts and abscesses exploratory puncture is invaluable.

The EXTIRPATION OF CERVICAL GLANDS may be very difficult. A free incision, a dry wound, no cuts in the dark, and the knife always turned toward the glands to be removed, are obvious necessities. In operating near the jaw, behind the line of the facial, the facial vein must always be remembered, crossing down and back superficially to the submaxillary gland, and being joined by the anterior division of the temporo-maxillary trunk to form the common facial; this opens into the internal jugular about the level of the hyoid, after having received the lingual and superior thyroid veins. The upper carotid glands stand in intimate relation to this large vein; and it will often be necessary to remove part of it between double ligatures, on account of adhesion to a gland.

Removal of the *glandulæ concatenatæ* frequently involves the laying bare of the carotid, jugular, and vagus. Pieces of both vessels have been excised, but such operations are of doubtful benefit, and, if the vagus is involved, almost hopeless. The internal jugular has often been wounded, and cut across without ill result. Such injury when necessary should be left till the tumor is otherwise isolated; if a ligature can be placed round the opening, it is easier and better than double tying the trunk. These vessels may be greatly displaced and widely separated; one must be prepared to meet them anywhere; often the artery can be felt before operating. If it is intended to cut the vessels, it is best to start with their double ligature below.

WRY-NECK OR TORTICOLLIS.—This deformity is either *congenital* (*non-spasmodic*) or *acquired* (*spasmodic*).

Congenital Cases.—It will often be found in these that there was some difficulty at the birth, rendering rupture of fibres of the sterno-mastoid likely; consequently, a lesion of this kind leading to chronic shrinking myositis is often regarded as the cause. It is said sometimes to be preceded by a congenital sterno-mastoid tumor.

The deformity is not usually noticed until weeks or months have elapsed; then it is found that, owing to rigid shortening of the sterno-mastoid, the mastoid process is drawn down towards the shoulder, and that the chin points persistently towards the opposite side. The rigid muscle may be two inches or more shorter than its fellow in cases which have been neglected for years. In these instances it will be found also that there are rigid bands of the cervical fascia—especially the sheath of the muscle—maintaining the deformity after division of the sterno-mastoid; and the cervical articular processes certainly have undergone changes in form and direction like those in club-foot and lateral curvature (*q. v.*). A compensatory dorsal scoliosis may be present, and quite commonly the ear and side of the face which is kept constantly down to the shoulder are smaller than the corresponding parts; probably the circulation in the dependent part is defective, but compression of nerves and congenital defect have also been suggested. The latter seems unlikely, if it is true that symmetry is very likely to result from division during childhood.

TREATMENT.—If the contraction is discovered early, it may be opposed by a rigid collar, or by Little's strapping, and especially by passive and active exercise of the opposite sterno-mastoid. But when congenital cases are seen, almost the only resource is *division of the sterno-mastoid.*

Operation.—An assistant takes the head, and endeavors steadily to raise it from the shoulder, and turn the chin toward the diseased side, thus stretching the contracted muscle. Now make a puncture internal to the muscle, or between the two heads just above the clavicle, with a sharp-pointed tenotome, carry the knife on the flat between the skin and the inner head, turn the edge toward and press it upon the muscle, until the latter gives way with a dull snap. The right hand must be well supported and the knife under perfect control; it must not bury itself in the deep tissues when the muscle is cut through. The clavicular head will now become more tense and prominent, and almost always requires division. This may be effected from a wound between the heads or a puncture at the outer border, as may be most convenient, unless the external jugular is close to the outer edge of the sterno-mastoid, when the former spot should be chosen. The section is made from before back, as in the case of the inner head. It is perhaps safer to use a blunt-pointed tenotome in this case; and its back and rounded end will act as a probe to assist the finger upon the surface in detecting dense bands of fascia and strands of muscle requiring division. Directly a dull snap indicates that division is complete, make pressure with a thumb in the gap for a minute or two to limit extravasation. It is not uncommon to see a hæmatoma form rapidly, from wound of the ant. jugular or other vein, but as a rule it soon ceases to extend. There are, however, on record a few cases of death from wound of the great vessels; bands of fasciæ in their immediate vicinity are, therefore, best let alone, to be dealt with by extension.

Some surgeons make a puncture between the heads of the sterno-mastoid, and from it push a director beneath them, first one and then the other; and they divide the fibres by running a probe-pointed tenotome along the groove, and cutting towards the skin. This is certainly preferable to pushing knives beneath the muscle; but any instrument thus used frequently goes through instead of under the muscle, and division of fibres by a knife-edge turned backward is ultimately necessary.

The wound being closed by a bit of wool and collodion, any soft parts remaining tense should be strongly stretched, and the head should then be fixed, if possible, with the chin pointing a little towards the affected side, and the mastoid process on this side raised a little above its fellow. To effect this, Dr. Little recommends putting a broad piece of strapping round the forehead and occiput—the head being shaved—and another round the waist. A strong tape is sewn firmly to the plaster round the head behind the ear, on the sound side, and another to the waistband in the opposite nipple line; the two tapes are tied together and act in the line of the lengthened sterno-mastoid. In bad cases the head cannot be brought at once into the above position, so elastic traction must be made by inserting one or two lengths of stout drainage-tube in the tape. There are also various orthopædic contrivances with arms to turn the head into place. Thrice a day after the third the divided muscle is to be well stretched by passive motion, and this should be done for some months, till the lengthened sterno-mastoid is able to hold its own. The latter should be regularly exercised, the patient standing in front of a glass and endeavoring to bring the head straight.

ACQUIRED TORTICOLLIS is due chiefly to spasms of the sterno-mastoid, which may be either *tonic* or *clonic*. Under the head of TONIC SPASMODIC WRY-NECK are grouped many cases which have only a certain resemblance to wry-neck in that the deformity is present, but without any special rigidity of the sterno-mastoid. These cases arise from exposure to cold (rheumatism, stiff-neck), from the desire to relieve inflamed glands from pressure, or inflamed joints in cervical spine-disease; or the cause—*e. g.*, worms or other gastro-intestinal trouble—may act reflexly. Sometimes it occurs in hysteria. Rarely, distinct tonic spasm of the sterno-mastoid follows injury of the head and appears due to some central lesion.

This distortion may be due, in rare cases, also to palsy of one sterno-mastoid; the other muscle being unopposed turns the head permanently from its own side and shortens. If the administration of remedies calculated to remove any existing disease in the head or neck and improve the health, and if strychnine, blisters, and electricity fail, division of the sound muscle has been recommended.

Lastly, Gooch, in 1759, and Langenbeck more recently, recorded a case due to contraction of the platysma-myoides, and cured by its division.

In CLONIC SPASMODIC TORTICOLLIS the cause is usually very obscure. It begins as a rule in adults before middle age, and the occasional movements of the head at first scarcely excite attention; but after a time they are strong and incessant; the patient cannot keep looking straight forward or turn the head to the diseased side, for spasm of the affected muscle never quite relaxes, except during sleep when all movement ceases; nervousness increases the trouble. The electric irritability of the affected muscles is usually much increased, that of their opponents diminished. Deep muscles of the neck or face may also be affected, the combination with histrionic spasm (p. 420) being interesting.

TREATMENT.—In these cases the cause must, of course, be removed. Where this appears central, counter-irritation along the spinal accessory, even with the cautery, whilst succus conii in large doses (℥j and more, Harley), or bromide of potash, is given; occasionally the constant current does good, but it is not at all reliable, and faradizing the weak opponents has been useful in Dr. Poore's hands. Massage would seem to be worthy of a trial. These methods failing, *neurectomy* or excision of a short portion of the spinal accessory is the sole resource. In central tonic and in spasmodic cases, in which the sterno-mastoid and trapezius are alone affected, the operation usually gives permanent relief, but the prognosis is not so good in the latter as in the former. Stretching the nerve is of no use.

NEURECTOMY OF THE SPINAL ACCESSORY is performed through a three-inch incision on the anterior edge of the sterno-mastoid, having its centre opposite the angle of the jaw; turn back the muscle and divide the posterior layer of its sheath; the nerve will now be found at the level of the angle in the connective tissue, running down and slightly back to pass through the deep fibres of the muscle.

CHAPTER XXXVIII.

INJURIES AND DISEASES OF THE CHEST.

Contusions of the parietes only, though sometimes accompanied by a good deal of pain and subcutaneous hemorrhage, are of little importance. But force applied to the chest—*e. g.*, a cartwheel across it or a blow from a bit of shell, may cause a complete or partial rupture of a lung, or rupture of the pericardium or heart, and this without fracture of any bone. Contusions of viscera are more common. When ribs are broken (p. 258), such injuries, of course, occur more easily. Pleurisy, pneumonia, pericarditis, mediastinal cellulitis, and abscess, or caries of sternum or ribs may follow later. All such complications are uncommon; they will be recognized by their usual symptoms and physical signs.

Treatment.—That of fractured rib; but a bandage may add to the distress. In severe cases with much dyspnœa, if low diet and a purgative fail to relieve, free leeching, or bleeding from the arm, is said to act wonderfully.

Wounds of the chest are divided into penetrating and non-penetrating. If there is any doubt as to whether a wound does penetrate, a probe should never be used to decide the point lest it perforate the pleura.

Non-penetrating wounds inflicted by swords, bullets, etc., sometimes run long distances beneath the teguments, leaving troublesome sinuses and causing burrowing; the inflammatory complications of simple contusions may arise, especially if the wound is septic.

"A Bavarian soldier was struck on the side of the chest by a bullet, which, however, glided off the rib without fracturing it; the soft parts over the ribs were bruised. A few hours afterward the man had intense pain and symptoms of acute pleurisy. He ultimately died, and it was found that a large quantity of blood had been effused into the chest-wall outside the pleura. Owing to the pleurisy and the generally low condition of the man, this had not been absorbed; suppuration occurred into the chest cavity, which killed the man. Cases in which a bullet fractures ribs without entering the chest are also dangerous; they always lead to pleurisy or empyema, and not unfrequently to pneumonia; for the lung may sustain contusion as well as the chest-wall and the pleura." (R. W. Parker.)

Hemorrhage from large parietal vessels is more likely to occur in penetrating wounds.

Treatment.—Antiseptics, counter-openings, and drainage, and the uniform pressure of a wool dressing.

Penetrating Wounds.—The danger of these depends (1) on the admission of impure air, blood, etc., to the cavity of the pleura or pericardium, and perhaps on the lodgement of foreign bodies; (2) on injury to the large vessels or viscera contained in the cavity; (3) on injury to vessels of the parietes.

A small, penetrating, punctured, or clean-cut wound of the parietes may close with little or no sign of inflammation of the serous membrane injured; but the result of free entry of impure air or septic instruments through the chest-wall is usually suppurative inflammation. As to the *lodgement of foreign* *bodies*, they should always be at once removed if they can be felt by the finger or a large-ended probe; prolonged search is harmful.

Hemorrhage may occur from the internal mammary or intercostal vessels; but instead of escaping externally, the blood may all or nearly all pass into the pleural cavity, causing compression of the lung and dyspnœa, accompanied by collapse, the side of the chest becoming increasingly dull, full, and motionless. It may be impossible to say whether the blood comes from the chest-wall or viscera; but the question should always be decided by enlarging the wound down to the pleura and tying the bleeding vessel, if found. No harm can possibly come from making the external opening freer. It may be necessary to remove fragments, or a sound piece of rib, to secure the intercostal, or a bit of rib cartilage to seize the internal mammary. In gunshot wounds these vessels seem very rarely to give trouble.

Injuries of the large intrathoracic vessels are rapidly fatal. Wound of the *thoracic duct* is very rare; lymph escapes into the mediastinum and cavity of the pleura and often by the wound; it may compress the lung. It is a fatal injury.

Injuries of the Lung.—*Contusion* with slight hæmoptysis is common. *Rupture* has already been alluded to; it may be slight, or run completely across the lung, the prognosis varying accordingly. The patient may live some hours in a state of collapse, without any hæmoptysis and little hæmothorax, after complete rupture. Ordinarily the symptoms are those of wound. Gosselin thinks that the glottis is closed at the time of injury, and the chest compressed upon the inflated lung; the rupture may be at, or away from, the seat of injury.

Sometimes part of the lung is forced, by an expiratory effort at the moment of injury, through a wound and is nipped (*traumatic hernia*). Guthrie advised that it should not be reduced, but left to granulate, and in septic cases this would be the best practice; but if the lung is healthy, it should be thoroughly cleansed, reduced, and the wound treated antiseptically. Very rarely, the lung protrudes through the pleura beneath the skin; some pad or truss should be applied.

Wound of the lung may occur without wound of the chest-wall, when fragments of broken rib are driven into its substance (p. 258), and such lacerations and contusions are common enough; or there is present also an incised, punctured, lacerated, or gunshot-wound of the chest-wall. The *prognosis* is best in punctured wounds, whilst the incised are, on the whole, most rapidly fatal. The lodgement of a foreign body renders the prognosis decidedly more serious, but no extensive search is justifiable. Many are ultimately coughed up, or discharged from the wound, and a few become encapsuled. Conical bullets lodge much less frequently than round ones, and less commonly carry in bits of clothing.

Symptoms.—More or less collapse, dyspnœa, cough, hæmoptysis, hæmothorax, escape of blood by the external wound, emphysema; pneumothorax and escape of air by the external wound; perhaps hernia of the lung.

The *collapse* varies with the extent of the injury and constitution of the patient. *Dyspnœa* may be due to the injury to the chest-walls, to compression of the lung by air or blood, or to filling of the bronchi with blood. There may be but little with complete collapse of one lung, and if it is very marked, Longmore says that wound of both lungs is probable. *Hæmoptysis* is most likely to occur when a large bronchus is opened, and is usually early in incised and gunshot wounds. It may be rapidly fatal, slight, or absent; or, after some days, a little rusty sputum may be expectorated. Blood in the bronchi keeps up *cough*. *Hæmothorax* results from escape of blood into the pleura from either lung or chest-wall. It is recognized by increasing collapse and dyspnœa, and the ordinary physical signs of fluid in the pleura, perhaps coupled with gushes of blood from the wound, especially if posterior, when the patient coughs. In *emphysema*, air is forced into the subcutaneous tissue, as described at p. 258. The freer the external wound, the less likely is it to occur. It may be accompanied by *pneumothorax*, or either of these conditions may occur alone. Theoretically we should expect *collapse of the lung* to occur in wounds of the parietal pleura, where no adhesions exist; but, as a matter of fact, the lung may actually bulge into a wide opening in the wall. It is, however, certain to occur, if there is any cavity into which air can pass from the lung, or enter from the outer wound, but from which it cannot readily pass out; it then gradually accumulates under sufficient pressure to separate forcibly the accurately applied sticky surfaces of the pleura, and collapse and pneumothorax result. The entry of a blunt weapon into the chest tends to produce this separation, but immediate pneumothorax is commonly absent in gunshot injuries. As a rule, however, if the wound remains open, this coaptation of surfaces gives way and air enters the pleura. Traumatic pneumothorax gives rise to the ordinary signs; it is usually complicated by blood in the cavity.

COMPLICATIONS.—These are inflammatory. A simple wound of the lung necessarily excites sufficient inflammation to effect its healing, but this scarcely deserves the name of *pneumonia*. It has no tendency to spread, unless the wound becomes septic and drainage is bad; then it may run high, and cause even gangrene, with septic symptoms. The inflammation is clinically and pathologically different from croupous pneumonia.

Usually changes in the lungs after wound are concealed by *pneumothorax* and *pyothorax*. *Pyothorax* (empyema) is almost always due to entry of impure air through a wound or *large* bronchus, that in the finer bronchi being pure (p. 39). The blood usually in the pleura decomposes, inflammatory effusion is rapid, and soon becomes purulent, the signs of fluid in the chest are marked, and fever generally mounts high, becoming hectic after a time. Diffuse septic suppuration in a previously healthy pleura is very fatal. Rarely the fluid is not purulent, the superficial wound having probably healed early.

TREATMENT.—First, examine the wound, and remove splinters of ribs and foreign bodies, if found, being careful not to separate the visceral and parietal pleuræ, if they are soldered together. Penetrating wounds of the chest-wall without evidence of complication should be treated antiseptically and closed. Should any track in the lung be injected, be careful not to cause asphyxia from entry of the fluid into the bronchi. It is probable that, in punctured and incised wounds of the lung, with but slight hemorrhage, this still would be the best treatment; for, if it succeeds, pyothorax would almost certainly not occur, and pneumothorax, if it occurred, would check hemorrhage, and favor healing of the lung. Dyspnœa, if severe, should be relieved by aspiration.

In severe cases of deep or lacerated wound, close the skin-wound only partially, and insert a tube, or leave it widely gaping. A counter-opening at once will often be desirable; in septic cases, indeed, a large, well-placed wound may be the means of saving the patient's life. The patient should be laid *upon the injured side*, unless both lungs are injured, then upon his back. In all cases, especially when the wound is closed, inflammatory complications must be anxiously watched for.

Hemorrhage must be treated by absolute rest; ice to suck and applied to the chest-wall; and, in slight but prolonged cases, by opium (to insure rest and diminish the frequency of respiration), and astringents, as tannic acid, internally. It is, of course, desirable that no blood should collect in the pleura, and, when primary union is not to be hoped for, one should endeavor to drain the cavity into an antiseptic dressing changed often. But, if such hemorrhage endanger life, and examination has shown that the blood does not escape from a vessel within reach, the only means of checking it is to close the wound and allow the lung to be compressed by blood and air. In severe hæmoptysis the same treatment is indicated. Here, again, there will be much danger of septic pneumonia and pyothorax, should the hemorrhage be checked. If all goes well, blood and clot should be drawn off by repeated small aspirations after three or four days.

It may here be mentioned that in a case of *profuse hæmoptysis* frequently recurring, Mr. Hulke, at Dr. Cayley's request, opened the pleura in the sixth space and introduced a tube, producing pneumothorax and collapse of the lung. There were no signs of old mischief; and it was, therefore, thought that compression would act—being unimpeded by consolidation or adhesions. Two comparatively slight recurrences of hæmoptysis occurred the same night; then none up to death, which occurred suddenly on the fifth day—the pneumothorax being on the left side (*Trans. Clin. Soc.*, 1885).

Emphysema and pneumothorax require little treatment as a rule; for severe dyspnœa the chest may be tapped with a needle; and for extreme emphysema, punctures of the skin may be made.

Pneumonia hardly admits of special treatment. It is, however, *empyema* or *pyothorax* that we have chiefly to fear of the inflammatory complications. Every endeavor must be made to prevent this by antiseptics, and free drainage, if there is any doubt about success in obtaining asepsis. Should symptoms of empyema appear after closure of the wound, this should at once be opened up, if well placed for drainage; if not, make one or more counter-openings, and insert short, large tubes, resecting a rib, if necessary. The drainage must be extremely free, and Condy's fluid or some non-poisonous antiseptic used in large quantities, to wash out the cavity in offensive cases. Should the patient recover, the treatment will be the same as in the non-traumatic form of disease.

If there is any doubt as to the nature of the effusion into the pleura, aspiration should first be tried.

Injuries of the Heart and Pericardium.—*Contusion* and *rupture* have been referred to (p. 586). Wounds very rarely result from fractures of the sternum or ribs, usually from thrusts, stabs, and bullets. G. Fischer has collected 452 cases, of which 11 per cent. affected pericardium only, 27 per cent. the right, 22 per cent. the left side of the heart. Such wounds are usually immediately fatal from shock and hemorrhage into the pericardium; but healing may certainly occur, as shown by 72 of Fischer's cases, the scar being demonstrated *post-mortem* in 36. In 12 a foreign body (needle, 6; bullet, 5; thorn, 1) was found.

If death is not immediate, collapse and oppression of heart and breathing from hemorrhage into the pericardium are the chief *symptoms*. Small, oblique punctured wounds of the heart affecting the ventricles have the best prognosis; wounds of the auricles are always fatal within a few hours, if not at once. Our only remedies are absolute rest, opium, and cold to the chest, the wound being dressed antiseptically. It seems likely that this cavity may soon be explored in some cases of bleeding, with a view to finding the bleeding point and closing a wound by sutures.

Diseases of the Chest-wall.

Chronic abscesses are not uncommon in the chest-wall, being usually in connection with caries of the sternum or a rib; usually they point externally, but may make their way toward the pleura, and cause pyothorax. When they have an impulse, the diagnosis from a perforating circumscribed empyema may be difficult. A pointing lung-cavity must be remembered as a possibility.

Caries of the sternum or ribs may be tubercular, syphilitic, or the result of injury. Not uncommonly small sequestra are found. Tubercular caries of these bones is said to be frequently followed by general miliary tuberculosis, and free incision of the part affected is advised. In the syphilitic and traumatic forms general treatment and the use of the sharp spoon will very likely be sufficient.

Large *chondromata, pedunculated osteomata,* and *sarcomata,* are the chief *new growths* which spring from the ribs. They should be removed early, together with the bone whence they spring. Extensive operations, laying open the pleural cavity, have been performed.

Surgical Treatment of Diseases of the Lungs and Heart.

Thoracocentesis or tapping the pleura is required to remove from the pleura air, blood, serum, pus, or, rarely, hydatid fluid; air and blood have been referred to. As to serous fluid, in *hydrothorax,* when both pleuræ are full above the angles of the scapulæ, the fluid should be withdrawn; much larger quantities than this are sometimes found post-mortem, and they have doubtless had their share in killing the patient, though no dyspnœa may have been noticed. In *pleurisy with effusion* tapping is required: (1) when one pleura is full or almost full up to the clavicle; (2) when both sides are full above the angles of the scapulæ; (3) when fluid is not absorbed after ordinary treatment for two or three weeks. It should be done immediately in the first two cases, as several cases of sudden death, or death during sleep, are recorded, especially from large effusion into the *left* or both pleuræ. In *pyothorax* it is usually advisable to aspirate once or twice before opening.

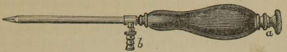
Operation.—The point of puncture, with a tolerably full pleura, may be either the seventh or eighth space near the angle of the scapula, or the fifth or sixth space in the mid-axillary line; in localized effusions or in doubtful cases, at the dullest spot. The aspirator (Fig. 6) is generally used, and is certainly the best instrument in cases of exploratory puncture, and when the pleura is thick. Siphon-action should be arranged for as at p. 82, or as follows: Aspirator and skin must be thoroughly aseptic. Feel for the upper edge of the rib bounding below the space chosen, and thrust the needle, guarded a short distance from its point by the forefinger, into the pleura close above this edge; as it enters the pleura, resistance is felt suddenly to cease. When the pleura is thick, or there is but little fluid, the vacuum should be turned on so soon as the aperture of the needle is buried; then it is pushed on slowly till fluid appears. If the needle-tube is now detached from the aspirator, and its end placed in a bowl beneath a little carbolic, siphon-action will be set up; to reverse the current, in case of stoppage, it must be again connected with the aspirator.

Instead of the aspirator, the siphon-trocar (Fig. 212) may be used. Fill the canula and India-rubber tube attached to it at *b* with carbolic lotion; then push forward the trocar, *a.* The free end of the rubber tube being under carbolic, make the puncture as above, and withdraw the trocar; siphon-action is at once established. An obstruction may be removed with little danger to the lung by pushing the trocar forward.

The removal of fluid should cease when much coughing is excited, when the stream is blood-tinged, or when two to two and a quarter pints have flowed.

The objects in pleurisy are to remove a cause of dyspnœa or of syncope; to reduce tension, that absorption may go on through previously compressed vessels; and to liberate the lung. None of these requires the complete removal of the fluid, were this possible; and the sudden withdrawal of a large

FIG. 212.



The siphon- or piston-trocar.

quantity may cause syncope, or death from urgent dyspnœa—probably due to œdema of the lung.

PYOTHORAX, EMPYEMA, or the formation of pus in the pleura, almost always demands the usual treatment of abscess. The pus is generally thin, and formed by increase of leucocytes in an effusion which is at first serous—the formation of thick pus, as such, from the pleura being common. It may therefore be said that pyothorax supervenes more or less rapidly—sometimes very slowly—upon pleurisy with effusion, and the *diagnosis* of pus is consequently rendered difficult. Nevertheless, the presence of hectic fever, after the fluid has ceased to increase, of œdema of the side, or of any tendency to point, are strongly in favor of pus, as also is the occurrence of the effusion during pyæmia or puerperal fever, or after a penetrating wound. In all cases of doubt, recourse should be had immediately to exploratory puncture, which, when the syringe and parts are clean, is quite harmless and almost painless. The suppuration may be localized or diffused; the pus is usually sweet, but fetor arises in cases due to gangrenous broncho-pneumonia, secondary to wound or, rarely, without obvious cause.

The *course of pyothorax* varies much. Rarely, and especially in children, it seems that pus *may be absorbed;* if this takes place in adults the probability is that the solid parts are left inspissated in the pleura, perhaps to calcify. Rarely, too, an empyema, especially localized, may remain latent, and is perhaps first noticed post-mortem. In chronic phthisis, pyothorax may cause less inconvenience than would a wound with the risk of sepsis. But, as a rule, pus in the chest keeps up fever of hectic type, cough, dyspnœa, and pain; and this may go on for long periods, the patient wasting greatly, and perhaps becoming albuminuric and *dying exhausted;* or death may be somewhat sudden, as in pleurisy, from *syncope* or *asphyxia.* Sometimes the *pus bursts through the pleura* in some direction, and most commonly *into the lung,* and is expectorated constantly or intermittently. The quantity which first enters the bronchi may be so large as to cause asphyxia in a weakly and perhaps sleeping patient. The expectoration of even a small quantity of pus *per diem* may keep up great irritation of the bronchi, causing much cough and watery mucous sputum. In such a state of matters, it would be expected that air would find its way into the pleura, and it often does so (*pyopneumothorax*); but usually this is prevented. Expectoration is both more frequent and more favorable than *external rupture,* chiefly because putrefaction of retained pus is inevitable in the latter case, whereas in the former it rarely occurs, unless the communication is direct with a considerable bronchus; but, in either, death from hectic and albuminoid disease is only too common after years of discharge, and putrefaction of pyothorax may prove quickly fatal by septic poisoning. External pointing may occur at almost any part of the thorax, but is naturally most common where the wall is thinnest. If the anterior wall of a thorax be held between the eye and the light, a spot in the fifth space between the edges of the rectus, pectoralis maj., and ext. oblique, and another in the second space close to the sternum, will be found translucent; in thin subjects, other spaces close to the sternum are also translucent, and these spots, especially the fifth (J. Marshall) and the second, are most often chosen.

Rarely, a pyothorax *pierces the diaphragm and causes an abscess beneath it*, or *bursts into the stomach or intestines;* or it descends behind the diaphragm, and *points in the loin*, like a lumbar spinal or perirenal abscess; or *runs along the psoas to the groin*, or even the popliteal space, being connected with its source by a narrow track. Such cases are very difficult of recognition, and opening the abscess low down only is likely to give but imperfect drainage.

Mode of Cure.—The effect of fluid in the pleura is to drive the lung, supposing adhesions to be absent, backward and inward upon its root, resonance and breath-sounds remaining longest in the vertebral groove; upon the surface of the pleura lymph is deposited, and its substance becomes infiltrated, until, in cases of months' and years' standing, it may be an inch thick. Obviously, as cure must take place by the meeting and adhesion of the visceral and parietal layers, this thickening of the pleura should be anticipated by early evacuation of fluid, whatever its nature may be. In tapping a recent pleurisy, one commonly feels the lung touch the canula toward the end of the flow; it has expanded considerably at once under the atmospheric pressure, and continues to do so if the fluid left is now absorbed. But this cannot happen once the pleura is considerably thickened, nor when its cavity is open; then the visceral layer must be drawn out to the parietal, or *vice versâ*, by the contraction of granulation tissue in the angles of the cavity; and the existence of patches of adhesion previous to the pleurisy favors recovery, by preventing wide separation of the pleural layers, and by subsequently furnishing many angles in which inflammatory tissue can exercise its force. As a result of its contraction, the collapsed lung may be more or less expanded, and this may be aided by systematic expiratory efforts with the glottis closed—as in coughing, when air from the sound lung is probably forced into the bronchi of the collapsed one—and also, it is said, by inspiration of compressed air; but its chief effect is to draw up the diaphragm, which adheres all round to the lower ribs, to draw over the structures in the superior and middle mediastina—the sound lung hypertrophying to permit the movement—and to drag the ribs down and in. The effect of this action is to produce a lateral curve of the dorsal spine (p. 472), concave towards the affected side, with compensatory curves in the lumbar and cervical regions. In many cases fortunately the apex is adherent, otherwise it is most difficult for the surfaces to come into contact here; for it is shrunken, driven down and in, the structures of the superior mediastinum are fixed, the short upper ribs can fall in but little, and the rising of the diaphragm has little or no effect. From all of which it appears that, ordinarily, the cavity left by a collapsed lung is closed first below and last above, and that lung touches the ribs behind sooner than in front. The *prognosis* is much better in children than in adults, owing to the greater elasticity of their bones and tissues, and their greater recuperative power. Any bagging in the cavity will resist the action of the inflammatory tissue, and must be relieved; but in many cases a state is arrived at, in which, in spite of perfect drainage, a cavity ceases to diminish. A certain amount of tension, as is well known from the example of the callous ulcer of the leg, inhibits the growth of granulations, and the only way of obtaining a cure, when this point is reached, is by finding some means of lessening the tension, such as a circular cut, or several short ones, round an ulcer. In the chest this means is provided by the operation of excision of ribs, which allows the superficial parts to fall in upon the lung.

TREATMENT.—Empyemata causing little trouble in chronic phthisis are best left alone; and cases in which expectoration or discharge by stomach or bowel is leading to a cure need not be treated. But if diminution of the cavity is very slow, or ceases, treatment should not be postponed lest the lung become firmly bound down.

It is, as a rule, advisable to begin treatment by aspiration, and to repeat it if the pus reaccumulates but slowly, and is then more serous in character. A single aspiration may cure, or three or four may be required. Godlee reports four of thirty children, and two of twenty adults, thus cured. These attempts must not be too long continued, lest firm adhesions bind down the lung.

Aspiration having failed, or being for some reason unsuitable, a pyothorax must be incised and drained like an ordinary abscess. When the disease is localized there is no choice as to the point of opening; but when it is uncircumscribed the fourth or fifth space in the axillary line is probably the best, the object being to find that spot which will afford efficient drainage for the longest time. As above shown, an opening low down and behind is soon occluded by the rising diaphragm; higher up the posterior parts of the ribs are thickly covered by muscle and by the scapula, and the lung probably adheres here and in front sooner than towards the lateral line; the point named drains the side well, especially when the patient lies upon it, as he usually does; and it is as near to the apex—the point which usually adheres last—as we can conveniently go. Marshall recommends the thin spot in the fifth space as the seat of election, in imitation of Nature; and cases do very well which are opened here. But it is a little far forward for drainage, and, if thinness of wall determines the pointing here, Nature's leading loses in authority. It is chiefly in adults that the point of opening is so important.

When an empyema is pointing, it is best to open it here, and, if the situation is unsatisfactory, to pass a probe through the opening and cut down upon it at the seat of election. It is often very difficult to find the track by which pus has escaped beneath the skin, but the exact path is of no consequence—another is so easily made.

When the original opening is made at the seat of election, bagging may occur in some corner, as below and behind, and necessitate a temporary counter-opening here.

Operation.—Chloroform should be given in preference to ether, anæsthesia being desirable if any bone is to be excised; simple incision in a recent case gives little pain, and this may be prevented by subcutaneous injection of cocaine (R. W. Parker). Godlee advises that no anæsthetized patient shall be turned much on to the sound side, especially if expectorating the pus, for it may run across and fill the bronchi on the sound side. Free access to the side, and in dorsal decubitus, is afforded by separating two high tables opposite the part.

For simple incision feel for the lower boundary of the space, draw the skin here down on to the rib and make a cut one and a half to two inches long through it; now let it return, and thrust a pair of closed sinus-forceps, guarded by a finger half an inch from the point, into the thorax, just above the rib; open the blades and withdraw the forceps, thus tearing a wound, which may be enlarged by stouter dressing-forceps or the finger. Many use a director to pierce the wall, but the more pointed forceps enter more easily. Where there is but little fluid, it will be necessary to make a free incision, and dissect through the layers above the rib. A finger should be introduced through the open pleura, and the cavity carefully explored, for the exact position of the lung and the presence of adhesions are points of much importance in after-treatment and prognosis. Masses of lymph may be felt and removed.

When this exploration cannot be thoroughly effected on account of closeness of the ribs, three-fourths to one inch of one of these should be excised (Godlee). In two-year-old children it is usually possible to push a finger of moderate size between two ribs; but as excision of a bit of rib renders drainage easier, and in no way complicates matters, some surgeons always perform it. The cut must then be two to three inches long, and directly on to the bone; the periosteum is separated with a slightly curved elevator from the surfaces and borders, much care being used at the lower edge (intercostal vessels); and the bone is divided in two places with a pair of curved cutting forceps or a fine saw. A cut is now made through the periosteum and pleura, and a large rubber tube, two to three inches long, is introduced; externally it is split into four equal pieces, and these, having been passed through a shield of stout sheet-rubber, are fixed to it by wire sutures tied on the aspect away from the chest (E. B. Baxter); it is thus prevented from slipping into the chest. When more than one aperture is made, a separate tube should be used for each.

Antiseptic dressings and the spray should invariably be used, even when the pus is fetid; it often becomes inoffensive after a few dressings, which should be frequent. Under these circumstances many surgeons wash out the pleura with large quantities of antiseptic lotions—Condy, iodine (ʒj and Oj), or chloride of zinc (1–15, 1–30, König); but several cases of sudden death during injection of the pleura have been recorded; and, though all have occurred in old cases which have been injected many times before, there seems to be no reason why a first injection should not prove fatal; no cause has been discovered.

The opening tends strongly to contract; a tube must be kept in, in adults, till discharge has almost stopped; in children, two to three weeks generally suffice. After its removal the wound soon closes, and should bagging now occur, cough, pain, general disturbance, and fever, indicate it; put in the tube again at once. Godlee advises that cases of empyema should sit up and move about as soon as possible.

After incision, with or without excision of a rib, a little necrosis of a rib may result. In the former case the edge of the lower ribs is almost always bare after a day or two of contact with the tube, but it granulates, and the ribs generally become connected by a pillar of bone on either side of the tube. After excision, new bone is quickly formed by the periosteum, and three ribs are usually welded together.

In a certain number of cases, in children as well as in adults, *a fistula remains* for months or years; it may lead to no cavity or to a small or large one; the discharge may be much or little, and the time of onset of albuminoid disease will vary with this, but it is sure to come sooner or later—perhaps only after many years, during which active work has been possible; consequently, these cases must be treated so soon as it is clear that healing is arrested. If there is any reason to suspect bagging, a counter-opening should be made at a favorable spot. Should healing still not occur, recourse must be had to treatment which Roser, Schede, and Estlander have been working out separately, viz., excision of the ribs and pleura bounding the sinus or cavity externally, and the laying down of the skin upon the lung.

THORACOPLASTY (Estlander).—The surgeon must first acquaint himself with the form and extent of the cavity, by exploring it with his finger at the time of operation, a bit of rib being removed, if necessary. The bones covering the cavity externally must now be exposed as fully as possible, by raising a flap upward or forward, or by two or three incisions parallel to the ribs, each admitting the removal of the bone over which it lies, and of one above and below it; or by L, T, or Z cuts. Muscle superficial to the ribs may be raised or left as is most convenient. Bleeding is often free from a number of small vessels during the raising of the flap, and must be dealt with by sponge-pressure. The periosteum of each rib is now separated so far as to allow the bone corresponding to the cavity to be excised by division with forceps at either end. Then part, or all, of the thick pleura, with the intercostal muscles and periosteum, is cut away with scissors, any vessels which bleed being easily tied. The cavity is now carefully examined, pockets of pus opened up, adherent lymph removed, and the surface disinfected with chloride of zinc or sublimate lotion and iodoform, and the skin-flap laid down upon the lung, fixed by a few sutures, drainage provided, and an antiseptic dressing so applied as to maintain contact. The weak point in this operation is that it has hitherto failed to deal with the upper ribs, which are so deep, and have such important relations; and it is at the apex that a cavity is most likely to remain irremediable. If smaller portions of ribs than above directed are excised, or if the periosteum is left, a dense plate of new bone forms before the flap and lung are united. This operation may require to be repeated twice or thrice.

With regard to purification of the surfaces, Godlee points out that we probably are open to the same danger as in injecting the pleura, for filaments of the vagus and sympathetic must suffer severely.

When a cavity is unavoidably left, a tube must always be worn, and if the discharge is fetid, siphon-injection through a tube *too small to fill the fistula* will probably be necessary. For further details see Godlee, *Lancet*, January, 1886.

PNEUMONECTOMY.—The surgery of the lung itself is still in embryo. Portions of one lung and both apices were many times removed in sheep, dogs, and cats, by Domenico Biondi, and with invariable success. After extirpation of one whole lung, he obtained fifty per cent. of recoveries. In a subsequent series of experiments, Biondi infected portions of lung with tubercle, and, after some weeks, when signs of the disease had developed, he removed the diseased lung, and none of the animals died of tuberculosis. We believe that extirpation of part of the lung has been attempted only once in man, and then with a speedily fatal result.

PNEUMONOTOMY has now been frequently performed, chiefly in cases of basic, but also in some apical, cavities from phthisis, pneumonia, and foreign bodies; it has proved very beneficial in cases of putrid bronchiectasis with sacculation, and in gangrene, expectoration being checked or stopped even when cure has not resulted.

The *diagnosis* of a cavity, based upon physical signs, is rendered accurate by exploratory puncture with a rather large aspirator-needle thrust slowly forwards under slight vacuum-pressure; and a cavity having been found, it may be opened by thrusting a large trocar alongside of the needle and tying its canula in, or a drainage-tube may be passed into the cavity and the canula withdrawn over it (Gould, *Trans. Med. Chir.*, 1884). In other cases Hilton's method has been adopted. Koch, of Dorpat (*D. med. Wochenschr.*, 1882, No. 32), has operated more boldly than most surgeons, thrusting a thermocautery through the lower lobe from the axilla to the mediastinum (!) and making two or three such punctures, though not upon the same day, after resection of a rib. He washed out large cavities with thymol solution. His results in two cases were favorable.

It is, of course, important that the pleura should be adherent at the seat of operation; where this is not so, Dr. Biss has suggested operation *à deux temps*, the two layers of pleura being sewn together on the first occasion; or the parietal pleura might be exposed and irritated.

Cavities in lungs have been injected through a fine canula with antiseptics, especially dilute tinct. iodi, in phthisis; and with tannin in cases of hæmoptysis (Theodore Williams).

Paracentesis of the pericardium may be required in cases of hydrops pericardii, pericarditis with effusion, and dropsy persisting after pericarditis. It is always performed with the aspirator; and a needle $\frac{1}{25}$th inch in diameter should be used—or $\frac{1}{50}$th inch if there is doubt as to the presence of fluid. With the latter the heart may be punctured with little danger (Dieulafoy). The puncture is made in the fourth or fifth space, one or two inches from the sternum, and the needle is pushed steadily backward with the vacuum turned on till fluid runs; it must then be held *motionless* whilst the fluid is slowly removed.

Pericardiotomy has been performed three times for purulent pericarditis —see S. West, *Trans. Path. Soc.*, 1884—successfully in two cases of the so-called idiopathic form, whilst death occurred in a pyæmic case. Rosenstein, the first operator, washed out the sac freely, and West thinks the three cases show that the pericardium may be opened and drained with as little risk as the other serous membranes.

Trephining of the sternum has been performed to effect drainage and disinfection in cases of suppuration in the anterior mediastinum, which may arise by extension of spontaneous or traumatic inflammation beneath the third layer of the cervical fascia, as well as from injuries and diseases of the sternum. The suppuration tends to spread to the pericardium and pleuræ, and is very fatal.

CHAPTER XXXIX.

THE SURGERY OF THE ABDOMEN.

General Remarks.—But a few years ago the peritoneum was almost sacred from the surgeon's knife, so fatal were wounds of the abdominal cavity; now it is bruised, torn, cut, or burnt, every day, and, relatively, with impunity. Formerly the great majority of the cases in which the peritoneum was opened died of septic peritonitis or of acute septicæmia; and the peritoneum, together with other serous membranes, was believed to have qualities rendering it more prone to inflame than other tissues; *i. e.*, the fault was said to lie in the membrane and not in the surgeon. The dissipation of this error is due chiefly to the clinical successes of ovariotomists. They discovered practically how the above fatal complications might be avoided; and the *rationale* of their practice was explained, and the practice itself improved, by Lister's views as to the nature of traumatic inflammation, and by Wegner's experiments upon the peritoneum (*Arch. f. Klin. Chir.*, xx. p. 351).

The peritoneum and serous membranes in general have peculiarities which it is most important to know, but they do not separate these membranes from other tissues. The peritoneum is a thin, moderately vascular membrane, of extent not much less than that of the skin—only 320 square centimetres in one case (Wegner). It is moist, and covers a number of very vascular nervous organs; consequently, heat is lost with great rapidity when the peritoneum is exposed; and, as secondary results, the body temperature falls, the intestines are paralyzed, and pulse and respiration depressed. An ice-bag laid on a rabbit's intestines, or the injection of cold fluids, stops the heart at once, but both pulse and respiration are unaffected by the exposure of the intestines for hours to warm vapor. Wegner next showed that the peritoneum was able to absorb in one hour fluid equal to one-eighth the body-weight, or a quantity equal to the body-weight in two days; and the lymphatics which remove it are so near the thoracic duct, that poisons injected into the peritoneum act almost as quickly as when injected into veins. Septic products could not be placed under more favorable conditions to produce their effects. This power of absorption varies with the intra-abdominal pressure; thus, more of 200 than of 150 grammes of fluid will be absorbed in an hour. Normally, transudation is more than balanced by absorption; but any enduring severe irritation of the membrane and lowering of intra-abdominal pressure by wound of the wall or removal of a tumor may reverse these conditions, for very large quantities of fluid may then transude in a short time, and absorption soon becomes further impeded by blocking of the stomata by fibrin, etc.

There is normally no peritoneal fluid free in the cavity. This fluid is very like serum, and highly putrescible. Wegner has shown that unfiltered air may be blown through the peritoneum for considerable periods without ill-effect, and every case of dropsy shows that putrescible fluid may accumulate in the cavity and cause no irritation; but if putrescible and unpurified fluid, as serum or milk, be introduced into the peritoneum, it is quickly decomposed and excites irritation, unless its quantity is kept below that which the peritoneum can speedily remove. In the latter case, non-irritant ptomaines may have formed previous to absorption, or infective organisms may be taken up with the fluid into the blood, the result being septicæmia of the most acute and fatal kind, whilst the peritoneum shows little or no sign of inflammation.

The intensely infective nature of septic peritonitis has been only too often proved by the effects of inoculation of the inflammatory products upon the hands of pathologists (p. 203), and also by many series of experiments upon animals. Such fluids swarm with organisms—cocci and rods usually.

It would seem, therefore, that to account for the chief causes of death after wound of the peritoneum, viz., peritonitis and septicæmia, two conditions are necessary: (1) the presence of organisms, which probably vary much in nature and are not necessarily infective; and (2) the presence of a soil suitable for their growth. Organisms usually enter by a breech of either the parietal or visceral surface of the peritoneum; but intestine, which is injured or inflamed throughout its thickness, almost certainly permits their passage through its wall. They may be brought to the peritoneum by the circulation, as in pyæmia, perhaps entering the cavity with the natural secretion; or, rarely, they may reach the membrane through lymphatic or venous channels, connecting it with the surface when this is the seat of infective inflammation. As to the soil, this is usually peritoneal exudation or blood; but to an infective organism such dead material is probably not essential even at the start, though the irritation of its growth in the peritoneal surfaces soon excites free secretion.

Lastly, it must be noted that an irritant, which has gained access to the peritoneum, will be carried from its original situation by vermiform movements, by movements due to respiration, to the emptying of viscera, change of position, or drainage of fluid from point to point. Thus an irritant is spread over the surface of the peritoneum.

The above statement has been thought necessary, before speaking of the injuries and diseases of the abdomen, together with the operations that they require, in order that we may infer from it the general rules that have long guided us in all surgically inflicted wounds of the abdominal cavity, and which are now being more and more acted upon in cases of injury.

As before said, the *dangers of wounds of the peritoneum* are by no means special to them, but owing to physical conditions they reach their maximum here. They are: Infection of the peritoneum; the presence of putrescible fluid in the cavity; great loss of heat; nervous shock and hemorrhage; and the chief *causes of death* after such wounds are septicæmia, with or without peritonitis, and collapse. To avoid these dangers it is necessary: (1) To render aseptic the skin about the wound, the hands of the surgeon and of his chief assistant who stands opposite to him, all instruments, and especially all sponges. Previous to the operation these should have been lying in 1 in 20 carbolic; and during it they must be cleansed, by simple squeezing, to remove all fluid or blood, then rinsing in *hot* 1 in 40 carbolic or in 1 in 1000 sublimate, and finally wringing *very dry* in a fomentation wringer, that as little as possible of the antiseptic may enter the peritoneum. (2) It is very doubtful whether the spray should be used to purify the air, for, even when the carbolic is hot, the spray is cold and chills the peritoneum greatly, and a quantity of carbolic acid, which may cause poisoning, enters the abdomen. Putrefactive and infective organisms not being common in most air, and it being certain that the peritoneum can deal with the former by absorption if there is no quantity of putrescible fluid present in which they can grow, it is found practically that the results of operations without the spray are quite as good as, if not better than, those performed with it. The spray seems to kill by shock and poisoning about as many as it saves from septicæmia. (3) When after an injury or during the course of an operation a breach of the peritoneal surface, such as would lead to septic infection (from gastro-intestinal tract) or intense chemical irritation (gall-bladder, bladder, ruptured ovarian cyst) of it, is found or accidentally made, means must be taken to close such opening or to insure that any extravasation shall occur through a wound in the abdominal wall. Any part of the peritoneum already infected and perhaps inflamed must be scrupulously cleaned with sponges and some antiseptic. Should the whole or greater part of the peritoneum be infected (diffuse peritonitis), it is best to adopt the plan, recommended by Lawson Tait and others, of flushing the peritoneum repeatedly with warm water until this returns clear; thymol or boracic lotion may be used, but carbolic, when of efficient strength, is too poisonous, and when weaker, is more dangerous than water. When a collection of infective fluid is opened between coils of intestine, every precaution in the way of sponges packed around should be taken against its escape into other parts of the abdomen. The opening of any viscus should, whenever possible, be performed outside the peritoneum, the wound being temporarily closed and protected by guards. (4) Whenever it is doubtful whether any infected surface has been efficiently disinfected, when portions of bowel have been seriously damaged in separating adhesions or otherwise, and especially if, in this case, much early exudation is to be expected, a *large* rubber or glass tube should be passed to the doubtful surface or to the deepest neighboring hollow—thus rendering the way out the easiest for exudation—and retained until the oozing has ceased. (5) When drainage is not thus rendered advisable, the final step is to sponge the peritoneum till the sponges remain dry and unstained. Special attention must be paid to dependent parts, and sponges held in forceps are usually necessary to cleanse Douglas's pouch. (6) The operation-room should contain no unnecessary furniture, no carpets, curtains, or things likely to harbor dust. Some days previously the walls and ceiling should have been cleaned, and the floor scrubbed; carbolic or sublimate lotion should finally be used. Ventilation, light, and drainage should be satisfactory; *cœteris paribus*, country is better than town for an operation. (7) The temperature of the room should be 60° to 65° for the operation. As above said, the sponges should be warm. The intestines and other viscera should be kept by the assistant as much as possible within the abdomen; when unavoidably protruded they should be covered by large warm flat sponges or a linen towel folded in several layers and wrung out of 1 in 40 carbolic. All fluids introduced into the abdomen for purposes of cleansing, especially if used in large quantity, should be at 98° to 100° F. (8) Everything likely to be wanted should be ready, and the assistants should know their duties before commencing. The surgeon should perform his part as quickly as he can, compatibly with good and accurate work—for time is an element in the production of shock coequal with cooling and nerve injury; and the longer an anæsthetic acts, the more severe will be its effects. (9) Hemorrhage must be most carefully checked by ligature, cautery, or liq. ferri perchlor.; before closing the abdomen every cut or torn surface must be carefully examined, for even small vessels in the warmth of the abdominal cavity will bleed freely as the heart-force rises, and coagulation in the peritoneum may be long postponed. To facilitate the finding of small bleeding points, especially in the omentum, it is best to spread out the part upon a white guard. (10) Immediate union of the wound in the abdominal wall is of great importance, both as a protection against infection and to lessen the chance of hernia. To obtain this, Sir Spencer Wells threads with a straight needle at either end eighteen-inch pieces of thin strong Chinese silk thoroughly carbolized, and passes each needle from within the abdomen through peritoneum and skin, skipping the rectus, about one-third of an inch from the cut edge. Others use but one needle, start with the skin on one side, protect the intestines with their fingers, and include all the structures of the wall in the deep stitches. These lie about one-half to two-thirds of an inch apart, and superficial sutures are inserted between them. All deep stitches must be passed before any is tied; and during their insertion it is well to cover the intestines with a flat sponge to protect them, keep them in the abdomen, and catch any blood from the suture punctures. The sponge is withdrawn just before the wound is rendered too small to prevent it; and a final swab-out is then given to the peritoneum. In tying the stitches bring the peritoneum and skin together accurately and closely, watching that no intestine or omentum becomes entangled. We believe that, with a wound of any length, it is best to sew the peritoneum with a continuous catgut suture, to unite muscle and tendon by stout silver wire sutures (to be left in), and the skin by continuous fine wire suture. (11) Some form of antiseptic dressing is applied; carbolic gauze as a deep dressing and some wool is best. It must be thick if the cavity is drained. It is an excellent plan to keep this in place with wide elastic webbing wound round the abdomen; this supports the stitches perfectly, tends to keep the affected parts at rest and to maintain intra-abdominal pressure. Under it, I have obtained a radical cure of a large umbilical hernia in spite of a most violent and frequent cough. (12) All sponges and instruments used, especially clamp-forceps, should be counted before the operation and before the closure of the wound; such things have several times been left in the abdomen.

After-treatment.—Place the patient in bed on the back, with the head low. Combat *shock* by warmth, and if stimulants are required, give them subcutaneously and by rectum, rather than by mouth. If possible, let the patient sleep off the effect of the anæsthetic, for it is very important to avoid *vomiting*. To this end Sir S. Wells recommends that bichloride of methylene be used as the anæsthetic; and abstinence from food for some hours before the operation should, as usual, be practised. To combat vomiting and retching, give ice, iced soda-water, or champagne in small quantities by mouth; bromide of potassium gr. xv. ad aq. ℥ij or ac. hydrocyan. dil. ♏ iij–v. When the patient is weak and exhausted, small, nutrient enemata often stop vomiting. Very little *food* should be given for two or three days—only slops and ice; none, if the patient is sick. In women, to avoid disturbance, the urine must for some days be drawn off without exposure every six hours. The *bowels* may be left alone or confined by opium, if there is any special reason to fear peritonitis, unless Tait's teaching (see below) is accepted; they should always, when possible, be well emptied before the operation, by castor-oil over night and an enema in the morning. *Flatus* somtimes accumulates and gives pain; the nurse should pass a tube two or three inches into the rectum and allow it to escape; much less often a stomach-tube must be passed, to draw off gas from this viscus.

If the wound is not supported by a lightly applied elastic bandage, long strips of plaster and a flannel binder should be used. Unless drainage is employed, the dressing may usually be left on a week, when the wound has generally healed and the stitches may be removed. The scar must be supported by hands until some covering and fresh supporting straps are applied. When a tube has been passed into the pelvis, it will be necessary to displace the lower part of the dressing several times a day, and draw off fluid with a syringe and tube. Sometimes the wound is burst open by some muscular effort or swelling of the abdomen, and intestines may protrude beneath the dressing; return them at once, and close the wound with fresh sutures. If signs of internal hemorrhage (increasing collapse) appear, reopen the abdomen and try to find the source, after sponging out the cavity. The nurse should record the temperature and pulse every three hours, that the earliest notice of any septic absorption or inflammation may be obtained. When symptoms of *incipient peritonitis* appear, treat as directed under "Peritonitis." Rise of temperature to any marked degree is best treated by Thornton's ice-cap; but since Sir S. Wells began the use of antiseptics, this has rarely been needed in his practice. *Intestinal obstruction* rarely occurs from involvement of intestine in the abdominal wound or in a stitch, from its compression between a pedicle treated extraperitoneally and the abdominal wall, from kinking of the gut by adhesions, or from paralysis of a short portion, owing to infective inflammation spreading from some surface, such as an ovarian pedicle (Wells). The diagnosis from peritonitis may be very difficult. *Fecal fistula* is also rare, being sometimes connected with accidental wound of the intestine, with sloughing of an injured part, or with the bursting of an abscess into the bowel and externally.

Acute Peritonitis.—We place this next, the traumatic and perforative varieties being all important in abdominal surgery.

Causes.—Wound, with infection of the peritoneum; rupture by violence of some part of the alimentary tract, and most often of the small gut, rupture of the urinary or gall-bladder; rupture of a hydatid, ovarian, or other cyst; perforation of an ulcer of the stomach or duodenum (see "Burns and Scalds," p. 194), of ulcers, especially typhoid, of the small intestine, of the vermiform appendix from acute inflammation, usually running on to gangrene, over a fecal calculus or other foreign body, and occasionally of the cæcum in cases of stricture of the large gut; rupture into the peritoneum of an abscess in the abdominal wall, in the thorax, or among the coils of the intestine from former peritonitis; direct extension from intestine inflamed after strangulation (internal or external), intussusception, or volvulus, rarely from the surface of a psoas abscess or suppurating gland; spread of infection through the diaphragm from a septic pleurisy or pericarditis, or up the Fallopian tubes in gonorrhœal, puerperal, or other form of metritis; rarely pyæmia, erysipelas, smallpox, and other infective diseases, and acute rheumatism; in a very few cases (idiopathic) no starting-point can be discovered. Bright's disease is a not uncommon cause, and malignant growths and tubercles of the peritoneum sometimes cause suppuration.

Morbid Anatomy.—In a typical case, many coils of intestine are much swollen, whilst others are collapsed under pressure of the former; the vessels are injected, especially those of the intestine, and injection is often most marked or present only along the lines of contact of the swollen coils ("suction-lines," Moxon) where there is some tendency to a vacuum; in the grooves here, on the surface of organs or of peritoneum bounding collections of fluid, lymph accumulates in shreds or layers, binding adjacent parts loosely together. When there is much lymph formed the peritoneum is dull and lustreless, and either there is little fluid in its cavity or it is not puriform. The subperitoneal tissue is œdematous, as also the intestinal wall, the muscle of which is paralyzed by the inflammation. The muscles of the abdominal wall may be pale and œdematous. The diaphragm is driven up in proportion to the meteorism, the bases of the lungs compressed, the heart displaced up and to the left. But in many cases, on opening the abdomen, the intestines are bright and shining, greasy to the touch, and, together with the rest of the peritoneum, smeared over with thin pus, which collects in some quantity in dependent parts and between coils of intestines, especially about the starting-point of the disease. In these cases meteorism may be little marked, so also injection, and lymph is in relatively small quantity, yellow, soft, sometimes almost diffluent or like the deposit of the solid constituents of pus which is often found in the pelvis or other cavity. The starting-point of the disease is often evidenced by the greater intensity of the changes there.

Between the fibrinous or adhesive and suppurative forms are others, characterized by the effusion of a very turbid serum containing flocculi and clots of lymph, and often offensive; it may accumulate rapidly and in large amount, or form only a few localized collections. The fluid may be hemorrhagic in cachectic conditions. Instead of becoming diffuse, as above described, the spread of inflammation may be limited by the omentum, the presence of old adhesions, or the rapid formation of lymph among the viscera round the starting-point. Thus inflammation in all its stages, from the adhesive to the purulent, may be found limited to the neighborhood of the uterus and ovaries, of the vermiform appendix, to the hypochondria (from ulcer of the stomach, or most commonly from injury, with effusion of blood) (Fagge), or even to the small bag of the peritoneum, which may be distended with pus. Such collections may perforate the abdominal wall, especially at the umbilicus, or in the groin, burst into some hollow viscus or into the peritoneum, or remain encapsuled for long periods. Of these localized inflammations by far the most important is that about the vermiform appendix (typhlitis).

Symptoms.—These vary greatly. As a rule, the patient is seized with chills or rigors, fever, and severe burning pain at some, usually the lower, part of the abdomen, whence it spreads over the whole, often remaining most acute at the starting-point; early in the disease exacerbations of pain occur from movements of the bowel, which may be felt and heard, but as the intestine becomes paralyzed and distended, the pain acquires a constant character. The surface is acutely tender, and pressure increases the pain. At first, it is common for the abdominal walls to be extremely hard and retracted from firm contraction of all the muscles, but slowly or rapidly, according to the progress of the disease, they yield before the dilating intestines, and become tightly distended. There is often some dulness in the loins or over a circumscribed collection of fluid. Douglas's pouch may be found full and tense, or a wave across the abdomen may be obtained. The patient complains much of tension; bedclothes even seem to press unbearably. He lies on his back with his knees drawn up, keeping quite still, and using his diaphragm little or not at all; his face is usually pale, pinched, and anxious, the eyes sunken; respiration almost entirely upper thoracic, very rapid, and often accompanied by working of the alæ nasi. The pulse is frequent, 100 to 150, perhaps hard at first, but it soon becomes small and weak. Thirst is insatiable. Eructation is frequent, and persistent hiccough, from irritation of the diaphragm, often occurs before death. Vomiting is one of the earliest symptoms, and may be only occasional—perhaps not always induced even by the taking of food or medicine—or very frequent; toward the end it is usually frequent, great quantities of green bilious fluid being pumped up with little or no obvious action of the muscles of the belly; this kind of vomiting is very characteristic. The vomit is rarely feculent, and then, usually, a section of intestine is found to be much inflamed, perforated, or otherwise impeded in its function. Constipation is early and often absolute, even at a time when it is probable that inflammation is not yet general, and when, consequently, inhibition, rather than paralysis, would seem to be its cause. Frequent small stools occur rarely, and probably only in pelvic peritonitis; micturition is difficult when the bladder is involved. Death usually occurs with a falling or subnormal temperature, and all the signs of collapse (p. 166). It may be preceded by delirium, or the mind may remain clear. In the traumatic form, the onset is gradual, whilst cases of peritonitis often begin with severe pain and collapse, upon which the above symptoms supervene if the patient live long enough.

A form of peritonitis, often met with after operations, in bad cases of typhoid, and sometimes in Bright's disease, is that known as asthenic or latent, in which the above symptoms are mostly or entirely absent. The patient lies in any position, does not keep the knees flexed, and may move about freely, using the abdominal muscles, and complaining of no pain or tenderness; the abdomen usually swells, but not always; the temperature remains low, but the pulse fails progressively; the mind is usually clear; there may be a little vomiting, and constipation persists. Diffuse suppuration is found *post mortem*.

Complications.—Rapid heart-failure must be looked upon rather as natural to the disease than as a complication; collapse of the bases of the lungs is frequent, and pneumonia often supervenes; œdema of the lungs results from cardiac failure. Pleurisy is the rule when the upper part of the peritoneum is affected, and not uncommonly it is suppurative; pericarditis is less frequent. Marked albuminuria may occur.

The *prognosis* in cases of diffuse peritonitis is very bad, being least hopeful in cases due to wound or perforation in which there is no drainage. The pulse and aspect of the patient are the most reliable guides.

Diagnosis may be impossible in latent cases. When the symptoms are marked, colic, hysteria, and intestinal obstruction will have to be eliminated. In colic, pain is intermittent, and usually relieved by pressure, tenderness being absent, also meteorism; a lead-line may be present, or the history of injudicious feeding; fever and general symptoms are absent. In hysteria, tenderness is superficial, and pressure is borne when the patient's attention is distracted; the history is important. If there is any doubt in the diagnosis, assume that peritonitis is present.

As above shown, peritonitis causes symptoms of intestinal obstruction; on the other hand, peritonitis often supervenes upon intestinal obstruction. The obstruction due to peritonitis can be overcome by a purgative, but to give one would often, at least, be a grave error. If the presence of peritonitis is evident, it may still be impossible to ascertain that some form of acute obstruction is not its cause; and if, on the other hand, the symptoms special to peritonitis be not marked, and one palpate the abdomen at all freely, perhaps under chloroform, for some tumors, undoubtedly mischief would be done. An exploratory incision would probably be the best treatment in serious cases of doubtful nature (see "Treatment").

A circumscribed peritonitis, especially that due to typhlitis, is recognized by localized swelling, pain, and tenderness, even though it be accompanied by general fulness of the abdomen, some vomiting, and constipation; the general symptoms are less severe than in the diffuse form.

In seeking to find the cause of peritonitis the history is of much value. Wound, contusion, or reduction of a hernia, of course, speaks for itself. Sudden localized pain with collapse points to perforation of a viscus at the seat of pain, and tenderness often distinctly starts thence. Ulcer of the stomach or duodenum, typhoid ulcer of the ileum, sloughing of the cæcal appendix, and affections of the generative organs in the female are, according to Fagge, the commonest causes of non-traumatic peritonitis. Each is likely to give a history, except inflammation of the appendix, which usually occurs without warning; but it must be admitted that in each case perforation may be the first serious symptom. In a child, man, or woman, whose generative organs are healthy, inflammation of the appendix is, in the absence of guiding symptoms, the most likely cause of diffuse non-traumatic peritonitis.

Treatment.—That in ordinary use may be summed up thus: *absolute* rest, opium given freely, the avoidance of all purgatives or enemata, ice, or a little iced milk only by mouth, feeding by rectum; ice-bags or poultices to the abdomen, some prefer one, some the other; the relief of distention by the long tube, or by puncture with a fine needle—but this is not altogether free from danger or extravasation.

It, appears, however, that, since 1875, Lawson Tait has pursued a very opposite practice with great success. "On the slightest indication of peritonitis after ovariotomy we give a rapidly acting purgative, it matters not what; the patient's bowels are moved and the peritonitis disappears" (*Brit. Med. Journ.*, May 15, 1886). I am ashamed to say that the above quotation came as news to me, though I heard my first lecture on surgery in 1876. Mr. Tait's teaching has apparently been ignored, most culpably, as it seems to me; but the results published in the above paper will surely obtain for it the fullest trial. The treatment is certainly inapplicable in any case in which a small segment of gut is seriously damaged, and especially when extravasation is likely to occur.

Cases of circumscribed abscess in the peritoneum have frequently been opened, drained, and irrigated successfully. Thus, in 1848, Hancock (*Disease of the Appendix Cæci cured by Operation*) incised the abdomen in the right groin in a case of typhlitis, in which, perhaps, the inflammation had become diffuse; a quantity of very offensive turbid serum escaped, a fecal calculus appeared on the sixteenth day, and the wound healed some ten days later. He expressed the hope that similar drainage would be successfully employed in other cases of peritonitis "terminating in effusion, and which usually end fatally." But recently the principle of evacuating pus and septic effusions as soon as possible has been applied to diffuse cases.

Treves (*Med.-Chir. Trans.*, 1885) in February, 1884, opened the abdomen of a woman in whom gonorrhœal pelvi-peritonitis had become diffuse; he washed out the abdomen with "many quarts of warm water mixed with a little carbolic" until the fluid returned clear; sponged the peritoneum dry; passed a large tube to the bottom of the pelvis and dressed with carbolic gauze. Much fluid drained away, and a tube was kept in for thirty-six days, after which the wound was allowed to close. Treves quotes four cases of recovery after abdominal section for other conditions during acute peritonitis, and points out that in three, as well as in his own case, old adhesions existed. The tolerance of a chronically inflamed peritoneum is well known. Krönlein (Langenbeck's *Archiv*, 1885) has operated in three cases with one success, the case being one in which the cause of the disease was not found and in which cleansing of the peritoneum was admittedly imperfect. Mikulicz also (Volkmann's *Sammlung*, No. 262) has operated thrice, once successfully, after perforation of an ulcer of doubtful nature, which he excised. Nussbaum records recovery in a very bad case of diffuse peritonitis after rupture of an ovarian cyst (Verletzungen des Unterleibes, *Deutsche Chir.*, No. 44, p. 28), and is strongly in favor of this treatment in suppurative peritonitis. Godlee and Barlow (*Clin. Soc. Trans.*, 1886) record a successful case of laparotomy and drainage for diffuse suppuration, probably starting from the appendix; and Tait describes in the *Brit. Med. Journ.*, May 26, 1886, a very remarkable success after draining twelve pints of pus from a girl's peritoneum. I have twice opened the abdomen in young children and removed a sloughing appendix; the first case was a desperate one of diffuse suppuration, and ended fatally a few minutes after removal to bed. The second had not become diffuse, I believe; I evacuated through the semilunar line a collection of offensive turbid fluid lying around the appendix outside the colon removed the appendix, sponged the surface with bichloride of mercury (1 in 500), and drained the part; but the boy died of diffuse peritonitis three days later, and the case must be regarded as a failure on my part to disinfect completely.

These results are too few for conclusions to be drawn. A desperate remedy is certainly justified in so fatal a disease. Treves would not apply it in cases of cancerous, tubercular, or pyæmic peritonitis, nor when extensive rupture of solid viscera is present. It may be noted here that Sir Spencer Wells once opened the abdomen by mistake in a case of tubercular peritonitis, and the patient recovered completely, after a sharp attack of peritonitis, and married.

For the treatment of injuries and ruptures of hollow viscera which may be found as causes of peritonitis, see next section.

Injuries of the Abdomen and Contained Viscera.

These may be classified as follows: 1. Contusions of the abdominal wall; 2. Ditto with rupture of viscera; 3. Non-penetrating wounds of the abdominal wall; 4. Simple penetrating wounds; 5. Penetrating wounds with protrusion of viscera; 6. Penetrating wounds with wound of viscera but without protrusion.

1. Contusions and subcutaneous lacerations of the wall are common. The skin and peritoneum, especially the former, are very elastic and tough; consequently they escape laceration by injuries which tear or even pulpify the muscles. Rupture of the abdominal muscles occurs not only

from blows, but also from violent efforts, the rectus being most often affected. A strong contraction probably explains the ruptures, even of the diaphragm, which sometimes occur in falls not directly injuring the abdomen. The rectus sometimes tears after prolonged fevers, especially typhoid, no doubt in connection with Zenker's degeneration. Suppuration may occur after these injuries of muscle, and the tendency to hernia is great. The chief signs are pain and a blood-swelling in the wall, over which the skin may or may not be bruised; a gap in the muscle may be felt. When both muscles and peritoneum are torn, which is rare without injury of viscera, a traumatic hernia may at once present beneath the skin.

A blow on the epigastrium, apparently without injuring viscera, may cause very serious collapse and vomiting, and death has several times occurred without any important naked-eye lesion.

2. Bruises and lacerations of abdominal viscera often complicate contusions of the wall. They are usually caused by direct violence—*e. g.*, buffer-accidents, squeezes between platforms and moving trains, blows, or the passage across the body of a cart-wheel; they are common also in falls from heights, and in warfare result from spent round-shot and fragments of shell. Any portion of the intestinal tract or bladder may be torn, and the most severe lacerations and ruptures of viscera may occur without any contusion of the elastic parietes. Distention alone renders hollow viscera liable to rupture, whilst extravasation of their contents becomes practically certain; but they may be lacerated when empty. A solid viscus may be completely smashed or show but a slight rent on its surface; morbid enlargement and softening predispose to rupture. The *prognosis*, of course, varies with the extent of the injury of any organ; lesions of the liver and spleen are graver than those of the kidney, and tears of the stomach worse than those of the intestine.

One *symptom*—shock—is common in all these injuries, and may be the only one present. It is due to injury of the abdominal sympathetic and often to hemorrhage also. Nervous shock occurs almost immediately in a comparatively intense form, which may deepen to death; hemorrhage, on the other hand, causes steadily increasing collapse. But frequently bleeding occurs in cases of severe nervous shock, and may thus be masked. Nervous shock is said to increase in intensity as the injury approaches the solar plexus. Bleeding is freest from the very vascular, solid organs. Extravasated blood may, in case of recovery, be absorbed, or be encapsuled and form a blood cyst. This may suppurate, as is best seen in pelvic hæmatocele; diffuse peritonitis in connection with extravasated blood is very rare.

The slighter ruptures of the solid organs are probably unrecognized and heal. In cases which have lived a few days, lacerations are often found held together by firm clot undergoing shrinkage and decolorization.

But diffuse peritonitis is likely to occur and prove fatal in all cases of rupture of hollow viscera which survive the period of shock and hemorrhage. A circumscribed abscess rarely forms, and bursts externally, into a hollow viscus or into the peritoneum.

The *recognition* and *differential diagnosis* of ruptures of the abdominal viscera are often impossible, and many are discovered only *post-mortem*, when death occurs in early stages. In all cases the situation of the injury, local tenderness, and perhaps tumor and dulness from extravasation, are most important. It must be remembered that several viscera are often injured in one case, and that injuries of the thoracic organs often complicate those of the upper part of the abdomen.

Lacerations and wounds of the *Omenta* and *Mesentery*, with their contained vessels, give rise only to signs of shock.

The *Liver* suffers frequently from direct violence, owing to its firmness, fixity, and large size, reaching from the anterior to the posterior wall. It may be torn also in falls, for the heavy mass tends to move on after the body has come to rest; I have seen it cut halfway through by the umbilical ligament. In deep ruptures not only is bleeding free, but large bile-ducts are torn, and their irritant contents escape into the peritoneum.

The *symptoms* at first will be those of great shock and internal hemorrhage; if the patient survive two or three days, these may be succeeded by local peritonitis with severe vomiting, hiccough, swelling, tenderness, and pain; jaundice, brown urine, glycosuria, colorless stools, and pain in the right shoulder. The peritonitis may become general, or an abscess may form rapidly or in the course of many weeks. It usually presents externally.

Rupture of the gall-bladder and larger ducts is almost always fatal from diffuse peritonitis, unless old adhesions are present, or it so happen that the cystic duct is occluded and the bladder full of mucoid fluid. An abscess bursting externally may leave a biliary fistula.

The *Spleen* is often torn; it bleeds very freely, and the great majority of cases die without presenting any specific symptom. When swollen from ague or other causes, slight blows, falls, or even vomiting may cause a rupture.

Injuries of the *Pancreas* are rare—contusions very rare—and present no specific symptoms.

Rupture and wounds of the kidney, though very serious, are less fatal than those of the liver and spleen. The symptoms are shock, hemorrhage, the blood escaping externally through any wound, into the peri-renal tissue, forming a large swelling; into the abdomen, if the peritoneum is torn, or into the pelvis, ureter, and bladder—perhaps in all three directions; urine may pass in the same directions, but is not recognizable during free bleeding; vomiting is often marked, as also are local pain and tenderness; at first there is often strangury. The bleeding may be so free, either from a wound or into the surrounding tissues and bladder, that life is endangered; the blood may clot in the bladder, distending it, obstructing the passage of urine, and causing great suffering; or clots may block the ureter, when symptoms of renal colic will arise, and the urine found in the bladder during the paroxysm will be clear, or clearer than previously. In the most serious cases of rupture, proving rapidly fatal, clear urine may be passed, none being secreted by the injured kidney; but not uncommonly in these cases very little or no urine is secreted even by the sound organ. In slight ruptures and contusions only a little smokiness of the urine may result. Sometimes long clots, evidently formed in the ureter, are passed (Hilton).

When the stage of shock, hemorrhage, and peritonitis from entry of urine into the peritoneum is survived, the patients have still to pass through the dangers of suppurative nephritis, and of perinephritic suppuration, spreading widely between the muscles and peritoneum, perhaps extending to this membrane or causing pyæmia, septicæmia, or hectic. Lastly, fistulæ may remain, from which urine escapes almost constantly, at the bottom of which calculi may form, or which, by occasional superficial healing, may cause much trouble.

Subperitoneal rupture of the *pelvis of the kidney* or *ureter* has rarely been met with. There are no immediate symptoms, but a large collection of urine forms in the course of a few weeks. In one case repeated tapping effected a cure. More direct treatment could now be employed.

Gastro-intestinal Tract.—Rupture of the *stomach* usually occurs near the pylorus, or near the greater curvature. It may cause speedy death from collapse; bloody vomiting may indicate the nature of the injury, but does not always occur. If the patient live long enough, diffuse peritonitis supervenes. Rupture of the *intestine* is commoner than that of the stomach. The jejunum is most often affected, especially at its junction with the fixed duodenum ; the latter part also is frequently torn, where it lies in front of the spine, behind the peritoneum, and is unable to slip away. Some great but limited violence, such as the kick of a horse, is a common cause. Shock, from simple rupture of the intestine, is often not extreme ; but speedily great pain and signs of spreading peritonitis appear and prove fatal ; for, even when collapsed, the gastro-intestinal tract almost always contains sufficient to cause a general infection of the peritoneum. Cases have occurred, however, in which even a transverse tear of the bowel has been closed by lymph, so as to resist some pressure of contents (Nussbaum), and smaller ruptures may adhere to surrounding structures or lead to fecal abscess only. Sometimes in these injuries gas escapes into the peritoneum, blowing up the belly, and obliterating the liver dulness; but resonance here may be due also to displacement of the colon between the liver and the diaphragm, or pneumothorax may drive the liver down. *Emphysema* of the abdominal wall is most likely to occur when a non-peritoneal surface of the intestine is wounded—*e. g.*, second and third parts of the duodenum, and parts of the large gut. It usually appears in the loins and spreads thence more or less widely. It causes no inflammation, and is therefore easily distinguished from the emphysema which accompanies gangrenous cellulitis ; and it is diagnostic of wound of the bowel if it can be shown not to be due to wound of the lung.

When the duodenum is ruptured behind the peritoneum, the symptoms are very obscure. There may be vomiting of blood or melæna. The intestinal contents excite suppuration, which spreads behind the peritoneum and causes peritonitis by extension or by bursting into the cavity of the abdomen.

The TREATMENT of these cases has usually been very simple. Shock has been cautiously combated, lest hemorrhage should be caused by a strongly acting heart, and opium given to quiet the patient and to prevent peristalsis. Feeding has been limited to ice and iced milk by mouth, together with enemata. Peritonitis has been met by opium, leeches, and warmth or ice. The mortality has been very high, and fully justifies the undertaking of serious measures, if they hold out any better hope than expectancy.

As regards shock, no improvement upon the old treatment (p. 166) has been suggested. In hemorrhage from a solid viscus, recognized early, Nussbaum recommends firm pressure around it by sponges and a bandage; perhaps Esmarch's bandage round the whole abdomen might raise the pressure sufficiently to limit extravasation. When the bleeding is too serious to be thus dealt with, extirpation has been proposed and carried out in the case of the spleen and kidney. As in ovariotomy and other operations, portions of the liver have been removed and bleeding dealt with by perchloride or the cautery, it might be possible to check hemorrhage from a rupture of this organ, if the tear could be discovered and exposed. Diffuse peritonitis should be dealt with as early as possible by operation (p. 603). If injury of the intestine, stomach, or gall-bladder can be recognized before the onset of peritonitis, laparotomy and suture (p. 611) should at once be practised.

Localized suppurations following upon injury may be recognized somewhat earlier by exploration with a fine needle; they should be opened as soon as possible, means being taken to insure adhesion to the abdominal wall if it does not already exist.

3. WOUNDS of all kinds occur and are divided into *non-penetrating* and *penetrating*. The former occur even in war, for pieces of shell sometimes

tear away flaps of skin and muscle, whilst bullets and bayonets may pass between the layers of the wall without penetrating. The dangers—suppuration, burrowing, and spread to the peritoneum—are to be guarded against by drainage, if necessary, and antiseptics.

4. Penetrating Wounds open the way to immediate infection of the peritoneum. The *diagnosis* between penetration and non-penetration in small wounds is difficult and, *per se*, of no importance, the treatment being the same; a probe should not be used without antiseptics. Penetrating stabs without injury of viscera do occur, but are rare; the intestine escaped 17 times in 185 stabs of the abdomens of corpses. But it is impossible in any given case to be sure that the viscera have sustained no injury. Assuming the absence of visceral complication, the surgeon should pass his finger into the wound (if it be large enough), to see that no intestine is beginning to protrude, and then cleanse and close it as usual; in mere punctures use no stitch, or only a superficial one. If, from the nature of the injury, it seem probable that intestine has been wounded, it would be right at once to enlarge the superficial wound and seek for and treat the injured bowel.

The *epigastric artery*, running from the middle of Poupart's ligament toward the xiphoid cartilage, has been wounded by stabs or even by an aspirator needle; enlarge the wound and tie both ends.

5. Wounds Complicated by Protrusion of Viscera are much commoner than simple penetrating; for prolapse occurs almost certainly with a sufficiently large wound. Not uncommonly, viscera are forced through small wounds, by coughing, vomiting or other effort of the belly muscles, and strangulated. The protruded viscus may be omentum, small or large intestine, spleen, kidney, or part of the liver. Shock varies much and also pain; thus we read of patients walking about with a kidney hanging from a wound in the loin, or a large part of their intestines wrapped up in their shirt and carried in their hat. If not reduced a layer of lymph soon forms upon the surface and tends to close the wound leading into the abdomen.

The prolapsed part, even the spleen, may become gangrenous and slough. Strangulation of intestine will, of course, cause the usual symptoms and perhaps sloughing and artificial anus. Lastly, the protruded viscus may be slightly or gravely wounded, and perhaps bleeding freely.

Prognosis.—Without early antiseptic treatment all such cases are very grave, although recovery has occurred when much of the intestines and stomach have been exposed for hours, perhaps dried and covered with sand.

Treatment.—The recognition of the protruding part is usually easy until it becomes covered with lymph. As, however, it is most important to know whether omentum is protruding alone or with intestine, lymph must be removed and the part carefully examined. Lung and spleen may resemble each other closely.

It must next be decided whether the protrusion should be returned to the abdomen or not. If it is not wounded, and likely to live, it should certainly be returned, even though no antiseptic is at hand; in which case, unless the part is dirty, water should not be used. To effect the return it is often necessary carefully to enlarge the wound in the wall. In the case of omentum exposed some time, after disinfection, draw out a little more and tie and cut off the protruded part. Viscera under like circumstances must, before return, be very thoroughly carbolized or mercurialized after removal of all lymph.

When the protruded part is going to slough or is already gangrenous, it is perhaps best to leave omentum alone; intestine must be opened and the stricture divided if necessary, or the gangrenous piece resected, according to the strength of the patient; the kidney may be tied and removed, and the spleen may be similarly treated, great care being taken not to open up the track to the peritoneum if it is closed.

The return or removal of an injured or bleeding part will depend upon the extent of the injury and our ability satisfactorily to check the hemorrhage.

6. Penetrating Wounds, with Injury of Viscera, but without Protrusion.—In the American War, viscera were wounded 3685 times in 3717 cases of penetrating wound, perhaps even more often; 14 times by thrusts and cuts, 3671 times by bullets. Among the latter were 79 wounds of the stomach, 653 of the intestine, 173 of the liver, 29 of the spleen, 5 of the pancreas, 78 of the kidney, 54 of bloodvessels, omentum, or mesentery, and in 2599 the nature was not stated—but only 186 are known to have recovered. Such injuries are extremely dangerous; 87 per cent. was the general mortality in the American War, and of 4863 collected by Nussbaum from various war statistics 80 per cent. died.

In punctured, gunshot, and small wounds, the difficulty in diagnosing the parts injured is almost as great as in subcutaneous ruptures (p. 605). The point at which the instrument entered the abdomen is known, but unless there is also an aperture of exit its direction and the depth to which it penetrated are probably unknown. The escape of bile, gas, or intestinal contents, etc., from the wound will be of great assistance; and the weapon may show traces of intestinal contents. Examination of the wound with a clean finger may be useful, especially in the discovery of bullets and foreign bodies. The latter symptoms are those given under rupture of viscera: and the dangers are the same, except that a septic wound greatly increases the chances of peritonitis and of suppuration.

Wounds of the Omentum can be recognized only by sight; their only danger is hemorrhage.

Wounds of the Liver and Gall-bladder are usually accompanied by wounds of other organs. Bile-stained fluid or bile sometimes (14 times in 61 cases, Mayer) escapes through the wound, and jaundice occurred only 24 times in 267 cases (p. 600). Of 59 gunshot wounds of the liver only 34 died; and of 114 complicated wounds, 74 died; of 51 punctured or incised, 26 died; of 12 cases resulting in abscess, 7 died (American War). Escape from early death does not mean safety, for the liver tissue, like that of the brain, is prone to chronic suppuration.

Wounds of the Spleen.—No special symptoms, except perhaps pain in the left shoulder. Hemorrhage is the greatest danger, then septic splenitis, perisplenitis, and peritonitis. Of 29 cases only 2 recovered.

Wounds of the Kidney present the same symptoms as ruptures, perhaps with the addition or escape of urine from the wound; the dangers are similar, but the chance of suppurative nephritis and perinephritis is much increased if the irritation of early sepsis is added to that of urine. Much will depend upon whether the wound is well placed to drain off the urine, and even more upon whether the peritoneum is sound or wounded. Of 78 cases, 52 died.

Wounds of the Pancreas are very rare: only 5 occurred in the American War. Bleeding was free, but easily checked, as the pancreas usually prolapsed. Injury of other organs, especially the stomach, is almost always present.

Wounds of the Stomach are, of course, favored by its distention, and also rendered more serious; for extravasation and wound of the large vessels along the great curvature are more probable. Of 79 American cases, 60 died. The situation of the wound, early vomiting, with fresh blood in the ejecta, and escape of acid stomach contents externally are the most reliable signs. Shock may be great, but is usually recovered from ; bleeding is slight unless some large vessel is wounded ; and extravasation in quantity through a small wound is less likely than in the intestine on account of the thicker mucosa which protrudes. Consequently a fistula or abscess is somewhat more likely to form.

Wounds of the Intestine are much the commonest complication of perforating wounds; the compressibility of the bowels and the ease with which they move upon each other enable them occasionally to escape, but scarcely from any really pointed weapon or rapidly moving ball. Rarely, too, a wound may be immediately blocked by the pressure of a tensely filled coil, adhesion occurs, and the diagnosis of wound is made only *post mortem*, or not at all. But extravasation does not invariably occur even when the patient lives many hours after transverse section of the small bowel; it is resisted by the close apposition of other parts, under the pressure of the abdominal muscles, and by the rapidity with which fibrinous adhesions form among them, whilst a small wound, an empty bowel, solid contents (large gut), correspondence of the visceral and parietal wounds, and arrest of peristalsis are unfavorable to its occurrence. Peristalsis is, however, more likely to be arrested with large than small wounds. Rarely a bullet solders perforated gut to the wound in the wall (p. 587), or sticks together two hollow viscera leading to a *fistula bimucosa*.

Experiment has shown that extravasation may not take place through a wound one-third of an inch or less in length, especially if transverse; for such is more or less completely blocked by protruding mucous membrane, round which the circular fibres are strongly contracted. The closure is less firm in longitudinal wounds. In complete transverse division the circular fibres contracting round the protruding and everted mucosa may quite close the lumen for a considerable time. Such closure by mucous membrane cannot be regarded as aseptic or safe ; but from a small wound extravasation is likely to be slight and easily circumscribed.

Fortunately injured intestine usually protrudes; when it does not, its *diagnosis* may be impossible when the wound is small and the injured gut does not lie beneath it. The most reliable signs are: escape of the contents of large or small gut, rapid tympanites, escape of gas from the wound and frequent early vomiting. Bleeding is usually slight, but blood *may* be vomited or passed *per anum*. Shock, if very marked, is probably owing to injury of nerve-plexuses, or of other viscera; but a bullet or sword passing through the abdomen may wound the intestine in three or four places.

The *prognosis*, if the dangers of shock and hemorrhage are passed, depends chiefly upon the early recognition and proper treatment of the lesion. With regard to bullet wounds, Otis could find no undoubted cases of recovery from such during the American War. Guthrie gives the histories of the survivors —six in number—out of many hundreds of such wounds occurring during the Peninsular War; in one the stomach was wounded, in one the bowel sloughed on the seventh day, and the remaining four were wounds of the large bowel.

Treatment.—When there is a large wound through which it is obvious that certain viscera are injured, the treatment should be such as would be adopted if the injured viscera were prolapsed (p. 608), coupled with *la toilette du péritoine* and drainage, if this membrane is seriously infected.

When there is only a small bullet wound or punctured opening, or perhaps apertures of entry and exit, the treatment approximates to that of subcutaneous ruptures of the viscera; but the surgeon's first care should be to guard the peritoneum from infection through the wound. Then *shock* must be treated. If *bleeding* is at all free from the external wound, and comes from an intra-abdominal vessel, try pressure so adapted as not to close the wound and force the blood back into the cavity. If this fail, enlarge the wound and seek for the source of hemorrhage, which will probably be some large vessel close by. A few stitches, the cautery, or perchloride may stop the bleeding, or extirpation of the whole or part of an organ may be required. The latter course is necessary in uncontrollable hemorrhage, and probably in wounds of the kidney and of the peritoneum over it, to prevent peritonitis from extravasation of urine. If injury to intestine may also have occurred, or peritonitis is present, abdominal would be preferable to lumbar nephrectomy, even though the wound were in the loin.

A patient apparently dying from hemorrhages should have the chance of laparotomy, if there be any guide as to the region whence the blood comes.

Evidence of injury to the gall-bladder, stomach, or intestine, except non-peritoneal parts of the large gut, necessitates enlargement of the wound, or, if this be inconveniently placed, or doubtfully related to the injured bowel, section in the mid-line and treatment of the damaged viscus. Clean-cut wounds, even gunshot, should be sutured ; slight laceration may be removed by trimming with scissors, but extensive laceration will require resection of the part. In each of the above cases, however, an artificial anus, which may be closed later, should be established, if the patient's condition does not justify so prolonged an operation as suture or resection.

Dr. Parkes, of Chicago, saved the lives of nine out of nineteen dogs, after shooting them through the abdomen and allowing extravasation to occur, by laparotomy and suture of the wounds of the intestine. Kocher and Bull have each operated successfully on man three and seventeen hours respectively after bullet-wound of the stomach and of the intestine. Tiling sewed up a punctured wound of the stomach and saved the life of the patient (St. Petersb. *Med. Wochenschr.*, 1884, No. 44).

When the abdomen has been penetrated or traversed by some weapon, but there is no sign of severe hemorrhage, or of injury to viscera, choice must be made between opium treatment and an exploratory laparotomy. In favor of the former would be any reason for believing that the intestine was not damaged, or that, if damaged, the wound was decidedly less than one-third of an inch long. But, as a rule, if wound of gut is likely to have occurred, enlarge the wound and examine the parts lying near. See a case of stab thus treated by Barker (*Lancet*, 1886, vol. i. p. 347). Should signs of diffuse peritonitis occur under the opium treatment, laparotomy should be performed, and the peritoneum cleansed ; but it is likely to be too late.

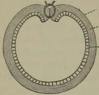
It will be perceived that the treatment recommended throughout in injuries of the abdomen is based upon their high mortality and the causes of death under the opium plan, and a knowledge of the way in which these causes have been set aside in ovariotomy. Rash laparotomy is not counselled. In the treatment of internal hemorrhage, especially, the indications should be clear, lest the shock of the operation be added to that of nerve-injury ; even when the region traversed or injured is known, it may be very difficult to find the bleeding vessels. No one questions its advisability when intestine is certainly wounded, and the rarity of simple penetrating wounds is such as to justify exploratory operation in most cases which affect the intestinal region. Lastly, if by its means local infection and fluids ready to decompose, or decomposing, can be removed and septic peritonitis be warded off or checked, laparotomy will be a great boon. It must be admitted that it is an operation which requires considerable experience and plenty of time to gain the best results.

Sutures for Wounds of Hollow Viscera.—These are planned to bring together the serous surfaces, and, when possible, to avoid piercing the mucosa—partly that the contents of the viscus may not soak out along the thread and render the wound septic, and partly that the usually everted mucosa may have less chance of intervening between the serous layers. The threads are, therefore, passed from the serous, through or beneath the muscular, coat and out again through the serous; they enter about one-eighth of an inch from the edge of the wound, come out one-eighth of an inch further away (Fig. 213), and are placed one-twelfth to one-tenth of an inch apart. It is very difficult to avoid the mucosa in distended small gut. Fine carbolized Chinese twist is the best material for the sutures.

The *continuous* or *Glover's suture* is often employed, and acts well; it can be introduced much more rapidly than any other—a matter often of great importance. But if one stitch cuts out the rest may loosen.

Lembert's suture (Fig. 213) is most commonly used; it differs from the above chiefly in being discontinuous. The *Czerny-Lembert* suture begins

FIG. 213.



Lembert's suture.

with a series of stitches uniting the edges of the serous membrane; and to these is added a series of Lembert's sutures.

These stitches can be used, not only in wounds, but also in complete transverse division of the bowel, and are probably the best. Treves, however, prefers, in the latter case, first to unite the projecting mucosa by about fifteen stitches, and then to insert some twenty-five Lembert's. In either case, the insertion of stitches should begin at the mesentery. Jobert's method of invaginating the upper end (not always easily recognized) into the lower, of which the serous coat has been inverted all round for half an inch, is rarely used.

RESECTION OF THE INTESTINE may (1) be followed at once by suture of the ends, return of the bowel to the abdomen, and closure of the parietal wound; or (2) an artificial anus may be established, and closed subsequently if the patient survive. The latter method is to be preferred when the patient is at all exhausted.

The following directions will serve whether the resection be undertaken for injury or disease. In the latter case, in the absence of very clear indication to the contrary, the mid-line below the navel is to be preferred for the preliminary incision. Where a new growth can be localized in the ascending or descending colon, a colotomy incision is the best.

1. Draw out the coil of intestine until healthy bowel is well exposed, close the abdominal wound with sutures as far as the protruding loop will permit, or plug the wound with warm carbolized sponges. Clamp each end well beyond the seat of disease with Bishop's clamp, and cut away the diseased segment of bowel with scissors, taking care to protect the peritoneal cavity, by means of a sponge placed beneath the bowel to be excised.

Remove a corresponding wedge of the mesentery, but that the blood-supply of the cut ends of intestine may be as perfect as possible, let the base of the wedge be less, by half an inch at either end, than the distance between the ends of the bowel; tie all vessels and bring the cut edges together with sutures. Approximate the ends of the intestine by screwing up the clamp, and unite them by one of the methods given above. Remove the clamps, gently wash the groove of union and the exposed loop with an antiseptic, replace the loop in the abdominal cavity, and close the wound in the parietes.

2. Proceed as above as far as the closure of the gap in the mesentery. Then remove the lower clamp and secure the margin of the divided intestine to the edges of the abdominal wound. Close the parietal wound as far as possible, plug the remaining aperture carefully, and then draw the upper segment of the bowel well out of the wound, remove its clamp and allow the intestinal contents to escape. Now unite its margin to those of the parietal wound and of the lower piece of bowel.

CHAPTER XL.

HERNIA.

Nature and Causes of Hernia Generally.

Definition.—Hernia signifies a protrusion of *any* viscus from its natural cavity; but, unqualified, it means a protrusion of the abdominal viscera.

Causes.—The abdominal viscera are frequently and violently compressed by the muscles surrounding them. We may say that, to prevent hernia, every square inch of the abdominal wall should be able to resist the highest intra-abdominal pressure which the action of the muscles of the wall can produce. In a strong man this is so, and we may therefore say that rupture is always the result of defective resisting power on the part of the wall. Many a person, however, is obviously predisposed to rupture, yet does not acquire one, as he leads a sedentary life, with no strong exertion; again, some spot in the wall is so feeble that no special exertion is required to cause a viscus to force its way through it.

The *exciting* cause—that which drives viscera from the cavity—is always compression of the viscera by the abdominal muscles. Hence hernia results frequently from violent exertion, especially lifting heavy weights, rowing, bicycling, and the like, in which the hips are partly flexed and the aponeuroses of the groin relaxed. It is not uncommon in cases of stone or stricture, and in children with phimosis, from the frequent straining to pass water.

The *predisposing* cause is a weakness of the parietes of the abdomen, which may be variously produced. (1) Certain parts are apt to be feebly developed—*e.g.*, the umbilical scar and the region of the inguinal canal. Many groins bulge out as the patient stands, owing to weakness of the transversalis and internal oblique, which latter probably arises from only the outer third of Poupart's ligament, and scarcely covers the deep ring; the superficial ring is often large, and the intercolumnar fibres weak. Constant distention of the abdomen during childhood probably leads to this condition. The crural ring is naturally a weak spot. (2) The abdominal parietes may be weak from actual malformation—*e. g.*, the recti may be widely separate, the anterior wall wanting as in ektopia vesicæ, the funicular process of peritoneum may not be closed, the testis may be late in its descent or retained in the canal, dilating it and preventing closure of the peritoneum in either case. (3) They may be weakened by injury or disease, or by distention by the pregnant uterus, obesity, dropsy, or a tumor. (4) Weakness and emaciation cause removal of fat which had previously fortified an orifice (crural) predisposed to hernia. (5) The mesentery and other serous folds must be unnaturally elongated to allow viscera to leave the abdomen. This is usually secondary, due to dragging of the viscus which is passing through the aperture, but both mesentery and omentum may be abnormally long. (6) Heredity appears in about thirty-four per cent. of the cases, and among these about twelve per cent. occur in the first year. Weakness of the inguinal region, late descent of the testis, great width from the anterior iliac to the pubic spine, and unusual length of mesentery are likely to be hereditary.

Structure.—A hernia consists almost always of a sac and its *contents*.

Contents.—The viscera most liable to hernial protrusion are the small intestine, omentum, and arch of the colon. But all except the pancreas (even the gravid uterus) have occasionally been found protruded, partially or entirely—especially in cases of congenital deficiency of the abdominal parietes.

The *sac* of a hernia is a portion of the *parietal* layer of peritoneum which the protruding viscera push before them in the form of a containing pouch. It soon adheres to the surrounding cellular tissue, and does not return into the abdomen when the viscera are replaced; although a hernia may rarely be pushed back *en masse*, sac and all, without the use of any great force in taxis. As the hernia increases in size, the sac also increases—partly by growth, partly by distention, but chiefly by dragging down of more peritoneum. Sometimes it diminishes in thickness whilst increasing in capacity, especially in umbilical and ventral herniæ; in the groin, it usually thickens and becomes more opaque as it grows older. Its *neck* (the narrow part which communicates with the abdomen) is always puckered from the pressure of the muscular or ligamentous ring which surrounds it, and, if the hernia is kept up, the folds at the neck grow together, and thicken, and contract, perhaps effecting a cure. If not, a small aperture in very dense tissue is left, and strangulation is very probable, if a rupture which has been well kept up for years is at last forced down. Sometimes the sac has two constricted portions or *necks*—either because (as in oblique inguinal hernia) it passes through two tendinous apertures (the external and internal abdominal rings), or because the original neck has been pushed down by a fresh protrusion above it. Some herniæ are destitute of, or imperfectly covered by, a sac. This may happen—(1) If the whole of a protruded viscus is not naturally covered by peritoneum—as the bladder; the cæcum, though completely covered, may shell out of its peritoneum as it descends. (2) If the hernia occur at once in consequence of rupture of peritoneum and muscles. (3) In some cases of congenital umbilical hernia. (4) Hernia may be considered as virtually sacless, if the sac has been burst by a blow, or become entirely adherent to its contents. Instances, again, are known in which two peritoneal sacs have protruded through one and the same aperture in the abdominal parietes, or another sac has come down within a previously existing one, or two separated protrusions have occurred in a single sac (case by H. Lee, *Med. Chir. Trans.*, vol. li. p. 93).

Division.—Hernia is divided into several species, the chief of which are named—1, according to the *situation*—inguinal, femoral, etc.; and 2, according to the *condition of the protruded viscera*—which may be (*a*) *reducible*, or returnable into the abdomen ; (*b*) *irreducible*, that is, not returnable into the abdomen, but without constriction; or (*c*) *strangulated*—that is, subject to constriction, which not only prevents their return into the abdomen, but also interferes with the passage of their contents, and with their circulation.

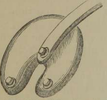
Reducible Hernia.

Symptoms.—A soft, compressible swelling appears at some part of the abdominal parietes. It increases in size when the patient stands up; it has an "impulse"—*i. e.*, if grasped, it is found to dilate when he coughs or strains; and it diminishes or disappears when he lies down, or when properly directed pressure is made upon it, but sometimes an omental hernia is irreducible from the first. If the sac contain intestine only (*enterocele*), the tumor is smooth, rounded, and elastic; *borborygmi* (or flatulent croakings) are occasionally heard in it; it is resonant on percussion, and when pressed upon the bowel returns into the abdomen with a sudden jerk and gurgling noise. If it contain omentum only (*epiplocele*), the swelling is inelastic, doughy, and often knotty and unequal to the touch; it is non-resonant; the impulse is slight, not expansile, but of the nature of a push of the mass out from the abdomen; and when pressed, it returns without noise and slowly, the pressure requiring to be continued till it has disappeared. But very often a hernial sac contains both intestine and omentum (*entero-epiplocele*, from κήλη, *tumor;* ἔντερον, *intestinum;* and ἐπίπλοον, *omentum*); and frequently it is impossible to ascertain its exact contents by any external examination.

Treatment.—This may be palliative or radical. The palliative plan is to employ a *truss*, an instrument consisting of a pad placed on the seat of protrusion, and of a band or steel spring passing round the body, and pressing the pad with the requisite degree of force. In writing for an inguinal or femoral truss, it is usual to give the circumference of the body at the hips, midway between the spine of the ileum and the trochanter; and it is better also to add the distance of the centre of the hernial opening from the point last named, and its distance below the above circle round the body. To test the efficacy of a truss, let the patient bend well over the back of a chair to relax the oblique aponeurosis, and endeavor with all his strength to force it into the ground; also let him cough strongly in this position. If the rupture does not escape the fit of the pad and strength of the spring are suitable: comfort and the ability to retain its place depend upon the curve of the spring and minor points of which wear is the only test. Professor John Wood is doubtless right in urging, among other things, that the truss-pad should have a flat surface instead of the markedly rounded one commonly used, which tends to act as a wedge and to widen the aperture in the wall over which it is placed. It is advisable, also, that the pad should be non-absorbent—*i. e.*, made of ivory, ebony, vulcanite, or boxwood. A pad filled with sand, or an India-rubber air-bag, may act best with tender skins. The pad must extend well beyond the edge of the aperture. The spring must be of strength proportioned to the size of the hernial aperture and to the power of the patient's abdominal muscles. It should be nickel-plated, or covered with vulcanite; and patients often like a layer of flannel or linen, which can be washed, wrapped round the whole instrument. For cheap trusses, basil leather is a better covering than chamois, as it does not get so foul. The patient must expect to find the truss rather irksome for the first week. It should be constantly worn by day; and if the patient will submit to wear it at night also so much the better. If not, he should apply it in the morning, before he rises from the recumbent position. The skin of the part which it presses upon should be regularly washed, bathed with eau-de-Cologne, or spirit, and dusted with fuller's earth, or violet powder, to prevent chafing.

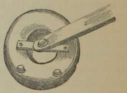
There are some cases in which the common truss fails to keep up a rupture comfortably, and for these the surgeon should try other instruments, which are, for the most part, the property of various individuals; each claims some peculiarity adapting it to particular cases. The *Moc-Main lever truss* has a belt passing round the body, instead of a circular spring; and pressure on the pad is effected by a strap passing under the thigh and acting on a spring-lever attached to the pad. *Salmon & Ody's self-adjusting truss* has a pad revolving on a ball and socket, with a half-spring acting from a flat back-pad and placed on the opposite side of the pelvis, so as to push outward and upward upon the hernial aperture. The *Maidstone truss* allows the pad to slide on the spring, so that the circumference of the instrument may be adapted to the varying size or movements of the body. *Adams's graduated pressure truss* has two springs of different curves; by sliding one on the other the amount of pressure may be varied. Instead of a steel spring, an elastic India-rubber belt may be used; such trusses are constructed by Bourjeaud. For umbilical or ventral hernia an *India-rubber band* and *pad* generally answer. Among the more expensive trusses Professor Wood's are, perhaps, the best. They have been employed with much success in curing small herniæ, as well as in keeping up and preventing the increase of those for which an operation for radical cure has not been deemed advisable. These trusses are of four kinds, viz., *inguinal—oblique* and *direct; femoral*, and *umbilical.* They are all based on a distinct principle, that of applying pressure by a *flat* pad *at the sides* of the hernial opening, instead of in the *axis.* The pad for *oblique* inguinal rupture is of the shape of an obliquely curved horse-shoe, the outer limb, which presses upon Poupart's ligament, being shorter than the inner, which is laid over the inner pillar of the ring (Fig. 214). The curve of the horseshoe is placed over the deep hernial opening, and the bearing of the side-spring is exactly in the centre of the pad. The hard surface may be covered by an India-rubber water-bag of the shape of the

Fig. 214.



Wood's pad for oblique inguinal hernia.

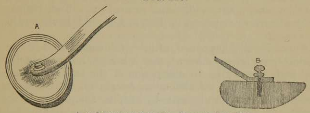
Fig. 215.



Wood's pad for direct inguinal hernia.

pad. The pad for *direct* inguinal hernia is an ovate ring, the hole in the middle corresponding to the axis of the hernial opening. This exerts its chief pressure upon the margins, preventing their giving and enlarging under the pressure of the bowels (Fig. 215). The double bearing of the horseshoe and ring pad enables them, under sufficient pressure of the side-spring, to keep in place better than the convex pads, while the tension of the integuments across the opening prevents the rupture from emerging there. In the former kind, the spermatic cord and pubic spine escape the pressure of the pad by sliding and lying in the cleft or opening. For large and difficult cases of inguinal rupture Mr. Wood employs a double or twin pad, each half of which presses upon each of the pillars of the ring or sides of the neck of the sac. The spring goes entirely round both hips, one end pressing upon the inner, and the other on the outer, of the half-pads, so that any increase of pressure can be made upon either half that may be desirable. The two pads are bound together by a transverse strap. Thus a lateral as well as a backward pressure is kept up. The pad for *crural* hernia is egg-shaped in outline, its bearing surface being flattened for pressure upon the front wall of the crural canal, its upper border rounded to support Poupart's ligament, and its lower tapered off to accommodate itself to the saphenous opening (Fig. 216 A; B shows a section).

Fig. 216.



A, pad for femoral hernia; B, same, in section.

Radical Cure.—If the patient is below the age of puberty, or not much above it, and if the hernia has not existed very long, a proper truss, if constantly worn, will, in many cases, effect a permanent cure. No longer subject to distention, the neck of the sac and the fibrous ring around it become contracted and finally obliterated. This cure may, perhaps, occur in two or three years; but, as a measure of precaution, the truss should be worn for two years more. This result is most frequent with the umbilical and other herniæ of infants; in adult patients treatment by truss is rarely other than palliative, and must be continued throughout life. Of late years numerous operations have been devised for the radical cure of hernia, and the simplest and best of them are now frequently practised (*see* "Special Hernia").

Irreducible Hernia.

Definition.—Hernia is said to be *irreducible*, simply, when the protruded viscera cannot be returned into the abdomen; although there is no impediment to the passage of their contents, or to the circulation of the blood through their tissues. Very often it is omentum only that is irreducible; but this may prevent the wearing of a truss, and always keeps open a passage down which bowel may be forced.

Causes.—Hernia may be rendered irreducible—(1) By an adhesion of the sac to its contents, or of the latter to each other, or by membranous bands formed across the sac. (2) By enlargement of the omentum or mesentery from development of fat and from fibroid thickening, due to constriction at the ring where the mass is atrophied and may consist of fibrous tissue only. (3) From the absence of a sac in herniæ of the bladder or cæcum, permitting these viscera to adhere directly to surrounding parts.

Consequences.—Irreducible hernia may produce many inconveniences. It frequently tends to increase steadily until most of the bowels may be in the scrotum or labium, the penis being buried or the vagina closed. The patient is liable to dragging pains in the abdomen and perhaps attacks of vomiting, which come on after food or when he or she assumes the erect posture, because fixation of the protruded omentum resists all upward movements of the stomach. These inconveniences will be greatly aggravated if the patient becomes fat or pregnant. The protruded bowels being deprived of the support naturally afforded them by the abdominal muscles, their feculent contents are apt to lodge in them, causing swelling, tension, colic, constipation, perhaps vomiting and diminished impulse (*incarcerated hernia*). Irreducible herniæ are much exposed to injury, and from this and other causes may become *inflamed;* these symptoms of obstruction arise in combination with signs of local inflammation and of peritonitis spreading from the sac. Lastly, the bowel is in constant hazard of strangulation.

TREATMENT.—This may be either palliative or radical. (1) The *palliative* treatment consists in applying a bag-truss, or a truss with a hollow pad or circular India-rubber water-pad, that shall firmly embrace and protect the hernia and prevent any additional protrusion. The patient should avoid all violent exertion or excess in diet, and should never let his bowels be confined.

(2) It has occasionally happened, after confinement to bed for several weeks with some emaciating ailment, that a hernia, irreducible before, has been replaced with ease, owing to absorption of the fat of the omentum or mesentery, and relaxation of the abdominal apertures. The same result has in some cases been effected also by art—by keeping the patient in the recumbent posture, and on very low diet for six weeks or two months, by the frequent use of clysters and laxatives, and by maintaining a constant equable pressure on the tumor by means of a bag-truss made to lace over it, a bag of shot or sand, or an India-rubber bandage. This plan is very uncertain as to its results, and will be effectually defeated if there are any adhesions; besides, there are not many patients who will submit to it. It will be more likely to succeed if the hernia is omental than if it contain intestine. It is now rarely, if ever, used.

(3) Operative treatment varies in details with the variety of hernia; *see* "radical cure" and special varieties of hernia.

When *incarcerated hernia* is diagnosed, suitable diet, gentle taxis, large enemata form the treatment; purgative enema or a sharp purge by mouth may be given, if strangulation is certainly eliminated. *Inflamed hernia* is treated by leeching, belladonna fomentations, and opium.

STRANGULATED HERNIA.

DEFINITION.—Hernia is said to be *strangulated* when it is so constricted that intestinal contents cannot be propelled through the protruded bowel, and that its circulation is also impeded—more or less. These two factors must be kept distinct. The herniæ most likely to become strangulated are those produced by one violent effort, herniæ which have been well kept up by a truss and are suddenly forced down, and irreducible omental herniæ into which a coil of gut is pressed. Usually the whole width of a coil of intestine is strangulated, and the coil may vary in length from a few inches to several feet. Rarely only a part of the lumen on the convexity is nipped (*Littre's hernia*), but the obstruction to feces, even here is, as a rule, complete, owing to the spur formed by the sudden kink; the symptoms are usually not severe.

PATHOLOGY.—The *seat of stricture* varies with the different kinds of hernia (*see* "Special Herniæ"). Usually it is at the neck of the sac, and is due to thickening of the peritoneum (p. 614), or to tendinous bands external to the sac. In some cases the bowel has been constricted by membranous bands, or by fissures in the omentum within the sac itself, or by an old neck of the sac which has been pushed down lower. The aperture does not actively constrict the parts protruded through it; these either are too large from the first, or swell and press against the margins.

A hernia may be at once strangulated upon its first descent, the aperture through which it passes being so small as to prevent not only the onward passage of bowel contents, but also the entry of arterial blood. In this case, which is rare, the bowel, even after some hours, is but little changed in appearance; but infarction, in proportion to the duration of the constriction, or gangrene, follows its return to the abdomen, as in Cohnheim's experiment upon the rabbit's ear (p. 41); but the intestine suffers much earlier. Much more commonly the hernial aperture, whilst arresting the bowel contents, and, to greater or less extent, the escape of venous blood, permits the entry of arterial. The result is venous congestion, with swelling of the bowel from effusion between its coats and into its lumen, leading to its complete constriction with arrest of arterial supply. Before this occurs the bowel becomes purple or deep red, hemorrhages appear beneath the serosa, and then run together into a bloody infiltration. Fluid, which is at first clear, serous, and then more or less deeply blood-stained, escapes into the sac, and, mixed with mucus, into the strangulated gut. The protruded bowel may die *en masse;* it then loses its polish, becomes very dark and friable, and may either remain tense or shrink. As the coat of the bowel dies it permits the passage of gases, fluids, and organisms from its interior; and the fluid in the sac becomes turbid and offensive. Then, as a consequence of putrefaction, the bowel-wall often becomes ash-gray everywhere, or in patches; ultimately it may burst into the sac or peritoneum, especially if taxis be employed. As these latter changes occur the integuments over the rupture usually become infected; they swell, a livid red blush appears upon the skin, and crepitation from presence of putrid gases in the tissues may be discovered; or gas may be found only on section of the tissues, which are infiltrated with a thin, offensive pus. The opening of such an abscess results in an *artificial anus.* It will be noticed that the bowel presents, in these cases, a typical example of moist gangrene. Here, as elsewhere, it is difficult or impossible to be sure that gangrene has occurred until signs of putrefaction are present. In other cases, as a consequence of pressure against a sharp constricting edge, ulceration of the mucosa may occur and end in perforation, either on the abdominal or hernial side of the stricture, or the wall of the gut may necrose at this spot. Apparently the healing of such an ulcer may cause narrowing of the bowel.

In another set of cases the constriction interferes chiefly with the passage of bowel contents. I have operated on a patient moribund after a week of mild symptoms of strangulation, and have found a small knuckle of bowel with a large mass of omentum in the sac; neither showed any signs even of congestion. But all degrees are met with between these cases and those above described. When interference with the circulation does not increase rapidly, inflammation, with formation of lymph, or even pus, occasionally occurs.

In all these instances it is surprising how rarely diffuse peritonitis occurs, the explanation being that whenever inflammation, perforation, or gangrene occurs in the sac, lymph glues the intestines to the abdominal wall around the neck. Sometimes, however, this fails to protect. After reduction of a strangulated hernia by taxis a sharp attack of peritonitis may occur; the intestine probably inflames after the anæmia, and perhaps allows infective irritants to transude; it almost always subsides under treatment. Sometimes peritonitis results from the reduction of gut, which inflames and dies after reduction; but a small slough may separate into the bowel when this early contracts adhesions, or feces may escape through an operation wound (*fecal fistula*).

The bowel above a hernia is more or less distended and injected, full of offensive yellow fluid, which, low down, is often bloody; the hyperæmia is probably the result of strong peristalsis, and leads to free secretion into the bowel. Below a strangulated rupture the intestine is collapsed.

SYMPTOMS.—The patient, usually after some effort, first complains of more or less sudden, griping *pain*, often referred to the navel. At the same time he may be conscious that something has "given way" in the region of the groin or elsewhere, and there may be pain at the seat of rupture; but local pain and knowledge of the existence of a swelling may be quite wanting, and the pain in the abdomen may be slight. In acute cases there is more or less *shock*, from compression of the nerves of the bowel, and there may be immediate or speedy *vomiting* of the stomach contents; but in less acute instances vomiting is usually preceded by a desire to go to stool, with inability to pass anything—reflex inhibition. If, however, the lower bowel is full, one or two stools *may* occasionally pass; usually *constipation is absolute* from the first. (It should be remembered that when an enema is given wind may be introduced into the bowel and subsequently expelled.) Vomiting may be incessant or infrequent, perhaps brought on by the taking of medicine, food, or drink; the vomit is at first stomach contents, then bilious, and finally, *stercoraceous*—*i. e.*, having a feculent odor owing to long delay in the small gut—*true* fæx being rarely ejected. This vomiting was formerly attributed to the recurrence of inverted peristalsis, which experiments on animals have proved; but it will not account for all the facts. Brinton maintained that peristalsis was not inverted but usual, and that it passed the outer layer of the contents of the bowel down toward the hernia, whence an axial stream was reflected toward the stomach. The hernial tumor, if irreducible, is usually larger than usual, tense, and somewhat tender, but it may be lax; no part of it can be replaced. There is *no impulse* in it on coughing, for communication with intestine in the abdomen is practically interrupted; when the tumor has a neck it may be found that the impulse ceases at a certain point, just above the stricture, whilst the sense of fluctuation, obtained when the body of the sac is compressed with one hand whilst the fingers of the other grasp the neck, ceases just below it, and thus the point of stricture may be localized. The abdomen becomes more or less swollen and painful, and it is often impossible to say certainly that peritonitis is not present.

After a variable time, according to the severity of the symptoms, signs of *cardiac failure* appear—small, frequent, compressible pulse, cold extremities, clammy, sweaty skin, and sunken features (*facies Hippocratica*).

The symptoms of strangulation vary according as the constriction is tight or lax, though the difference is one of degree only. In *acute* cases the onset is sudden, shock considerable, pain and other symptoms severe; in *chronic* cases intensity is lacking, the rupture may be soft, the bowels may have acted once or twice with or without an enema, vomiting may be infrequent, or even absent, unless food or a purgative is given, yet the pulse shows that the patient is sinking from starvation and exhaustion. Mistakes have often been made in these cases: doubt being felt as to whether strangulation exists, or operation being postponed until too late. A patient with an irreducible swelling like a hernia anywhere, and symptoms of chronic obstruction should be operated on as soon as other means have failed.

The onset of *diffuse suppurative peritonitis* before (or after) operation may be quite unrecognizable, all its signs but those of cardiac failure and swelling of the abdomen being absent; it is rare unless the hernia has been reduced.

Gangrene may be found quite unexpectedly, but is usually indicated by collapse, hiccough, foul tongue and breath, cessation of pain, and, locally, diffuse swelling and loss of shape of the tumor from emphysema and inflammation of the coverings, whilst the skin shows a livid blush.

The *diagnosis* of strangulated hernia is at times difficult. (1) *The patient may not be aware that he has a hernia*, or, if aware of it, may think it of no consequence, or may be deterred by false shame from mentioning it. Thus, an elderly clergyman consulted the author respecting various dyspeptic symptoms—nausea, loss of appetite, painful dragging at the stomach, and irregularity of the bowels. When asked if he was ruptured he said that he had never thought it worth mentioning, but that whilst preaching, some time ago, he had felt something come down into the scrotum. He had in reality a large double scrotal rupture, which was the cause of his dyspepsia. When, therefore, a patient is affected with vomiting and constipation, especially if the face is pinched and anxious, the surgeon should examine for himself—first, the *ordinary* seats of hernia, such as the inguinal and femoral rings and the umbilicus; and then the *extraordinary*, such as the linea alba, and the thyroid and ischiatic foramina. It would be a sad thing to be treating a patient for inflammation, and let him die of strangulated intestine, which might be relieved by operation.

(2) *The patient may have a tumor* at one of the common seats of rupture, *which is yet no hernia*—*e. g.*, an enlarged gland at the bend of the thigh. Yet if, with such a tumor, the patient have decided symptoms of strangulation, the surgeon should not hesitate to cut down upon it. A small hernia has often been found behind such a tumor; and in any such case the rule is—*if in doubt, operate.*

(3) There is on record a series of cases in which only *gangrenous* or *inflamed omentum* has been found in the sac. This may occur simply as the result of constriction, extreme or moderate, or the strangulation may be brought about by injury leading to swelling of the incarcerated omentum. The symptoms have been those of subacute or chronic strangulation, and the treatment is the same.

(4) From *obstructed* and *inflamed irreducible hernia* the diagnosis is based chiefly upon the absence of intensity and completeness in the symptoms of obstruction, upon distinct signs of peritonitis spreading from the sac, and upon the history of a cause for one or other of the above conditions. Failure of treatment, and persistence or increase of signs of strangulation, necessitate operation.

(5) *The patient may have a hernia*, reducible or irreducible, which yet is *not the cause of the symptoms.* (*a*) There are numberless causes of internal strangulation which may exist along with a hernia. (*b*) *Acute general peritonitis combined with an irreducible hernia*, chiefly omental and without impulse, may cause grave difficulty; for the constipation may be absolute and the vomiting feculent. It is the surgeon's duty in case of doubt to examine the hernial swelling; if this will not account for the symptoms, the treatment of peritonitis must be further considered. (*c*) The *vomiting and constipation of early pregnancy* with a retroverted uterus have, in cases of irreducible hernia, caused difficulty. (*d*) I have seen a case of slightly strangulated femoral hernia in which the symptoms persisted after reduction by taxis, the vomit being bloody; the sac was cut down upon and opened, and the patient died of septicæmia. Multiple ulcers of the stomach were found, to which most of the vomiting before reduction was probably attributable.

(6) *There may be two herniæ.* When both sacs are lax, it may be difficult to decide which is strangulated: pain, tenderness, greater tension, and complete absence of impulse on the affected side must be relied on. Again, both herniæ may be strangulated: one may be large and reducible without much trouble; the other, small and concealed by fat, which may be discoverable only where laparotomy is done to seek an internal cause.

(7) *A strangulated hernia may seem to be reducible.* The patient or his friends may have partially reduced a hernia *en masse*, and upon coughing, bowel may be forced down from an inner to an outer portion of the now hour-glass sac, being easily reducible. A swelling is often felt deeply, the ring is wide, and the hernia when apparently reduced may be felt by a finger introduced through it. The treatment in case of doubt is exploratory operation.

(8) An *inflamed, undescended testis* may cause symptoms of strangulation. The state of the pulse is most important in giving a *prognosis;* if it is of bad quality, one must be guarded if an operation is required, even in the absence of the other symptoms above mentioned. After days of strangulation with slight symptoms the patient may be suffering but little, be able to walk to the operating table and have considerable physical strength, yet if the pulse shows much cardiac weakness, death from asthenia is very likely even after a successful operation.

TREATMENT.—The indications are to return the hernial contents, especially bowel, to the abdomen, either by taxis or by cutting operation.

TAXIS.—This is a Greek word, used to signify the acts of gentle pressure with the hands by which ruptures are reduced. The bladder having been emptied, the patient should lie down in an attitude of complete repose, and be put under the influence of chloroform; if this be not used, he may be made to lie in a warm bath, and both his thighs should be raised toward the belly, and placed close to each other, so that every muscle and ligament connected with the abdomen may be relaxed. If not narcotized he should be engaged in conversation, to prevent him from straining with his respiratory muscles. In order effectually to remove the expulsive force of the diaphragm, Dr. Buchanan directs the patient to make a deep expiration, and to abstain from drawing in the breath as long as possible. Then the surgeon, if the tumor be large, places upon the fundus the palm of one hand and gently compresses it, so as to squeeze out a little flatus and venous blood, and with the fingers and thumb of the other hand gently kneads the parts at the neck of the tumor, occasionally drawing them very gently downward, in order, if possible, to dislodge them. It is well so to support the neck that the sac shall not wrinkle here when the fundus is pressed upon, but remain like a funnel leading to the abdomen; and, still more important, the constant pressure of the fingers round the neck prevents the intestine from bulging out just external to the hernial opening. This operation may be continued for a quarter or half an hour at the outside, if the tumor is not painful; not so long as it is tender. At last, perhaps, the surgeon will be rewarded by hearing the gurgling sound accompanying the return of a portion of intestine; and by feeling the bowel slip from between his fingers. The slip and gurgle are very characteristic of proper reduction. Mere diminution in size of the sac may be due to the forcing of fluid into the abdomen; and sudden disappearance of the whole swelling, without the above signs, to reduction *en masse*. If a patient is certain that his hernia was completely reducible, it is right, if all cannot be reduced by taxis, to cut down upon the sac without allowing the patient to come round from the anæsthetic. The operator should recollect that too much force may bruise or rupture the viscera, or drive sac and contents into the abdomen, or push them between the layers of the abdominal muscles.

Pressure with the fist above Poupart's ligament has been found useful in the reduction of herniæ, and traction by the hand in the rectum has been used. In children one or two fingers may be passed easily from the anus to the inguinal region. In women an obturator hernia is quite accessible to traction through the vagina.

Taxis with Inversion.—In many cases of strangulated hernia resisting the ordinary application of the taxis, reduction has been effected by raising the pelvis so as to turn the trunk of the patient "topsy-turvy." This may be done by raising the pelvis on a chair placed under the lower part of the mattress of the bed, and letting the patient's head and shoulders rest upon the bed itself. Care must be taken to keep the legs bent up to the body, and the trunk itself bent forward, so as to relax completely the aponeurotic structures in the groin. Inversion of the patient acts by the gravitation of the viscera toward the diaphragm, and thus dragging the mesentery and omentum out of the neck of the sac. This, aided by a gentle application of taxis, and by frictions over the belly made in a direction *from* the strangulated part, will often succeed in overcoming the strangulation when other means fail.

Contraindications to Taxis.—Taxis should never be employed if there is reason to fear that the bowel is severely damaged. But tight nipping has caused gangrene in six to eight hours, and there would probably be no symptoms to indicate either it or the ordinary ulceration at the ring.

Certain measures are employed as *auxiliaries to taxis:*

(*a*) *Chloroform*, or *ether*, should be given to produce complete relaxation in cases at all resistant to taxis.

(*b*) The *hot bath* (96°–100° F.), continued long enough to produce great relaxation, may be employed in similar cases when no anæsthetic is obtainable; but it is very depressing.

(*c*) A large dose of *opium*, or *morphia*, is most useful in cases of acute strangulation—when the pain and vomiting are violent—if for any reason chloroform cannot be given, and an operation at once undertaken, should taxis fail.

In cases of a subacute and chronic kind, such as occur most often in large, long irreducible umbilical and inguinal herniæ of old people, the following remedies are applicable; but care must always be taken that they do not prove causes of injurious delay:

(*d*) *Cold* may be applied for a few hours to a hernia by means of pounded ice, or ether-spray (Barclay); Schelle calculates that by cooling to 10° C. the gases alone shrink one-twelfth. It is often very beneficial in removing congestion and swelling, especially when combined with

(*e*) *Elevation of the pelvis* and lower limbs. Taxis under chloroform will then often succeed.

(*f*) *Enemata* are useless and irritating in cases of acute strangulation; but in the above-mentioned class, an enema of as much gruel with ℥j–ij of olive-oil as can be injected through a long tube passed into the sigmoid flexure, sometimes appears to act well, probably by causing some peristalsis, altering the relation of the abdominal viscera, and clearing the colon. Cold injections cause more peristalsis, but are depressing. Simon says that large, slowly administered enemata may pass through the ilio-cæcal valve and cause direct traction upon the protruding coil.

(*g*) *Constant elastic pressure* (Maisonneuve) must be used early, if at all. I have seen a large umbilical hernia lightly wrapped in an Esmarch's bandage, but strangulation continued and the skin sloughed widely.

(*h*) *Aspiration* with a fine needle is frequently employed in France as an adjunct to taxis to diminish the bulk of the intestines to be returned; it does not seem to have been very successful, but is harmless in most cases. In a few cases in which it has been employed late, the intestine being probably much damaged, fatal perforation has resulted. Kocher would never employ it in place of antiseptic herniotomy, if consent to this can be obtained.

Seutin's Plan.—Baron Seutin (*Ranking's Abst.*, vol. xxiv. p. 164) described a method of dilating the stricture, which he employed so successfully that he rarely had occasion to use the knife for strangulated hernia. "The surgeon seeks with his forefinger for the aperture that has given issue to the hernia, pushing up the skin sufficiently from below; then, with the pulp of the finger toward the bowel or omentum, he insinuates it between the viscus and the aperture. This proceeding demands perseverance. When introduced, the finger is to be hooked, and made to stretch the ring till a sensible dilatation or tearing is produced. The plan appears to have been most successful in femoral hernia, and when the stricture was seated at the external abdominal ring." It is open, however, to the serious objections that the strangulated viscera are exposed to further damage by the forcible traction and pressure of the finger, and that the aperture will be much and rudely enlarged. Similar objections apply to Langenbeck's dilatation of the stricture by the finger, after division of the skin and fat, and to J. Guérin's subcutaneous division of it with a tenotome.

After-treatment.—A truss, or a good pad and spica-bandage, should be applied after reduction and the patient kept at rest until out of danger. Not uncommonly the patient vomits once or twice after reduction of a hernia, especially under chloroform. Flatus is usually passed within twelve hours, and a motion may escape very quickly; but it may be days before this happens. Until it does the patient should be kept upon spoon diet and at rest. It is certainly unwise to administer a purgative before the bowel has given this evidence of ability to perform its function. But the passage of a motion soon after reduction does not prove this. Such a motion may contain, or even consist very largely of, blood which has escaped from the vessels of the now intensely hyperæmic bowel. Again, frequent, small, loose stools are not uncommonly passed after reduction, and C. J. Bond, of Leicester, has endeavored to connect this with ulceration of the bowel, at the point of nipping; but further observations seem necessary to prove it. Whenever there is reason to think or to fear that the returned bowel is a good deal injured, it is well to keep the patient under opium, and secure rest to the part.

Local peritonitis, fixing the bowel—in some cases a sharp attack of *peritonitis*, spreading from the returned bowel—ensues, and must be met by opium and belladonna fomentations.

General purulent peritonitis is almost certain to result and to prove fatal if a piece of bowel is returned perforated, ruptured, or gangrenous; and the chance of escape by the formation of adhesions with or without a fecal abscess is but little better when perforation or gangrene follows reduction. The condition of the patient is likely to be very unfavorable for further operation; yet, if he is not moribund, to find and remove the damaged portion, clean out the peritoneum, and establish a temporary artificial anus, probably gives him the best chance. In such a case the abdomen should be opened over the spot where the damaged bowel is likely to lie.

The *mortality after taxis* is about four per cent. for inguinal, five per cent. for femoral, herniæ (Bryant).

Operation.—The factors which militate chiefly against the success of herniotomy are *long duration of strangulation*—implying irretrievable damage to the bowel and extreme exhaustion—and *sepsis; age* has a minor influence.

The parts in the inguinal and genital regions are very difficult to render and keep aseptic, especially in children and adults in whom there is any loss of control over the motions. Yet asepsis, or a near approach to it, can generally be maintained by careful nursing and the use of a large dressing, secured by a double spica-bandage. For males it should have a *small* hole cut in it, through which the penis is brought out. Round about the penis, behind the scrotum, beneath the crossing bandages, and in the fold beneath the thigh and perineum must be most carefully packed. In young male children a piece of mackintosh should be laid over the dressing, and the penis brought through a hole in it; much urine can then be caught in a bottle, if the baby is kept upon his back by a flannel noose round each ankle, drawing the legs well apart. In women the catheter should be used regularly. It is often a good plan to fix down and waterproof the edge of a dressing at a point of danger with collodion, but its removal from these parts is somewhat painful. A great help in the prevention of peritonitis is to be found in the growing practice of tying the neck of the sac, and thus closing the peritoneum. We are not aware that any extensive statistics of antiseptic herniotomy have yet been published, but there can be no doubt in the mind of any experienced surgeon that, *cæteris paribus*, the results compare very favorably with those of the septic period, during which the mortality was variously estimated at from twenty-five per cent. to fifty per cent.

But this mortality was by no means entirely due to sepsis. A very large proportion was due to the fact that from neglect or fear on the part of the patient, or dread of peritonitis on that of the surgeon (now in a great measure removed), *operation was too long delayed*. Time is of extreme value in the treatment of strangulated hernia. If taxis does not succeed early, it is not likely that it will succeed later, when the bowel has been longer nipped, and is more thickened by congestion.

In every case, therefore, the surgeon must decide : 1. Is taxis justifiable at all? and, in the great majority of cases, the answer will be in the affirmative (p. 623). 2. How long a time may be devoted to taxis, and the various measures auxiliary to it? Here we must have regard to the intensity of the symptoms, to their duration, and to the condition of the patient as indicated by his appearance, and especially by his pulse; pain, great tension of the sac, swelling of the abdomen, and frequent or stercoraceous vomiting, demand early relief. In all cases we must be upon our guard against too long postponement of operation, the danger of which may be said to increase with every hour of strangulation. In large, old-standing cases, occurring in old people, the surgeon is usually justified in waiting some hours to try the effect of the measures recommended at p. 623; but in all acute cases, and in subacute cases in feeble persons—especially the femoral herniæ of old women, however small the protrusion may be—we would earnestly inculcate the rule, that if taxis under an anæsthetic be not speedily successful, herniotomy should be performed without further delay. It is another rule, to which there are but few exceptions, that a patient with a strangulated hernia should not be subjected to the depressing influence of an anæsthetic more than once. With these principles in mind, the surgeon must in each case determine how soon herniotomy should be done ; it may be right to operate in six hours or earlier, or not for twenty-four to forty-eight hours. It is usually necessary to operate upon femoral and umbilical herniæ somewhat earlier than inguinal, as they are, upon an average; more tightly nipped ; femoral herniæ come to operation rather more often than the inguinal, although they are a good deal less common.

Two kinds of cutting operation are performed for the relief of strangulated hernia—herniotomy without (*external*) or with (*internal*) opening of the sac. The former is the outcome of fear of septic peritonitis, and can be employed only when the stricture is external to the sac, as it frequently is in femoral hernia. It is rather more difficult than the operation in which the sac is opened, and has the disadvantage that the parts returned to the abdomen are not examined, and many points of importance in the case may be missed. But in suitable—*i. e.*, early, uncomplicated—cases this operation should be remembered in children and adults, in whom for any reason the dressings are likely to be displaced or rendered septic, and in large, irreducible herniæ in which it is not thought advisable to attempt a radical cure.

Seutin's procedure (p. 623), Langenbeck's dilatation of the ring with his finger after division of the superficial fascia, and J. Guérin's subcutaneous division of the stricture with a tenotome, are all to be rejected as endangering the bowel.

External Herniotomy.—The parts must be shaved, thoroughly scrubbed with soap and water, then with sublimate lotion (1 in 500), and finally covered with a cloth wrung out of this lotion for as long as possible. An incision one inch to one and one-half inches long, varying with the amount of fat, is made in the long axis of the hernia on its upper aspect and over the external hernial aperture. This cut is usually made by transfixion of a fold of skin pinched up, at right angles to the intended cut, by the operator with his left fingers, and an assistant; but it may be made from the surface, if preferred. It is deepened down to the connective-tissue layers round the sac, and then these are picked up with forceps and divided all along the wound with a knife held on the flat until no more can be raised, and the hernial aperture and the sac are exposed. The tense edge of the former can usually be felt plainly so soon as the superficial fascia is divided. An attempt is now made to reduce by taxis with the aid of a finger upon the neck of the sac. If unsuccessful, a wide flat director, or a probed bistoury, is insinuated beneath the edge of the constricting ring, and this is slightly notched; whilst the sac is drawn down as much as possible by an assistant. Should taxis again fail, it is sometimes possible to detect with a director, and to divide, tense bands of fibrous tissue around the neck of the sac; but if no other constricting band external to the sac can be found and divided, internal herniotomy must be done.

If, on the other hand, reduction without opening the sac is effected, the wound is accurately sewn up, a catgut or horshair drain placed at its lower angle, and an antiseptic dressing is applied. The drain is removed in twenty-four to forty-eight hours, and the second dressing may probably remain on for a week, when the wound is usually healed soundly.

Radical cure by ligature of the neck of the sac, subsequent removal of its body, and suture of the hernial aperture may precede the closure of the wound.

Internal Herniotomy.—A similar incision, but somewhat longer than that for the external operation, is required. The sac is exposed in just the same way, and is recognized, after division of the enveloping *fascia propria*, as a smooth, shining, usually tense, membrane, upon which small ramifying vessels are sometimes evident; unless adherent, it can usually be thrown into folds and made to move over the subjacent structures by pinching with the fingers; and except in the case of an old thick sac, one can generally see intestine through it, or the presence of fluid can be made out, or it seems to contain a mass of yellow fat when omentum lines it. A bit of it must be picked up with the forceps, notched by a knife placed flat on the sac, and then in the great majority of cases the escape of more or less fluid tells that the sac has been opened. The hole must be carefully enlarged until the left forefinger can be introduced, and upon this as a director the sac is slit up and down with a probed bistoury to the full length of the wound. The contents are now carefully examined and treated according to their condition (*see* next paragraphs), the omentum if present being turned aside so as to expose fully the intestine, which, if it is not gangrenous, should be gently drawn down to allow inspection of the points of nipping. Supposing that everything is in a fit state to be returned to the abdomen, the left forefinger is again introduced to explore the hernial aperture. It is not very uncommon to find this wide enough to permit reduction without any division of the neck, now that force can be employed at the greatest advantage; but in many cases a tight stricturing ring—either the neck of the sac or some external band—is felt and requires notching. The tip of the forefinger must, if possible, be insinuated into the stricture; a hernia-knife, or a probed bistoury of which the blade, except the last half inch, is wrapped in a strip of carbolized rag, is passed flat along its palmar aspect till the point is through the stricture, and then the edge is turned against the band so as to divide it in a suitable direction. For this incision there is no guide like the finger, and no director so well prevents the bowel from lapping round the blade and being wounded; but if the finger-tip cannot be passed beneath the band, a broad flat director must be used. The cut should be as limited as possible (it is better to have to make a second than to have one too deep), and made by pressure rather than by to-and-fro movements of the knife; thus an abnormal vessel situate in loose tissue, in front of the blade, is likely to be pushed before it instead of being wounded. The contents are now to be returned to the abdomen—intestine first and then omentum—by gentle pressure; and those parts are to be returned first which protruded last. A finger should be passed through the stricture into the abdomen to make sure that the parts are completely reduced.

If the contents of the intestine cannot be expressed, and there is still difficulty in reduction, the finger must be passed through the ring to seek some further cause of obstruction—*e. g.*, an hour-glass sac, band at mouth, etc. The rest of the intestines may be so distended that not only do they resist any addition to the abdominal contents, but some may protrude; it will then probably be necessary to aspirate the bowel or even to incise it, let gas and feces escape, and then sew up the wound. After this, great care must be taken to cleanse the bowel and to check oozing before its return. It is now customary to finish the operation by a so-called "radical cure" (p. 632) if the patient is in a state to bear further treatment. If not, a counter-opening should be made through the bottom of the sac, a drain-tube, starting just outside the external ring, brought out through it, and the wound sewn up accurately. A thick pad of gauze of suitable length should be laid along either side of the cut, and over both these another pad; the dressing (p. 624) should then be firmly applied.

Difficulties and Complications.—It may be very difficult to recognize the sac—the fibrous layers surrounding it are sometimes so tense and compact that the forceps will scarcely pick them up, and it is thought that the sac is reached, especially when they cover a thick layer of subperitoneal fat, looking like omentum; these layers are opaque, and present no ramifying vessels, but such points are not conclusive. In such cases it is necessary to go cautiously on, picking up and examining each bit of tissue before notching it, until the sac is opened, if possible at a spot beneath which omentum seems to lie; adherent intestine may be unavoidably wounded when the sac is opaque. The same accident may happen when the sac and its coverings are very thin and the former is opened before it is recognized. Rarely an empty sac lies in front of that containing the hernia, it usually contains fluid, and is either an old cured sac or a bursa developed under a truss, and usually complicates femoral hernia. In the hernia encysted into the tunica vaginalis also, the latter sac, perhaps containing fluid, is first opened. In both cases the swelling remains, and the indication is plain to go on through the posterior wall of the sac.

Management of the Intestine.—The surgeon has always to determine whether the intestine is or is not in a fit state for return to the abdomen.

This is a most difficult question, especially in very acute cases in which a bowel either dead or past recovery may appear almost natural (p. 619). On the other hand, intestine which is very dark colored and the coats of which are infiltrated with red corpuscles, *may* recover. Loss of polish (shedding of endothelium), collapse of the bowel, patchy or extensive gray or yellow discoloration of it, fecal odor on opening the sac, and the escape of a turbid offensive fluid—signs, in short, of commencing or advanced putrefaction—are the only certain signs of gangrene.

The seat of nipping, as well as the exposed coil, must be drawn down and carefully examined for signs of perforation or sloughing. Further, if it be very markedly constricted, it is recommended by some that it should be gently dilated before reduction by a finger invaginating a piece of bowel drawn out from the abdomen; for, since the time of Scarpa, persistence of this narrowing has been regarded as being sometimes the lesion causing persistence of symptoms after reduction. Others would remove a very markedly constricted piece of bowel as being incapable of recovery, and almost sure to lead to peritonitis if reduced.

Bowel which is certainly gangrenous, or which would slough if returned to the abdomen, may be treated in one of two ways: (1) by excision of the gangrenous part, suture of the edges, and return of the intestine to the abdomen; (2) by the formation of an artificial anus, which, if the patient live, may be closed subsequently. Reichel (*Deutsche Zeitschr. f. Chir.*, 1883, p. 230) found that of 56 cases of resection for gangrene after hernia, 29 died and 27 recovered, but 3 had permanent fecal fistulæ; peritonitis was the great cause of death, collapse coming next but far behind. The great frequency of peritonitis was probably due to faults in the operation—imperfect *toilette du peritoine*, or imperfect suture, but in these cases it is difficult to be sure how much bowel will slough; and under any circumstances the divided ends are not in the best state for rapid union. Against the operation of resection may be urged also that a barrier, the line of union and damaged gut about it, is still opposed to the passage of feces, and that the strain upon this line will be very great, the bowel above it being much distended, whereas an artificial anus is free from these objections; that when the sac is septic and the tissues around inflamed, the neck cannot be tied and the rest removed, so an opening for infection by extension is left; and lastly, that a patient in whom a gangrene of intestine from strangulation has supervened is usually in a very depressed condition, and quite unfit to undergo any prolonged operation such as resection.

Until, therefore, the results of resection improve it will be best to establish a temporary artificial anus in cases of gangrene of the bowel, except when the upper jejunum is known to be affected; here resection and suture should, if possible, be done to prevent death from starvation. It must not, however, be supposed that the establishment of an artificial anus renders the patient's recovery by any means certain; many patients die subsequent to this of some local or general septic disease. We are not aware that the mortality has been calculated.

Resection of the intestine is done as described at p. 612. The hernial aperture will probably need considerable enlargement to allow the bowel and mesentery to be drawn freely out, but before this is done every effort should be made to disinfect the sac.

An *artificial anus* is established in cases in which the whole coil of intestine has become gangrenous simply by slitting the bowel along its convexity from end to end, removing part if it is large; it will be held in place by adhesions to the neck of the sac. Some surgeons in these cases divide the stricture, thereby running considerable risk of infecting the peritoneum from the oftentimes abominably offensive sac. But there is no need to do this, for swelling of the bowel, which is a main cause of strangulation, will now soon subside, and it is usually easy to pass into the upper end a fair-sized rubber tube through which feces escape freely.

When there is but a small slough, which can be excised and the wound sutured without causing dangerous constriction, in a coil of strangulated bowel, the temptation to carry out this treatment is great; as much as three square centimetres have thus been successfully removed from small intestine. To establish an artificial anus in such a case cleanse the sac, divide the stricture, pass a loop of silk through the mesentery corresponding to the slough, and then, holding on by the silk, reduce the bowel until only the slough remains visible. Some now trust to such fixation as the silk loop attached to strapping affords, but it is better to sew the bowel round the slough most carefully to the surrounding parts, and then to withdraw the loop, leaving the slough to burst, and hoping that before it does so fresh adhesions will have made the peritoneum doubly secure. Such an anus or fistula is likely to close by itself in a few months.

When a piece of intestine is doubtful the stricture must be divided, and the bowel returned with a silk loop through the mesentery, if the operation is aseptic, to keep the coil close to the ring. Both in this case and after resection (Czerny, Schede) the bowel has been kept outside the ring until its fate is decided; but this plan is open to the same objections as the extraperitoneal treatment of an ovarian pedicle, and leaves the intestine under conditions which are distinctly unfavorable to recovery.

When the *bladder*, or *large gut*, other than transverse colon, enters a hernial sac, it becomes speedily adherent by its non-peritoneal surface to surrounding parts. If the hernia is cautiously approached over the part formed by the adherent viscus the muscular fibres of the latter will be recognized, and its adhesions must be broken down with the finger until the sac is reached and opened. When, however, the sac is exposed and opened as usual, a swelling will remain behind it after its contents have been reduced; and if its nature is not recognized either the viscus will not be returned and a truss will on recovery be applied over it, or attempts, very likely leading to wound of the viscus, will be made to dissect off the peritoneum, that the sac may be returned. When the nature of the swelling is recognized, the non-peritoneal surface should be freed from adhesions, as above said, and the viscus and sac should be pushed back into the abdomen, the ring being subsequently closed (Banks).

Management of Omentum.—When healthy, this may be returned; but its removal complicates matters so slightly, that it is probably better always to take it away rather than to leave a piece which has become abnormally lengthened, and which will be constantly ready again to enter a hernial aperture. If the omentum is adherent, or has undergone fibrous or fatty hypertrophy, removal and return of the stump should certainly be practised, for an incarcerated piece of omentum forms, as Mitchell Banks puts it, a kind of inclined plane for intestine to slide down at any moment. If, however, the omentum be gangrenous or acutely inflamed and covered with fibrin or pus it is probably best to remove the mass of it, carefully avoiding interference with adhesions about the neck, or even sewing the stump to parts around—for it is impossible to be sure that the return of such, even after careful disinfection, will not be the means of conveying septic organisms to the peritoneum. But it must be noted, that radical cure rarely results from this, for the omentum usually shrinks and the hernia reappears after a time; and, moreover, the adhesion of omentum about the ring may give rise to frequent dragging pains and colic, whilst the band may prove a cause of internal obstruction.

The *removal of omentum* may be effected by drawing the mass down until the part which has occupied the ring, and which is usually fibroid, appears, tying this very tightly with a single thread of strong, carbolized silk, cutting the omentum a short distance beyond, cutting the ligature short, and allowing the stump to retract. This is satisfactory only when the pedicle is quite small; under other circumstances there is danger that the central vessels may not be tightly compressed and may bleed in the abdomen, and also that the lump left below the ligature may not be reducible. When the pedicle is wide it is necessary, therefore, either to tie it in several portions, or it may be tightly clamped with rubber-sheathed dressing forceps, cut off with scissors bit by bit beyond them, and each vessel tied with catgut or fine silk. To tie in several portions, take a long piece of silk and with an *aneurism-needle* pass a portion near one end through the omentum, half an inch from either border; hold the loop in the needle's eye and bring back the needle along the long end of the silk; now pass the needle again through the omentum and repeat the process till, by dividing the loops on the upper surface, a ligature for every bit of the membrane is provided. Adjacent ligatures should *not* interlock, and of course all vessels should be avoided by the needle. One often sees a ligature put around the whole pedicle after it has been tied in parts—to make all secure; obviously one or other ligature is useless.

It may happen that a portion of intestine is concealed within the omentum, completely enveloped in a kind of sac formed by it, especially in umbilical hernia. Sir Prescott Hewitt (*Med. Chir. Trans.*, vol. xxvii.) remarks that "when the hernial sac appears to contain thickened omentum only, the omentum ought to be drawn out and carefully examined, to see that it does not form a sac containing a portion of intestine." If it is thickened, and firmly united to the neck of the hernial sac throughout its whole circumference, it should be carefully torn open at some point, and its deeper and internal parts exposed. It is often extremely thick, and the intestine may be firmly adherent to its inner surface. The surgeon ought *carefully* to "examine every portion of omentum which is in a hernial sac, so as to ascertain that no knuckle of intestine is contained within its folds, before it is returned into the abdomen, left in the sac, or removed altogether."

Management of Adhesions.—Adhesions are most likely to be found in old, long-irreducible herniæ, and the surgeon must decide from the condition of his patient, size of the hernia, etc., at the time of operation, whether a radical cure is or is not to be attempted. By the division of the stricture, and return of any recently prolapsed bowel, strangulation will be relieved and the patient will, if he recover, be left in much the same state as before the operation. When adhesions exist between omentum and sac, the omentum must be cut off, as above directed, and the mass may then be removed by tearing through the adhesions. Broad, close adhesions about the neck are generally easily broken down by a sweep of the finger, and bleed little or not at all.

When intestine is adherent by bands, a fine ligature should be applied to each end of the band and the intervening part removed. If broad, close adhesions break down easily, they should thus be separated; if they are firm, it is usually best to return a bit of the sac or omentum, adherent to the bowel. When, however, adhesions of this kind exist between coils of intestine, it is usually best to leave them.

Hemorrhage from a flat surface, whence an adhesion has been separated, may be checked by ligature of, or fine suture round, the points, or by perchloride or some other styptic. Bleeding should be *thoroughly* arrested before a part is returned.

HEMORRHAGE *during herniotomy* may occur from section of a normal vessel by a misdirected cut, or from section of an abnormal vessel by a proper cut (see "Special Operations"). Bleeding may occur also from slipping on a ligature or an omentum stump, and may be very troublesome if the latter retracts; it must be seized and drawn down, the wound being enlarged if necessary.

This, too, is the commonest source of *internal hemorrhage after herniotomy.* M. Banks (*Notes on the Radical Cure of Hernia*, 1884) gives a case in which he had to open up the inguinal canal, to make sure that he had cut no abnormal vessel by his deep incision; and, finding that he had not, he was obliged to open the abdomen in the linea semilunaris to above the navel before he found the bleeding stump, an inch below the transverse colon. The patient recovered well.

WOUND OF THE INTESTINE during herniotomy should be treated as usual, by suture, and cleansing of the parts. It is most likely to occur when the finger is not used as the director in the deep cut.

PERSISTENCE OF SYMPTOMS AFTER REDUCTION BY TAXIS occurs occasionally, and may be due to the following conditions: 1. *Slow recovery* or *non-recovery of the strangulated bowel*, the diagnosis of which is reached chiefly by exclusion; a slip and gurgle will probably have been felt in reduction, the symptoms are generally ameliorated, and a little flatus will very likely pass if recovery is going to occur.

2. The *supervention of purulent peritonitis*, which, of course, is much more frequent after operation, may keep up all the symptoms, and the diagnosis will be difficult in proportion as the peritonitis is masked (p. 602).

3. *The bowel may have been incompletely reduced*, or *may have been forced down and again strangulated after its return.*

4. There may be *a second strangulated hernia*, usually of small size, so that it is easily overlooked.

5. There may be *internal obstruction*, and this is most likely to be in some way connected with the hernia. Thus, a slight volvulus (a half turn on its axis) of the strangulated coil may occur, and adhesions may fix it in the faulty position; or the bowel may become entangled in some band-like adhesions or omental cord at the mouth of the sac; or constriction at the neck of the sac may not have been the cause of the symptoms, but strangulation by a band in the sac or through an aperture in the prolapsed omentum or mesentery, or in an omental sac (Prescott Hewitt). In the latter cases gurgling on reduction is often absent.

6. *Reduction en masse* is by far the most distinct of all the causes of persistence of symptoms. The term implies that the sac with its contents has been pushed up through the aperture or canal by which it escaped, and lies external to the fascia transversalis. It may have been pushed straight in so that the neck is the point furthest from the surface; or the fundus of the sac may have turned through a quarter of a circle, so that its neck remains in the vicinity of the external aperture. The accident was first diagnosed in a case of femoral hernia, and proved post mortem to have occurred, by Le Dran (*Obs. in Surgery*, Eng. trans., 1740, p. 194), in 1726; the full sac was three inches in depth, and eight inches in circumference. The symptoms were: persistence of the symptoms, a hollow in place of the hernia, a widely open crural canal almost admitting four fingers; no gurgling had occurred during reduction, nor any "slip," but the hernia passed in a heap, "like a tennis-ball," beneath the ligament. Besides these, a swelling, the full sac, has often been felt by a finger passed along the canal, and also above Pou-

part's ligament, but it is not uncommonly absent; in a case of left inguinal hernia reduced *en bloc*, which the author saw with Mr. Walton, there was no hardness or tenderness here. Moreover, the patient had two herniæ. Mr. Walton operated in the linea alba, and released a loop of intestine confined in the sac, which had been quite pushed into the abdomen. Of 96 cases, 87 were inguinal and 9 femoral herniæ (Turati). The force required to cause a reduction *en masse* is not always great. In some cases the reduction is incomplete, and the sac becomes hour-glass, part within the abdomen, part superficial (*hernie en bissac*); and the bowel often passes freely from one part into the other. These cases are almost always inguinal, and often congenital (Krönlein).

In other rare cases (Birkett) the sac ruptures, and the intestines escape through the rent; or the neck of the sac may be torn from the body, and the intestines constricted by it reduced; sometimes there is a sound or feeling of tearing at the moment.

Treatment.—Except in the case of reduction *en masse*, and not always even in this, exact diagnosis is usually impossible; though the age, size, reducibility or irreducibility, presence of omentum and intestine, and points noticed at the operation, if one has been performed, may enable one to guess with more or less probability at the cause of the persistence of symptoms.

In reduction *en masse* the patient should first be encouraged to cough and strain and try to force down the rupture that it may be operated on at once. This failing, either the inguinal canal must be opened up, or laparotomy—by a curved incision parallel to and above Poupart's ligament, over the displaced sac—must be done, the sac opened, the neck notched, and the contents reduced.

When the diagnosis is quite doubtful, but it is plain that some cause of obstruction persists, the choice still lies between an extended herniotomy and laparotomy, which should usually be done in the groin. Hitherto the results after herniotomy have been much better than after laparotomy, though the latter is always superior as an exploratory operation.

Radical Cure of Hernia.

From the earliest time attempts have been made to produce a radical cure of inguinal herniæ, and of late years, also of other forms. The various operations at present practised will be noted under the special hernia which they concern. We must here consider the conditions under which attempts to obtain a radical cure are justifiable.

The opinions of surgeons upon this point vary a little according to the success which they look for from operations for "radical cure." Mitchell Banks is of opinion that the great majority of patients after a successful operation ought to wear a light truss to prevent recurrence; consequently, he argues that no case should be operated upon in which a truss controls the hernia satisfactorily, for the patient would be very little better off than before as regards safety and trouble. Others, more enthusiastic, urge that all children with inguinal ruptures, not cured by truss-pressure by five years of age, should be operated upon and "cured for life." Even if this suggestion be the outcome of a too sanguine temperament, it is certain that many cases have been recorded in which, after an operation of this kind, patients have remained free from hernia for many years, although no truss has been worn; but probably it would be wise, even in such cases, to prescribe the wearing of a truss whenever any unusual exertion is to be anticipated.

(1) Operations for the radical cure of hernia may be undertaken in children in whom trusses are unavailing because of neglect, large size of rupture,

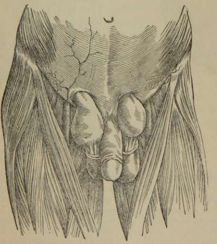
soreness of groin, etc. (2) In boys and young adults prevented from entering some profession or following some occupation by the presence of a controllable hernia, or wishing to embark in some employment likely to throw heavy strain upon the rings in countries where good trusses and advice are scarce, an attempt to obtain a radical cure should be made. (3) In adults all herniæ not efficiently controlled by a truss should be operated upon, if the patient is healthy and not too old. Difficulty in the action of a truss in adults is very commonly due to the presence of adherent omentum; less often an elongated piece of omentum keeps slipping down. The danger of sudden descent and strangulation of bowel is so great in these cases that removal of omentum and sac is usually advisable. Relief may be given also when great size of the hernia and of the rings prevents a truss from acting. The operation now becomes more serious, especially when the rupture is irreducible; and the chances that complete closure of the opening will result are less than in previous considered instances, even after two or three operations. But as these large uncontrollable herniæ quite incapacitate from work and cause much suffering, the operation should be undertaken in suitable cases after explaining its somewhat serious nature. The ability to wear a truss must here be regarded as a distinct success. (4) An operation of permanently curative intent should be undertaken in all cases of strangulated hernia in which the patient can bear the more prolonged operation and the bowel is fit to be returned.

Inguinal Hernia.

Definition.—Inguinal hernia is that which protrudes through one or both abdominal rings.

Varieties.—There are two main varieties, the oblique or external and the direct or internal. The deep epigastric artery, which ascends internal

Fig. 217.

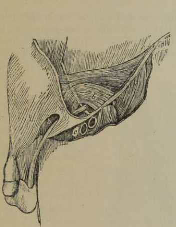


Oblique inguinal hernia on the right side, direct on the left.

to the deep ring, marks the difference. The first variety passes through the deep ring, *external* to the epigastric artery, and takes an *oblique* course in the abdominal wall, traversing the whole length of the inguinal canal. The second leaves the abdomen *internal* to the deep epigastric artery, passes out through the superficial ring, its course through the wall to the surface being *direct*. A hernia (*parainguinal*) may burst through the anterior wall of the canal.

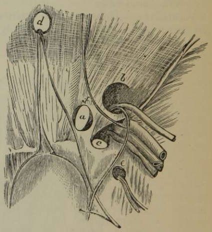
Each of these divisions includes subdivisions. The *oblique hernia* includes (1) the *ordinary* type, in which the sac lies in front of the tunica vaginalis; (2) the *congenital* form, in which the bowel descends *into* the *tunica vaginalis*, the funicular process not having undergone obliteration; and (3) the *infantile* (Hey, *Pract. Observations*, 3d edit., p. 226), or hernia encysted into the tunica vaginalis, in which the latter lies in front of that of the hernia. *Direct hernia*, on the other hand, may be *superior* or *inferior*, according as it leaves the abdomen above (outside) or below (inside) the obliterated hypogastric artery. An examination of the inguinal region from within shows that a triangular space (Hesselbach's) lies between the margin of the rectus, the epigastric artery, and the inner end of Poupart's ligament. The peritoneum in this region is slightly raised over the obliterated hypogastric, on either side of which there is a slight fossa. The epigastric artery lies a little external to the hypogastric and also sometimes slightly raises the peritoneum. There will then be three fossæ—internal, middle, and external; the latter corresponding to the deep ring. The middle is not as a rule marked, for the epigastric artery is not prominent, and the interval between it and the hypogastric is usually small. Consequently the *internal direct hernia* which protrudes inside the hypogastric is by far commoner than the external direct, which passes through the middle fossa.

Fig. 218.



The inguinal region from the front: *a*, superficial ring; *b*, the fibres of the internal oblique, normally covering the deep ring, and restraining protrusion; *c*, crural ring. The lower fibres of the *transversalis abdominis* muscle, and the epigastric artery, lying behind the *fascia transversalis* and crossed by the cord, are also shown.

Fig. 219.



Diagrammatic *internal* view of the enlarged openings and parts concerned in the formation of inguinal, crural, umbilical, and obturator hernia; *a*, the superficial ring seen through the opening at which *direct* hernia protrudes (the obliterated hypogastric should be *external* to this); *b*, the deep ring through which *oblique* hernia passes; *c*, the crural ring; *d*, the umbilical ring; *e*, the obturator opening; *f*, the epigastric artery.

1. The *ordinary oblique* inguinal hernia is the most common. It takes the same route as the testicle in its passage from the abdomen into the scrotum. It commences as a fulness or swelling at the situation of the internal ab-

dominal ring, a little above the centre of Poupart's ligament, next passes into the inguinal canal (in this stage it is called *bubonocele*); and if the protrusion increase, it projects through the external ring, and descends into the scrotum of the male, or labium of the female. The *coverings* of this hernia are: (1) *Skin*. (2) *Superficial fascia* in which the *superficial external pudic arteries* ramify. (3) The *intercolumnar fascia*, a tendinous layer, derived from the curved transverse fibres which connect the two margins of the external ring. (4) The *cremasteric fascia*, composed of cremaster muscle and the fascia connecting its fibres derived from that investing the internal oblique and transversalis muscles. (5) The *infundibuliform fascia*, a tube continuous with the *fascia transversalis* of the abdomen. (6) More or less *subperitoneal fat*. And, lastly (7), the *sac*. The *deep epigastric artery* is internal to the neck of the sac, its position forming the distinction between the oblique and direct varieties. The *spermatic cord* is generally behind the sac; but its constituents may be separated or lie spread out in the front of the sac. The *testis* is at first *below*, then below and behind the hernia, becoming increasingly prominent as the sac becomes tense.

2. The *inferior direct* inguinal hernia usually protrudes before it the *conjoined tendon* of the internal oblique and transversalis muscles just behind the external ring. Its coverings are the same as those of the oblique variety, except that the *conjoined tendon* replaces the *cremasteric fascia*, which more closely invests the spermatic cord, and is usually displaced with it by the protrusion. This hernia may, however, separate or burst through the fibres of the conjoined tendon. The *epigastric artery* runs external to the neck of the sac. The rare *superior direct* hernia protrudes *outside* the border of the conjoined tendon, takes a more oblique path to the surface, and is covered by a few cremasteric fibres. The cord lies on the outer side of this form of hernia, and its elements are said never to be separated or placed in front of the sac.

3. *Hernia into the tunica vaginalis* (*congenital hernia*) depends for its origin upon the non-obliteration of the *funicular process*. It was supposed to be either congenital or to originate very shortly after birth—whence its name; but it is now known that a hernia of this type may not appear until adult age. Birkett states that all scrotal herniæ in children under puberty are of this type; there is, however, little doubt that he is mistaken, ordinary oblique herniæ being common among them. The protruded bowel or omentum lies in immediate contact with the testis, surrounding the organ except where the vessels enter; and very often adhesions to the testis are established (Fig. 220). If such adhesions occur before the descent of the testis, they may cause retention of the testis or protrusion with it of the bowel. The sac is formed by the *tunica vaginalis*, and its coverings are the same as those of the ordinary oblique variety. In woman a "congenital" inguinal hernia sometimes occurs *into the canal of Nuck;* it usually appears before puberty.

4. *Encysted hernia* (or *hernia infantilis*) is a sub-variety of the congenital. The protruding bowel pushes before it a sac of peritoneum, either into or close behind the tunica vaginalis, and adheres to it. This hernia therefore has, as it were, two sacs—viz., one proper sac, and another anterior and superficial to it, composed of the invaginated tunica vaginalis, which in these cases is liable to be the seat of hydrocele. Wood thinks that in these cases the funicular process is closed only at some point above the testis, and that the hernia dilates rapidly the unclosed upper part and forces it into the usually large tunica vaginalis. Lockwood (*Med.-Chir. Trans.*, 1886), however, found that in all the cases in the London museums, the tunica vaginalis either opened into the peritoneum or was closed simply by pressure and ad-

hesions. Fig. 221 shows a variety of the *encysted* hernia, in which the sac was formed after the communication of the cavity of the tunica vaginalis with the abdomen was closed, but still remains above, and uncovered by, that tunic.

Fig. 220.

Congenital irreducible omental hernia (King's College Museum).

Fig. 221.

An encysted hernia, a form first described by Hey, of Leeds.

Diagnosis of Inguinal Hernia.—1. The *external* or *oblique* cannot be distinguished with any certainty from the *internal* or *direct* form, but slow development and obliquity of the neck, detected by the eye, and by the finger passed into the canal, are in favor of the external form. The epigastric artery can rarely be felt even in an operation, or there would be little difficulty in the distinction. In old cases of oblique hernia the neck of the sac is dragged more and more in toward the mid-line, till the internal lies behind the external ring, and the track is as "direct" as in the internal form. The latter variety may at first have quite an oblique course (p. 634) in the wall. It is very rare in women.

2. The *congenital* is distinguished from either of the above forms by the fact that in it the testis becomes increasingly obscure as the sac tightens, and may be discoverable only by making sudden sharp pressure over the gland, and thus exciting testicular pain. In the ordinary form of hernia the testis stands out more as the sac fills. The *encysted* hernia can be recognized only by operation.

3. *Hydrocele of the tunica vaginalis* may be reducible (*congenital* form, q. v.) or irreducible, and resemble reducible or irreducible hernia especially of the congenital kind. Hydrocele is distinguished from hernia by its beginning at the bottom of the scrotum, by its translucency, tension, fluctuation, weight, dulness on percussion, absence of impulse and of borborygmi on manipulation; the testis is more or less difficult to discover, but the cord and its individual elements can be distinctly felt above the swelling. When reducible, the fluid of a hydrocele passes, more or less slowly, into the abdomen, when the scrotum is compressed; there is no slip or gurgle, and if the

patient stands, fluid again fills the sac in spite of such pressure as would retain a hernia. Hernia, on the other hand, begins above and descends to the bottom of the scrotum, is not translucent, does not fluctuate, is light and resonant in proportion to the gas it contains, and has an impulse; in its *ordinary form* it does not conceal the testis, but obscures the cord. We must, however, be prepared for departures from these descriptions; the history is often worthless; a hydrocele may be neither translucent nor tense, and when it extends into the inguinal canal it may have an impulse and conceal the cord. A tense enterocele may be quite translucent, especially in children, very tense and elastic, or heavy and dull from presence of omentum and fluid, with very slight or no impulse (incarcerated hernia or a bit of adherent omentum only). Fortunately all these difficulties do not occur together, and a sufficient number of characteristic signs usually remain to render diagnosis possible. It must be remembered that hydrocele and hernia not infrequently occur together.

4. *Hydrocele of the cord, encysted or diffuse,* may, if low down, be distinguished by its translucency, tension, fluctuation, and the distinctness of the cord above it; but if high up it may receive an impulse on coughing, and seem to be reducible; generally, however, it can be made out that this is not the case. As a hernia may be concealed behind such a swelling, the rule—*when in doubt, operate*—should be acted upon, if symptoms of strangulation appear.

5. *Solid tumors of the cord,* of which the commonest is fatty, closely resemble irreducible omental herniæ, and cannot, as a rule, be distinguished from these.

6. *Varicocele,* or varix of the spermatic veins (q. v.), is always mentioned in the "diagnosis" of scrotal hernia, as it increases in the erect posture, and has an impulse on coughing. But it is never in the least like a hernia, for it feels like a bundle of distended veins, or a bag of worms; and although it disappears when the patient lies down and the scrotum is raised, it quickly reappears if the patient stand and pressure—which would prevent a hernia from coming down—be made upon the external ring.

7. Lastly, a testicle that has not come down through the external abdominal ring into the scrotum has been frequently confounded with a *bubonocele,* or small hernia in the inguinal canal; and has been compressed with a truss, to the great pain and detriment of the patient. A little care and attention will prevent this mistake.

TREATMENT.—1. Inguinal hernia, if *reducible,* must be kept up by a truss, unless a radical cure by operation be attempted. The rupture must be thoroughly reduced while the patient is lying, and then a well-fitted truss must be carefully adjusted, with the pad bearing level upon the centre of the deep hernial aperture, and the spring or band exerting its pressure evenly upon it. Care must be taken not to let the pad press against the spinous process of the pubes, nor upon the spermatic cord. If the rupture, under some extraordinary pressure, escape beneath the pad, the truss must be *immediately* removed, the rupture carefully returned, and the truss readjusted. Young children should be frequently examined to see that the truss is in place.

For treatment by truss of a *hernia complicated by retained testis,* see "Imperfect Descent of the Testis." For *Radical Cure,* see p. 638.

2. *Irreducible* inguinal hernia must be supported by a bag-truss. If it contain only *omentum,* a common truss is sometimes applied, in the hope of producing a radical cure, by making the omentum adhere to and plug the neck of the sac. But this cannot often be borne, and is liable to induce swelled testicle. For these cases a ring-pad-truss on Wood's principle, with

an India-rubber water-cushion, is the most comfortable and effective apparatus; but an operation for radical cure should as a rule be done.

3. In attempting the reduction of *strangulated* inguinal hernia by taxis, the patient should be placed with the body bent, pelvis raised, and thighs as close together as possible, the surgeon passing one arm between them, and the pressure must be made upward and outward.

HERNIOTOMY.—The *operation* for this kind of hernia is formed thus: The parts being shaved and thoroughly aseptic, the skin is rendered tense and a two to three-inch incision is made through the skin in the axis of the tumor, beginning from above its neck. The object is to bring the external ring fully into view. Then the successive coverings are divided as directed at p. 625; one or two pudic arteries may require tying. Cautious operators will make many more layers than those anatomists enumerate, especially in old herniæ; the practised surgeon will make fewer; yet it is better to be somewhat slow than to make a hole in the gut. The sac will be recognized by the signs given at p. 627, and must be opened as there advised. The stricture is usually at the deep ring, but may be at the superficial one (or at both) or, rarely, at the edge of the internal oblique; if it require notching, it must be dilated, if possible, to allow the finger to pass partly into it, and a curved hernia knife (Sir A. Cooper's)—cutting only for half an inch, and not quite to the point—should be passed up flat on the finger through the stricture, and its edge then turned up so as to divide it. In every case the division should be made *directly upward*, parallel to the linea alba, so that, whether the hernia be direct or oblique, the epigastric artery will not be wounded.

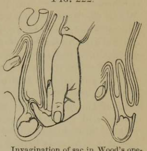
In the operation *without opening the sac*, the first point is to ascertain the exact seat of the stricture—which it is by no means easy to do. The best guide is the point at which impulse from coughing or compression of the hernia seems to cease. "The next step is, to divide the integuments so that the centre of the incision shall be directly over the stricture. The various fasciæ are subsequently divided, until the neck of the tumor is fairly exposed. If this be carefully and completely done, a depression will usually be observed at the site of stricture, presenting a more contracted appearance than at other parts. This contracted part feels thick, while into it thin layers of fascia dip, which may be mistaken for the stricture itself; but they may be divided and no relief result. When these layers are turned back, the real stricture is exposed to view." The next step is to scarify the structures forming the stricture, so as to render it dilatable, without actually cutting through it, and then the taxis is to be used for the return of the hernia. When the stricture is caused by the margin of the external ring, it is easily divided with the hernia-director and bistoury; when at the internal ring, it is more difficult (Luke, *Med.-Chir. Trans.*, vol. xxxi. p. 108).

If the hernia is still irreducible the sac must be opened, omentum and adhesions of various kinds dealt with as directed at p. 630, and the radical cure completed by removal of the sac and suture of the canal.

RADICAL CURE.—Many have been the operations devised for the radical cure of this hernia, especially measures calculated to obliterate the sac. Thus, excision of the sac, and of the testicle with it; ligature of the sac; pressure by hard trusses; injection of iodine; the use of hard caustics, to produce a slough and subsequent firm cicatrix; the introduction of isinglass and goldbeater's skin, have been practised with much danger and little success. Gerdy's and Wützer's operations, described in former editions. have had their day; and the operations which are practically employed are *Wood's*, *Spanton's*, and the *Open operation*, the third only being applicable to forms of herniæ other than inguinal.

Wood's Operation.—Wood believes, and rightly, that dilating the hernial apertures by means of a plug, as in Gerdy's and Wützer's operations, is erroneous and injurious—not effecting the object proposed, but rather increasing the size of the rupture, in case of failure to produce a cure. His operation is designed to draw forward the hinder and inner walls of the hernial canal by transfixing the conjoined tendon, and to unite it to the front and outer wall by suture, so as to close up the hernial canal entirely. He invaginates the hernial sac without including the skin, and by the arrangement of the sutures draws it up into the deep hernial opening (Fig. 222). On each side, the pillars of the superficial ring are bound closely together, no skin being suffered to intervene. The conjoined tendon and Poupart's ligament are caused to adhere across the cord, and are blended in one mass of adhesion with the invaginated sac and pillars of the superficial ring.

Fig. 222.



Invagination of sac in Wood's operation for the radical cure of hernia. The scrotal incision is not now made over the fundus of the sac, as shown.

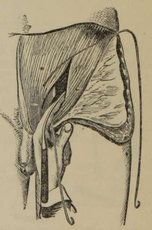
The instruments used are very simple; a small tenotomy-knife, and a stout semicircular needle, mounted in a strong handle, with a point flattened antero-posteriorly, and adapted rather for splitting the tissues than for cutting through them. The needle is introduced each time unarmed. When the tissues are transfixed by it, a piece of stout copper-wire, silvered, or of stout carbolized kangaroo, deer, or ox-tendon, about one foot long, is passed through the eye of the needle, and drawn back with it through the tissues.

The operation is conducted as follows: The patient is laid on his back, with the shoulders well raised, the knees bent, the pubes cleanly shaved, and

Fig. 223.

Wood's operation, needle passed through internal pillar.

Fig. 224.



Needle passed through external pillar.

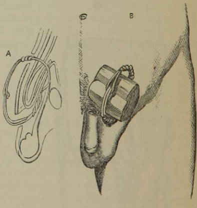
the rupture completely reduced; chloroform is administered, and an oblique incision about an inch long made in the skin of the scrotum over the cord, just below the pubic crest, down to the sac. The forefinger is then passed into the canal, and the sac invaginated before it up to the deep ring. The finger then feels for the lower borders of the internal oblique and transversalis muscles and lifts them forward to the surface. By this means the outer edge of the conjoined tendon is felt to the outer side of the finger. The needle is then carried carefully up to the point of the finger along its inner side, and made to transfix two layers of the sac, the transversalis fascia, the conjoined tendon, and the inner pillar of the superficial ring (Fig. 223.) When the point is seen to raise the skin the latter is drawn well over toward the mid-line, and the needle made to pierce it as far out as possible. An end of the wire or tendon is now attached to the eye of the needle, drawn back with it into the scrotum, and then detached. The finger is next passed low down behind the outer pillar to the level of the internal ring, the cord is felt for and pushed aside, and Poupart's ligament is raised as much as possible from the deeper structures. The needle is then passed along the outer side of the finger, and pushed through the layers of the sac, transversalis fascia, and Poupart's ligament, a little below the deep hernial opening (Fig. 224). The skin is now drawn strongly out and the point is pushed through the skin-puncture before made, the other end of the wire or tendon threaded, drawn back into the scrotal puncture before, and then detached. Next, the sac at the scrotal incision is pinched up between the finger and thumb, and the cord slipped back from it, as in taking up varicose veins. The needle is then passed across behind the sac, entering and emerging at the opposite ends of the scrotal incision (Fig. 225). The inner end of the wire is again hooked on, and drawn back across the sac.

If the hernia is large, and especially if it be direct, the needle is, lastly, to be passed through the end of Poupart's ligament, just above the pubic spine, and then through the inner pillar and triangular fascia, close to the os pubis, at the edge of the rectus. The outer end of the wire is then connected and drawn across, so as to lace up the canal like a boot.

Fig. 225.

Wood's operation, needle passed behind sac.

Fig. 226.



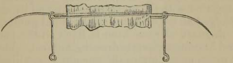
Position of, and mode of dressing, parts after Wood's operation.

If a tendon-ligature has been used, it is now to be braced up tightly, tied securely in a reef-knot, cut off close, and buried in the wound. If wire, the ends are drawn down until the loop above is near the surface of the skin, twisted together into the incision, and cut off to a convenient length. Traction upward is then made upon the loop, to invaginate the sac well up into the hernial canal, and draw the walls together. The loop of wire is finally twisted in the upper puncture and bent down, and the two ends are hooked on to it in a bow or arch, under which is placed a stout pad of lint. (Fig. 226, A and B.) The whole is held steady by a spica bandage. Wood uses no other dressing and no tube in wire cases, the wires acting well as a drain, and suppuration being rare. But in tendon cases he places a tube from the external ring to the scrotal wound, and dresses antiseptically until the wounds are healed and the tendon buried. Wire must be removed after ten to fourteen days or even longer, according to the amount of action it excites.

After a few days the parts traversed by the wire can be felt thickened and hardened by exudation, which blends together the sac, the pillars of the superficial ring, and the tendinous boundaries of the hernial canal into a resisting mass, whilst the wire becomes more and more loose by ulceration. It can then be untwisted and withdrawn upwards.

For the small herniæ of children, Wood formerly employed a pair of rectangular pins, one of which is made to traverse, from above downwards, the conjoined tendon and inner pillar, and the other Poupart's ligament from below upwards. Both these pins are made to enter and emerge at the same cutaneous aperture, without any incision of the skin. During their application the forefinger invaginates the thin skin of the scrotum into the hernial canal, and thus protects the important deep-seated parts. The same structures are transfixed as described in the preceding operation. The pins are bent at a right angle near the blunt end, and provided with loops at the bent part (Fig. 227), so that each can be locked into the loop of the other,

Fig. 227.



Wood's needles as applied to children.

and then by a half-turn can be twisted round so as to entwine closely the included structures, and cause them to adhere intimately, as the pins ulcerate nearer to each other, and finally meet. By the oblique direction of the pins, an adhesion along the whole length of the canal, between the surfaces of the perforated sac and the tendinous walls of the canal and pillars of the ring, is insured.

A horseshoe pad is worn for a few months. It may then be laid aside, unless in exceptional cases, or when the patient is about to be subjected to violent strains or lifting.

The *chief causes of failure* are (1) not planting the suture close to the edges of the *deep* ring from fear of injuring the epigastric, which in Wood's practice has never given trouble; (2) the conjoined tendon is not well secured, or gives way early; or (3) the inflammatory adhesions established prove slight and transitory.

The wide-shouldered point of the needle renders wound of the epigastric, which lies in loose tissue, very improbable; the cord and the femoral vessels must be protected by the finger; atrophy of the testis occurred in two cases.

Wood regards the following as the advantages of his operation over others: The deep ring is closed flush with the peritoneum; the conjoined tendon is drawn out and fixed behind the outer pillar, close upon the cord and twisted sac, thus restoring the "valve-action" of the canal; and the pillars of the superficial ring are laced together. Three lines of defence against descent of the hernia are thus provided. All these parts are united by inflammatory tissue.

Wood's statistics, as given in his recent Hunterian lectures (*Brit. Med. Journ.*, June 13, 20, and 27, 1885), to which we are largely indebted, are as follows: He has done 339 subcutaneous operations in 317 cases with 7 deaths —one or two perhaps unconnected with the operation, the rest apparently due to hospital causes. The total mortality has, therefore, been slightly over 2 per cent. If 17 early operations in which a hemp-cord was used, with 1 death, and 49 pin-operations with 2 deaths, be left out, the mortality among 273 wire cases (9 double, 11 second operations)—almost all selected—has been 1.46 per cent.; and with antiseptics it would probably have been less. As to success: 96 cases have remained sound during periods varying from 23 to 2 years, the majority wearing no truss, the rest a light one, constantly or occasionally; 152 were found cured after periods less than 2 years; 59 were more or less failures, most of them being improved and able to wear a truss. None was made worse by the operation. The success is, therefore, about 73 per cent.; or, if wire cases only are taken, 82 per cent.

Among 28 cases in which Wood employed his mode of suture together with ligature and removal of the sac under the spray, 2 died (about 11 per cent.). There were no early failures.

Spanton's Operation (*Brit. Med. Journ.*, Dec. 1880).—A preliminary incision is made as in Wood's operation through the skin, which is dissected up for three-quarters of an inch all round; the forefinger invaginates the sac and its coverings up to the deep ring; the point of an instrument like a corkscrew (kept in four sizes) is introduced through the skin over the point of the finger and made by rotation of the handle to pierce first one pillar and then the other, together with the invaginated sac and its coverings, thus dragging the pillars together. The finger in the canal guides the point and protects the cord. A guard of some kind is fixed on the point of the screw in the scrotal wound and an antiseptic dressing applied. The screw is removed after a week or more, according to the amount of swelling caused.

In 1882 (*Brit. Med. Journ.*, July 22) Spanton had operated on 51 cases without any death, and with more or less improvement in all. Of 34 cases (Dec. 1879, to July, 1881), 30 were cured and 4 much relieved; how many had to wear a truss is not stated.

Several surgeons have spoken in favor of this operation, after considerable experience of it. Most seem to consider it incapable of dealing with large herniæ; and, of course, it cannot be employed in irreducible cases. Its chief field appears to be the herniæ, other than the largest, of children.

The Open Operation.—The revival of this under antiseptic protection was only natural; it is the only one possible in irreducible cases, it is applicable to every form of hernia, and forms a fitting sequel to herniotomy. There are many varieties, but we believe that practised by Mitchell Banks (*Med. Times*, July 5, 1884) to be the best. It is most important that the parts concerned be shaved and carefully disinfected. A pretty free incision is made over the neck, in the long axis of the hernia, and deepened till the sac is reached; the surgeon is apt to think he is on the sac long before he really exposes it. All bleeding being checked, the sac is freed by tearing and dissection from its surroundings; this is most difficult below, where adhesion to the tunica vaginalis is always present. Early in this process the vas deferens and other structures of the cord must be found and separated, a task which is specially difficult in the congenital herniæ of children, in which the vas is small and closely adherent and the sac thin. In this form the lower part of the sac is cut off and sewn up with fine cutgut as a tunica vaginalis, the rest being treated as in the ordinary kind in which the whole sac is cleared, its neck well drawn down, a ligature of catgut tied round it as high as possible, and the sac beyond cut off. If the hernia is irreducible, of course the sac must be opened and its contents treated as directed at p. 630; and the sac should be opened also in strangulated hernia. The hernia should not be reduced until the sac is recognized, but after this most operators prefer to proceed with the bowel kept in the abdomen by an assistant's fingers upon the ring. The pillars of this opening having been rendered clear in the wound, they are to be drawn closely together by three or four sutures of silver wire sufficiently stout to hold with a single knot (Fig. 44, ss. 1). These should be passed through *all* the structures, raised upon either side by a finger n the canal, and should enter and come out half an inch or so from the margin of the ring; before passing the needle through the structure on the outer side, make sure that the epigastric artery is not before its point, and in making the hooks upon the sutures see that the wire ends do not project. A small drain is now inserted, the skin-wound brought together, and an antiseptic dressing applied (see p. 624). In some cases, especially in children, primary union results; but in a good many, suppuration of the roughly handled scrotal tissues occurs, and more often, perhaps, than after its rival operations some epididymitis ensues. Under these circumstances no dressing is better than boracic fomentations with some iodoform on the wound.

In these cases, in spite of some suppuration, it is uncommon for the wire sutures to come out; almost always they remain as a permanent truss. In 25 cases of non-strangulated inguinal hernia, M. Banks had 1 death—from shock—the patient being a child of two and the operation having been very difficult and prolonged; he has not yet published his percentage of success, but it is apparently high. Of 71 aseptic cases, 4 (5.6 per cent.) died, and 66 (93 per cent.) were cured (Israelsohn). Among 26 cases of strangulated hernia, many of them unpromising, 3, aged 77, 70, and 60, died, but without symptoms of septic poisoning (Banks).

Choice of Operation.—Spanton's operation is generally regarded as best suited to herniæ of moderate size; in such cases it seems to give good results, and up to 1882, at least, Spanton had met with no death. He enters a strong plea for the "radical cure" by his method of all cases occurring in children, and points out that babies a few months old bear the treatment extremely well.

Wood's operation does not seem to have been at all frequently employed by other surgeons. The description of the operation makes it appear complex, and surgeons nowadays have a strong objection to working in the dark; it is said, too, that the femoral vein has been wounded by the needle. But in the hands of its author the results have been very good; there have been no accidents, and the mortality, in selected cases, is very low. Its success would probably become greater were silver wire used and left in, instead of tendon—though this is but slowly absorbed.

Banks's statistics cannot be compared with Wood's, for his cases were all selected because trusses failed to make the patients comfortable, and were, therefore, more or less severe. His results have been very satisfactory in spite of this. We believe that his operation is that most usually practised at the present time, and it has the advantage of being applicable to every kind of hernia.

Probably none of these operations closes the deep ring flush with the peritoneum in a hernia with a long oblique neck, and in a large hernia probably none restores the "valve-action" of the canal. Consequently we think that Banks's embedded wire sutures must be a valuable barrier against recurrence.

When the hernia is complicated by retained testis, it is always of the "congenital" variety, and is often accompanied by adhesions, intrasaccular obstructions or strangulations. The testis may be above the deep ring, but occasionally drawn into it by descent of the bowel and nipped. The wearing of a truss is usually painful. In these cases, if the testis cannot be discovered and removed, Wood removes the sac and closes the canal by suture up to the deep ring. When the testis is in the canal or just outside the superficial ring, it can usually be freed from its adhesions by careful dissection, brought down with the lower part of the sac (as a tunica vaginalis) into the scrotum (previously dilated by the finger if necessary), and retained there by a tendon suture passed through the lower and hinder part of the scrotum and through the fibrous tissue at the lower end. This Wood ties over a small pad of gauze. When the scrotal opening is wide, it may be narrowed above the testis by a buried catgut suture. In three cases Wood was unable by stretching the cord to place the testis in the scrotum; he then dissected the vas free from the epididymis and inverted the testis, thus gaining its length. Atrophy did not result; the testis reascended a little, but remained out of harm's way. In all these cases the inguinal canal is closed as usual by suture, the sac having been tied as high as possible, and the lower part sewn up and used as a tunica vaginalis.

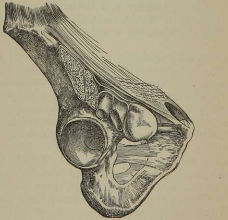
This practice of endeavoring to preserve the testis should be followed only in children. A testis which has not descended till puberty may usually be regarded as useless. It should therefore be removed and the ring completely closed—treatment which often does away with the necessity for a truss.

Femoral or Crural Hernia.

Definition.—*Femoral hernia* is that which escapes through the crural canal, behind Poupart's and just outside Gimbernat's ligament.

It passes first through the *crural ring*—an aperture bounded internally by Gimbernat's ligament, externally by the femoral vein, before by Poupart's

Fig. 228.



Femoral hernia and its relation to other parts beneath Poupart's ligament. (King's Coll. Mus.)

ligament and behind by the bone; next descends behind the *falciform process* of the fascia lata; then comes forward through the *saphenous opening* of that fascia; and lastly, as its size increases, it does not descend on the thigh, but turns up and out over the falciform process, on to the anterior surface of

Poupart's ligament. The reason for this is not obvious; and in some cases a femoral hernia passes toward the upper end of the labium. The *coverings* of this hernia are: 1. Skin. 2. The *superficial fascia* of the thigh, often loaded with fat and divisible into an uncertain number of layers. 3. The *cribriform fascia*, which closes the saphenous opening, transmits the lymphatic vessels, and is blended more or less with the next. 4. The *fascia propria*, a layer of dense areolar tissue derived from the inner compartment of the sheath of the femoral vessels, is generally pretty thick about the neck of the hernia, but thin, or even deficient, on its fundus. 5. The *subperitoneal fat*, sometimes absent, but often in considerable amount, forming a yellow layer that might be mistaken for omentum. 6. The *sac*.

Femoral hernia rarely attains a very large size. It is much more frequent in the female (seventy-five per cent.) than in the male, obviously from the greater breadth of the pelvis and greater span of the crural arch; but it is scarcely known before puberty—inguinal hernia, especially into the canal of Nuck, being the hernia of girls before this period. Littre's hernia usually occurs in the femoral ring; Hey (*Pract. Observations*, 3d ed., p. 205) gives a good case at the abdominal ring, with a post-mortem.

Diagnosis.—(1) Femoral hernia may be distinguished from *inguinal* by tracing Poupart's ligament over the neck of the sac, and feeling the pubic spine internal to and above it; whereas it is the reverse in inguinal hernia. If a large femoral hernia obscures Poupart's ligament and fat conceals the spine, a diagnostic mark is, that while an inguinal hernia descends toward the labium, a femoral mounts upward and outward toward the spinous process of the ilium (James, of Exeter, *On Operations for Strangulated Hernia*, 1859, p. 10); but a femoral may encroach on the upper part of the labium, and an inguinal does not always reach it. If the abdominal ring can be examined, and is free, all doubts as to the crural nature of a hernia is removed.

(2) *Psoas abscess* resembles this hernia roughly in its situation, impulse, and diminution or disappearance when the patient lies down. The points of distinction are—that the abscess generally issues external to the femoral vessels, is not tympanitic, can be pushed down by pressure upon the abdomen, and is usually attended with symptoms of spinal disease; fluctuation is often obtainable from the swelling in the groin to an iliac collection; there is no slip or gurgle on reduction.

(3) *Varix of the femoral vein* also resembles this hernia, inasmuch as it dilates somewhat on coughing, and diminishes when the patient lies down; but then, if pressure be made below Poupart's ligament, the swelling quickly reappears, although it must be evident that under such circumstances a hernia could not come down.

(4) *Enlarged glands and other solid and tense tumors* in the region of the saphenous opening may in most cases be recognized by their physical character, course, and causes; but an omental hernia may be irreducible, without impulse, and the patient may state that it has never gone away since he first noticed it. In such a case, if symptoms of strangulation occur, *operate;* for, though the tumor may prove to be an enlarged gland, yet there may be a small knuckle of gut strangulated behind it.

(5) Lastly, the possibility of there being a strangulated *obturator hernia* behind the femoral hernia should not be lost sight of.

Treatment.—(1) The *reducible* femoral hernia should be supported by a truss, the pad of which should tell against the hollow which lies just inferior and external to the spinous process of the pubes. This hernia is very seldom thus cured radically; only a few cases are recorded.

(2) The *irreducible* kind may be supported by a truss with a hollow pad;

or, if it be omental, the pressure of a common pad may be borne. But a patient thus treated is in constant danger of strangulation from slipping down of gut beneath the truss (p. 632), and removal of omentum and sac should be advised to enable the instrument to act effectively.

(3) When *strangulated*, femoral hernia gives rise to much more severe symptoms than inguinal, because of the denser and more unyielding nature of the parts which surround the neck of the sac, and more often comes to operation. In performing taxis, the patient should be placed with the hip joints well bent, and the leg of the affected side rolled inward, and crossed over the other. The tumor, when large, should first be drawn downward and inward, from the front of Poupart's ligament, and then be compressed in a direction backward and upward. If the taxis under chloroform does not succeed, herniotomy should at once be done.

INTERNAL HERNIOTOMY.—The parts being shaven and aseptic, and the surgeon's great object—next to freeing the bowel—being to keep the wound sweet, a vertical three-inch cut, beginning a little above Poupart's ligament, is made through the skin over the *outer* part of the swelling. The skin is drawn inward, and the fascial layers divided one by one over the mid-line of the swelling down to the sac. This is recognized and opened as usual (p. 626). The seat of stricture has been very variously stated. The deep crural arch (a band of fibres crossing the front of the femoral sheath behind Poupart's ligament) and the neck of the sac seem to be decidedly the most frequent seats; but some surgeons regard Gimbernat's ligament and the edge of the falciform process as frequent. Whichever of these structures may form the constricting band, an incision *upward and inward* will divide it without endangering any normal vessel; it should be as limited as possible. The hernia being reduced, the wound should be drained, sewn up, and dressed antiseptically; it is well to seal the edge toward the groin with collodion.

In rare cases (one in eighty operations, Lawrence) the obturator artery, rising from the epigastric, runs above, and then internal to, the crural ring, and is, therefore, in danger of division. This accident is best avoided by a limited deep cut, made by pressure on the blade rather than by to-and-fro movements. Should it, however, happen, the surgeon's choice will be between—pressure by means of pad and bandage or hands, and securing the vessel. The latter may be attempted by acupressure, a clamp-forceps, compression by a suture passed round it and through the abdominal wall, or by ligature, if the bleeding point can be felt or exposed, after such enlargement of the wound as is possible, without dividing Poupart's ligament. These methods and pressure failing, the best plan is that followed by an Austrian surgeon: expose the bleeding point by Cooper's operation for ligature of the ext. iliac (q. v.), and tie the vessel. A. E. Barker found the recorded results of pressure and of securing the bleeding point to be about the same; but it is probable that the more severe cases fell into the latter category.

The spermatic vessels or femoral vein can scarcely be regarded as in danger, unless very free or misdirected cuts are made.

EXTERNAL HERNIOTOMY, when thought desirable, can be performed more readily in femoral than in inguinal hernia; for it is easy to expose the neck of the sac through a vertical cut, and after drawing it well down to insinuate the finger-tip or a director, and then a bistoury, beneath the junction of the falciform process, Gimbernat's and Poupart's ligaments. Should the stricture not thus be relieved, the fibres of the deep crural arch may be exposed, by drawing more strongly on the sac, and similarly divided. If reduction be still impossible, the sac must be opened.

Radical cure of femoral hernia has not been largely practised. Rarely it has resulted after herniotomy, but, as a rule, the rupture is then larger and less controllable than before. Of late years many operators have always tied the neck of, and removed, the sac after such operations; and Banks has several times done this for irreducible omental herniæ, apparently with curative effect. Wood practises a more perfect operation, which may be used simply for radical cure or as a sequel to herniotomy. The sac is exposed by a vertical cut over its neck, separated from the parts around, opened, and its contents dealt with. Wood transfixes the neck of the sac and ties it in two pieces, but this does not seem so good as drawing the sac strongly down, tying the neck as high as possible with stout catgut, cutting off the sac, and allowing the stump to retract. Now pass Wood's needle deeply through the pubic portion of the fascia lata—entering it one inch below and bringing it out close to the pectineal line—and then through Poupart's ligament, upon which it should take a good hold ; thread it with tendon or wire, and withdraw. Introduce thus two or three sutures between the femoral vein and Gimbernat's ligament, and by means of them draw Poupart's ligament into close contact with the fascia over the pectineus. The femoral vein must be protected from the needle by a finger or spatula. The wound usually heals by first intention.

The Umbilical, Ventral, and other Remaining Species of Hernia.

Umbilical Hernia (exomphalos).—This leaves the abdomen at the navel. It is most commonly observed a few weeks after birth, after the separation of the cord, and is due to some weakness of the umbilical scar, or to violent straining or flatulent distention of the abdomen, causing a normal scar to yield. It may, however, be present at birth, a larger or smaller portion of the intestine occupying the base of the cord, which is greatly distended and even transparent. Hey (*loc. cit.*, p. 232) gives three cases of this sort, and in one the sac burst during delivery. Umbilical hernia is not uncommon also in women who have been frequently pregnant. It is rare in males and youths and young adults of both sexes. In many apparently umbilical herniæ of adults, the hernial aperture is a little on one side of the umbilicus (*para-umbilical*), some vascular hole in the tendon having been opened up by the growth in them of pellets of fat or by the effect of abdominal distention.

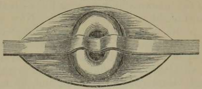
This hernia in adults may reach a huge size, may be of irregular lobulated form—perhaps divided into two distinct masses and protruding through two apertures close together—and when of any standing, is usually irreducible. The *coverings* are skin, superficial fascia, stretched umbilical scar-tissue and peritoneum—all very thin and usually inseparably blended over much of the sac. The skin of large herniæ is often ulcerating from the irritation to which it is exposed, or may be converted into white or pigmented scar-tissue. Naturally, the tumor hangs down, and intertrigo is common in the fold between the rupture and the belly-wall. The *hernial aperture* in the linea alba is very sharp, firm, and thin. The *contents* are usually omentum, transverse colon, and some small gut; intrasaccular adhesions are very common, and thick omentum often conceals bowel. Strangulation is most likely to occur from pressure against the lower edge of the ring, and demands early relief; not infrequently it is due to some intrasaccular band or hernia.

Treatment.—The truly congenital form should be treated immediately by reduction of the contents and ligature of the sac, with a flat ligature, as near as possible to the navel; the scar must be supported as in other forms. In infants the best treatment consists in wearing a round flat disk of sheet-lead or a penny covered with adhesive plaster with the sticky side out. It is well to have two such plates and body-bandages, with a bit of elastic let in to keep them tight. The child should be washed and dried whilst wearing one plate and bandage, which should then be carefully changed. These herniæ are almost always cured by contraction of the circular opening.

Reducible herniæ in adults should be similarly treated, but there is no prospect of cure.

Wood has successfully employed the truss shown in Fig. 229, which is made of India-rubber, and worn under a broad elastic body belt, held in

FIG. 229.



Wood's pad for umbilical hernia.

place by shoulder-straps if necessary. The ring exercises pressure upon the margins of the opening, whilst the sheet of India-rubber prevents prolapse.

Irreducible hernia must be controlled by hollow pads, which should be adapted to raise and to prevent pressing down of the swelling.

Strangulated umbilical hernia may be treated by taxis or herniotomy; and remembering the sharpness of the umbilical opening, we should resort to the latter early. In employing taxis, *raise the sac well*, place the fundus in the hollow of one palm and knead the neck gently whilst employing pressure on the whole rupture.

HERNIOTOMY.—The incision is best made in the mid-line above, but any spot may be chosen to meet a special indication. An external operation has sometimes been successful, the tendinous edge outside the sac being divided; but it often fails to relieve the strangulation. Formerly operation in large herniæ of this kind was very fatal; now antiseptics have changed the prospect. It is usually best, therefore, to open the sac. Much caution is necessary until this is accomplished, as the coverings are very thin and often adherent to the contents.

RADICAL CURE OF UMBILICAL HERNIÆ.—In four small reducible cases Wood has performed a subcutaneous lacing-up of the ring with wire, protecting the point of the needle in the abdomen with his finger, upon which he invaginated the sac and its coverings. After closure of the neck, the sac, which projects as a vertical ridge, may be cut off. Tendon might be used instead of wire.

Banks, Barker, Lucas, and others have operated upon large irreducible cases by the open method; and others, again, have added a radical cure to the operation of herniotomy. In a case of this kind I removed nine ounces of omentum, freed a widely adherent transverse colon, cut away most of the sac and its coverings, stripped up and sewed together the peritoneum from near the edge of the opening, drew the tendinous margins together by five sutures, and closed and drained the skin-wound. The patient left hospital with a belt; she had no sign of hernia, and the cure has lasted six months. During the separation of adhesions, etc., the opening into the abdomen should be plugged with a sponge.

VENTRAL HERNIA is that which protrudes through the *linea alba*, through a *linea semilunaris*, or through any other part of the abdominal parietes, save those which are the ordinary seats of hernia. It may be congenital, or due to distention of the abdomen, causing, especially, separation of the recti, or it may be a consequence of wounds or bruises. It must be treated in all respects like umbilical hernia. Strangulation is rare, but if it is necessary to operate, care must be taken to avoid in any deep cut the epigastric and other arteries of the abdominal wall.

An omental hernia sometimes forms in the linea alba and is scarcely distinguishable from the so-called *hernie graisseuse*, in which subperitoneal fat grows through an aperture in the same line. Either may be reducible, but both are usually irreducible.

Obturator or thyroid hernia protrudes through the aperture at the upper external angle of the thyroid foramen, which normally gives exit to the obturator artery and nerve, and is closed by loose connective tissue. The hernial sac is never of large size, and lies between the obturator ext. and the pectineus. Its relation to the obturator vessels and nerve is inconstant; usually these lie behind and outside.

This hernia is not very uncommon after fifty, being apparently connected with senile loss of fat; it is much more frequent in women than in men. Among 73 recorded cases 65 were women, 8 men (Pimbet, quoted from Erichsen). Most of the cases have been discovered post mortem, the small size and depth of the hernia preventing it from attracting attention during life. Hüter, however, claims to have recognized 3 cases, and to have successfully treated them by trusses. The diagnosis of this hernia when strangulated was rightly made in 17 of 26 cases collected by Thiele; but it has been overlooked more often than these figures show, and has led to laparotomy for intestinal obstruction (Hilton,[1] Coulson,[2] Godlee[3]), or it has been taken for a femoral hernia.

The *symptoms* are: Slight, ill-defined, more or less tender, swelling at the inner side of the thigh, below and inside the ordinary seat of femoral hernia, and having no neck traceable to the saphenous opening; pain down the inner side of the thigh, and perhaps leg, along the course of the obturator nerve (11 in 26 cases); and pain on moving the hip, especially on rotating it strongly out. All or any of these symptoms may be absent. In 4 of 6 cases in which it was followed, Röser's suggestion to examine by vagina led to a correct diagnosis (Thiele).

Taxis or pressure over the swelling, combined with traction through the vaginal wall, has been successful in a few cases. In 13 cases collected by Erichsen, herniotomy led to recovery in 4, to death in 9. We know of no success recorded after reduction by laparotomy; the cases have usually been attacked too late.

In a case in which there were symptoms of strangulation, slight fulness in the triangular space at the upper part of the right thigh as compared with the left, and a distinct hardness in the neighborhood of the femoral vessels, behind the saphenous opening, Obré (Ranking, vol. xiv.) made a vertical incision and exposed the saphenous opening. No hernial sac was found, but something hard could be felt lying deep, so the dissection was continued through the fascia lata, and the pectineus divided transversely for an inch and a half, when a hernial sac was exposed, and rose up into the wound to the size of a pigeon's egg. The finger was passed down to the obturator opening, the sac opened, and found to contain small intestine; the edge of the aperture was then divided (in doing which the saphena vein was wounded, and was tied), and the intestine returned. The patient recovered. The stricture may most safely be divided *down and in*.

[1] Med. Chir. Trans., vol. xxxi. p. 323.
[2] Lancet, 1863, vol. i. p. 303.
[3] Univ. Coll. Hosp. Rep., 1884, p. 204.

Perineal hernia descends between the bladder and rectum, forcing its way through the pelvic fascia and levator ani, and forms a tumor in the perineum.

Vaginal and rectal herniæ project into and block up the vagina or rectum, instead of descending to the perineum.

Pudendal hernia descends between the vagina and ramus of the ischium, and forms a tumor in one of the labia. It is to be distinguished from an inguinal hernia which has descended into the labium by the absence of swelling at the abdominal rings. The four herniæ last mentioned must be replaced by pressure with the fingers, and be kept up, if possible, by pads made to bear against the perineum, or by caoutchouc pessaries worn in the vagina or rectum.

Ischiatic hernia protrudes through the sciatic notch. This is exceedingly rare, and the tumor is of necessity small. If discovered to exist during life, the rupture must be returned and supported by proper apparatus; and if strangulated, the stricture must be divided by operation through a large wound clearly exposing the notch and vessels.

Diaphragmatic hernia is either a result of congenital deficiency (Balfour, *Edin. Med. Journ.*, April, 1869), of slow dilatation of a weak spot in the diaphragm, of violent falls on the abdomen, or of muscular efforts capable of lacerating the diaphragm and driving some of the bowels into the thorax; it may result also from punctured or gunshot wounds of the diaphragm. Guthrie, in his *Commentaries* (6th ed., p. 505), predicted the possibility of diaphragmatic hernia from bullet-wound, and suggested laparotomy for its reduction. He informed the author (January, 1856) that he had received from the Crimea an account of a case in which most of the stomach and duodenum protruded through a wound in the diaphragm caused by a Minie-ball. A similar case is described in Williamson's *Military Surgery* (p. 91).

These herniæ rarely have a sac; the acquired or traumatic never have. Naturally they occur most often on the left side, as the liver blocks the way on the right. The stomach, transverse colon, omentum, and spleen are the most usual contents. Congenital herniæ are often so large that they lead to speedy death by compression of the thoracic viscera. Strangulation is rare —18 times in 120 cases (Duchaussoy).

When strangulated, such a hernia causes the usual symptoms of intestinal obstruction; under ordinary circumstances dyspepsia, vague pains, dyspnœa, signs of pneumothorax with displacement of the heart to the right, and perhaps occasional constipation and vomiting, will probably be the symptoms. Immediately after an accident, the diagnosis would surely be pneumothorax; but persistence of the above symptoms would justify a strong suspicion of the nature of the case, and led König (*Lehrbuch*, vol. ii. p. 353) to a right diagnosis.

Treatment.—If a diagnosis of strangulated diaphragmatic hernia is arrived at, a small opening should be made in the mid-line of the epigastrium, two fingers introduced, and the viscera withdrawn from the thorax. It might be possible to lace up the aperture.

Lumbar hernia presents above the iliac crest, between the margins of the latissimus and ext. oblique; abscess also may point here, but gurgling in the bowel marks the difference.

CHAPTER XLI.

INTESTINAL OBSTRUCTION.

The symptoms of ordinary strangulated hernia, which we have just considered, are those of intestinal obstruction; yet strangulated external hernia is not included under the above heading as employed clinically. The term in its clinical sense implies *mechanical* obstruction of the bowels whilst they are within the abdomen.

The *causes of intestinal obstruction* are very numerous, and it is very important that we should understand the pathological conditions which we may be called upon to treat. All will find a place in the following *pathological classification:*

(1) Strangulation by bands or through apertures. (2) Volvulus. (3) Intussusception. (4) Strangulation by adhesions and by shrinking mesentery—results, other than "bands," of peritonitis. (5) Compression of the bowel by tumors, etc., external to it. (6) Stricture of the bowel, simple or malignant. (7) Obstruction by new growths filling the lumen. (8) Obstruction by foreign bodies, gall-stones, enteroliths or impacted feces.

(1) Strangulation by "Bands."—Strictly speaking, a "band" is a fibrous cord, usually of small diameter (¼ inch and less), formed by the stretching of a peritoneal adhesion and moulding of it by movements of the intestine into a rounded form. Such bands may be quite short and broad, or many inches long, and are frequently single, whence the name *solitary band* (Gay). They may form without stretching, between fixed points, as the sides of the pelvis. Many other structures act similarly and are included under this heading.

Omental cords are formed by adhesion of the omentum to some point which is the seat of local peritonitis; usually this is found in the sac of some hernia, especially in the left femoral or the umbilical of adults. Then the dragging and rolling movements of the intestines shape the omentum or the adherent portion of it into a cord which widens out towards the transverse colon, and is generally a good deal thicker and longer than the solitary band. There may be more than one such cord.

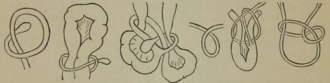
Meckel's diverticulum is the persistent remains of the vitelline duct which led during fœtal life from the umbilical vesicle through the navel into the intestine. It almost invariably joins the ileum not higher than three feet from the valve, and looks like a piece of normal gut attached at right angles to its side. It is usually one to four inches long and free in the abdomen, somewhat narrower than the ileum whence it springs, and, if anything, narrower at its free extremity. Rarely it is attached to the umbilicus and opens on the surface. More commonly it ends as, or is represented by, a solid cord (obliterated omphalo-mesaraic vessels) which may be attached at the navel, or, breaking away from this spot, may float free, or, as is more usual, acquire a fresh attachment. The ordinary diverticulum may also do so if it come in contact with an inflamed patch.

The secondary adhesion, according to Treves, is far most commonly to the mesentery, then to a spot near the navel, and then to the small gut. The free end of a diverticle sometimes becomes distended into an ampulla (Fig. 230)—of much importance in "knotting."

The last form of cord is yielded by *the abnormal attachment of the free end of some normal structures* such as the vermiform appendix or Fallopian tube, or by the fixation of a coil of small gut so as to stretch the mesentery into a band beneath which another coil may pass.

Modes of Strangulation by Bands.—Most commonly the bowel passes beneath the band in quantity sufficient to stretch it more or less tightly, the firm structures of the posterior wall of the abdomen or the mesentery usually forming the floor of the strangulating arch. But long loose cords may form a simple noose (Fig. 233) through which a coil of gut may pass and become snared and strangulated, or a more or less complicated knot may be formed around the base of a coil. For a free diverticulum to form a knot it must be of good length and have a clubbed extremity to prevent the end from slipping out through the tightening noose; under these conditions it may

FIGS. 230–235.



Figs. 230–232, simple and complicated knots formed by a free diverticulum with ampullary end; 233, a simple noose formed by a long cord; 234 and 235, more complicated "knots" by cords (Treves).

thread itself round a coil of gut. Strangulation by snaring and knotting is much less common than strangulation beneath a band; it is predisposed to whenever a coil of gut is fixed in the form of a horseshoe (Fig. 231), by shrinking lymph or mesentery, so that a neck is prepared to receive the noose.

The following modes are all rare: Strangulation by falling over a band, the weight of the dependent coil causing its occlusion on the line and acute obstruction. Bands of all kinds attached to intestine may, when drawn upon, cause obstruction by *acute kinking* of the gut at their point of attachment. Diverticula attached to the navel and solitary bands to the ileum (of which the mesentery is short) are usually found in these cases. Often the viscus, to which the end of the band remote from the intestine adhered, has moved away, as when an ovarian cyst has been tapped, an abscess emptied, or a gravid uterus has contracted. Acute obstruction is the result. Lastly, as Treves (*loc. cit.*, p. 129) shows reasons for believing, the chronic traction of an adherent diverticulum may lead to stricture of the bowel just at or above its point of attachment.

Bowel may pass through normal and abnormal openings in peritoneal folds and become strangulated. Thus small gut has several times been found in the small bag of the peritoneum, having entered through the foramen of Winslow. Treitz has pointed out that *retroperitoneal herniæ* tend to form especially at three points, where more or less marked fossæ or depressions of the peritoneal surface are present with greater or less frequency; taking these fossæ as starting-points, the bowel occasionally pushes out a sac of peritoneum behind the membrane on the posterior wall. A fold containing the upper end of the inf. mesenteric vein often gives rise to the *duodeno-jejunal fossa*, looking downward, just to the left of the duodeno-jejunal junction; the hernia may contain only a coil of jejunum, or the whole gut may lie in a thin sac behind the peritoneum. The *subcæcal fossa*, on the median side of the cæcum and limited above by a fold running from the promontory to the cæcum, and the *intersigmoid*, between the left ureter, the superior hæmorrhoidal vein and the spermatic vessels, may likewise give origin to herniæ of small gut; and Biesiadecki has described a *subfascial iliac hernia* due to atrophy of a patch of the iliac fascia and protrusion through it of peritoneum. All these are very rare, and strangulation of them exceedingly so—the sub-cæcal and intersigmoid being most often nipped.

Abnormal apertures may occur in all the mesenteries and omenta, but are very rare except in the mesentery of the ileum, near the intestine, and in the great omentum. They may be either congenital or due to injury. Apertures in wide inflammatory bands are not very uncommon.

In all of the above cases the lower ileum is the intestine usually involved; the large gut rarely is. The symptoms are typically those of acute obstruction, except in the case of stricture from traction.

(2) In VOLVULUS, a coil of intestine may (very rarely, and only in the colon) twist about its own axis, or at right angles to its long axis, or two coils of intestine may twist round each other, so as to cause obstruction. Of these displacements by far the commonest is the second.

The sigmoid flexure, the cæcum and ascending colon, and the small intestine are liable to volvulus, that first named being much the most frequently affected.

The conditions necessary to permit a twist of a coil of intestine at right angles to its long axis are (1) that its mesentery be long, and (2) that the ends of the coil be close together, so as to form a well-marked neck. The width of the base of the mesentery or of any part of the mesentery is practically constant, but it can increase much in depth and in the length of its intestinal border. Lengthening of the intestine, therefore, insures its attachment to the spine by a relatively narrow pedicle. Küttner states that volvulus is specially common in Russia, and has shown that the small gut of Russians, is, on an average, seven or eight feet longer than that of Germans, a fact which he connects with the more vegetarian diet of the former. A lax abdomen, such as exists in some old people and multiparous women, is thought to favor volvulus.

The natural arrangement of the *sigmoid flexure* approximates to that required for volvulus; the ends of this piece of bowel may be close together congenitally, or they may be dragged together by a shrinking mesentery or adhesions; but prolonged distention with feces is regarded as commonly causing both lengthening of its meso-colon and approximation of its ends. When this condition is reached some unwonted peristalsis—perhaps coupled with overloading of the upper half of the flexure, violent effort, or blow upon the abdomen—permits or causes the rotation upon the pedicle to take place. The coil may move through 180°, 360°, or even two or three complete circles; and it seems obvious that in the latter cases the involved coil must be passive. The result is closure of the ends of the loop where they cross, obstruction to the passage of feces and to the circulation, increasing congestion, serous and hemorrhagic transudation into the peritoneum between the coats of the bowel and into its cavity, and distention of the coil with gas, sometimes so enormous that the flexure touches the liver, drives up the diaphragm and shows numerous rents in its peritoneal and muscular coats. Patches of gangrene may form, but perforation is uncommon. Peritonitis spreading from the volvulus occurs early and almost constantly. The symptoms are most acute. When untwisted post-mortem, the bowel often springs back into its abnormal position; it remains untwisted when the gas is let out, but often recurs if the coil is refilled.

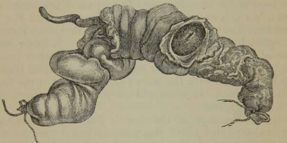
A sigmoid flexure with a narrow pedicle may intertwine with a similarly arranged coil of the lower ileum and cause acute obstruction.

The *cæcum and ascending colon* can form a loop or become intertwined with a coil of small gut or twist upon their own long axis only when their mesentery is unusually long. As a rule, there is also some congenital malposition of the cæcum in these cases which are all more or less rare. I have recently seen a volvulus through 180° of the cæcum and lower ileum, carrying the former into the umbilical region. There was an ascending mesocolon. No symptoms had been caused.

Any part of the *small gut*, especially the lower ileum, may, when suitably prepared, twist about its transverse axis. This may be caused by adhesions, shrinking of the mesentery, or presence for any time in a hernial sac. The occurrence of volvulus is one cause of persistence of symptoms after a reduction of a strangulated hernia, and volvulus of a coil which has passed through an aperture or beneath a band may form, causing strangulation which otherwise might not have occurred. The whole small gut may rotate when the attachment of the mesentery is very limited. The symptoms vary greatly in intensity. Intertwining of coils of small gut is very rare.

(3) INTUSSUSCEPTION is, on account of its frequency, one of the most important causes of intestinal obstruction. In it a piece of bowel becomes invaginated into that with which it is continuous, either below or above; but the descending form is infinitely more common than the ascending or retrograde. An intussusception (Fig. 236) consists of three layers; an outer

FIG. 236.



Ileocolic or ileocæcal intussusception. A large coil of small intestines and the caput coli are engulfed within the ascending colon. The vermiform appendage projects, and through an aperture, made artificially, the black and gangrenous intestine is seen strangled within the ascending colon. (Drawn by Dr. Westmacott.)

sheath or *intussuscipiens*, an inner or *entering* layer, forming, together with the middle, *returning* or connecting layer, the *intussusceptum*. An intussusception increases by continued infolding of the sheath at the upper angle or neck, and the lower angle or apex is constantly formed by the same piece of intestine that was first invaginated, almost the sole exception being in the ileocolic variety, which commences by prolapse of the ileum through the ileocæcal valve; in this the bowel forming the apex changes until prolapse ceases. The mesentery or mesocolon lies between the inner and middle layers and often causes by its traction marked curving of the intussusceptum, and more or less of the sheath; this curvature may, however, be absent. It is remarkable with what ease the mesentery seems to enter the colon in cases of extensive ileocæcal invagination.

Treves states that *double* intussusceptions are not uncommon, one invagination causing fresh infolding of the sheath so that it consists of five layers; *triple* intussusceptions with seven layers are rare.

Any part of the bowel may be involved—the duodenum very rarely, however. In 100 cases, Leichtenstern (*Ziemssen's Cyclopædia*, vol. vii.) states that about 44 would be *ileocæcal*, 30 *enteric*, 18 *colic* or *rectal*, and 8 *ileocolic*, terms which almost explain themselves. In the ileocæcal variety the ileocæcal valve forms the apex of the invagination, which may be so extensive that the valve protrudes from the anus and the orifice of the vermiform appendix may be seen; it is the usual form in children. In the ileocolic form, the ileum prolapses through the valve and forms the apex; later the cæcum becomes enfolded. The enteric invaginations are usually limited to a few inches, and are most common in adults.

As a rule, there is but one intussusception; one causing obstruction may be associated with slight secondary ones, but Treves has been unable to find two coexisting obstructive invaginations.

It is necessary to distinguish, from the clinical intussusceptions above described, certain others which form in the death-agony or post mortem. These occur chiefly in children, and especially in such as have died of brain disease; with few exceptions they affect the small gut only, are short, easily reducible, cause no vascular or other morbid changes in the bowel, are often multiple, and not uncommonly ascending.

Mode of Production and Causes.—The experiments of Nothnagel (*Beitr. z. Physiol. u. Path. d. Darmes*, p. 42, 1884) quoted by Treves seem to show very clearly that intussusception may result from either irregular contraction or paralysis of a segment of intestine. By faradization, Nothnagel produced an extreme ring-like contraction of a short segment of a rabbit's intestine. Above, the contraction may end abruptly or gradually, and, in the former case, a slight and temporary ascending invagination, having no tendency to increase, forms by sliding of the bowel above over the contracted portion. Below, the contraction ends suddenly, and here a true descending invagination forms by the drawing up of the bowel below over the contracted portion, and increases entirely at the expense of the sheath, as was demonstrated by marking spots upon the bowel. These invaginations persisted for a time, but disappeared as the contraction of the bowel passed off; they were at once undone by stimulation of the bowel *below* the invagination, whilst stimulation above had no effect and stimulation of the sheath rendered the invagination more rigid. This form is the *invaginatio spasmodica*. The occurrence of an *invaginatio paralytica* also was demonstrated as follows: a segment of bowel was paralyzed by crushing; stimulation of the bowel above this caused merely the usual ascending contraction, but below it caused a typical descending invagination.

In these cases the contracted or paralyzed gut seemed to act as a fixed point whence the longitudinal fibres of the bowel could act and draw the normal over the abnormal segment; for the action of the longitudinal fibres extends over the line of meeting of the paralyzed or contracted and uncontracted transverse fibres. Once started, increase is apparently due to peristalsis of the sheath excited by the presence in it of the invaginated mass.

The results of intussusception are: (1) More or less obstruction of the lumen of the bowel; and (2) more or less obstruction to the circulation, which induces greater or less swelling of the intussusceptum, increased obstruction of the lumen of the bowel, and frequently more or less gangrene. Exudation occurs upon either surface, that upon the peritoneal aspect leading to the formation of fibrinous adhesions, whilst that into the bowel is usually bloody and mucous. It is obvious that the relative size of the invaginated bowel and its sheath, and the mobility of the part affected, will be all-important in such a process as the above. The tighter the fit, the greater the interference with the circulation, the more likely is gangrene, the more severe the impression upon the nervous system, the more sudden and absolute the obstruction, the more intense the symptoms. Naturally, invaginations of the small gut are usually more acute than ileocæcal or colic, in which the symptoms may be very slight, and, on the whole, intussusceptions become less severe and more chronic after twenty. The more mobile the part, the longer the invagination.

Irreducibility may be met with early from swelling of the intussusceptum; adhesions between its serous layers are very variable, being often found in acute cases and absent in chronic, and *vice versâ;* on the whole they are more common in chronic cases, and offer little resistance to reduction during the first four or five days of acute.

Gangrene, though very fatal, ranks as a mode of *natural cure* with spontaneous resolution of the invagination. The cure depends upon the existence of stout adhesions at the neck of the invagination before the sloughing intussusceptum is cast off in mass or in shreds. Before this end is reached, however, the patient is very likely to die of collapse, fecal abscess and peritonitis, hemorrhage, or septic poisoning of some kind. It is usually taught that a severe stricture is likely to result from the casting off of the intussusceptum; but this is certainly far from common. Leichtenstern found the general mortality of 557 cases to be 73 per cent.; but of 149 cases in which the intussusceptum separated, only 41 per cent.

The exciting cause of intussusception is doubtful in the majority of cases, the displacement occurring during apparently perfect health; acute or chronic intestinal catarrh, a mass of undigested food in the intestine, a blow on the abdomen, a general shock such as that given to a child when it is "jumped," and the presence of a polypoid growth which has been seized by the bowel below and passed down by peristalsis dragging its point of origin after it, have apparently been causes. In a very extraordinary case (ileo-cæcal) of C. Heath's (*Univ. Coll. Hosp. Rep.*, 1881, p. 27), the ileocæcal valve was the seat of a large epithelioma.

Intussusception is decidedly more common in males than in females up to thirty-five, when the relation is reversed. More than 50 per cent. of the cases occur before ten years, and about 25 per cent. during the first year (Treves). The symptoms may be extremely acute, causing death in collapse within twenty-four hours; or they may last many months, sometimes intermitting completely, and ultimately causing death by marasmus. Acute cases (less than seven days) and subacute (seven to thirty days) are common, the latter being the most likely to recover by sloughing.

(4) Traction and compression by adhesions other than bands. Peritonitis leaves many marks of its presence other than those which have received the special name of bands, and which may cause intestinal obstruction. They may be classed together under the heading of "adhesions."

There are a number of cases which Treves speaks of as *bending of the bowel.* In consequence of inflammation of a patch of its own serous coat, or of inflammation of a surface of peritoneum with which it is in contact, a piece of bowel—sometimes very limited, sometimes many inches long—becomes fixed in a more or less bent position to the abdominal parietes or even to the comparatively fixed viscera. Long periods may elapse before symptoms supervene. Then suddenly *acute kinking* of the adherent gut (usually large) is caused by its over-distention, or by displacement of the viscus to which it is fixed; or, usually in the small gut, a little peritonitis completely abolishes peristalsis, which is always much impaired in the adherent segment, even though only the convexity of the bowel is affected, and symptoms of acute obstruction arise though the gut is *patent;* lastly, when much bowel is adherent in a straight line, in a bent position, or so as to form a letter N or M, the limbs perhaps being adherent all along, there is always much mechanical obstruction, evidenced by the usual clinical signs and hypertrophy of the bowel above, and complete obstruction may be induced by a purgative, indigestible meal, and other means. The symptoms are subacute or chronic. Cases of this kind are rare and much commoner in women than in men, being due, as Treves shows, especially to pelvic peritonitis, hernia (especially femoral), omental cancer, and gall-stones—all most common in women.

In other cases the affected bowel is not fixed, but *intestine is matted together* in various ways. Thus, inflammation of a herniated coil over an ulcer tending to perforate or a caseous gland may cause the formation of a loop of intestine of which the limbs may be adherent only at their extremities (open loop) or throughout (closed loop). The formor acts chiefly as a predisponent to obstruction, for it is the condition which favors volvulus or snaring by a band.

But the more acute kinking at the bend of the closed loop must cause considerable impediment to the passage of bowel contents, and this usually culminates in obstruction. The limb nearest the stomach becomes more and more dilated until the descending limb seems to leave its side and may even be compressed by it; the communicating orifice is much narrowed, and any sudden dilatation of the upper limb may bring about the impending obstruction. The symptoms are those of stricture of the small gut.

In other cases the matting of the bowel by band-like or membranous adhesions may involve several coils, or the whole intestine in cases of tubercular or other form of chronic peritonitis. The intestine is then bent and compressed in all manner of ways, and chronic obstruction with its usual antecedent symptoms may result. I have, however, seen a case of tubercular peritonitis, in an oldish man, cause acute obstruction, for which laparotomy was performed, and other similar cases are recorded.

Bands of contracting lymph around a short piece of bowel may cause stricture of it. This is most common at the hepatic and splenic flexures, where Leichtenstern thinks that the peritonitis is often excited by fecal impaction. It is rare in the small gut and apparently always either secondary to ulcer of the mucosa or complicated by some adhesion and perhaps bending.

Sometimes chronic peritonitis, especially from tabes, leads to such shrinking of the mesentery that it drags back the intestine against the spine. A similar cirrhosis and contraction may result from mechanical congestion and in chronic Bright's disease. In all these cases last mentioned the symptoms are those of stricture of the small gut.

(5) COMPRESSION OF THE BOWEL by tumors, abscesses, or cysts external to it, or by the gravid or displaced uterus or an extrauterine fœtation, may cause obstruction which is acute when due to sudden displacement on to the gut of the compressing mass, chronic when due to such compression as a rapidly enlarging kidney might exercise upon the colon.

(6) STRICTURE OF THE BOWEL, due to morbid changes in its coats, is of two kinds, (*a*) *simple* and (*b*) *malignant*. The large bowel is affected by both varieties much more commonly than the small, and the rectum is the part which suffers most frequently. Many of the changes both of small and large gut, due to adhesions above detailed, must clinically be regarded as strictures.

(*a*) *Simple stricture* is due to the healing of some non-malignant ulcer and consequent scar-contraction, the effect of the latter upon the lumen of the bowel being proportionate to the size of the ulcer and to the direction of its long diameter—transverse or longitudinal. There are many forms of simple ulcer of the intestine, but it is usually extremely difficult or impossible to decide to which a stricture is due. We already know that ulceration may be due to *mechanical injury*, such as strangulation by any sharp band, chronic invagination, or acute leading to gangrene and separation of the part; Treves believes he has found two cases due to a blow and a cartwheel over the abdomen respectively, and one perhaps to the passage of gall-stones. *Stercoral ulcers*, oval and running transversely round the gut, are common in the cæcum, hepatic and splenic flexures, and other parts of the colon above an obstruction, and probably often lead to stricture. Stricture from *typhoid ulcers* is extremely rare, and *tubercular ulcers*, which are usually transverse, rarely heal; in either case the lower ileum and region of the valve of Bauhin is most likely to be affected. The *chronic ulcer of the duodenum*, which owns the same pathology as the chronic ulcer of the stomach, and is far more common in men than in women, may, it is said, cause stricture. *Chronic catarrh* frequently causes follicular ulcers; stricture? Submucous *gummata* may break down at any point, especially the lower ileum. *Dysentery* destroys the mucosa on considerable, perhaps very extensive, tracts of large bowel starting from the anus; and recovery often leads to stricture of the rectum or sigmoid flexure, and less often of higher points. The scar is so thick and irregular that Treves thinks cases of recovery from dysentery are sometimes mistaken for cancer. On the whole, stercoral and dysenteric ulcers must be looked upon as the chief causes of simple stricture above the rectum.

(*b*) *Malignant stricture* of the bowel is, practically, always due to columnar epithelioma, which occurs in just the same form and undergoes the same secondary changes as in the rectum (*q. v.*). It is very rare in the small gut, but, on the whole, increases in frequency from above down; the ileocæcal valve, hepatic and splenic flexures, and especially the junction of sigmoid and rectum, are its favorite seats. The growth is usually annular, and compared with the thick and wide rings seen in the rectum, often very limited, sometimes appearing to the naked eye as a band of scar-tissue. Less often, free ulceration postpones stricture and may lead to gangrene or perforation of the peritoneum or some other organ or surface to which adhesion has previously occurred. Affection of lymphatic glands is frequent, though somewhat late, and large masses not uncommonly form in the liver; generalization is unusual.

(7) NEW GROWTHS of the intestine other than epithelioma do occur—*e. g.*, the mucous polypus, fibroma, lipoma, lymphoma, myoma, and adenoma. These are usually of small size and tend to become pedunculated; some of them are often multiple. As already noted, they are an occasional cause of invagination. When large they may themselves block the lumen of the gut and induce symptoms of more or less chronic obstruction. Sarcoma may extend round the bowel and cause stricture. All these tumors, except the mucous polypi and fibrous warts, are rare, lipoma and myoma very rare.

(8) FOREIGN BODIES of all kinds have been swallowed internally by accident, or during sleep. Lunatics and hysterical women often swallow the oddest things. Fruit-stones, coins, false teeth, pins, needles, nails, hair, cocoa-nut fibre, strings, bits of blanket, clasp-knives, are examples. Marcet (*Med.-Chir. Trans.*, vol. xii. p. 52) reported the case of a sailor who, during ten years, swallowed thirty-seven clasp-knives, and passed many of them *per anum*. Large coins, plates bearing many teeth and armed with hooks, a door-key, and a small flute (Treves) have also been passed safely through the intestine; but, of course, the large and more angular a body is the more likely is it to give trouble. Pins and needles when swallowed often work their way to the surface of the body at points far distant from the bowel and either escape or are cut out; Marshall (*Med.-Chir. Trans.*, vol. xxxv. p. 65), however, has seen the duodenum completely blocked by a pound of pins.

Hair, string, and such materials frequently accumulate in the stomach, and mixed with food and mucus are rolled by its movements into a ball.

Foreign bodies may pass *per anum* after long residence in the canal without doing harm, and tend to linger, especially in the stomach and cæcum; but they often excite ulceration and peritonitis, ending in stricture, or the ulcer may perforate the peritoneum, a neighboring viscus, or the abdominal wall, and the body may escape through the fistula.

Gall-stones of size sufficient to cause obstruction may enter the intestine through a fistula, which is thought soon to heal, between the gall-bladder and duodenum; when stones enter the transverse colon they rarely if ever cause obstruction. Anything which has passed down the bile-duct almost always, but not always, is too small to do mischief. Stones over three inches round have been passed, but anything two inches in circumference is very likely to become impacted near the juncture of duodenum and jejunum or in the lower ileum.

Stones cause intense enteritis at points of impaction, and general peritonitis may spread thence.

Calculi (*enteroliths*) sometimes form in the bowel, and consist of either mineral phosphates and carbonates—when they are hard and firm; of fibrous materials that have been swallowed (hair, oat-husks, cocoa-nut, and other vegetable fibres)—when they are felt-like or velvety; or substances like carbonate of magnesia, which have been taken as medicine in large amount—when they are hard but friable. These materials, together with food particles and mucus, are moulded slowly by the bowels into a hard or somewhat spongy mass which usually occupies the cæcum or rectum. The *symptoms* are generally long-continued constipation, dyspepsia, and wasting; rarely, acute obstruction is induced by the impaction of a mass formed in the stomach or a diverticulum moving on and becoming impacted. The mass can usually be felt by abdominal or rectal touch.

Fecal Impaction.—In cases of chronic constipation the colon becomes more and more loaded with feces of a firm, clayey kind, becoming drier and sometimes forming scybalous masses in the sigmoid flexure and the rectum. This accumulation results chiefly from feeble peristalsis—though insufficient secretion, indigestible food, and the taking of too little liquid or of astringent drinks, have their share—and it naturally occurs most often and earliest at points of difficulty, viz., the cæcum, the flexures, or rectum. At these points a fecal tumor can often be felt. In other cases the accumulation of feces in the colon is enormous, and distends the bowel everywhere to a diameter of six or eight inches. Stercoral ulcers (p. 658) are common either just above an impacted mass of feces or in the cæcum; and perforation, especially of the cæcum may occur.

DIAGNOSIS.—There is perhaps no more difficult subject in the whole range of surgery than the diagnosis of intestinal obstruction. It may be considered under the four headings: 1. Is the patient suffering from intestinal obstruction? 2. Is it acute or chronic? 3. What is the cause? 4. In what part of the bowel is the obstruction situate?

1. *Is the patient suffering from intestinal obstruction?* The mere recognition of internal mechanical obstruction is sometimes by no means easy: as Treves says, "How many and diverse are the morbid conditions which excite simultaneously the great symptoms of obstruction, viz., pain, vomiting, and constipation!" The most important of these are the following:

Acute peritonitis, especially perforative or arising from inflammation and sloughing of the vermiform appendix. Usually before perforation takes place there have been symptoms connected with the stomach, intestine, or gall-bladder; or there has been a painful, tender swelling in the right iliac region. But the peritonitis may appear suddenly during perfect health, with intense pain and collapse, and these are the most difficult cases. The chief points of contrast between the symptoms of acute peritonitis (p. 601), and of acute obstruction (p. 661), are these: Very intense collapse, ending fatally in twenty-four to forty-eight hours, is more likely to be due to perforation than to strangulation. Peritonitis is a febrile disease, the temperature rising to 102°–4° as collapse passes off, and then being remittent with a maximum of about 102°; it usually falls before death. In acute obstruction the temperature is normal or subnormal, but this may be the case also in peritonitis. In peritonitis the pain is increased by pressure, tenderness being marked and universal, and colicky exacerbations cease so soon as the inflammation is general; in obstruction the pain is often relieved by pressure and exacerbations occur. The abdominal walls in peritonitis are rigid and usually retracted at first, then uniformly dilated, and there are no visible coils; in obstruction the walls are flaccid, unless peritonitis supervene, meteorism may be slight and local, and coils of bowel may be evident. In peritonitis the patient usually assumes that position which most relaxes the abdomen. Vomiting is very variable in peritonitis, and is on the whole more urgent and much more commonly feculent in obstruction; but in volvulus of the sigmoid and acute intussusception this symptom is not prominent. The forcible escape of the vomit, without obvious effort, "as if it were pumped up," is very characteristic of peritonitis. Constipation may not be absolute in peritonitis, and when the pelvic viscera are affected (puerperal form) there may be diarrhœa; on the other side, diarrhœa is usual in acute intussusception, but in the great majority of cases the stools are mixed with blood. Although there is no one symptom which is constant in, or diagnostic of, acute obstruction or peritonitis, the latter disease can generally be recognized when the complex of symptoms is carefully considered. But the diagnosis of peritonitis does not show that it is the cause of the obstruction, for peritonitis often supervenes upon acute strangulation; here we must trust to the data of the onset of symptoms. The differential diagnosis between acute obstruction and peritonitis of the kind mentioned is much less important now than formerly, for if a patient has either, almost his only chance lies in laparotomy and direct treatment of the cause.

Tubercular peritonitis at its onset rarely causes the symptoms of acute obstruction (p. 661). The presence of fever, œdema at the navel, of fluid in the abdomen, diffuse tenderness or a mass like a rolled-up omentum; a history of previous illness with wasting, and perhaps abdominal pain and diarrhœa, or manifestation of tubercle elsewhere—*e. g.*, lungs or testis—would raise the suspicion of some chronic disease. But when these symptoms are present the obstruction is usually of a chronic kind due to bending or matting. *Malignant disease of the peritoneum* may act similarly.

The most frequent of all mistakes in diagnosis has perhaps been that of taking intussusception for *dysentery* or *intestinal catarrh*. Paroxysmal abdominal pain and diarrhœa or passage of bloody mucus with tenesmus should always lead to a careful examination of the abdomen for tumor of the character noted at p. 662.

Pseudo-strangulation is the name given to cases in which there are symptoms of obstruction, but no mechanical constriction of the bowel. 1. More or less of the bowel is paralyzed from direct injury, such as strangulation or temporary impaction of a foreign body, or from inflammation spreading to the muscular coat from either the mucosa or serosa. 2. Reflex paralysis may apparently be induced by severe irritation of nerves more or less directly connected with the solar plexus: hence the occurrence of symptoms of strangulated hernia in some cases of inflamed testis, especially retained, of acute abscess in the abdominal wall, etc. 3. Symptoms of obstruction may arise from disease of the central nervous system—especially hysteria.

Fagge records a case of internal strangulation admitted to Guy's during an epidemic of cholera in a state of such intense collapse that it was supposed to be cholera with retention of stools; and similar cases have occurred elsewhere. The severe abdominal pain of strangulation and ultra-acute intussusception is of chief importance in cases with constipation; whilst in longer cases with diarrhœa, the "rice-water" stools and vomit, retracted abdomen and cramps of the limbs in cholera, are distinctive.

Other diagnostic errors have occurred in connection with meningitis (Fagge; the obstruction was high up, the abdomen retracted, and the patient delirious), hepatic and renal colic, arsenical poisoning and certain cases of lead poisoning.

Diagnosis of the Cause of Obstruction.—The main *symptoms* of intestinal obstruction are those of strangulated hernia—pain, shock, vomiting, and constipation; and, as in strangulated hernia (p. 620), their urgency varies according as the obstruction is sudden and complete or gradual and incomplete. Hence the two great clinical groups of *acute* and *chronic intestinal obstruction* have been formed. If certain pathological conditions always caused acute whilst others always gave rise to chronic obstruction the first step towards the discovery of the cause of the symptoms would be easy; but conditions which usually cause acute obstruction sometimes give rise to only subacute or even chronic symptoms, whilst there is not one of the morbid conditions which generally lead to chronic obstruction that does not occasionally cause an acute attack—the first sign of even a stricture high up in the rectum may be such an illness. It is much more common, however, in cases of this class, for an acute attack to supervene upon symptoms of gradually increasing obstruction—a portion of the canal, which has for some time been much narrowed or hampered in its functions, becoming suddenly either completely occluded or placed *hors de combat*, and this sequence of events may be regarded as characteristic of an important subdivision of the class of chronic obstructions.

Accepting the above classification of pathological conditions as being, in spite of its defects, the best for clinical purposes, we find that *acute obstruction* generally arises from: (1) Strangulation by bands or through apertures; (2) Volvulus of the sigmoid flexure; (3) Foreign bodies—chiefly gall-stones, rarely bodies swallowed or enteroliths; and (4) Acute intussusception. These conditions in their history, and the symptoms to which they give rise, differ sufficiently to allow of more or less accurate differential diagnosis; but there are several other comparatively rare conditions which are usually indistinguishable by either history or symptoms from certain of the above. Thus under (1) must be included certain cases of volvulus of the small gut (p. 654) and all cases of sudden compression by tumor or of acute kinking of the same part; again, volvulus of the sigmoid flexure (2) is simulated by volvulus of the cæcum and acute bending and kinking of the large gut.

The *signs* of *acute obstruction* in general are the following: onset sudden; pain severe and constant, though there may be exacerbations, and usually referred to the umbilical region; collapse marked; vomiting early, frequent, and soon offensive or stercoraceous, and the quantity of urine is diminished in proportion as the collapse and vomiting are severe; constipation absolute; meteorism slight or very great, usually first in central regions; coils of gut and peristalsis rarely seen; average duration one week or less.

Chronic obstruction, on the other hand, is due to: (1) Stricture of the small gut, malignant or simple, both rare, and the many conditions due to adhesions or to shrinking of the mesentery (p. 657) which cause the symptoms of stricture. (2) Stricture of the large gut (malignant or simple), which becomes increasingly common as we pass down the colon, and the effects of adhesions, which are less frequently felt than in the small bowel. (3) Fecal impaction; and (4) chronic intussusception. Symptoms like those of stricture of the small gut are produced by some volvuli of it, by rare cases of gall-stone or enterolith, by large pedunculated new growths, by some gradually increasing tumors outside the bowel, and some volvuli of the cæcum. In the second group must be included also cases of gradual compression by tumor and most cases of enterolith.

The *signs* of *chronic obstruction* are: Onset gradual, *i. e.*, preceded by a longer or shorter period, during which there has been increasing constipation, and not uncommonly there is a history of prolonged attacks of constipation with colic and some sickness, or of constipation alternating with diarrhœa; pain not severe and distinctly intermittent, the intermissions being shorter the more complete the obstruction (Treves), or it may be absent; no early (reflex) collapse; vomiting occasional and bilious, feculent late, if at all, sometimes provoked only by taking food or medicine, perhaps not appearing for days or even weeks after constipation has become absolute, and then long intervals of apparent improvement, free from vomiting, may occur; the secretion of urine is unaffected; constipation is usually absolute, but in the slightest incarcerations, scarcely to be classed with the cases we are now considering, a small stool may occasionally pass; meteorism is very marked when, as is often the case, the obstruction is below the splenic flexure, for the thin abdominal walls yield continuously, though perhaps slowly, under the constant pressure; outlines and movements of distended coils of bowel are frequently visible through the abdominal wall, because their muscular coat has become hypertrophied above an obstruction of some standing, and this in many cases has led also to some emaciation and thinning of the belly wall.

Cases in which *acute symptoms supervene upon chronic* are distinguished from the truly acute by the slighter intensity of the pain, collapse, and other symptoms; frequently by the presence of visible coils and peristalsis—physical signs of an old-standing obstruction—and by a history pointing in the same direction. These cases really belong to the chronic group.

Mistakes are liable to arise when a gradually increasing obstruction gives rise to no symptoms until it becomes suddenly occluded, and intense symptoms forthwith appear; when in a case of strangulation by band or through an aperture there is a history of previous slighter but similar attacks, or when in gall-stone there is a history of intestinal trouble leading more or less rapidly up to a final acute attack; and such a coincidence as increasing chronic constipation (say from sedentary life) and strangulation by band is quite possible. Indeed every step of the diagnosis bristles with difficulties.

Differential Diagnosis of the Main Causes of Acute Obstruction (the symptoms in general are given at p. 661).—In *strangulation by bands or through apertures*, which is most common in young adults, and rare after forty, there is very often a history of previous peritonitis. The symptoms are typically those of acute obstruction, the pain being often exceedingly severe, and vomiting frequent, early, and soon feculent; the collapse marked; meteorism is usually slight and central, the abdominal walls remaining lax until peritonitis sets in, as it may do after some days, when tenderness appears.

Volvulus of the sigmoid flexure is much commoner in men than in women, is rare before forty, and is usually preceded by chronic constipation; pain is less severe than in the foregoing, may be intermittent for a time, and is at first referred to the umbilicus; but as peritonitis sets in early, the region of the sigmoid flexure becomes both painful and tender, and the abdominal walls get rigid; collapse is less than in strangulation by bands, and vomiting is later in onset, irregular, does not as a rule become feculent, and is by no means a marked feature; meteorism begins early in the left iliac and hypogastric regions, spreads into the umbilical and epigastric areæ, producing at this stage the form of belly characteristic of the obstruction of the small gut low down (Treves), and continues to increase rapidly, soon becoming very great, and causing more or less dyspnœa; tenesmus sometimes occurs, but nothing escapes *per anum.*

Acute intussusception is rather more common in males, and the great majority of the cases occurs during childhood, especially in the first year. In rare cases (*ultra-acute*), almost all in very young children, pain and collapse prove fatal within twenty-four hours. Usually pain is not severe, and occurs at first in paroxysms which pass more or less quickly into continuous pain, with paroxysmal exacerbations; usually it is umbilical, but may be localized to the invagination, which *may* soon become tender from peritonitis, and this complication will cause more or less rigidity of the abdominal wall, followed by general distention; collapse is the more marked the younger the patient; vomiting usually does not occur early, is not urgent, and does not become feculent till late; unless peritonitis sets in, meteorism is slight and central, or absent. But the characteristic symptoms of intussusception are tenesmus, which is the more marked the nearer the invagination approaches the anus; the passage of bloody mucus; the frequent escape of small quantities of feces, absolute constipation being exceptional; the discovery of a tumor on palpation of the abdomen and often of a mass in the rectum; sometimes the escape *per anum* of the intussusceptum which has sloughed. The tumor is sausage-shaped, rarely more than six inches long, often distinctly curved, resonant or sub-resonant on percussion, most commonly found in the hypogastric and right iliac regions, and may often be traced thence along the line of the transverse colon; it varies much in distinctness, and becomes especially plain during an attack of colic; manipulation may excite perceptible peristalsis in it. The absence of a tumor should not be concluded until the abdomen has been explored during a pain, and under chloroform if meteorism or rigidity of the abdominal wall is present. Fagge and Hutchinson think that a tumor of this kind *may* thus always *be* discovered, unless the patient be very fat; Treves says that it *has been* discovered in less than half the cases. It may be simulated by a fecal mass, an omentum matted by tubercular inflammation or some less common intra-abdominal mass. As to the rectal mass, it is best described as "like a large os uteri;" it may be continuous with a left iliac swelling, or protrude some inches from the anus, when it must be distinguished from prolapse of the anus or rectum.

As before pointed out, the symptoms of intussusception vary extremely in intensity, and as cases occur, especially of the enteric form, in which pain is very severe, collapse great, vomiting frequent and soon feculent, constipation absolute, and tenesmus, bloody discharge, and tumor are absent, it is obvious that their differential diagnosis will be impossible.

Obstruction by gall stone is four times as common in women as in men (Treves), and the patients are almost always over forty. There may be a history of hepatic colic, of passage of gall-stones *per anum*, or of peritonitis about the gall-bladder; but more often there is none; when there is such a history, symptoms of obstruction may not occur for some weeks. They are those of acute obstruction, but vomiting is early and specially profuse, and pain and collapse are much less marked than in strangulation by band, which it most resembles: meteorism is slight, and, in rare cases, a tumor (the stone) has been felt—tender, unyielding unvarying in consistence, and unaccompanied by tenesmus or passage of blood. Sometimes the passage of a stone down the gut may be traced by progress of pain and attacks of temporary but severe obstruction.

A gall-stone causing chronic symptoms can scarcely be recognized, and only a history strongly pointing to it or a hard tumor would lead to the suspicion of a *foreign body* or *enterolith* causing acute obstruction.

Differential Diagnosis of the Causes of Chronic Obstruction; Stricture of the Small Gut.—This, either simple or malignant, is rare, but it expresses best the kind of obstruction characteristic of the group given at p. 657, of which compression is the commonest member. Simple stricture occurs usually from twenty-five to thirty-five, malignant from thirty-five onward, but is uncommon before forty; the latter form causes on the whole more rapid emaciation than the former, and in it a tumor can, not infrequently, be felt. A history of some kind of ulceration, of peritonitis, strangulated hernia, abdominal tumor, gall-stone, foreign body, or rapid loss of flesh, will guide us with some probability toward the nature of the pathological state; distinction by symptoms and physical signs is usually impossible. The onset is gradual, the patient suffers from attacks of colic, prostration, nausea, sickness, and constipation, which get more frequent and severe, while he loses flesh more or less rapidly, the attacks may appear without obvious cause, but are often excited by food—especially indigestible; they pass off after a time, the constipation sometimes yielding to diarrhœa, perhaps after the administration of a gentle purge; but in a severe attack even this will make matters much worse, and a strong purgative may induce complete obstruction. Ultimately complete obstruction supervenes; constipation is absolute; pain constant with attacks of colic, relieved by pressure; vomiting not severe, becoming feculent late; meteorism slight; epigastric and central peristalsis marked.

Stricture of the Large Gut.—The differences between simple and malignant stricture are the same as in the small gut, and the diagnosis of the variety of simple stricture, if possible, depends upon the history. The onset and course are similar to those in stricture of the small gut, but in the occasional and final attacks all the symptoms are less severe and later. Progressive constipation is a much more marked feature, and aperients or enemata are usually required to procure every action; but diarrhœa not uncommonly occurs, being excited either by the ulceration causing a simple stricture or by the irritation of solid feces retained above an obstruction. Blood is not uncommonly passed, especially in malignant cases; tenesmus is frequent, and feces may be shaped when the rectum is the seat of mischief; meteorism becomes increasingly marked when constipation persists and the abdomen at first assumes the broad form; peristalsis is marked, and may, rarely, obviously cease at the stricture; a cancerous tumor is frequently felt through the abdomen, and examination by the finger or hand in the rectum will reveal an obstruction low down.

Fecal impaction is most frequent in women as a result of sedentary habits, neglect, or an hysterical desire to excite interest. The history is costiveness lasting for months or years, together with the dyspepsia, loss of appetite, foul tongue, sallow tint, piles, hypochondriasis, and general ill-health characteristic of confined bowels; aperients and enemata have become constant necessities, and in spite of them the intervals between the actions of the bowels have lengthened to perhaps weeks or even months. The surgeon often finds a fecal mass at some point of the large gut. It is firm, irregular, movable or fixed according to the connections of the bowel it occupies, neither painful nor tender, sometimes retains an impression of the finger, and may remain at the same spot perhaps for weeks without causing absolute obstruction ; it usually disappears under enemata. In prolonged attacks the abdomen swells, there is more or less colic, eructation and nausea increase and finally pass into vomiting. An enema well administered will probably relieve, and under proper treatment the patient may get quite well; or similar attacks may recur, and ultimately, though very rarely, neither enemata nor purgatives act, the symptoms of complete obstruction set in, and the patient dies of exhaustion, perforation of an ulcer, or sloughing, or, rarely, rupture of the bowel.

Sudden and severe symptoms may supervene upon the above at any moment, from volvulus of the sigmoid flexure (p. 662), sudden complete obstruction of a narrow passage, development of peritonitis over a fecal impaction, or paralytic distention of a segment of the bowel.

The great difficulty in these cases is to be sure that the fecal accumulation is not occurring above a stricture of the colon, the special signs of which must be carefully looked for.

Chronic intussusception is that form which lasts from one to many months. It is more common in males than females, in adults than children, and is usually ileocæcal, rarely enteric, but Goodhart has lately recorded a case of jejunal invagination lasting twenty months. The previous history shows nothing of value. The onset may be sudden, the symptoms soon quieting down, but it is usually gradual. The course is very variable, and is made up of attacks of partial or complete obstruction alternating with intervals of absolute or relative ease. All the symptoms are exceedingly irregular : there may be much or little pain or vomiting, but usually neither is severe, and vomiting is very rarely stercoraceous ; the bowels may be confined, loose, or, rarely, normal; the motions are often mixed with blood, and tenesmus occurs when the lower part of the large bowel is affected. The discovery of a tumor (see p. 664) in the abdomen or rectum is of chief importance, and is usually possible: it is rarely tender. Meteorism varies with the constipation and is rarely marked ; colic and visible peristalsis occur.

This form does not tend to cure itself by sloughing : unless relieved by art the invagination tends to increase and the patient dies of exhaustion or peritonitis.

Seat of Obstruction —It is most important for purposes of treatment to know : (1) Whether the obstruction is in the large or small gut; and (2) Whereabouts it may be in either of these segments.

(1) *Small or large gut?* This question resolves itself at first into that of *acute or chronic?* (p. 662)—the supervention of acute upon chronic symptoms being included in the latter class; for acute symptoms are generally due to obstruction in the small, chronic to obstruction in the large, gut. In dealing with *acute cases* we must, however, remember that volvulus and acute kinking of the large gut produce symptoms which it will tax our diagnostic skill to distinguish from those of sudden complete obstructions in the small gut.

Again, in *chronic cases*, mild and late symptoms cannot be held to imply that the obstruction is in the large gut, though, *à priori*, it is probably so, stricturing of the large gut being more common as a cause of obstruction than stricturing of the small. As the treatment differs materially according as the obstruction is in the small or large gut, we must endeavor to ascertain this fact by attention to the points noted under the differential diagnosis of stricture of the small and of the large gut (p. 664).

(2) *Position of the obstruction:* (*a*) *In the small gut.* Sudden obstruction high up causes early and profuse bilious vomiting which often relieves temporarily and is much aggravated by food. Meteorism may be absent and

the abdomen hollow; or it may be slight and epigastric. Gradual obstruction high up causes symptoms somewhat like those of stenosis of the pylorus, including dilatation and hypertrophy of the stomach and gut above. In sudden obstruction low down vomiting may be very urgent, gives little relief, is less affected by food, and becomes feculent early; meteorism is epigastric, umbilical, and hypogastric, the abdomen appearing somewhat "pointed" in the region of the navel. This appearance, however, is simulated by distention of the sigmoid flexure in volvulus (Treves). It is lost more or less quickly by lateral extension, and in many cases of obstruction of the large gut low down it is impossible to say that the abdomen is broadly distended, though it may not be typically pointed. The localizing value of meteorism is therefore not great. In chronic cases, from matting, etc., meteorism may be slight. In malignant stricture a tumor may be felt. Evidence that an enema has reached the cæcum would almost certainly indicate that the colon was free.

(*b*) *In the large gut* the seat of obstruction may be revealed by (1) Fixed pain at the spot. (2) Cessation here of obvious peristalsis (rare). (3) Obvious dilatation of the colon above it, especially with fæx in chronic cases; or, without this, bulging of the flanks giving a broad shape to the abdomen; or bulging upon the right side with greater resistance here than on the left may point to obstruction at or below the hepatic flexure. Fagge cautions against mistaking for a distended transverse colon a segment of much dilated small gut crossing the epigastric or umbilical region; the transverse colon when distended loops down toward the symphysis. If any part of the colon is plainly distended, it is a valuable sign, but absence of it does not imply that the obstruction is in the small gut. (4) Discovery of a tumor by palpation through the abdominal wall. (5) Discovery of a stricture by examination with the finger or hand introduced into the rectum. (6) The passage of a long tube: this is useless, for the tube hitches in folds and natural bends, and seems to indicate a stricture, or curls upon itself below an obstruction and seems to pass far beyond it. (7) The injection of measured quantities of fluid *per anum*, the rectum being said to hold one pint, the sigmoid flexure two pints more, and so on (Brinton). This also is useless, for the capacity of the rectum and sigmoid flexure varies greatly—the rectum alone may retain three pints (Treves); some patients soon strain and expel the fluid; in other cases fluid may actually pass through the stricture (Fagge). (8) By auscultation of the colon during the administration of an enema the fluid may be traced along the bowel even to the cæcum. It is, however, difficult to localize the sounds, which are heard everywhere, and some of the objections to the last method hold.

The EXAMINATION OF CASES OF SUSPECTED INTESTINAL OBSTRUCTION must be most systematically conducted according to the order which is usual in the investigation of abdominal cases. We append a plan: the meaning and bearing of the various questions will be evident to any one who has read the foregoing paragraphs.

History—most important; divided into "history of the attack" and "previous history."

HISTORY OF THE ATTACK: *Onset*—exact date, sudden or gradual? Intensity of collapse? Fever? Rigor? Thirst? Order and times of appearance of symptoms. Take up each symptom and note its history from day to day in acute, from week to week in chronic, cases.

Pain—time of onset, character, severity, and original situation, variations in intensity and position since, constant, remittent, or intermittent, and, if intermittent, the duration of the painless intervals.

Tenderness? Where?

Vomiting—time of onset, frequency, with or without exciting cause, "pumping."

Vomit—quantity and nature of?

Urine—quantity, dysuria?

State of bowels—absolute constipation, diarrhœa, passage of flatus, blood, and mucus, tenesmus?

State of abdominal walls—early rigidity and retraction, early localized swelling and its seat, visible coils and peristalsis?

The PREVIOUS HISTORY may give some clue to the causation of the case, to the pathological condition which is producing the symptoms. First ascertain the *state of the bowels* for some time *previous to the attack*—normal, increasing constipation, constipation alternating with diarrhœa, or attacks of obstruction, perhaps slighter than, but still similar to, the present—facts which would indicate that the obstruction is of a chronic nature even though the symptoms of the present attack be intense. Attention will be drawn to almost all cases of rectal stricture by the answers to the above questions.

The causes of intestinal obstruction of which the patient is likely to be able to give any history are: The swallowing of a foreign body or bodies, or of materials likely to give rise to an enterolith; a specially indigestible meal; injury to the abdomen, including any operation (even tapping) upon the peritoneum; violent effort in relation to the present illness. Peritonitis, almost always localized and due—to pelvic trouble (in women), to typhlitis (chiefly in men), to tubercular disease of mesenteric glands (chiefly in childhood), to injury of the peritoneum, and especially the slight or grave damage which is often inflicted upon intestine or omentum in a hernia. The existence, past or present, of a hernia, and of troubles (especially inflammation or strangulation) connected with it, should always be specially inquired for. There are many other causes of local peritonitis, such as the various ulcerations of the gastro-intestinal tract or inflammations of other viscera; so a general question with regard to abdominal and intestinal troubles should be put. Hepatic colic, gastric or duodenal ulcer, typhoid, dysentery would then be mentioned. The patient may have been aware of the presence of an abdominal tumor, and under this heading comes the pregnant uterus. A history of marked wasting may lead to a suspicion of malignant growth or with other symptoms of tubercular peritonitis.

PHYSICAL EXAMINATION. *Inspection of the Patient.*—Note: the aspect, with reference to pain and collapse; habitual position, whether dorsal decubitus with knees drawn up; the avoidance of movements which require the use of the abdominal muscles; respiration, whether frequent, shallow, and thoracic; eructation and hiccup; vomiting, with or without effort; characters of vomit and of anything passed *per anum*. Order all dejecta to be kept for inspection.

Inspection of the Abdomen.—Note: the presence of any hernia, the state of the walls, flaccid or rigid; any distention, the regions affected, and the general form of the abdomen; visible coils and peristalsis; œdema about umbilicus.

Palpation will show the state of the walls. First examine carefully all the ordinary and extraordinary hernial regions. Then note tenderness, general or local, a tumor or an ill-defined resisting mass. The patient should lie on his back with shoulders raised and hips well flexed, and breathe easily. Before free palpation is employed, the surgeon should feel pretty clear that he is not dealing with a case of acute peritonitis or typhlitis.

Percussion of the abdomen should be systematically employed, and resonance or movable or fixed dulness must be interpreted as usual. It does not often yield indications of much value in these cases.

Auscultation is of value only in conjunction with *injection of the colon* to learn how far the bowel is permeable to fluids.

Digital examination of the rectum should never be omitted. It will reveal the presence of fecal masses, enteroliths, stricture of the rectum, and of many ileocæcal, colic, and rectal invaginations. In cases in which there is strong reason to believe that a stricture exists at the junction of the sigmoid flexure and rectum or low down in the flexure, a small hand—under eight inches in circumference—may be introduced into the rectum to perfect the diagnosis.

Methods of Treatment.

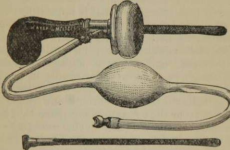
(1) General Points.—There are certain points which may be spoken of in a general way.

Aperients.—It may be taken as a rule to which there are few, if any, exceptions, that a purgative should never be given in a case of true intestinal obstruction. In cases of chronic constipation the bowels may respond to a full dose of calomel, elaterium, or croton oil, when milder means have failed; but, except for the relief afforded by the action, the patient is worse rather than better for the treatment, and in the worst cases—those spoken of as "fecal impaction"—the purgative may not cause the bowels to act, but induce vomiting and much pain. In cases of persistent or gradually increasing stenosis of the bowel a strong purge has again and again induced symptoms of more or less acute obstruction by hurrying a large quantity of stuff into the bowel above the constriction and choking it, after which the violent peristalsis causes vomiting; but in the early stages of these maladies gentle laxatives, such as ol. olivæ, sulphur, aloes in small doses, administered so as just to insure softness of the intestinal contents, are very valuable, especially when employed with a liquid and digestible diet. Even these, however, should be given up if there is rapidly increasing meteorism, visible peristalsis, or vomiting. In acute cases purgatives administered in doses of ½ to 1 oz. are usually vomited at once, but those given in very small quantities do the greatest harm by increasing peristalsis and hyperæmia and secretion of the intestines. Nothing of the kind is permissible.

Simple enemata act in two ways: first by exciting peristalsis, which affects the large gut chiefly, though rarely the small is thrown into violent action even by a digital examination of the rectum; and secondly, by soaking into and softening fecal masses. The peristalsis ordinarily is gentle and is not of long continuance, so it may be regarded as well under control compared with that excited by purgatives. Consequently enemata may be continued safely in cases of obstruction after purgatives have been abandoned. It is an advantage in all cases of obstruction to have the lower bowel empty at the start; but the cases in which enemata form a valuable mode of treatment are those of fecal impaction, enterolith with chronic symptoms, stricture, bending and compression by adhesions of the large gut, also similar cases in the small—though the latter are less amenable to their influence. (Intussusception is here omitted, enemata having a different action in it.) In all these the symptoms are chronic; if seen early there is no urgent need for immediate relief, so mild measures, even if their success is problematical, may be fairly tried; and as the cause of the complete obstruction in all is impaction of a fecal mass in an inert segment of bowel, or above or in a stricture, or over-distention of the segment of gut above a bend, or a little local peritonitis over a fecal mass, we may obviously hope that under favorable conditions it will be overcome, and that the patient will recover or be granted a reprieve. Gentle peristalsis reaching, as we hope, but little higher than the obstruction, and the gradual softening of the obstructing mass, will certainly favor the removal of the cause. In many cases it is necessary also to quiet the peristalsis of the small gut to give the patient ease, and to prevent greater accumulation immediately above the obstruction; this is to be done by opium (see below). In acute cases—disregarding their special action in intussusception—enemata are worse than useless once the lower bowel has become cleared; after this they exhaust the patient for nothing.

The enemata employed in chronic obstruction and intussusception may be spoken of as "forcible," for as much liquid is injected as the patient can bear. Cold soap and water, olive oil, or thin gruel, is generally used. The patient should lie upon the left side, inclined forwards, and the enema should be run in slowly from a siphon-douche hung two or three feet above him, and connected with a Lund's inflator (Fig. 237).

FIG. 237.



Lund's inflator—a Higginson's syringe, connected with a special handle.

If this is not at hand pass a long rectal tube, wrap a little tow round it, and let an assistant press this hard against the anus and push the buttocks strongly together. A Higginson's syringe (Fig. 237) or other enema apparatus gives more pain than does the siphon. Kneading the colonic region helps the entry of fluid. The enema should be forcibly retained as long as possible. Too much pressure must not be used: the bowel has been burst at Guy's (Fagge).

V. Ziemssen (according to Treves) strongly recommends enemata of carbonic acid to excite peristalsis or to enable the surgeon to map out the colon. He pours into the bowel through a long tube to which a funnel is attached a third or fourth part of 300 grains of bicarbonate of soda, follows this with a proportionate part of a solution of 225 grains of tartaric acid, and then runs in some water to clear the tube. This is repeated twice or thrice when effervescence of the quantity first introduced may be supposed to have ceased.

Opium is invaluable in certain cases in which it is all-important to check peristalsis and to relieve pain. There is no better example than that of intussusception, in which, once started, progress and pain are due to peristaltic action. Given early it is quite possible that spontaneous reduction may occur, as in Nothnagel's experiments, after cessation of the stimulating current (p. 655). In chronic obstructions colic may be subdued and vomiting postponed whilst enemata and other means are tried; and in cases where no operation is meditated or possible large quantities are required to make life bearable. In acute strangulation with violent pain and marked collapse the effect of opium is very marked, the pain and vomiting soon cease, the temperature rises, the skin warms, the pulse becomes fuller, and the patient seems to be recovering. Herein lies the danger of opium: it masks the symptoms—the strangulation remains unrelieved, progress towards gangrene, perforation, peritonitis, etc., is uninterrupted, and yet the patient is comfortable and markedly better as regards symptoms than at the onset. A surgeon called to a case thus drugged may have the greatest difficulty in determining the true state of matters. Even the surgeon who gave the opium is apt to be misled, and, hoping that the patient is really better, to delay direct treatment until it is too late; for, in internal obstruction, time is quite as important an element in treatment as in strangulated hernia—everything depends on the state of the gut. We believe that the safest rules with regard to opium are: (*a*) To give it in cases of typically acute obstruction only as a means of combating collapse or as the first means of treatment when acute intussusception is diagnosed or suspected; in either case 12 to 24 hours will be the outside time to allow for this experiment, and if the obstruction still persists further treatment should be undertaken. (*b*) To give it in cases of chronic obstruction and cases of acute supervening upon chronic symptoms, in which there is pain to be relieved, and to continue its use when it is believed that operative relief is impossible; in other instances it is to be employed only so long as there seems reason to hope for relief from non-operative measures, but here, as in slightly strangulated herniæ (p. 625), the surgeon must always beware of waiting until the patient's strength (indicated chiefly by aspect and pulse) is failing. Opium, when used in obstruction, should always be given hypodermically in the form of morphia.

Feeding.—Part of the patient's exhaustion is due to inability to retain and absorb food taken by the stomach. In chronic and subacute cases digested food in moderate quantity, or the substances suggested by Thomas (see below) may be given, so long as they do not excite vomiting; and enemata of pancreatized milk, milk-gruel, or beef-tea should also be used. In acute cases, and whenever food taken by mouth causes vomiting, ice only can be given in this way, all nourishment being given by bowel. Unfortunately enemata also may excite vomiting or very painful peristalsis. In cases in which feeding by mouth is possible there can be no doubt that it is better to give only just sufficient food to maintain the patient's strength (*i. e.*, to underfeed rather than overfeed), aliment likely to leave little residue being chosen.

Opium and Diet.—This is an old form of treatment which has been employed empirically, *i. e.*, without reference to the nature or seat of obstruction. It has recently been warmly advocated by H. O. Thomas (*Intestinal Disease and Obstruction*), who regards it as giving, on the whole, the best results: and in support of this view, he points to the great difficulty of differential diagnosis and to the high mortality which has hitherto attended the operative treatment of obstruction. Thomas admits that certain cases require operative interference, and he leans towards primary enterotomy.

According to Thomas, the patient must be kept at perfect rest in bed, warm, and well covered—except the abdomen, which is to be cooled by exposure; the foot of the bed should be raised ten inches that fluid may not gravitate to the obstruction and increase the pressure there. Morphia is to be given hypodermically to free the patient from all pain. The diet ordered is the following, and is of chief importance: arrowroot, sago, or ground rice, cooked with water, for milk generally aggravates the symptoms; pea, lentil, or bean flour cooked with water and carefully strained: a little wine, brandy, nutmeg, sugar, salt, pepper, and butter, may be used to flavor; occasionally some flesh broth is allowed. Everything must be liquid, containing no solid masses, and food is to be given in as small quantities and as seldom as the patient's hunger and thirst will allow. Thomas says that under this treatment a patient's stamina will not suffer much in six weeks, before the end of which time the obstruction usually gives way: if the patient dies, it is from the disease, not from temperance. Should the bowels act, continue the treatment until they are regular.

Inversion and succussion of the patient may be tried before operation on cases, chiefly subacute, of doubtful diagnosis, in the hope that some loosely nipped hernia or strangulation may be reduced as the intestines gravitate towards the diaphragm. The patient is fully anæsthetized, and then suspended vertically by his knees placed on the shoulders of a man who rises on to his toes and drops sharply on to his heels alternately. The abdomen may be gently palpated. In a successful case under Marcus Beck a loud gurgle and a feeling like the reduction of a large hernia were perceived; but such successes are very rare.

PALLIATIVE OPERATIONS: *Puncture of the Intestine*.—A trocar or aspirator needle (a line in diameter) is thrust at one or more points well into distended coils of gut, and left there for some minutes until gas, with perhaps some fluid fæx, ceases to escape; it may be cleared from time to time with a blunt rod, and in withdrawing it a finger should be placed closely upon its opening to prevent escape of fæx into the peritoneum. In chronic obstruction such punctures have often given great temporary relief, and have been many times repeated without ill effect; but in cases of acute and great dilatation, and especially with peritonitic softening of the bowel, even small punctures may leak.

Some cases of unknown nature have most unexpectedly recovered after such punctures; possibly the over-distended segment above an obstruction was relieved, or a dilated strangulated coil was emptied, but the chances against such a thing are very many.

Enterotomy and colotomy are palliative procedures, and consist in opening the bowel above the obstruction and relieving the symptoms by the establishment of an artificial anus, the cause of obstruction being untouched. One or the other is adopted according as the obstruction is believed to be above or below the valve. Each may be made to some extent an exploratory operation. Thus enterotomy, of which the aim is to open the first distended coil of small gut that presents, may be used to examine and, if it be distended, to open the cæcum. Right lumbar or inguinal colotomy (*q. v.*) may, as suggested by Morris and Coupland, be converted into an enterotomy, if, when exposed, the colon should be found contracted, by opening the peritoneum and drawing out a distended coil of small gut, which is almost certain to be one towards the end of the ileum and close above the obstruction. Except in urgent cases either operation may be done in two stages, the first being aseptic and most valuable even if only of twenty-four hours' duration. Enterotomy is performed in the right groin, and its steps are those of inguinal colotomy (*q. v.*).

The chief objection to these operations is, of course, that the cause of obstruction is left untouched; whatever it may be, it runs on to its natural ending in gangrene, perforation, cancerous infection, and so forth.

But there are others which apply much more forcibly to enterotomy than to colotomy. Thus gangrene and peritonitis form the natural ending of the acute strangulations, which affect chiefly the small gut, and will prove speedily fatal in spite of enterotomy; if they do not, there is but little likelihood that the cause of obstruction will disappear and allow the opening to close, and a permanent anus communicating with small gut is a much greater nuisance on account of the fluid contents than is one opening into the colon; there is no certainty as to where the gut may be opened, and marasmus may result from cutting off a large digesting and absorbing surface; the anus may be far above the obstruction, which may, perhaps, turn out to be in the rectum; and accumulation of intestinal contents in the long tract below an enterotomy wound is very troublesome and difficult to deal with. With regard to colotomy, it is usually done for the chronic obstructions of the large gut, the causes of which are not likely to lead to very speedy death—except by inducing perforation of a stercoral ulcer, an accident which shows only that the operation should have been done earlier; malignant disease is the chief, and it pursues its course, if the patient recover from the operation. Just as enterotomy may upon an erroneous diagnosis be done when the obstruction is low in the colon, so colotomy may be performed below the stricture; but when the opening is properly placed and made, it is certain to be within a reasonable distance of the obstruction, does not cut off a valuable absorbing surface, and should not permit fecal accumulation below it; if this occurs, as in practice at present it often does, it can at least be more easily dealt with than after enterotomy. Lastly the mortality after these operations has been extremely high. According to Treves's statistics two out of every three cases of enterotomy for non-malignant, and seven out of every eight for malignant, obstruction have died. According to Van Erckelen (*Arch. f. Klin. Chir.*, 1879, p. 41), the mortality within three weeks after lumbar colotomy (for all causes) has been more than one in three, and after inguinal colotomy nearly one in two.

Radical Operations.—What, then, are the alternatives? Laparotomy and direct treatment of the obstruction, or colectomy. These operations, if successful and if the patient survive them, are curative.

Colectomy.—To take the latter first, if a malignant growth can be felt in the line of the colon, and especially if the duration of the case be short, the health fair, the growth movable and unaccompanied by obvious enlargement of glands or liver, it is certainly more rational, and only in accordance with the general rules for the treatment of malignant disease, to cut down upon the morbid mass and excise it, together with any glands that may be seen or felt, instead of doing colotomy above the growth and leaving this to kill the patient. Frequently, however, the seat of the obstruction in the large gut cannot be so accurately determined that it can be cut down upon, and sometimes it is thought that the obstruction is not in the large gut at all, but in the small. In the former case a right lumbar or inguinal colotomy is usually done, in the latter enterotomy; and the question arises whether it would not be better to do an exploratory laparotomy, find the obstruction, and remove it through the mesial wound if possible, or through a wound made directly over it. There can be no doubt that colectomy is a more serious operation than colotomy, and much graver when preceded by exploratory laparotomy; but the operations have been too rare to allow of even a surmise as to their mortality. John Marshall (*Lancet*, May 13, 1882) collected seven cases; four lived several months—the ultimate result of one case being unknown, only five months had elapsed since the operation in another, and two died seven and ten months after the operation; three cases died on the first, third, and ninth days, a mesial and a lumbar incision having been employed in two, a large T-cut in the third. In two successful and two unsuccessful cases the bowel was sutured and returned, and in the other two successful and one unsuccessful case an artificial anus was left.

In the present state of knowledge we think that colectomy should replace colotomy when a stricture in the colon can be exactly localized by ordinary examination; that colectomy should be done in most cases when an exploratory laparotomy reveals a stricture in the large gut, limited in extent and apparently completely removable—except when the patient is too weak to stand anything more than colotomy; that in selected cases exploratory laparotomy with a view to colectomy is justifiable; and that it is at present doubtful whether it is better, when possible, to excise through the mesial incision and suture the ends, or to establish an artificial anus in the loin.

To describe the steps of colectomy would be to repeat those of enterectomy (p. 612); but it should there have been stated that the upper end of the gut is to be drawn well out of the wound and its clamp removed in order that its contents may escape as fully as possible, whilst every precaution is taken to protect the wound. The ends of the bowel must be cleaned with some strong antiseptic before they are sutured together or in the wound.

Laparotomy.—As the diagnosis of intestinal obstruction can rarely be regarded as certain, laparotomy in relation to it is always more or less exploratory. Still there are cases in which the diagnosis is fairly clear, and laparotomy is done with a definite idea of treatment, and there are others in which the cause is quite obscure and laparotomy is primarily exploratory. It is obvious that we cannot treat directly any cause of obstruction of the bowels within the abdomen without opening the abdomen, so when the methods of indirect treatment which appear suitable to any given case have been tried and have failed an exploratory laparotomy seems to be indicated in suitable cases.

The arguments against it are: (*a*) That the mortality after it has been very high. But in this respect it does not differ from any other abdominal operation which is now established in practice. An exploratory laparotomy nowadays has but a trifling mortality when undertaken before the patient is exhausted, and many cases of obstruction can be relieved without further operative procedures. These become more frequently necessary and more severe—culminating in enterectomy—with every hour that a strangulation remains unrelieved. But according to Reichel (*Deut. Zeitschr. f. Chir.* 1884, p. 230) the mortality among 121 cases of enterectomy, with suture and return of the bowel, has been less than one in two, although nearly half the operations were done for gangrene of the gut in herniæ, and a very large proportion of the deaths was due to imperfect work, and yet the result compares favorably with the mortality (according to old statistics) of enterotomy. There can be little doubt, therefore, that when laparotomy is undertaken early and skilfully performed, in suitable cases, its mortality and that of intestinal obstruction will sink greatly.

(*b*) It may be impossible to relieve the obstruction found except by enterotomy or colotomy, the former of which at least might have been done at first. This is true in certain cases of malignant growth of the peritoneum, matting, volvulus of the sigmoid flexure, and stricture of the large gut so placed that it cannot be reached for excision; but the cases of this kind that will lead to exploratory laparotomy are very few.

(*c*) An artificial anus may have to be established if laparotomy shows the intestine to be gravely injured; but it is an anus which may be subsequently closed.

(*d*) Laparotomy may reveal no cause of mechanical obstruction. Peritonitis, perforative or starting from a sloughing appendix, is the only disease likely to have led to this, and laparotomy is the best treatment for it. We must, however, be very careful about obstruction persisting after passage of a gall-stone or reduction of a hernia.

Cases suitable for Laparotomy.—All cases of acute obstruction, except volvulus of the sigmoid flexure, which do not speedily yield to non-operative treatment; cases of chronic obstruction which do not similarly yield, and which appear to be due either to malignant stricture, to a limited stenosis from simple cause, to compression by tumor, to volvulus, or to some body firmly impacted in the lumen of the gut. Cases of widespread matting, shrinking of the mesentery, or peritoneal " cancer," are unsuitable.

Contra-indications to Laparotomy.—*Exhaustion* owing to delay, coupled with the probability that the bowel is much damaged, must be allowed greater weight in these cases than in strangulated hernia; to operate on moribund patients is simply to discredit laparotomy, yet we must not be too cautious for the sake of statistics—apparently hopeless cases do sometimes recover.

The supervention of *general peritonitis* is held by Treves usually to indicate so serious a state of bowel that the case is unfit for operation ; he records two cases, however, in which under these circumstances recovery ensued—the bowel required no special treatment. A. E. Barker has recently reported a successful case of peritonitis apparently secondary to volvulus of the jejunum treated by laparotomy and thorough sponging of the peritoneum (*Clin. Soc. Trans.*, 1886). As the patient will certainly die, and speedily, if nothing is done, and as laparotomy and thorough washing out of the peritoneum does offer a chance, it ought to be practised in cases where the exhaustion is not extreme. *Local peritonitis* is an additional reason for the performance of laparotomy, that its spread may be prevented.

The case may be of such a nature that laparotomy could not relieve it any more effectually than primary enterotomy or colotomy.

Age, debility, cachexia, the desire of the patient to run no risk not absolutely necessary will incline the surgeon to palliative treatment.

The performance of Laparotomy.—For general points, see p. 598. The patient should be clothed and covered with a macintosh apron, as for ovariotomy. Empty the bladder with a catheter. Make a 3-inch cut in the linea alba—unless there is some very clear indication pointing to another spot—deepen it quickly to the peritoneum, check all bleeding, and open the peritoneum on a director or the finger. If the abdomen is much distended, the bowels now protrude largely in spite of all efforts to keep them in the abdomen ; and to avoid this the distended coils must be punctured either now or before commencing. A systematic search for the cause of obstruction is now to be made, and the difficulty is to find a starting-point which will show the surgeon exactly where he is, and, when he leaves it, whether he is going towards the stomach or rectum. The *only* point which will do this is the junction of the ileum and cæcum. Pass a hand into the abdomen to feel for it; if the ileum is collapsed follow it up as quickly as possible, drawing out only one coil at a time, and it will lead to the obstruction; if the ileum is distended follow the colon round with the hand until the obstruction is reached. Deal with it as may be advisable (see special treatment), return any protruding intestines, puncturing, or even incising and suturing in cases of great difficulty, clean the peritoneum, and close the wound. The operation should be done quickly, yet with care and gentleness, and both surgeon and assistant should be ready at a moment's notice to prevent extravasation of feces through any ulcer or tear in the soft distended bowels, or of any collection of fetid fluid opened in the search. In cases of marked meteorism the return of the intestines is very difficult, and spots where they are punctured, even with a grooved needle, sometimes leak obstinately ; they should be picked up and gently tied.

(2) Treatment of Special forms of Obstruction : (*a*) Acute Obstruction.—Ice only is to be given by mouth, the rectum must be cleared once for all by enema, and morphia should be given only to combat shock, unless an operation is for some reason out of the question. Thomas highly recommends small doses of atropia for this purpose. In serious cases of doubtful diagnosis an early exploratory laparotomy should be done, followed

by whatever further treatment the condition found might necessitate. When the diagnosis is clear the treatment recommended in the following paragraphs must be adopted in the first instance.

Strangulation by Bands or through Apertures.—Once the probability that one or other of these conditions is present, laparotomy should be done; there is not the slightest ground for hoping that anything but harm will come of waiting. The treatment will vary somewhat according to the condition found. A "band" should be divided carefully to release the bowel, a pair of artery forceps being first clamped upon either side of the point of section; the ends must then be followed to their attachments, tied and completely removed. Omental cords should also be removed, like omentum in herniæ (p. 628). Diverticula should be taken away, and this is best accomplished by cutting them off one-quarter inch from the bowel, inverting the edges and uniting them by continuous or Lembert's sutures. Difficulty arises when the diverticulum or bowel is ulcerating or sloughing at their line of junction; the slough must then be freely excised and the bowel closed in the transverse or longitudinal direction as may seem best. The appendix or Fallopian tube should, if possible, be freed; it is by no means easy to close the appendix securely by suture, its lumen being too small to permit inversion of the edges. Complete removal and suture of the ileum is simpler, but there seems no reason why the end should not be cut off beyond a tight ligature, the mucous membrane which protrudes beyond the thread being cleaned, excised as far as possible, and finally touched with strong chloride of zinc. Acute kinking of either large or small gut will be dealt with by removal of the band, cord, or adhesion; acute volvulus of the small gut by reduction, or, if this fail, by enterotomy, with formation of an artificial anus above the twist, or by enterectomy if the affected coil is not viable. Sudden compression of the bowel by a tumor will usually require removal of the growth.

Volvulus of the sigmoid flexure has usually been discovered by laparotomy, when, according to Treves, the distention has been found too great to admit of reduction even after puncture; and there is every probability that the twist would recur, as the coil again became distended even if reduction were effected. He therefore recommends left lumbar colotomy as the treatment; the colon is usually distended with fæx. If the diagnosis were made before laparotomy, he would first puncture the flexure and await the result. A cæcal volvulus Treves thinks may be successfully reduced after laparotomy.

Acute intussusception requires the administration of opium at once to check peristalsis and consequent advance. Then give a forcible warm water enema or insufflate—*i. e.*, forcibly distend the colon with air by means of a Lund's inflator, or a simple Higginson's syringe. A hand placed upon the tumor, and perhaps kneading it slightly, will often feel the mass pass backwards along the line of the colon, until it finally disappears. Sometimes it is lost before the observer is satisfied that it has gone, or he thinks it has gone, but in an hour or two it reappears, necessitating a repetition of the insufflation or enema; it is, therefore, difficult to be quite sure that the intussusception is completely reduced by this method. Even after complete reduction the invagination might recur, and it is, consequently, necessary to continue the administration of opium and very careful feeding for two or three days.

Some surgeons prefer enemata, others insufflate, and others again inject air and water; the patient should be completely anæsthetized, and the pressure of the injection upon the lower end of the invagination should be maintained for ten or fifteen minutes before failure is accepted. Reduction or rupture of a gangrenous invagination would, of course, be fatal.

Should the method not succeed, the choice of further treatment lies between morphia and suitable diet, in the hope that the invagination will slough, laparotomy with a view to reduction or resection should the invagination prove irreducible. With regard to the hope of sloughing, Treves states that this occurs in 42 per cent. of all cases; it occurs most often in the tightest strangulations—*i. e.*, in enteric cases (61 per cent.)—least often in the ileocæcal (20 per cent.). The latter is the common form in children, and during the first year, in which 25 per cent. of all cases occur, the intussusceptum is cast off in only 2 per cent., and between the second and fifth years in only 6 per cent.; after this separation of the intussusceptum becomes much more frequent, rising to 38 per cent. before ten years, and to 46 per cent. after sixty years (Leichtenstern). It is plain, therefore, that a child under five has little to hope from sloughing; but from ten onwards the chance would seem to be much better. Treves, however, shows that over 40 per cent. of the patients in whom sloughing occurs die from causes connected with the process, and that (excepting young children) the probability of death after sloughing increases with the age of the patient. From his figures it would seem that from eleven to forty years about 28 per cent. of untreated cases would pull through; from forty-one to sixty, about 26 per cent.; and from sixty onward, about 6 per cent. Can treatment by laparotomy show better results? There are no statistics forthcoming; but the results can hardly be worse than those of expectancy in young children, and laparotomy seems to have met with fair success. In adults, also, most surgeons nowadays would operate. Here again everything depends upon the time at which the operation is undertaken; if done within twenty-four hours, reduction would probably be an easy matter, and even a young child's strength would not be exhausted; but as days go on, many complications may arise which will necessitate enterectomy when the patient is much weakened.

In the attempt to reduce an intussusception, Hutchinson recommends pressure on the sheath just beyond the apex rather than traction upon the entering gut—*i. e.*, it is better to try to draw the sheath off the intussusceptum rather than to drag the latter out of the former.

Foreign bodies and gall-stones causing acute obstruction are difficult to treat, because they not infrequently give rise to severe symptoms, and then move on, perhaps to become again impacted—perhaps, even after this to be passed *per anum.* Each case must be treated on its own merits. Opium will check peristalsis and relieve pain, and the patient must be fed by enemata. But the greatest watchfulness is necessary under these conditions, lest operation be too long postponed, not only because the patient is becoming exhausted, but because an impacted gall-stone may excite intense enteritis (and, perhaps, peritonitis), rendering enterectomy necessary where enterotomy, removal of the stone, and subsequent suture would earlier have sufficed.

(*b*) Chronic Obstruction.—In cases of doubtful diagnosis, we may often hope that we have fecal impaction to deal with, and so long as this is possible, treatment suitable to it should be adopted, and operative measures postponed. There is no need here for hasty action.

Fecal Impaction.—Diet calculated to leave the smallest remainder in the intestine, opium to relieve colic, regularly given large enemata of various kinds (p. 666), and perhaps the administration of laxatives (p. 665) and massage should be employed; electricity and doses of liquid mercury may also be tried. Such measures will often temporarily relieve in cases of a more serious nature. If in spite of it the symptoms endure and become more severe, fecal impaction may usually be set aside and some operative procedure will be necessary to relieve.

The treatment of *enterolith* causing chronic obstruction will be that of fecal impaction, unless the mass be in the rectum, when it should be at once broken up and removed.

Chronic intussusception is the next cause to be considered clinically. Treatment by diet and opium may be adopted, but separation of the intussusceptum is unlikely to take place. An enema or inflation *may* reduce the invagination, but, as a rule, fails to do so. Now, as chronic intussusception is a fatal disease, the patient will have to decide between death in perhaps a few months, and enterectomy with the establishment of an artificial anus and its immediate risks.

When fecal impaction and chronic intussusception have been eliminated, the obstruction must be due to one of the many causes included under stenosis of the large or small gut.

Stenosis of the large gut, causing chronic symptoms, is due chiefly to stricture, or to compression by some enlarged organ or new growth external to it. The latter form may be treated by rectifying the position of some displaced organ, opening an abscess, changing the position of some mobile tumor, or removing it.

Obstruction from stricture has been treated by colotomy above the narrowing. Most commonly this is in the rectum, or sigmoid flexure, and left lumbar colotomy suffices; but if there is doubt as to the position of the stricture, or it is certainly above the points mentioned, do right lumbar colotomy. If it is doubtful whether the obstruction is in the large or small gut, operate as for right inguinal colotomy, and examine the cæcum; if it is distended, open it; but if it is below the obstruction, do enterotomy.

This treatment is palliative only, but may be considered satisfactory in cases of simple stricture. When, however, the stricture is epitheliomatous, its position known, and the case not obviously unfavorable, colectomy is certainly indicated (see p. 668).

Stenosis of the small gut is due chiefly to traction and compression by adhesions acting upon one or many coils, true stricture being much less common; similar symptoms are caused by shrinking of the mesentery, tumors compressing the gut, some volvuli of the small gut, and rarely by gall-stones, foreign bodies, and polypoid new growths.

For a long time non-operative treatment will often succeed; but at last the obstruction does not give way to it. Malignant stricture may not uncommonly be diagnosed and localized by tumor. A foreign body or gall-stone may also, perhaps, be recognized and localized; the presence of a compressing tumor may be made out, and matting or bending may be strongly suspected, but in the great majority of cases the diagnosis will be very doubtful or perfectly open; exploratory laparotomy alone can reveal the cause of the symptoms. This will permit the treatment of all the above causes, except widespread matting and shrinking of the mesentery which scarcely admit of relief. Stricture, either simple or malignant, should usually be resected; enterotomy, removal and suture of the wound are required for foreign body and gall-stone; a compressing tumor should be removed if possible; a "bent" coil may require enterectomy; a few adhesions may be separated, but matting and chronic shrinking peritonitis should not be subjected to operation if they can be recognized. The only alternative to the above treatment is a blind primary enterotomy.

(For further information consult Treves on *Intestinal Obstruction*, which has been largely drawn upon in the above article; also Fagge in *Principles and Practice of Medicine*, vol. ii.)

CHAPTER XLII.

SURGICAL DISEASES OF THE ABDOMINAL VISCERA.

Gastro-intestinal Tract.

Foreign Bodies in the Stomach.—When these are of large size—*e. g.*, a mass of hair, string, etc.—or pointed or irregular, like knives and forks, they will require removal, either because they are causing obstruction and dilatation or have excited inflammation and perhaps adhesion of the stomach to the abdominal wall, where an abscess may form through which the body may escape; or because perforation of the peritoneum or of other viscera, or passage of the body into the intestines, is feared. Removal is effected by *gastrotomy*—*i. e.*, cutting into the stomach without establishing a fistula (gastrostomy, p. 559). The situation of the body is ascertained by palpation or by an œsophageal bougie used as a probe and sound, the stomach is well washed out with boracic or salicylic lotion (1 per 1000), and cut down upon in the left linea semilunaris drawn out in part, packed with sponges, and opened parallel to its circular fibres sufficiently to allow extraction of the body; then the wound is closed with two rows of Lembert's sutures, the exposed peritoneum cleaned, the stomach dropped, and the parietal wound sewn up.

Stenosis of the pylorus is due to cancer in the vast majority of cases; sometimes to fibroid induration affecting this region, to cicatrization of gastric ulcers, or very rarely, to the action of caustics.

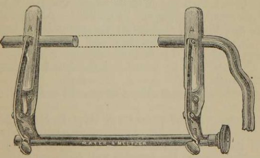
Symptoms: the chief are pain and vomiting, usually some time after food, of "coffee grounds" or frothy fluid containing sarcinæ and in various stages of putrefaction; anorexia, offensive eructations, pyrosis, melænia, constipation, and wasting are more or less constant. The stomach is found dilated, and its wall may be hypertrophied or thinned; its form may be evident, especially after giving an effervescing draught; its peristalsis may be seen and its percussion note recognized even down to the pubes and high in the left axilla. A tumor is as a rule felt in cases of pyloric stenosis, especially from cancer, and usually in the right hypochondrium or epigastrium, but it may be in the iliac fossa or pelvis (Wilson Fox) or in the left hypochondrium (Fagge); it may early contract adhesions and remain concealed beneath the liver; tenderness is not very marked as a rule. Cancer is said to be a good deal commoner in men than in women, and occurs usually after forty.

The diagnosis is usually clear, but may be very difficult. Ektasia of the stomach may rarely occur without mechanical obstruction at the pylorus or beyond it. The tumor has been mistaken for a fecal mass, intussusception, aneurism, enlarged glands, glandular, omental, ovarian, or uterine tumors, floating kidney (Billroth), the spleen (Cayley)—with many of which pain and vomiting may occur. Simple stricture is recognized by its long history, usually of the symptoms of chronic ulcer, and often by its early commencement and in women. The *prognosis* was formerly death from starvation, and in malignant disease it remains absolutely fatal.

Treatment: *Pylorectomy.*—After numerous experiments on animals by many observers, who showed that partial or even complete excision of the stomach was not necessarily fatal, Péan, in 1879, removed a cancerous pylorus, the patient dying on the fifth day; Rydygier performed a similar operation in 1880, death resulting in twelve hours; and in 1881, Billroth performed pylorectomy upon a woman who recovered rapidly, gained flesh, and returned to her work, but died of recurrence four months later. The operation of pylorectomy then came into vogue, and, in April, 1885, Winslow (*Am. Journ. Med. Sci.*, from which these data are taken) found 61 cases recorded: 16 recovered from the operation and 44 died, the result being unknown in 1 case. The younger and stronger patients bore the operation best; no patient recovered when the operation lasted three hours, and the duration depends upon the skill of the operator—Billroth is the quickest operator, and 6 of his 11 cases recovered—and the difficulty of the case. The latter varies chiefly with the adhesions, the existence of which cannot be detected through the wall and not always immediately with the hand upon the tumor. Firm adhesions to the pancreas should negative the operation, the gland bleeds so freely and is so liable to slough and pour its juice into the peritoneum; almost every case with pancreatic adhesions died. Extensive adhesions to the transverse colon, requiring much stripping of the bowel from the growth, led more than once to gangrene of the gut, so that Czerny proposed to excise it too. Adhesions were present in the great majority of cases, and enlarged glands were still more frequent. Colloid cancer yielded decidedly better results than undegenerate cases.

Of 55 *cases of cancer*, 41 died from the operation, in 1 the result is unknown, and 13 recovered; of the latter, 1 (colloid, a case of Wölfler) was alive nearly 4 years after the operation, with recurrence and having had one recurrence removed, one lived 27 years, one 1½ year, one 1¼ year, and the rest either died within twelve months, or there was no statement on the point. Of 10 cases, the average duration of life was sixteen months; no case lived two years without recurrence. The very high mortality in the hands of good surgeons, the often short respite when the patient recovers, the apparent impossibility of removing all the disease and consequent certainty of recurrence, and the impossibility of selecting cases free from adhesions, seem certainly to show that the operation is doomed unless results improve when cases are attacked earlier. In 6 cases of *simple stricture* half recovered perfectly. The *causes of death* were: Collapse within twenty-six hours in almost 50 per cent. of the cases, then peritonitis from gangrene of the colon or slipping of stitches in 16½ per cent., inanition, and various relatively infrequent causes.

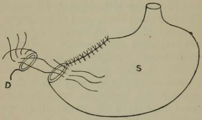
FIG. 238.



Bishop's clamp, for enterectomy or pylorectomy.

Operation.—Wash out the stomach well with boracic or salicylic lotion. Use a median incision, if possible, or one in the semilunar line; transverse and oblique have often been employed. At once examine the tumor for adhesions, if there are many to the pancreas, or if enlarged glands, which cannot be removed, are found, sew up the wound or do a palliative operation. If the case is favorable, isolate the tumor from the omenta, which are to be divided between double ligatures inside the main vessels, but no further than is necessary, as the nourishment of the cut edges will depend on them. Draw out the tumor, place a sponge beneath it over the wound, and apply Bishop's clamp (Fig. 238) or a ligature on either side. Feel for the edge of the growth on the stomach side, and, wide of its margin, cut through the viscus, tying vessels as they bleed. The edge may be very difficult to define, owing to hypertrophy of the muscular coat; the impression received by the finger must be corrected by that on the eye after opening of the viscus. Remove with sponges anything from the interior of the stomach. Now close the wound in the viscus, starting from the small curve, until an opening corresponding to that of the duodenum is left (Fig. 239); first unite the edges

FIG. 239.



The best mode of uniting the stomach and duodenum after excision of the pylorus and much of the lesser curvature. Three Lembert's sutures are in position. D, duodenum; S, stomach.

of the mucosa, then the peritoneal surfaces, by a row of Lembert's sutures, including one-third inch of peritoneum, and complete by a second row of interrupted suture or a continuous suture ("tier-suture" of Czerny).

Now cut the growth free from the duodenum, tie the vessels, and unite the cut end to the margins of the aperture left near the great curve of the stomach. The difficulty is with the posterior halves of the viscera. The peritoneum is first united by Lembert's sutures passed from the cut edge through the muscular and serous coats of the stomach, then from behind through the serous and muscular coats of the duodenum, and tied within (*i. e.*, from the front), then the mucous edges, and, lastly, the anterior portions are united as in enterectomy (Fig. 213). All the posterior sutures must be passed and then all tied before the anterior are inserted. Finally, examine the union carefully, disinfect and return. Close the abdominal wound as usual, and feed by rectum only for twenty-four to forty-eight hours; then give iced milk by mouth. Solid food has usually been taken after the second week.

Gastrectomy has been attempted by Connor, of Cincinnati; the patient died on the table.

Gastro-enterostomy was performed by Wölfler, in 1881, on the spur of the moment in a case in which he found pylorectomy impossible. He raised the nearest loop of jejunum, clamped it, made a 1½-inch cut along its free edge and a corresponding one in the anterior wall of the stomach near its greater curve, and united the margins of the wounds. The patient should be prepared as for pylorectomy. Two cases have died of kinking of the gut just beyond the fistula; this may be avoided by uniting the bowel in a suitable line to the stomach for a short distance below the fistula. Barker, in a successful case (*Brit. Med. Journ.*, Feb. 13, 1886), at first made the incisions through serous and muscular coats only, then united the peritoneum posteriorly by a continuous suture, opened the mucous membrane, united the anterior edges by Czerny's tier-suture, and, lastly, raised the bowel and applied a second continuous suture posteriorly.

The operation has given marked relief. It has been done 17 times for cancer with 11 deaths, many of the cases being desperate at the time of operation; and 4 times for simple stricture with 1 death. It seems probable that this operation is the best in malignant cases, unless the subjects are strong and the disease limited; then pylorectomy, by practised hands, seems justifiable. In cases of simple stricture, too, its results, so far as they go, are better than those of pylorectomy; moreover, if peptic digestion is possible, it may occur.

Duodenostomy, or the formation in two stages of a fistula into the first part of the duodenum, has been done thrice, the cases dying of inanition within a week; two were for fibrous stricture. It is difficult on the dead body to attach the first part of the duodenum to the abdominal wall, but when the pylorus is lowered by cancer the difficulty disappears (Southam, *Brit. Med. Journ.*, vol. i. 1884).

Jejunostomy, or the formation of a fistula leading into the beginning of the jejunum, was performed by Robertson, in 1883 (*Brit. Med. Journ.*, Feb. 21, 1885), and later by Golding Bird and Pearce Gould (*ibid.*, Dec. 5, 1885). The operation gave satisfaction to the operators, though the patients died early from exhaustion. The objection to both this and duodenostomy would probably be trouble from escape of juices. Jejunostomy is easier than either gastro-enterostomy or duodenostomy.

Digital divulsion of the pylorus was performed, in 1882, by Loreta, of Bologna, who has operated 4 times. Up to February, 1885, Winslow found 2 other cases; 3 lived, 2 died, and 1 was doing well (third day). Loreta makes a five- or six-inch cut parallel to the right ribs, draws out and opens the stomach near the pylorus, passes one forefinger through the stricture, then the other, and separates them forcibly till the orifice measures about three inches. The wounds are then closed as usual. The operation is applicable only to simple strictures. It takes thirty to fifty minutes, and shock is slight; there is no fistula; nourishment is soon taken, flesh gained rapidly, and a report on two cases about a year after operation described the cure as perfect and permanent. It would be satisfactory, however, to have a further account, as we cannot but fear that contraction will recur. The operation has been applied, also, to short cicatricial stenosis of the cardia.

Recurrent Typhlitis.—In a case in which a man was frequently incapacitated from active work by attacks of acute typhlitis, Charters Symonds, at the instigation of the late Dr. Mahomed, cut down upon the appendix and found it to contain a fecal caculus, which he removed, with the result that the man was completely relieved.

Fecal Fistula and Artificial Anus.—When part of the intestinal contents escape through a skin opening the patient is said to have a "fecal fistula;" when the whole, an "artificial anus." The *causes* are: injury, wounding abdominal wall and gut and causing direct adhesion of the peritoneal edges or formation of a fecal abscess which opens through the superficial wound; ulceration of the gut causing adhesion to the abdominal wall and perforation, or fecal abscess opening on the surface; a circumscribed suppurative peritonitis may burst both on the gut and skin surface; gangrene of the gut, from strangulation, which is by far the commonest cause; lastly, cancer of the bowel. *Seats:* usually, the femoral or inguinal rings, less often the navel; other points much less common. The *anatomy* varies: (1) There is an aperture in the skin leading into a short sinus, lined by granulation tissue, at the bottom of which the intestine with a hole in its side is adherent, in the form of an arch, to the abdominal wall; a catheter or finger passes towards the anus almost as easily as towards the mouth. In this form a small area of the wall has sloughed, only part of the bowel contents escape, and the tendency is to heal. (2) The aperture in the skin has a more or less protruding margin of bright red mucous membrane; a catheter passes easily towards the mouth, but only with difficulty is the way towards the anus found, because a valve-like fold ("spur") intervening between the two apertures is driven over the latter by the pressure of feces escaping from the upper opening; the "spur" may be visible in the skin-opening. The upper and lower portions of intestine lie side by side as they approach the aperture, and either the greater part of the circumference of a short segment of gut has sloughed and the bowel has become sharply bent, or a coil of some length has separated, leaving two distinct ends of intestine in the aperture; the spur is formed by the projecting mesenteric side of a bent coil, or by the contiguous walls of the two pieces of bowel which open on the surface. All feces escape by the wound in this case. It is obvious that there is no line between this form and that first mentioned; the bowel may form an angle of any degree of acuteness, and the prominence of the spur varies proportionately, as also does the escape of feces. (3) A long sinus may lead among coils of bowel to the intestinal opening. The skin round the opening is always more or less irritated. In all cases the bowel below the opening tends to contract and atrophy.

Complications.—Prolapse of mucous membrane or bowel is common from the upper end, and is usually easily reducible; it may become strangulated, greatly swollen and gangrenous, or be irreducible from adhesions between the serous surfaces of prolapsed bowel or from fibroid thickening. Not uncommonly the skin-opening becomes strictured, causing constipation and even vomiting, dilatation of the upper end of the bowel, and more complete occlusion by pressure of the lower.

The DIAGNOSIS, even of fistula, is usually easy, but may be difficult when the opening in the gut is very small and an abscess is present; the discharge is chiefly pus, and the smell may be feculent without communication with the gut; escape of flatus and the presence of bits of food in the discharge must be looked for. Recognition of the part of the gut affected depends upon the nature of the discharge, the effect of eating upon it, and the situation of the skin-opening. An anus high up causes wasting and scanty urine; in the colon it has no such effect.

TREATMENT.—For about three months in all cases, except those of jejunal fistula in which resection and immediate suture of the bowel have not been adopted, it is usual to wait and allow the patient to regain health, the adhesions about the wound to become firm, and septic inflammation to pass away. During this period, in many cases of fistula the discharge will become manifestly less, and the opening will contract or even close. In this case before the end of the time mentioned the actual cautery may from time to time be applied to the edge of the sinus to cause it to granulate freely, and a suitable dressing may be worn beneath the pad of an ordinary truss to prevent the exit of fecal matter. The patient should be kept at rest in bed with the limb fixed upon a Thomas's hip-splint if the opening is in the groin; and a diet which leaves little residue should be given. The action of the cautery may be aided by the insertion during full granulation of a stout silver wire button-suture to hold the walls in contact, the patient being fed by enemata during the experiment. When thus cured the bowel usually remains adherent beneath the scar, but the traction of the mesentery and movements of the intestines may lengthen the adhesions, which are often very limited, or even sever them when healing has occurred early.

If there be no sign of improvement in three months the patient should be anæsthetized, and the anus carefully examined with two silver catheters, or with a finger, to ascertain the presence, prominence, and depth from the surface of the spur; also, in cases coming later under notice, the amount of contraction of the lower segment. Care must be taken, especially when the finger is used, not to break down the adhesions, and any notching of the margin must be limited.

The first thing to do is to get rid of the spur; this is usually done by clamping it with Dupuytren's "enterotome"—really a pair of forceps—which is put on rather loosely at first and cautiously tightened from day to day; it comes away in about a week, bringing a piece of septum in its grasp. It sometimes excites vomiting and constipation, but the danger is septic peritonitis. Von Nussbaum estimates the mortality of this method as three to four per cent., and the success as sixty-six per cent. Mitchell Banks has recently successfully employed elastic pressure on the spur by means of a large rubber tube thrust into the bowel on either side of it, the tube being fixed by a string through the anus; he kept it in for a week at a time on two or three occasions, and in three months the fistula was healed.

Once the spur is destroyed many cases get well in the course of a few weeks or months, or the patient may be satisfied with the relief a pad under a truss gives. But a more rapid cure being usually desirable, the cautery is used; or the edges are pared and brought together, two hemi-elliptical cuts being made at a little distance from the anus to permit their approximation; or the skin around the anus is removed by two hemi-elliptical cuts, one of which lies close to the aperture, the other at ¾–1 inch away; parallel to the former, 1½–2 inches distant, a longer cut is made, and the strip of skin included between the two is raised, glided so as to cover the aperture, and attached to the raw edge on the opposite side of it, a raw surface being left on the flap side; a flap may be twisted to cover the opening; or, lastly, the abdomen may be opened, the bowel dissected from its adhesions, closed, and dropped into the cavity. This operation is decidedly the most serious; its mortality has been at least 25 per cent., but otherwise it has been a decided success. The first step is to cleanse the anus thoroughly with a sharp spoon, and 1 in 20 carbolic or 1 in 500 sublimate lotion well scrubbed in; a finger is then passed into the upper opening, carefully cut down upon in the most convenient direction, and the bowel clamped with rubber-sheathed forceps; the peritoneum is opened sufficiently to allow the adhesions which bind the bowel to the wall to be dissected through, some enlargement of the wound over the descending piece being probably required. If the opening be small and lateral, it may be closed by suture; but when this operation is performed it will usually be necessary to resect the ends of the bowel and a wedge-shaped piece of mesentery, and to suture the parts, as directed at p. 612. The abdominal wound is then closed carefully with buried sutures. In the case of femoral hernia, instead of dividing Poupart's ligament to enlarge the opening, laparotomy should be done close above and parallel to the ligament. The above operation was done by Czerny in two cases of artificial anus in irreducible herniæ, a "radical cure" being performed at the same time.

In all the above modes of treatment it is most important to fix the limb on a Thomas's hip splint, to maintain light uniform pressure with wool over the wound, to have the bowels well cleared some hours before starting, and to limit greatly the food by mouth and make up with rectal feeding.

In old cases, when the descending bowel requires dilatation, this would probably be best effected by the wearing in it of a sausage-shaped India-rubber bag, blown up after introduction ; it would be easy to cause this also to make pressure on the spur as in Banks's plan.

Other fecal fistulæ than the above occur: either small or large gut may open into the bladder, uterus, or vagina, or two portions of the alimentary tract may communicate and cause anomalous symptoms, *e. g.*, vomiting of fæx. The suffering and wasting in these cases often justify laparotomy with a view to separation and suture of the communicating viscera, provided that the fistula is not due to cancer and that there is no reason to suspect general matting of the bowels.

The Kidneys.

Malformations and misplacements of the kidney have acquired more surgical importance since operative interference in renal disease has been undertaken.

One kidney may be absent, or so extremely small as to be practically absent. Much more often a kidney weighs one to two ounces, such gland structure as it possesses being healthy, in which case it is very doubtful whether it would serve the purposes of life if the other were removed. Again, the two kidneys may be more or less completely fused ; they most usually form a horseshoe-shaped mass, the two organs being united by their lower extremities, and placed symmetrically but closer than normal to the spine. Less commonly the kidneys are more intimately blended, even the pelvis and ureters uniting; the mass thus formed is usually found in front of the spine.

As, from the point of view of nephrectomy, atrophy of one kidney has the same effect as congenital absence, we may mention here that, as a result of chronic interstitial nephritis, the presence of a calculus in the pelvis in some cases, and obstruction of various kinds to the escape of the urine from the pelvis, atrophy of renal substance may be very complete. But in many of these cases, the previous history and the results of examination of the patient will reveal the true state of matters, whereas in congenital absence there are no such helps.

Morris (*Surgical Diseases of the Kidney*, p. 68) shows that congenital absence or rudimentary development of a kidney occurs 1 in 3000–4000 cases; horseshoe-kidney 1 in 1600; 1 more completely fused kidney in 8178; whilst 59 kidneys were small or atrophied among the latter 8178 cases.

As to misplacement, we have already noted that in cases of complete fusion the renal mass usually occupies the midline. When there is only one kidney it may either occupy one loin or be displaced ; and when there are two kidneys, one may be displaced, and is often malformed. The ordinary displacement is towards the sacro-iliac synchondrosis, but the kidney may pass further into the pelvis, sometimes giving rise to great pain during menstruation and to obstruction in parturition, or into the iliac fossa. In these situations, and in the midline, a single or fused kidney may be felt, either fixed or movable, and occasion the suspicion that some tumor is growing. Should the mass possess a reniform outline, especially a hilum, this is important in the diagnosis, but it is often absent; the sickening pain which handling a kidney induces is said to be as characteristic as testicular pain, and watching will show that no increase occurs. Morris suggests that examination of the urine after free handling might reveal some change—*e. g.*, albumen or microscopic blood.

Movable and Floating Kidneys.—The distinction between these is anatomical: a *movable* kidney, which is pretty common, is so loosely connected with surrounding parts, that it moves sufficiently freely *behind* the peritoneum for its movements to produce symptoms and to be perceived by examining hands [the kidney always moves a little with the diaphragm, as may be seen when it is exposed]; a *floating* kidney is one which has a mesonephron, or fold of peritoneum like the mesentery, and is excessively rare. But, clinically, the movements of a kidney behind the peritoneum may be so extensive that it is impossible to distinguish such from one with a mesentery, and it is conceivable that a normally placed kidney might, on becoming very movable, acquire a mesentery, in which case there would be no real difference between the movable and floating varieties. At the bed-side, therefore, kidneys which only slip in and out or up and down are called "movable," whilst those which make wider excursions, so as to be found even in contact with the anterior abdominal wall, at some distance from the loin, are called "floating."

Kidneys which move abnormally are much more common in women than in men. They are frequently attributed to some shake, blow, or violent effort, and are distinctly related to parturition, which causes not only violent straining, but also laxity of the abdominal wall; emaciation and loss of perineal fat, congenital deficiency of this tissue, and conditions like hydronephrosis, calculus, or new growths, which increase the weight of the kidney, are other causes.

The SYMPTOMS vary from slight discomfort to absolutely disabling suffering, and the most movable kidneys are by no means always those which cause the most severe symptoms. There is a feeling of weight or dragging often amounting to real pain in the loin, with occasional severe attacks resembling renal colic; sometimes also there is a feeling of something moving in this region; with these abnormal sensations, attacks of vomiting, obscure dyspeptic, hysterical, and hypochondriacal symptoms occur. The urine is normal, unless the kidney is diseased. To make a physical examination of the kidney, let the patient lie on the back, with well-bent hips; engage him in conversation, or make him breathe deeply through the open mouth, place one hand beneath the loin, the other in the iliocostal space in front, and let them work towards each other. The lower end of a normal kidney can often thus be felt, apparently fixed; but in the conditions we are now considering, it will slip in and out or up and down, or its mass will be felt more or less close to the abdominal wall, more or less freely movable about a point deep in the loin to which its pedicle is attached. This fact, with the shape, solidity, fixed size, and peculiar sensations excited by handling the kidney, are the chief points of distinction between a movable kidney and mesenteric or omental cysts and tumors, pedunculated, uterine, and ovarian tumors, fecal masses, distended gall-bladders (very frequently mistaken, L. Tait), and other less common intra-abdominal masses. But misplaced kidneys may be movable, and cannot then be pressed into the loin, and the shape may not be characteristic, and the points, other than renal pain, are often of little value. Many cases of movable kidney require no TREATMENT other than such simple measures as avoiding certain forms of exercise, relieving constipation, resting during menstruation, when the symptoms are usually worse, and so forth. Other cases, again, are rendered comparatively comfortable by some form of belt, of which the best probably is made of elastic, fits the abdomen closely, and has an India-rubber air-pad fixed so as to press the kidney back into the loin. When these measures fail, there remain Hahn's operation of suturing the kidney into position (see "Nephrorrhaphy"), and nephrectomy (*q. v.*). The latter should be done only after Hahn's operation has failed, or when the movable kidney is diseased in such a way as to justify the operation, its fellow being presumably capable of supporting life; the presence of a mesonephron would not justify it in the first instance. Lumbar nephrectomy should be chosen as being least fatal, but, as Morris (*Surgical Diseases of the Kidney*) points out, this operation requires that the diagnosis should be absolutely certain, lest a healthy kidney be removed, and some tumor—the real cause of the symptoms—be left.

Renal Calculus.—Crystals of uric acid or oxalate of lime often form in the pelvis of the kidney, and in most cases pass down the ureter to the bladder, and are thence discharged—the crystals of uric acid appearing *at once* "like cayenne pepper" at the bottom of the chamber, and being known as "gravel." But in some cases these substances do not remain discrete crystals, but are deposited round one or several nuclei, and form calculi either in the kidney substance, or, much more commonly, in a calyx, or in the pelvis, in the latter case often sending branching offsets into the calyces (dendritic calculus). Phosphatic calculi are unusual in the kidney.

The symptoms are much more marked when the stone is loose in the pelvis than when it is fixed in a calyx or in the substance of the kidney. They are those of pyelitis, the mucosa of the pelvis being mechanically irritated, and include pain in the loin, varying from a dull ache to the most excruciating agony, having a marked tendency to shoot toward the groin, testicle, labium, and inner part of the thigh, and brought on or aggravated by movement, especially jolting; the more severe attacks of pain (renal colic) are accompanied by more or less faintness, nausea, perhaps vomiting, and sometimes by retraction of the testis; the frequency of micturition is almost always increased, and during attacks of pain may be incessant and accompanied by scalding; the urine usually contains an excess of mucus or muco-pus, and the microscope often reveals the presence of the tailed epithelial cells of the pelvis, and of red blood corpuscles, especially after jolting or handling of the loin; the guaiacum test may also be used to detect blood, but in some cases the urine is smoky or deeply blood-stained. The urine, when the patient is seen, may contain "gravel" or crystals of oxalate of lime, or there may be a history of the passing of gravel, or of one or more small calculi, with symptoms of renal colic; but these points are often absent. Sooner or later suppuration of the pelvis is almost always produced; the urine remains acid, and, if the ureter be not obstructed, a deposit of pus will be found in the urine; it is a common symptom for the pus to vary in amount, or even to disappear for a time, only to reappear in greater quantity upon the removal of some obstruction to its escape from the pelvis; and its diminution or disappearance is accompanied by aggravation of the renal pain, owing to increased tension in the kidney, by fever, and, perhaps, rigors. Under the action of this pressure, the kidney often dilates, and ultimately forms a tumor in the loin (pyonephrosis). By manual examination this tumor will be detected, but, still earlier, the renal region will be found tender; pain will be induced by full, active flexion of the hip as the patient lies on his back, owing to pressure of the thickened psoas on the kidney, and constipation, to which the tendency is often great, increases the discomfort. Cases are recorded in which renal calculi have been felt, and been caused to grate upon each other; and stones have several times been struck by an aspirator needle introduced at the level of the first lumbar spine, just outside the erector, and passed straight forward or slightly inwards.

If a stone get into the ureter, and be passed along it, the symptoms are those of the most intense renal colic.

The diagnosis must be made from gall-stones and biliary colic without jaundice (stone in cystic duct), by the more distinct localization of pain in the loin and shooting to the groin, by increased frequency of micturition, and often by hæmaturia; from movable kidney by the non-detection of mobility; from septic pyelitis, by the absence of cause for this or of symptoms of surgical kidney; from tubercular pyelitis, by the absence of tubercle elsewhere, usually by the stronger health, and differences in the urine may help; from typhlitis, by the higher seat of the tumor, tenderness, and absence of fever; from lumbago, by the unilateral distribution of the pain. In severe doubtful cases the kidney must be cut down upon and explored with a darning-needle held firmly in a needle-holder.

TREATMENT.—During the descent of a renal calculus, opium must be freely administered, and mustard poultices or belladonna fomentations be frequently applied to the painful region; if these means fail, relief may be given by the inhalation of chloroform. Large enemata of warm water may relieve the pain, by relaxing spasm of the ureter. If the stone does not descend, medical means may be first tried with a view to dissolving it, or so reducing its size as to admit of its passage along the ureter. If the calculus be uric acid, it may possibly be dissolved by keeping the urine continuously alkaline by the administration of the citrate or acetate of potash—grs. xl–l every three hours, in aqua ℥iij–iv, for an adult (Roberts). If these means with rest do not relieve the symptoms, or if the patient must lead an active life, the question of removal of the calculus by nephrolithotomy (*q. v.*) must be entertained; and this operation becomes one of emergency, and obligatory in case of anuria resulting from impaction of a calculus in the ureter of a kidney, of which the fellow is already *hors de combat* from a similar or some other cause. The kidney last affected should first be examined.

When the kidney is suppurating and swollen, nephrotomy and drainage, with search for and removal of the calculus, if found, must first be done (*see* "Pyonephrosis"); and nephrectomy is required in cases in which, though careful examination of the exposed kidney by fingers passed in front of and behind it and by a needle fails to detect a stone, the patient's sufferings are sufficiently severe to justify the measure, and are apparently due to a morbid condition of the kidney. In a few cases this operation has been practised and a calculus found on laying open the kidney (Morris, *Med. Chir. Trans.*, 1884).

PYONEPHROSIS implies dilatation of the renal pelvis and of the kidney itself by the accumulation of pus within them; the most common *causes* of this condition are calculus and tubercle; chronic obstruction in the lower urinary tract with cystitis and decomposition of the urine may lead to some dilatation and suppuration of the pelvis of the kidney, but such conditions do not commonly give rise to sufficient dilatation to constitute pyonephrosis. As already said, hydronephrosis may at any time pass into pyonephrosis. The presence of a calculus in the pelvis of the kidney at first sets up a superficial inflammation with desquamation of the epithelium; later on suppuration takes place, and, if the pus can find a ready vent by way of the ureter, dilatation does not occur; but it frequently happens that the stone causes partial or complete obstruction to the exit of the pus, which consequently accumulates in the pelvis of the kidney and causes dilatation of it; the obstructing cause may be temporarily removed, and then a free discharge of pus escapes; this is a symptom which, if it occur from time to time, the urine being acid and clear, or containing but little pus in the interval, is practically diagnostic of pyonephrosis affecting one kidney. The accumulation of pus later on gives rise to atrophy and flattening of the pyramids, and, finally, absorption of the cortex, so that nothing remains but a single or multilocular sac containing pus.

Symptoms.—At first those of pyelitis (p. 686), with fever and commonly rigors; emaciation; and, sooner or later, an obscurely fluctuating, more or less painful, tender tumor appears in the loin, extending backwards to the erector spinæ, having the colon in front of it, and dull on percussion. If left to take its own course, the pus may point toward the loin or burst into the colon, or rarely into the stomach, duodenum, left lung, or peritoneum.

Treatment.—There is no medical treatment which is of any avail in pyonephrosis, and it is most important that efficient surgical means should be adopted before the renal substance is entirely destroyed. Aspiration is of no value as a curative measure, though as a means of diagnosing the presence of pus, and possibly by a lucky chance striking a stone, it is valuable. Nephrotomy (*q. v.*), drainage, and, if a stone be found, its removal, is the proper treatment; it is possible that after this the wound may close up and a cure result, with, however, more or less destruction of kidney substance. If the wound fail to close it may be necessary to remove the kidney, but in all cases it is better to make a second operation of this than to perform nephrectomy in the first instance.

Tubercular Kidney.—Tubercle may affect the kidney as a part of a general miliary tuberculosis, the granulations being sparsely scattered, chiefly in the cortex, running together here and there perhaps into small yellow patches. This form is much most frequent under ten, and almost always affects both kidneys (Morris), but it gives rise to no characteristic symptoms and has merely a pathological interest. In the *tubercular*—or, as it used to be called, *scrofulous*—kidney, the morbid process is either primary in the kidney, whence it often extends down the ureter to the lower urinary apparatus; or, as is more often the case, it is secondary to or concomitant with pulmonary phthisis or other local tuberculosis (*e. g.*, of the testis, bladder, and prostate, of the spine, or of some joint), the kidney disease being a very important, if not the chief, factor in the case.

As a rule, this variety of tuberculosis begins by the formation of granulations, which quickly coalesce, or of a diffuse infiltration in the cortex of the kidney at one or more points; it may, however, commence in the points of one or more papillæ in cases in which extension from the pelvis has not occurred. The patches of infiltration extend marginally and undergo the usual caseous degeneration, so that in an early stage a section shows one or several cavities full of cheesy stuff, either dry, pultaceous, or puriform, in the cortex of the kidney, invading the papillæ and approaching more or less nearly to the calyces, whilst the remaining renal substance is the seat of interstitial infiltration or shows distinct granulations. A little later and the cavities communicate, the papillæ are completely destroyed, and some of the tubercular detritus escapes into the pelvis, leaving spaces with walls rendered shaggy by adhesion of undetached but degenerate tissue. The kidney is much increased in size and closely adherent to the surrounding fat, which is fibroid, to the colon, and to other neighboring organs. The mucous membrane of the pelvis now (if not sooner) becomes inflamed, thickened, and ulcerated, and the tubercular infiltration extends more or less rapidly down the ureter, causing more or less complete obstruction. The result is high tension in the pelvis, dilatation of the kidney, and its conversion into a large tubercular abscess which runs the course of a calculous pyonephrosis.

In other cases the tubercular stuff does not soften, but dries, and often undergoes more or less calcification. We then find a quantity of mortar-like material in a fibroid capsule divided into spaces by fibrous septa, the whole enveloped in a mass of dense fibro-fatty tissue.

Of 15 such cases at the Middlesex Hospital, Morris found that none occurred under eleven, and the great majority in adults; 9 were males, 6 females. Of 95 cases, both kidneys were affected in 47, 1 only in 48 (Dickinson), the right more often than the left; and Morris shows from these figures that after twelve years of age the frequency of affection of both kidneys is decidedly less than before twelve.

The SYMPTOMS are in no way distinctive, being those of pyelitis and later of pyonephrosis, viz., lumbar pain, tenderness, and later tumor; extreme vesical irritability and perhaps scalding; urine, which is at first acid, contains mucus or pus, and later small cheesy masses which Grainger Stewart regards as diagnostic; hæmaturia is unusual and slight; casts are rarely found; the most important point perhaps is the discovery of the tubercle bacillus in the urine, and careful and frequent search should be made for it in all cases of doubt. Fever, rigors, and ultimately hectic occur; when both kidneys are involved, the quantity of urine is said to diminish and vomiting may be repeated; death may occur from uræmia or from anuria. Evidence of tubercular disease elsewhere must be sought for, as the diagnosis of tubercular from calculous pyelitis rests largely if not chiefly upon this.

The natural duration of the disease is given as varying from a few months to four years. Evidence of involvement of both kidneys, of the lower urinary passages, or other internal organ, makes the case most unfavorable.

TREATMENT consists: 1. In the ordinary medical treatment of tubercle (p. 98). 2. In the alleviation of pain by the use of morphia, and hyoscyamus combined with an alkali, if the urine is very acid. 3. In certain operative measures. These are: (*a*) Nephrotomy and drainage of the kidney, by which means great relief may be given to the chief symptoms—fever, pain, and vesical irritability; and (*b*) Nephrectomy. Many regard the latter measure as out of the question, because both kidneys are frequently affected, and when one only is tubercular the disease may have spread thence down the ureter. Nevertheless, it seems likely that the question is not yet decided. Among twenty cases collected by Gross (*Am. Journ. of Med. Sciences*, 1885) the mortality was forty per cent. Dickinson's statistics show that in adults the probability is in favor of there being only one kidney affected, and the results of a preliminary nephrotomy may render this almost certain. Examination of the urine for bacilli will probably enable a diagnosis to be made early (health of prostate and testes being ascertained), and the abdominal operation will permit an examination of both kidneys and ureters and free removal of the latter.

When nephrotomy is employed, the incision should be very free, and made with a cautery knife into the convex margin of the kidney, that as many cavities as possible may be drained, and perhaps some tubercular stuff with phosphatic or calcareous salts be removed with a spoon.

PERINEPHRITIS AND PERINEPHRIC ABSCESS.—More or less inflammation of the fatty tissue round the kidney, leading to its condensation and adhesion to the kidney, occurs in all cases of nephritis; it is usually slight and gives rise to no symptoms, but in other instances it runs on to suppuration or, stopping short of this, it still causes marked symptoms.

Perinephric abscess may be primary and due to injuries and wounds not affecting the kidney or ureter, or to some more doubtful cause such as cold; but it is usually secondary to pyelitis, either calculous or tubercular; to pyonephrosis or renal abscess arising by direct extension of the inflammation, by lymphatic absorption, or by actual escape of urine and inflammatory products from the kidney into the surrounding tissue; escape of hydatid fluid may similarly excite inflammation. In other cases abscess of this kind, due probably to absorption of septic material, follows upon castration, operations upon the rectum, or suppuration in the broad ligament. The pus almost always appears first upon the posterior surface of the kidney, but may ultimately surround the organ. The usual signs, local and general, of deep suppuration (acute or chronic) arise, and the chief difficulty after localizing the mischief is to distinguish it from pyonephrosis. The swelling to which it gives rise is much more diffuse than when the pus occupies the pelvis of the kidney, and when fluctuation is perceived it is said to be more superficial; the urine is not of much help, as the abscess is so often secondary to renal disease. These abscesses, however, have but little tendency to point in the loin; much more commonly they burst into the lung or pleura, or into the colon, ureter, or peritoneum, or run along the psoas into the groin.

If opened early, the PROGNOSIS in cases of primary abscess is good; but that of secondary abscess varies greatly with the nature of the primary affection.

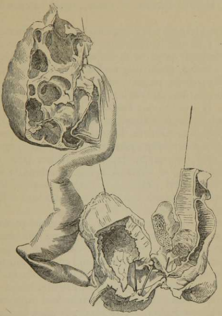
Perinephritis without suppuration is uncommon, but causes symptoms so like those of hip-joint or spinal disease that it deserves mention. The inflammation is due to injury, direct extension of inflammation from the kidney, or perhaps its escape and its encapsulation of a small quantity of pus or some irritant fluid from the kidney. The loin becomes tender, and pain, radiating into the thigh, and perhaps to the knee, is complained of; but, unless an abscess is going to form, there is usually no perceptible swelling; there is at first, however, marked fever, perhaps 103°–4°. The hip-joint becomes rigidly flexed, so that in lying when the back touches the table the thigh rises, and when the knee is pressed down the lumbar spine becomes arched, and in standing the hand is often placed upon the thigh to support the more or less overhanging trunk. Still more marked in some cases is lateral flexion of the spine towards the affected side; it may be so marked that the ribs and iliac crest touch. The spine is held rigid and may present a long, uniform curve forwards; it is not tender to percussion nor affected by jars.

The DIAGNOSIS from *hip-joint disease* is made by noting that there is no atrophy or shortening of the limb, no pain, tenderness, or swelling about the hip, no pain is excited by driving the head of the femur into the socket, or by movements of the hip which do not stretch the ilio-psoas—it has been noticed that adduction is more likely than abduction to cause pain; from *spinal disease*, the unilateral distribution of the pain and tenderness, and absence of local spinal symptoms.

TREATMENT.—In cases not running on to suppuration, the measures to be employed are: cupping or leeching, perhaps belladonna fomentations, suitable diet and enemata or laxatives, whilst flexion of the hip is prevented by a Thomas' splint or weight extension. So soon as any swelling, combined with general signs of suppuration, and not speedily resolving under the above treatment, is detected, it should be explored with an aspirator, and if pus is found it should be immediately let out. Should none be found and the symptoms of suppuration nevertheless continue or increase, it is right to make a small incision aseptically down to the kidney and explore the region with the finger, which will often evacuate pus lying a little on either side of the track of the knife.

HYDRONEPHROSIS may result from obstruction to the escape of urine from the pelvis of the kidney, either in the urethra, the prostate, ureter or pelvis of the kidney; wherever it be, the dilatation of the pelvis of the kidney and of the kidney itself, which is implied by the term *hydronephrosis*, is due to the force of renal secretion or, in other words, to blood-pressure, on which the renal secretion so largely depends. The obstruction may be caused by congenital closure of the ureter, by its oblique entry into the pelvis, or pressure of an accessory renal artery crossing it; or it may arise in later life from traumatic rupture of the ureter, from impaction of a calculus in the ureter, from stricture of the ureter due to the cicatrization of an ulcer or compression by inflammatory bands, or various tumors, chiefly pelvic. In congenital cases the tumor often becomes evident in infancy, and both kidneys may be affected, as may be the case also when the dilatation is due to obstruction below the opening of the ureter. As a result of the obstruction, the pelvis of the kidney and the ureter above the obstruction become dilated, the pyramids of the kidney become atrophied until fossæ replace the promi-

FIG. 240.



Dilatation of the ureter and kidney (Middlesex Hosp. Mus.). The cut shows a tight stricture about three inches from the extremity of the penis; the urethra dilated behind it; another stricture in the membranous portion; false passages, and abscess around; the bladder contracted, but enormously thickened; the ureter dilated and tortuous, looking like intestine; and the kidney atrophied and cystic, with scarcely any of its secreting substance remaining.

nent papillæ; the cortex of the kidney finally disappears, and nothing but the dilated capsule remains; the sac so formed may be single, but is almost always incompletely separated by fibrous partitions corresponding to the calyces and intervals between the pyramids (Fig. 240). If any of the renal tissue remain, it is increased in consistence from overgrowth of interstitial fibrous tissue. Hydronephroses contain a fluid of low specific gravity, in which urinary solids are present in small quantity, and urea may ultimately be absent; there is no albumen at first, but in advanced cases there is usually a trace, and sometimes pus and blood. Suppuration, when it occurs, often takes place quietly. When the renal tissue is destroyed and secretion ceased, the fluid swelling may remain or dry up.

SYMPTOMS.—Hydronephrosis may be recognized by the presence of a painless fluctuating renal tumor combined with the absence of fever and of pus, or other abnormal materials from the urine. Rarely the swelling subsides at intervals, large quantities of watery urine being passed.

TREATMENT.—Little or nothing can be done for hydronephrosis except by operation; the fluid may be removed by aspiration, but this will not cure the case; the hydronephrotic sac should be opened from the loin, and if any obstructing body be found it should be removed; if a suppurating sinus be left after this operation, or if no removable cause of obstruction be found, and the sac do not close up after drainage, it may, if inconvenience or danger to health necessitate it, be removed by nephrectomy (*q. v.*). Calculi have been removed from the orifice of the ureter in which they have been found impacted after the bladder has been opened for stone, and this operation might be designedly repeated after median cystotomy or dilatation of the female urethra. Morris speaks of ureterotomy after abdominal section as justifiable.

Hydatid of the kidney is occasionally met with, and usually forms a large tense elastic swelling in the loin. Small cysts containing the echinococci with their characteristic hooklets are often found in the urine, by far the most frequent course, according to Dr. W. Roberts, being for the cyst to burst into the pelvis; the passage of these small cysts often causes renal colic. Turpentine in diuretic doses has been credited with the power of dislodging them. If the lumbar swelling be of sufficient size to be detected by physical examination, the simplest and safest treatment is aspiration; but if this fail to effect a cure, the kidney should be exposed in the loin and the cyst opened; the secondary cysts and the parent cyst should be removed as far as possible and the cavity drained. When left alone the case may run a very protracted course, cysts escaping occasionally with colic; the cyst may burst, drain itself, and dry up; or suppuration with the usual symptoms may occur and necessitate immediate treatment. Rupture into neighboring cavities may take place.

Malignant disease of the kidney is not unfrequently met with. Sarcomata are either congenital or occur in young children, both plain and striated muscular cells being sometimes found in congenital growths (*see* cases recorded by Eve, Dawson-Williams, and others, *Trans. Path. Soc.*, 1882). Carcinoma occurs after middle age; it is usually soft and rapidly growing, but in some cases the fibrous tissue element is abundant; calculi are often present with it, but whether they should be looked upon as cause or effect is difficult or impossible to decide. The *signs* of malignant disease of the kidney are a rapidly growing, solid renal tumor, associated with more or less profuse hæmaturia; but it must be borne in mind that in nearly half the cases no bleeding occurs from first to last, and it is rarely noticed before the tumor. Vesical irritability is often very marked.

Removal of the kidney for malignant disease should not be entertained; in the early stages, when alone complete removal of the growth would be possible, the diagnosis of the disease cannot be made; and in the later stages the wide implication of the lymphatic glands renders it inadvisable to perform such a serious operation as abdominal nephrectomy for a disease which is not very painful, particularly as the removal of the whole disease is wellnigh impossible.

General Points in the Diagnosis of a Renal Tumor.—(1) An enlarged kidney, though it may increase uniformly in all directions, seems to do so chiefly from the loin in a direction forward and inward, toward the midline, just above the navel. It may obliterate the hollow or cause uniform fulness of the loin, but if it form a distinct prominence, it will be in front, *not* behind.

(2) The mass is easily grasped by hands placed behind and in front of the loin, and it may be pushed to-and-fro between them. As a rule, it does not move with respiration, but it may do so very distinctly. It often retains a good deal of the shape of the kidney, and its limits and surface are rounded—not sharp, notched, or angular. A malignant growth may present

irregular protuberances, but usually renal tumors are smooth. Their consistence varies extremely; malignant growths may be so soft as to be mistaken for fluid. With regard to size; a hand can usually be pressed in between the lower end of the mass and the pelvis, and the inner border rarely reaches the midline; but in a few cases, chiefly of sarcomata in children, the abdomen has been actually filled by the tumor, and, from their invasion of the pelvis, renal cysts have occasionally been mistaken by skilled operators (C. Heath, Wells) for ovarian tumors. The fingers can never be pressed in between a renal tumor and the spine, as they can be in the case of a large spleen.

(3) The relation of the colon to a renal tumor is very important: it almost always lies in front of the mass, and is felt here when empty, or containing fæx, as a more or less vertical cord, or it may be mapped out by percussion when it contains gas; inflation of the colon may be practised in doubtful cases to elicit this sign. This relation of the colon to the kidney explains the frequency of constipation (from pressure) or of diarrhœa (from irritation) as a symptom of renal disease.

It often cannot be made out when the renal mass is so small that small intestines lie between it and the abdominal wall; and in cases of irregular enlargement of the kidney or presence of a mesocolon, the large gut may lie inside the tumor. It is very rare for the colon to lie over a hepatic swelling; I have once found it (*post mortem*) outside an enlarged spleen.

(4) Percussson, in a case in which the tumor reaches the abdominal wall, yields, if we pass from the inner border of the tumor, round to the back: first, an area of dulness, then the line of colonic resonance, and then absolute dulness right back to the spine. An enlarged liver or spleen is dull over the whole of its outer surface, and there is resonance, generally, between the hinder edge of an enlarged spleen and the spine.

(5) When a renal tumor is "movable," the ability to press it back into the loin and to feel it clearly from behind is very important in the diagnosis.

THE OPERATIONS PERFORMED ON THE KIDNEY are: 1. Paracentesis; 2. Nephrotomy, or incision and drainage of the kidney; 3. Nephrolithotomy (including exploration of the kidney), or the removal of calculi from the kidney before the organ is dilated sufficiently to form a renal tumor; 4. Nephrectomy, or the removal of the kidney; 5. Nephrorrhaphy, or the fixation of a movable kidney.

1. PARACENTESIS OF THE KIDNEY is more of diagnostic than of curative value. The aspirator needle should be inserted at the outer border of the erector spinæ, opposite the first lumbar spine, and passed straight forward; but if the kidney be dilated the needle may be passed into it at any point behind the line of the colon, without traversing the peritoneum. It is useful to complete the diagnosis of hydronephrosis and pyonephrosis, and if a stone be present the needle may, by a lucky accident, strike it. Paracentesis may possibly effect a cure of hydatid of the kidney.

2. NEPHROTOMY implies simply incision of a kidney distended with pus or urine, or of a hydatid cyst which has not been cured by aspiration. The kidney is exposed in the loin by an incision like that used for colotomy (*q. v.*), and then a small cut must be made into it, from which pus may escape and through which the finger may be introduced in order to explore the calyces and renal pelvis. This operation is required in hydronephrosis, some hydatid cysts, and pyonephrosis, whether due to calculus or to tubercle; in some cases in which stones have been removed from pyonephrotic kidneys a complete cure has been produced, but in others the dilated kidney has failed to contract and heal; if the kidney do not heal, the question of nephrectomy would have to be considered, but in all cases it is better to

drain the kidney for a time rather than remove it in the first instance. Morris has had a receptacle constructed to fit the loin and catch the urine from a fistula.

3. NEPHROLITHOTOMY is the name given to the operation in which the surgeon, having come to the conclusion that there is a stone in the kidney, from a consideration of the symptoms of the patient at a time when there is no enlargement of that organ to be detected in the loin, deliberately cuts down upon and explores the kidney, and removes the stone if one be detected. This operation was first performed, in 1880, by Henry Morris, who named it nephrolithotomy in contradistinction to nephrotomy, which is an operation primarily undertaken to evacuate an abscess or a cyst, though if perchance a calculus were found it would be removed. The operation has been done 21 times, with complete success in 19 cases (Morris, 1885). The steps of the operation are as follows: The patient should be placed on his sound side with a small pillow beneath his loin, to render the loin of the affected side more prominent; an incision between four and five inches long should be made in the loin parallel with the last rib and three-quarters of an inch below it. The muscles of the abdominal wall should be cut through one after the other for the whole length of the incision until the fascia lumborum has been divided and the outer border of the quadratus lumborum exposed; if the quadratus be very broad, its outer border should be notched; the fascia transversalis and peri-renal fat should then be torn through with the fingers or forceps until the kidney is exposed; this part of the operation is facilitated if the kidney is rendered prominent in the wound by the pressure of an assistant's hand on the front of the abdomen. The surgeon should now introduce his finger into the wound and explore the posterior surface of the kidney and the renal pelvis, and feel carefully for any local prominence or hardness of the kidney: if nothing of this kind be found, he should explore the anterior surface of the kidney in a similar manner, or take the kidney between two fingers; if any suspicious spot be detected, he should insert a fine needle into the kidney and direct its point toward this spot. If no stone be thus discovered a systematic examination with the needle must be made of the whole kidney by separate punctures made in all directions. If, however, a stone be struck, a knife should be passed along the needle until it also strikes the stone, and as the knife is withdrawn an incision of just sufficient size to admit the tip of the finger should be made; the finger may then be gradually bored down to the stone and the latter either tilted out with the finger or removed by a pair of forceps or a scoop. If no stone can be detected by the bidigital method or with the needle (and both have failed), and the symptoms of stone have been well marked, an incision should be made into the convex border of the kidney and the finger inserted so as to explore the renal pelvis.

The only trouble likely to be met with is rather free bleeding when the kidney is incised, as occurred in a case under Mr. Beck's care; this is unusual, and, should it occur, may be arrested by the pressure of a sponge maintained for a few minutes.

The skin wound should be closed, except at the posterior part, where a drainage tube should be placed. For a few days there will be a free discharge of urine from the wound, but it soon ceases; pus soon disappears from the urine, and in the course of three or four weeks the sinus in the loin will probably close. In this operation the incision should always be made in the kidney in preference to the renal pelvis, as a wound of the latter does not close so readily as a wound in the substance of the kidney. Perirenal cellulitis may occur, or a fistula may be left.

4. NEPHRECTOMY or extirpation of the kidney was first deliberately per-

formed in 1869 by Simon, of Heidelberg, for renal fistula; it may be effected through either a lumbar or an abdominal incision, but it is at present almost universally held that, where it is possible to remove the kidney through the loin, the lumbar operation should be adopted in preference to the abdominal. Nephrectomy should be looked upon as a last resource, and should not be performed until simpler means have been tried and have failed. It may be required for hydronephrosis and pyonephrosis after the failure of nephrotomy; so long as the kidney substance is not totally destroyed, the existence of a urinary fistula, unless this be a source of intense annoyance to the patient, would not justify the removal of the kidney. In tubercular disease nephrotomy is usually preferable, as it frequently happens that both kidneys are affected—a point about which we are as yet unable to obtain certain information—and the removal of one, though diseased, might lead to a fatal result from uræmia or anuria. Nephrectomy may be required for severe and incurable injuries of the kidney or the ureter.

The first steps of the *lumbar operation* are identical with those of nephrolithotomy. When the kidney is exposed, if the transverse incision does not afford sufficient room, it may be converted into a T-shaped incision by carrying another cut downward to the iliac crest; the kidney must then be separated from the surrounding tissues, and if much difficulty is experienced in doing this, it is well to incise the capsule and shell the kidney out of it with the fingers; the kidney being separated, a long double ligature should be passed transversely across the kidney between the vessels and the ureter; the loop should then be divided so as to leave two ligatures, the lower of which will serve for tying the ureter, and the upper the renal vessels. After the pedicle has been securely ligatured in two pieces, the kidney should be drawn out of the wound and separated by snipping through the pedicle as close to the kidney as possible. Part of the wound may then be closed, but free provision for drainage must be made.

The *accidents* possible in lumbar nephrectomy are tearing the peritoneum; tearing the colon; tearing the renal vessels, especially vein, in the endeavor to draw out the kidney and pass or tie the ligatures; slipping of a ligature upon the vessels after the kidney is cut away; and wound of the pleura. None of them is necessarily fatal. In an aseptic case the peritoneum might bel eft alone, but it is probably safest to suture it, and wound of the colon should be similarly treated, careful disinfection being added. Tearing the renal vein may be avoided by not endeavoring to draw the kidney out before the ligature is secure upon the vessels. Should a ligature slip, the wound must be held widely open and the bleeding point clamped and tied; in troublesome cases, Morris recommends clamping the pedicle with Wells's large forceps, and leaving them in to act as the drain. The pleura may descend as low as the first lumbar transverse process, and may, therefore, be wounded by a cut carried far back and closer than three-quarters of an inch to the twelfth rib; also by excision of part of this rib, which has been performed with the object of giving more room for the difficult manipulation required to separate the upper end of the kidney. But as much space can be safely gained by strongly dragging up the ribs.

The *abdominal operation* is best performed through an incision in the linea semilunaris (Langenbuch), of sufficient length, and having its centre as near as possible to the centre of the mass to be removed. All bleeding must be checked before opening the peritoneum, and it is a good deal more free than with a median cut. Now turn the small intestines toward the centre of the abdomen, and have them held out of the way with a flat sponge; notch and tear the peritoneum *outside* the colon, and with the fingers work through the perirenal fat till the kidney is felt, then separate fat and peritoneum from the kidney and turn the colon inward until the hilum and its contained structures are exposed; these are now tied separately, if possible, with double ligatures, and cut between. Care should be taken to prevent anything from escaping from the ureter into the wound, and the end beyond the ligature must be thoroughly disinfected. The mass of the kidney can now be separated and removed. The colon is brought back into position, and the abdominal wound is closed. In exceptional cases—*e. g.*, complicated by perinephric abscess—a drainage tube may be brought out in the loin from *behind* the peritoneum.

This operation has certain advantages over the lumbar, the chief being that the other kidney can be examined; it is also easier, permits freer access to the vessels, allows of the removal of long portions of the ureter, and also of enlarged glands if operation in cases of malignant disease be undertaken, and is almost the only operation practicable when the mass to be removed is very large and solid and the iliocostal space is small. On the other hand, statistics tell very strongly against the abdominal operation, which has been twice as fatal as the lumbar. We cannot help thinking that this is due largely to want of practice of the profession generally in operations upon the peritoneal cavity; in the hands of many, these operations seem to retain much of their old fatality, but the results obtained by an experienced ovariotomist—like Knowsley Thornton, who strenuously advocates the abdominal operation—will compare favorably with any that operators through the loin can show. It, therefore, seems reasonable to think that, as surgeons in general become more skilled in abdominal sections, abdominal nephrectomy may come to yield better results than lumbar.

5. NEPHRORRHAPHY is an operation suggested and first performed by Hahn, of Berlin, to fix a *movable* kidney, which is the source of much pain unrelieved by rest and a suitable belt. It may be employed also in *floating* kidney when the organ can be forced back into the loin. This kidney is exposed in the loin by the nephrotomy incision, and brought forward in the wound, to the edges of which it is fixed by catgut sutures which pass through the capsule of the kidney; the wound is left to granulate.

All operations on the kidney should be performed with the strictest antiseptic precautions. The scar left by lumbar incisions may become the seat of a hernia.

IVER AND GALL-BLADDER.

ABSCESS may arise from penetrating wound or simple contusion, or from suppuration of a hydatid cyst—in which case the pus contains booklets (p. 201)—but is more commonly secondary to tropical dysentery, in which it is thought that infective clots are carried from the radicles of the portal vein, corresponding to the intestinal ulcers, into its ramifications in the liver. Not uncommonly, however, "tropical abscess" appears without dysentery or obvious cause; some believe that suppuration is still due to organisms which have entered through the intestinal mucosa, but without exciting ulceration of it, and have been carried to the liver. These abscesses are usually single or few in number, of considerable or large size (even fifty to eighty ounces), though they commence and spread by the formation and blending of many small foci; the pus is often fetid and discolored; they may form anywhere, but most commonly tend to point below the ribs in front or between the ribs behind or outside; they may burst externally or into the bowel, or cause peritonitis, pleurisy, or pericarditis by extension, or by rupture into the cavity concerned; rarely do they become encapsuled and dry up. Multiple abscesses, usually of small size, are due to pyæmia, malignant endocarditis, farcy, and similar diseases; obstruction of the hepatic ducts may cause suppuration about them, and a clot in the portal vein may soften, when fine channels full of pus are found; all these admit of no treatment and rarely cause local symptoms.

Tropical abscess may form with severe local and general symptoms, or insidiously; there are more or less pain and tenderness and some swelling of the liver; then, probably, the hand feels a tumor which soon causes some bulging over it, and neighboring organs are displaced; more or less quickly, if pointing occurs, the skin becomes œdematous and red; fever may be severe, with rigors, or slight, and the local symptoms vary greatly, pain and tenderness being greatest when the peritoneum is involved. Exploratory puncture should be used when in doubt. In a case at Charing Cross Hospital a needle drew off a little pus and an incision was made on the strength of this; *post mortem* it was found to be a case of multiple abscess. The diagnosis is often very difficult with posterior or central collections.

TREATMENT.—Empty by aspiration and repeat if refilling is slow and pus get thinner. If this fail, "pointing" abscesses which are surely adherent may be incised and drained as usual; but when not pointing nor adherent, either cut down on to the abscess, open the peritoneum, and leave a plug of wet gauze on the surface of the abscess, or cut down, aspirate the abscess fully, open its sac, seeing that nothing enters the peritoneum from it, sew the margins of the wound closely to the peritoneal edges of the parietal wound, insert a tube, and close up the wound round it. In abscesses deep in the substance of the liver, found by the aspirator, Fayrer recommends the thrusting along the needle of a long trocar and canula, the latter to be left in some days and then replaced by a rubber tube. If in draining superior collections the pleura be opened, pneumothorax, which will probably become a pyopneumothorax by escape of pus into it, is established. Antiseptics are most important in all cases.

HYDATID CYSTS are much more frequent in the liver than elsewhere; they are usually single, but not uncommonly multiple; they cause symptoms only by their bulk, unless they suppurate, when the signs of abscess (acute or chronic) will appear. A hydatid cyst gives rise to a rounded, tense, elastic, or distinctly fluctuating swelling, which often yields the "hydatid fremitus"—*i. e.*, a prolonged thrill when the left fingers are laid on the swelling and percussed: there is no pain or tenderness, and often adhesions prevent movement with the diaphragm; on tapping hydatid fluid (p. 202) is drawn off. Displacement of organs and pressure-symptoms vary with the direction in which the cyst protrudes from the liver. It may simu ate a cystic or, when thick-walled, a solid tumor of any abdominal organ, dilatation of the gall-bladder from any cause, or right pleurisy with effusion; from hydronephrosis it is distinguished by the absence of the colon in front of it and by the imperfect way in which it distends the loin; distention of the gall-bladder without jaundice is rare; the line of dulness in sub-diaphragmatic hydatid is markedly convex and unvarying (Fagge); and tapping, with chemical and microscopic examination of the fluid, eliminates most errors. A cyst of this kind may end in the death of the parasite and more or less inspissation of the contents, in suppuration, or in rupture—either before or after suppuration—into any cavity, viscus, or great vein with which it is in contact. Rupture into the peritoneum or pleura causes acute suppuration of the sac, and is therefore of surgical interest; whilst rupture into the pericardium, heart, or vena cava, causes sudden death.

TREATMENT.—Fagge and Durham cured seven, or perhaps all, of eight cases, by *electrolysis*, but Fagge found reason to refer the result to simple *acupuncture* with escape of fluid into the peritoneum; *aspiration* without complete emptying of a cyst is often successful, though the cyst may speedily become again quite tense from effusion of albuminous fluid which is often bile-stained; this is usually absorbed if let alone. Fagge would not tap again within twelve months unless suppuration occur. Lastly, we may resort to operations exactly similar to those proposed for abscess; incision if adherent to the abdominal wall; laying bare of cyst and incision when adhesions are established, or immediate emptying of the cyst and close suture to the abdominal wound. The cyst should, if possible, be withdrawn.

GALL-STONES are much commoner in women than in men, and especially after forty—perhaps because of the more sedentary life of women after this age; they do occur in young adults, however, and have been met with in children. They may be small, rough, and soft, consisting chiefly of bile-pigment, or hard and smooth, chiefly cholesterine; sometimes single and perhaps filling the bladder, they are usually multiple and facetted where they touch; many hundreds may be present. In the majority of cases they cause no *symptoms*, and are found *post mortem*, loose in the bladder. In other cases the patient suffers from repeated attacks of biliary colic, being in the intervals hardly ever free from sense of weight or dragging in the hepatic region, much aggravated by movement and jolting. The pain is, no doubt, due to movement of a calculus exciting peristalsis. The severe attacks not uncommonly come on suddenly 2–3 hours after food, just when food is entering the intestine and bile is being poured in, and often subside equally suddenly, because the stone drops back from the duct into the bladder. A state such as that above described calls urgently for relief. A gall-bladder has occasionally been found so full of calculi as to form a perceptible tumor and to yield distinct crepitus from the stones grating upon each other. If a stone become impacted in the duct further complications occur. The constant irritation may excite ulceration, adhesion to the duodenum, or, much more rarely, to the transverse colon or stomach, and the stones may pass through into the intestine (see p. 663), and this may happen without local symptoms; the irritation may cause suppuration—so-called "abscess"—of the gall-bladder, which, fortunately, adheres in most cases to the abdominal wall, and if no incision be made, bursts through it—though not always over the ordinary site of the gall-bladder—and pus and gall-stones escape; the passage of a stone down the duct may cause ulceration leading to stricture of the cystic or common bile-duct; or a calculus may become fixed either in the cystic or common bile-duct. When the cystic duct is obstructed the gall-bladder usually becomes distended by thin colorless mucus, forming a very tense round or pear-shaped tumor, which usually passes down and in above the navel (Taylor) and is traceable to the liver edge; there is no jaundice and the stools contain bile. When the common duct is occluded, jaundice necessarily results, the stools are alcoholic and offensive, the gall-ducts as well as the gall-bladder dilate, and perilobular cirrhosis at first with enlargement then with atrophy of the liver follows. Total obstruction of bile generally proves fatal within two or three years, but even after a year's duration the obstruction has been known to give away.

TREATMENT.—When a patient is suffering severely from recurrent colic, without distention of the gall-bladder, or when the gall-bladder is enlarging from obstruction of its duct by stone, relief may be given by the operations of cholecystotomy or cholecystectomy. *Cholecystotomy* is performed through an incision made over the swelling in the linea semilunaris, if possible, and near the margin of the liver. If the bladder is adherent, it would be wiser not to open the peritoneum, but in many cases this is necessary to reach the swelling. All fluid is now to be drawn off by a fine aspirator needle, after which the sac may be drawn more or less out of the wound, packed round with sponges, opened sufficiently to admit a finger, and explored; all stones that can be felt must be extracted with forceps, and before finishing the operation a finger should be passed along the cystic duct in search of others impacted in it. If one be found, it may perhaps be pressed back; in a few cases it has been broken and removed, and in one case (Bernays's) slight notching of the ring above the stem, from the gall-bladder, whilst a finger kept guard outside, permitted the removal of the calculus. The gall-bladder may now be sewn up and returned, and the abdominal wound closed; or the wound in the bladder may be attached to that in the peritoneum, a tube inserted, and the rest of the abdominal wound closed. The latter—strongly advocated by Lawson Tait, who has by far the largest experience of the operation—seems the best; for we can never be sure that the duct is patent, accumulation of fluid under pressure in the bladder is likely to prove too much for the stitches (especially if the calculus happens to be in the common duct and all bile tries to escape through the wound), and it is very difficult to include peritoneum only on the thinned bladder; on the other hand, a fistula, if the duct is patent, will either close by itself, can be closed easily, or, if permanent, is not a very great inconvenience. Tait and others have shown that the danger of this operation is very slight. In 1884, Tait had done thirteen cases, and all recovered (*British Medical Journal*, May 3, 1884).

Cholecystectomy has been done at least eleven times (*British Medical Journal*, June 12, 1886) with a very considerable mortality. Langenbuch first performed it in 1882. The liver was held up and sponges placed to protect the intestines, the emptied bladder dissected from the liver, apparently with ease, the duct double ligatured and cut between. In his case the bladder not only contained stones, but was hypertrophied. This alone does not justify the operation, nor does suppuration. Its mortality should be very little more than that of cholecystotomy if it is to be performed merely to escape the inconvenience of a fistula, which may be only temporary. It seems just possible that a stone might be removed from the common duct, through the cystic duct, after removal of the bladder. If, in a case of recurrent colic, without distention of the bladder, it were impossible to suture the bladder, by reason of its shortness, to the abdominal wall, choice would have to be made between suture and return of the bladder and cholecystectomy. Epithelioma of the gall-bladder does not justify the operation, as the disease cannot be recognized sufficiently early.

The Spleen.

Movable spleen, like movable kidney, has occasionally called for extirpation; the organ is so vascular that it is doubtful whether hemorrhage would not follow an operation like that of nephrorrhaphy.

Hypertrophy of the spleen may be *simple*—*i. e.*, its cause is unknown, and it causes symptoms only by its size and weight; *leucocythæmic*, in which case it is accompanied by important blood-changes, especially great excess of leucocytes, and their results, and frequently also by enlargement of lymph glands, and transformation of yellow marrow into red; or *malarial*. In either of these forms the organ may reach a weight of many pounds and fill the greater part of the abdomen. Medical treatment should be thoroughly tried before passing to surgical, as splenectomy has had a very high mortality. The cases of hypertrophy demanding it are not many. Cases of leucocythæmia have been most frequently operated on, and we believe with an invariably fatal result; it is, therefore, generally held that such should be rejected as unsuitable. Cases of malaria are, as a rule, either too little inconvenienced for splenectomy to be thought of, or are too ill to allow of the operation, but cases suitable for it do occasionally occur. Cases of simple hypertrophy, in which suffering renders the patient willing to run the risk of removal, hold out the greatest hope of success.

Abscess, not pyæmic, of which the causes are obscure, is rarely seen in the spleen. When diagnosed, it should be treated by puncture or incision and drainage, from behind, if possible. The spleen has once been extirpated from the cavity of an abscess in which it lay, the patient recovering.

Simple cysts of great size, single or multiple, rarely form in the spleen. Credé removed a spleen of fifteen ounces which contained a cyst holding fifty-six ounces, and Knowsley Thornton has operated in two such cases; all were successful. If a single cyst were found, drainage might first be tried. Hydatid cysts are rare; treat as in the liver.

Malignant disease is very rare, and certainly does not justify splenectomy.

Splenectomy.—Experiments on animals and accidental wounds in man, leading to prolapse and extirpation of the spleen, established that life and health might continue after loss of the organ; its place is taken by other lymphoid structures, including the thyroid, which undergo temporary or permanent compensatory hypertrophy.

The removal is usually effected through a wound of sufficient length in the left linea semilunaris, but some operators have preferred the mid-line; in cases of hypertrophy, the cut is necessarily very long, but when the organ is cystic the cysts can be emptied before the spleen is drawn out. The next step is to bring it outside the wound, and this has frequently been accomplished with ease; there is, however, danger that the organ may tear in the manœuvre, or from the separation of some adhesion, when it bleeds very freely. This happened in Warington Haward's case (*Trans. Clin. Soc.*, 1883), but the hemorrhage was soon stopped with sponge-pressure. The pedicle should now be tied in several parts or clamped, and the vessels tied separately, and then the spleen is cut away; care must be taken that the tail of the pancreas is not included in the ligatures or clamp. The abdominal wound is closed as usual.

Nussbaum records 26 splenectomies for injury with 16 recoveries.

Credé collected 30 cases up to 1881: 16 were for leucocythæmic spleen, and all died: of the remaining 14, 9 lived, viz., 2 of cystic spleen, 2 of movable spleen, 4 of simple hypertrophy, and one in which the spleen lay in an abscess. The most recent statistics will, we believe, be given in K. Thornton's paper in the *Med. Chir. Trans.* for 1886.

The Uterine Appendages.

Chronic inflammation of the uterine appendages, viz., ovaries and Fallopian tubes, due usually to extension from the uterus, is a frequent cause of extreme dysmenorrhœa and painful attacks of pelvic peritonitis, completely incapacitating the sufferers from actual work and rendering them chronic invalids. In these cases (for the symptoms of which see works on gynecology) Lawson Tait and others have lately practised *removal of the uterine appendages* through the mid-line of the abdomen. An incision admitting two fingers is all that is required, unless complex adhesions have to be dealt with, when the operation may be extremely difficult. A broad ligament with the diseased tube and ovary is drawn out, transfixed with silk, tied in two pieces, and the tube and ovary cut off beyond the ligatures. As a rule, this must be done on both sides. Tait, up to 1885, had operated on 201 cases, with a mortality of 5 per cent. on the whole number, but only 3 per cent. on the second hundred. Relief was generally complete and immediate; but in a few cases extravasation of blood into the peri-uterine tissues occurred after operation, and seemed to be the cause of continued pain (*Brit. Med. Journ.*, Jan. 31, 1885).

Ovaries.

Tumors of the ovaries are, to the surgeon, by far the most important diseases of these organs. They may be either *cystic* or *solid*, the former being very much the more frequent.

Pathology of Cysts.—The ovaries consist of a fibromuscular stroma contained in a fibrous capsule, and throughout the stroma of each at birth are scattered something like 70,000 Graafian follicles—small cysts lined with cubical epithelium, each containing an ovum in a little fluid. The follicles and ova are formed by the growth of tubular processes of germinal epithelium into the mesoblastic stroma. From these elements of the ovary all primary new growths must spring.

Cysts are divided into *simple* and *proliferous*, the latter being distinguished from the former by evidence of the continued formation of new cysts in the walls of the primary cavities. *Simple cysts* may be single or multiple; usually one or two cysts much outstrip the rest in size; and by absorption of the fibrous septa many of the smaller come to open into the larger. *Proliferous cysts* are conglomerations of cysts of various sizes. They are more irregular and lobulated than the simple forms, but have the same blue-white or pearly fibrous surface—very different from the more or less deep red of growing uterine myomata. On slitting up cysts, or making a section of the tumor, the cavities are found full of a fluid which is usually yellowish and viscid, but may be pale and limpid, variously colored by mixture with blood, or purulent, or the contents may be a colloid material. The inner walls of the cysts often look softer and pinker than the outer; upon them are more or fewer rounded eminences, formed by new cysts in their walls, projecting into this cyst or that, and towards the interior rather than towards the exterior of the tumor. The smaller cysts may seem more vascular than the larger, and fringes of membrane, uniting frequently, may sometimes render their surfaces cribriform. The walls of the cysts vary much in thickness; usually they are well under one-sixth of an inch, and often are quite thin; a solid mass of some size is common at one or two spots. All these consist of connective tissue, and may be white and hard, or pink or yellow and soft. Under the microscope the cysts are for the most part lined with large columnar cells; but a few are said to be destitute of lining, having been formed by mucous degeneration of the stroma. This consists of fibrous tissue, dense, with few vessels or cells in the larger cyst-walls and masses, looser, with many long spindle nuclei, near smaller cysts. Here and there in the stroma are microscopic spaces lined by columnar cells, just like Lieberkühn's follicles cut across; these are growing tubules, and they may be found in all sizes up to obvious cysts. But there may be another way in which new cysts are formed. A section through the wall of a small cyst with cribriform surface shows this appearance to be due to the projection of vascular papillary processes, which often branch repeatedly, into its lumen; the branches of contiguous processes may unite, as Wilson Fox pointed out, and give rise to the appearances, in section at least, of cysts lined with columnar cells.

These papillary processes may increase so as to form large warty masses, not only filling the cysts (generally of small tumors), but bursting through them and spreading to the surface of the peritoneum. In other instances the stroma increases greatly in amount, being soft, œdematous, usually yellowish and cellular, and large masses of a similar nature often project into and fill up the cysts (*cystosarcoma*).

The *pathology* of these growths is still somewhat doubtful. Wilson Fox (*Med. Chir. Trans.*, 1864) taught that "all forms of cysts met with in the ovary originate from Graafian follicles," multilocular forms being due to the production of secondary cysts by blending of papillary processes as above described. Certain Graafian follicles are supposed to become distended with fluid or blood effused into them during menstrual congestions, which have failed to cause their rupture, perhaps because the capsule is thickened by chronic ovaritis. In support of this origin it may be said that small cystic ovaries having every appearance of it are not very uncommon, and that ova have been discovered, by several observers, in cysts under the size of a cherry. Its occurrence appears to be admitted by all, but some say that the tumors thus found rarely reach the size of a fist, and are of little clinical importance. Large, simple, and all truly proliferous cysts must, in this case, be regarded as *tubular adenomata;* tubules of ovarian cells start, perhaps from Graafian vesicles, perhaps from some embryonic remains, and grow through the ovarian stroma, becoming dilated into cysts at frequent intervals. In the walls of the cysts the tubules are cut across more or less frequently (see above).

Dermoid cysts occur with special frequency in the ovary, but they do not, as a rule, enlarge much until puberty. They may consist of a simple skin-like sac lined by stratified epithelium, and full of white or yellowish sebaceous stuff consisting of epithelial cells, free fat, and cholesterine, the whole forming a fluid at the temperature of the body; or we may find sebaceous, and even sweat, glands in the wall, hair follicles, giving rise to a coil of usually fair hair in the cyst, teeth, bones, cartilage, muscular and even ganglionic nerve tissue. Though usually of moderate size, these cysts may fill the whole abdomen. They may also be multiple, round about the ovary or in other parts of the abdomen. It is convenient to mention here certain *extra-ovarian cysts. Parovarian cysts* arise by effusion of fluid into the tubules of the parovarium in the broad ligament; they are monolocular, thin-walled, contain a fluid of sp. gr. 1.005–1.007 which is watery and but slightly albuminous; Tait, however, says he has met with fluid as viscid and grumous as in any ovarian cyst. *Cysts of the broad ligament* form by effusion of serous fluid between its layers; they may, perhaps, supervene upon a hæmatocele. Doran believes that simple thin-walled cysts are always developed in the broad ligament, either independently of the parovarium, or in the vesicle often present at the outer end of the horizontal duct; whilst the true parovarian cyst developed from the vertical tubes, generally contains papillary growths. *Hydatid cysts* may occur in the pelvis, unconnected with the uterus or its appendages, and it was suggested by Boinet, and it is still believed by some that an *unimpregnated ovum* may fall into the peritoneum and develop into a cyst. Dropsy, or distention of the Fallopian tube with mucous fluid, blood, or pus, must be remembered in the diagnosis of small ovarian cysts.

Solid tumors of the ovary are much rarer than the cystic, though these may contain so much stroma as to be practically solid (*fibro-adenomata*). Pure *fibromata* or *fibromyomata* are exceedingly rare. Malignant growths are generally secondary, but as primary tumors they are more common than simple growths. Perhaps the most interesting are cases apparently of tubular adenomata which have affected the glands and liver or even more distant parts, behaving like *columnar epitheliomata*. Both hard and soft acinous *cancer* occur; and *sarcomata* of various kinds, chiefly spindle-celled, are met with. *Myxoma* may be primary in the ovary.

Natural History and Signs of Ovarian Cysts.—Cystic disease of the ovary may occur at any age from infancy upwards, but is far most frequent during the period of sexual activity. The great majority of Sir Spencer Wells's cases occurred between twenty-five and fifty-five. The two organs are equally liable, and not uncommonly both are affected. As to social state, these growths are disproportionately frequent in the unmarried, and, among the married, in the sterile. Ovarian cysts vary much in their rate of growth, but as a rule they increase steadily and so rapidly, that in two or three years from their discovery they will fill most of the abdomen and induce pressure-symptoms; they *may* grow much more rapidly or slowly, the latter especially after the climacteric. As the tumor enlarges it interferes more and more with exercise, with digestion and absorption of food, and with the patient's happiness; moreover its nourishment is a heavy burden upon the system. The patient becomes feeble, thin, pale, and anxious in appearance, the weight and dragging pain confine her to the lying position, the lower limbs swell from pressure on their veins, and finally the diaphragm may be driven up and the lower ribs displaced outward, so that respiration and heart action are greatly impeded; the natural ending of an ovarian cyst is therefore: (1) Death from exhaustion and asphyxia.

Other treatments are possible: (2) The cyst may burst unto the peritoneum, either spontaneously or as the result of the injury. The result is often a sharp attack of peritonitis, which may prove fatal, but which usually subsides or becomes chronic. A simple single or parovarian cyst may thus be cured, but such an occurrence is rare, and in the latter case especially, the accident exposes the patient to the danger of spread of papillomata (p. 701) from the cyst over the peritoneum; hemorrhage may also prove fatal. Doran (*Tumors of the Ovaries*, 1882, p. 109) says, that in twenty-nine cases of rupture very acute peritonitis occurred in four and chronic in ten. If such cases are operated on at once, they usually do well; if they are left, adhesions will probably render a later operation (should the patient live) both difficult and dangerous, and it must be remembered that in the common multilocular and proliferous cyst there is no chance of cure by rupture.

(3) The tumor may suppurate in one or several cysts, giving rise to all the symptoms—fever, rigors, perspirations, pain, and peritonitis—and dangers of an intra-peritonial abscess. In some cases relief, more or less great, has followed the opening of the tumor and the discharge of its contents through the navel, or into some part of the bowels or genito-urinary tract. But these are rare, septic inflammation of the cyst cavity being a serious complication.

(4) The tumor may be twisted upon its axis by intestinal movements, and unless adhesions quickly check the rotation, the cyst becomes gangrenous, or such hemorrhage may occur into it, from venous engorgement, that it ruptures. In either case, the gravest shock and acute peritonitis usually occur. Intercurrent attacks of peritonitis without evidence of any of the above causes are common in the course of an ovarian cyst and are very depressing; each one renders operation more difficult and dangerous. Inflammatory fluid is often present in chronic cases.

(5) Obstruction of the bowels, uræmia, and other accidents, may lead to a rapidly fatal ending.

(6) The disease may rarely remain stationary, and life go on under the burden. The author, in 1853, mentioned the case of a lady, aged fifty-seven, of tall, commanding figure, in whom an ovarian tumor of immense size had existed for more than thirty years. Her health was pretty good, although when the disease first appeared, before the diagnosis was fully made out, she suffered for three years from all the remedies that the phy icians of the time of George IV. could devise for the dispersion of the swelling. She died in 1859 with symptoms of suppuration of the cyst.

It is obvious from this history that nothing is to be gained by waiting, whilst much may be hoped from early treatment of an ovarian cyst.

Its SYMPTOMS are the following:

The "facies ovariana," described by the late Dr. Wright, is often very marked in advanced cases. "The emaciation, the prominent or almost uncovered muscles and bones, the anxious suffering expression, the furrowed forehead and sunken eyes, the open, sharply defined nostrils, the thin, compressed lips, the depressed angles of the mouth form together a face which is strikingly characteristic" (Wells).

In a person ordinarily free from dysmenorrhœa, two or three consecutive menstrual periods accompanied by this symptom may indicate the commencement of the formation of a cyst from enlarging Graafian follicles; but a cyst often forms without any premonitory signs.

The menses are not necessarily interfered with, especially if one ovary remains healthy, though both menorrhagia and scanty menstruation may accompany ovarian disease. As a rule which is useful, but by no means invariable, it may be stated that the catamenia are increased in uterine and diminished in ovarian tumors.

Next come various *pressure-symptoms*—frequency of micturition, or retention; constipation, pain from pressure on nerves, weight and dragging of the tumor, œdema of the legs from pressure on the iliac veins, and, later, the more serious ones above mentioned—intestinal obstruction, acute or chronic; uræmia from pressure on the ureters and hydronephrosis; or exhaustion and asphyxia from pressure on thoracic and all the abdominal viscera. The early pressure-symptoms are naturally most severe when a cyst is retained in the pelvis. They are none of them characteristic, but may be induced by any abdominal tumor of large size springing from the pelvis.

The symptoms being so few and doubtful, it is evident, therefore, that the *physical signs* are all-important for the recognition of the disease. The examination must be systematically conducted, and serves as a type for the examination of abdominal tumors in general.

In the case of any apparently pelvic tumor, *distended bladder* should be eliminated at once by the passage of a catheter. Many a time has this precaution prevented a terrible mistake, for women, with bladder well above the navel, may make no complaint about micturition.

Inspection.—The patient should lie on the back, with shoulders low, hip raised, and abdomen bare. The abdomen is arched, uniformly if the cyst be unilocular and large, unequally if it be multilocular or small. If the cyst be multiple it may cause irregularity of surface all over abdomen. If the cyst be just rising out of the true pelvis, it often causes bulging of the iliac region on the side from which it takes its origin. In questioning a patient as to the history of a case, this fact may be often elicited, and is of use as indicating to which side the ovary affected probably belongs.

In advanced cases the tumor may fill the abdomen, pushing up the liver and diaphragm, and causing the lower ribs and xiphoid cartilage to protrude. In most cases the skin is tense, shining, and marked by lineæ albicantes, though over the pubic region the skin may become brawny from œdema, sometimes forming furrows and ridges. The umbilicus may be greatly stretched, but does not protrude unless fluid or a hernia is also present.

Mensuration.—Mensuration emphasizes the facts above noted. Measurements should be made from the anterior superior iliac spine on each side to the navel or xiphoid cartilage. If these measurements are unequal on the two sides, fluid is probably ovarian, not ascitic, and the cyst probably springs from the side on which the measurement is the greater. Repeated measurements indicate whether the cyst is stationary or increasing in size. Other measurements may be useful in special cases.

Palpation gives exact information as to size, form, character of surface, consistence, and tension of the tumor. If the hand can be made to sink in towards the spine above the pubes, the presumption against ovarian tumor is strong.

The sense of fluctuation, obtained in the ordinary way, over an abdominal tumor, is of less value than in other parts in distinguishing between fluid and soft solid; but the impression of a wave of fluid is evidence in favor of a cyst, disproving solidity. It can be easily elicited by laying the hand on one part of the tumor and tapping with a finger at another part, when, if no solid stratum intervene, the wave is felt. By changing the position of the observing and striking hands the whole area of fluctuation may be examined.

If the fluctuations be observed equally in all directions the inference is that the tumor is monocystic, or at all events that the fluid under observation is contained in one cyst. If the wave be absent in parts, or arrested in some position of the hands, the presence of solid parts or septa may be inferred; and this is confirmed by an irregular surface and by feeling hard masses. Ascitic fluid may be diffused in a thin layer over a tumor and yield a wave; then deep pressure may displace this layer and enable us to detect a fluctuating swelling, or this may not be possible until the ascitic fluid has been drawn off.

A thrill is sometimes felt in tense, thin-walled cysts which are not hydatid.

The limits of a sac can sometimes be made out by observing the bounds of the area of fluctuation, though this point can be best made out by simple palpation and percussion.

Percussion.—This is the most important and reliable test. By it the limits of resonance and dulness can be defined, and the dull area corresponds exactly with the position and size of that part of the cyst in contact with the abdominal wall. At first, if the cyst lie in one iliac region, and push the intestines upward and to the other side, we get dulness on the side where the cyst lies, resonance on the opposite side. Afterwards, when the cyst has risen to or above the level of the umbilicus, the intestines are pushed upwards and laterally, and the dulness occupies the pubic, umbilical, and hypogastric regions, spreading bilaterally into the adjoining regions. Hence we have resonance between the last rib and crest of the ilium on each side, and above the tumor where the colon and stomach lie. Occasionally one flank may remain dull on percussion if the ovary, from adhesions or resistance, have not assumed the more usual central position.

Change of position does not cause any marked change in the outline of the area of dulness over a cyst.

Auscultation is chiefly of negative importance, since beyond its value in seeking for *adhesions* (see page 711), it is useful mainly in helping to disprove the existence of pregnancy (by the absence of the fœtal heart-sounds and uterine souffle), and of some forms of uterine fibroids (by the absence of the souffle which occurs in some cases).

Vaginal examination enables us to feel the pelvic portion of a tumor (if there be any), to examine its nature (solid or fluid), to tell its relation to the uterus and the closeness of its connection with this organ, and to eliminate pregnancy.

Absence of vaginal roof-stretching, softened cervix, ballottement, increase in size and weight of the uterus (negatived by bimanual examination), and purple tint of the mucous membrane confirm the diagnosis by excluding pregnancy.

If a cyst be unilocular, and the abdominal portion be tapped, the examining finger in the vagina will feel the impression of a wave. Multilocular cysts are simply tense or elastic, possibly irregular; they may have a solid mass towards the base.

After excluding pregnancy, the uterine sound may be used to tell us the length of the uterus, its inclination and relative position to the tumor, and its mobility. To test the latter part fully, an assistant should move the abdominal mass in various directions. If the uterus be of normal length and freely mobile, we may assume that the tumor does not grow from the uterus, or, if it does, that it has a long pedicle. If the uterus be elongated and fixed to the tumor, the diagnosis must be made by concurrent signs between a uterine fibro-cystic tumor, and a uterus adherent to an ovarian cyst, elongated by pressure and dragging. Certainty may be impossible. The uterus at first lies in front of an ovarian cyst, which tends to drop into Douglas's pouch; as the cyst increases and rises out of the pelvis it may get in front of the uterus. There is no fixed rule in this respect. In spite of displacement and compression, pregnancy complicated by an ovarian tumor is not very uncommon.

The upward dragging of the uterus by the cyst as it rises, tends to conceal its vaginal portion so that the os uteri may be out of reach or almost level with the vaginal roof.

Rectal examination enables us to reach a rather higher level on the posterior and pelvic portions of the tumor than does a vaginal examination; and is of great service in deciding upon the existence of pelvic adhesions (p. 711).

Exploratory incision is necessary in a few cases to enable us to make a diagnosis. It should be employed only when everything is ready for treatment.

Table showing the abdominal conditions from which the diagnosis of an ovarian tumor may have to be made (after Sir Spencer Wells).

GROUP I. (In connection with the peritoneum.)

Ascites.
Encysted dropsy of peritoneum.
Tympanites and phantom tumors.
Fatty and other tumors of omentum and mesentery.
Hydatids.
Sarcoma, cancer, and tubercle.

GROUP II. (Uterine enlargements.)

Pregnancy—normal and abnormal.
Air or fluids in uterus—physo-, hydro-, pyo-, and hæmato-metra.
Fibroid tumors.
Intra-uterine carcinoma.

GROUP III. (Miscellaneous.)

Hypertrophy of abdominal wall.
Extra-uterine pregnancy.
Hydro-, pyo-, or hæmato-salpinx.
Enlarged liver, spleen, kidney, or lymphatic glands.
Hydatid cysts of liver or other abdominal organs.
Movable kidney, cysts and tumors of kidney.
Distended bladder.
Hæmatocele, pelvic cellulitis, and abscess.
Fecal accumulations.
Enchondroma, or sarcoma of ileum or vertebræ.

Only the more important of these can be dealt with here. The order of examination is that just given.

Ascites.—There is a history of cirrhosis or other disease of the liver, of cardiac or renal disease, or of chronic peritonitis; and symptoms and physical signs of these maladies are present. The health has become feeble more rapidly than an ovarian tumor, of size sufficient to cause the enlargement of the abdomen, would account for.

In ascites the abdomen is uniformly distended, the flanks bulge, and the umbilical region is flattened, unless the distention is very great, when the navel will probably be replaced by a translucent fluid projection; otherwise there is not, and never has been, any localized swelling. The respiratory rise and fall of a solid tumor may be simulated by some distended coils of gut (Wells, *Diagnosis and Surg. Treat. of Abdom. Tumors*, 1885, p. 13), but resonance on percussion settles all doubt. The shape of the abdomen varies distinctly with change of position. No tumor can be mapped out.

In a multilocular cyst fluctuation is limited to certain areæ, in ascites and a thin-walled cyst it is equal in all directions; but in ascites, unless extreme, it varies in site with the position. Sir Spencer Wells (*ibid.* p. 18) lays stress upon the fact that in ascites the wave of fluctuation may be felt, not only where the sound is dull on percussion, but also beyond the line of dulness, owing to the fact that the intestines float on the fluid, and the fluid may be thrown into waves among them.

In ascites, the bowels, as they contain air, float up through the fluid; and, in whatever position the patient may be placed, unless they are adherent to the abdominal wall, they tend to occupy the uppermost part, and the fluid the lowest. Therefore, in the supine position, there is resonance over the anterior surface of the abdomen, but dulness towards the sides; the outline of the dulness varies with the position of the patient; if she turn on to her hands and knees, resonance appears in the flanks, dulness in front. In ovarian cyst, in the supine position, percussion yields opposite results (p. 705). Yet, if the quantity of ascitic fluid be very large, and the abdomen so distended that the mesentery does not allow the bowels to float up and entirely reach the anterior wall, there may be more or less dulness everywhere. The diagnostic marks are rendered clearer if the patient's shoulders are depressed and hips raised by a pillow.

As a rule, if one loin be clear and one dull, it is due to an ovarian cyst on the dull side; but the same physical signs may be due to encysted dropsy of peritoneum on the dull side, or to ascites with adhesions, binding down the intestines to the clear side. It must be remembered that ascites is not uncommonly present *with* an ovarian tumor.

Chemical examination of fluids withdrawn from the abdomen may be of much value in doubtful cases.

Ascitic fluid is clear or slightly turbid, watery, bright or pale yellow, forming on boiling a dense clot, insoluble in strong acetic acid; it very rarely contains cholesterine.

Ovarian cysts *usually* contain colloid or ropy fluid (like solution of gum arabic) of sp. gr. 1.012–1.030; cholesterine is uncommon; large epithelial cells and granular corpuscles are often present. The fluid coagulates on boiling, and the large clot (paralbumen) usually dissolves, or becomes translucent when boiled in twice its volume of acetic acid. But ovarian cysts do not always contain fluid of this character.

Extra-ovarian (broad ligament) cysts contain *usually* a clear, colorless, limpid fluid of sp. gr. well below 1.010, with a mere trace of albumen, increased by the addition of acetic acid, and few or no cell forms. Hydatid cysts, hydronephrosis, and some dilated gall-bladders yield limpid fluids of sp. gr. below 1.010, and containing little or no albumen. The first may contain hydatids, hooklets, or bits of membrane; the second may contain urea (concentrate greatly, and add nitric acid to get precipitate of nitrate of urea); the last may contain bile-coloring matter.

Chronic peritonitis, with matting of the intestines and omentum, often combined with collections of serum or pus, limited by adhesions, may occasionally give rise to tumor-like masses, presenting, when they encroach upon the pelvis, a close resemblance to cysts or fibro-cysts of the ovary or uterus. The great cause of chronic peritonitis is tubercle, and there is usually evidence of this in other organs; the illness not uncommonly begins somewhat acutely, and then becomes chronic, perhaps with fitful exacerbations; irregular fever is usually present, and the patient has suffered from nausea, vomiting, anorexia, disordered bowels, abdominal pain, and wasting, more than an ovarian cyst will account for; the abdomen is usually rather hard, rigid, and flatter than when a tumor is present; it is often tender, and may be œdematous over the swelling or about the navel; the swelling is usually ill-defined in most directions, absolutely fixed, and lacks tension; fluctuation is very limited and indistinct, unless a large abscess—such as may rise from the pelvis in perimetritis—is present; the tumor may be formed entirely, or limited above, by a hard, transversely running mass, which should always excite a suspicion of the rolled up and thickened omentum, which is common in chronic peritonitis; dulness is absent or incomplete over what appears to be a tumor, unless there is a considerable surface of fluid in contact with the wall; fluid withdrawn by needle may be serous, turbid, highly albuminous, and often fetid or purulent; should an exploratory incision be made, it can be used for the evacuation of such fluid.

Malignant growths of the peritoneum may give rise to a tumor or tumors of the most varying character, and cause effusion into the peritoneum of much fluid, some of which may be encysted, matting of the intestines, thickening and rolling up of the omentum. They are often secondary to malignant diseases of abdominal organs, and the peritoneal mischief supervenes upon cancer of the stomach, uterus, ovary, etc.; wasting is even greater than in chronic peritonitis, which the case much resembles, but ascites is usually more marked, and jaundice and œdema of the legs not infrequently supervene; more than one tumor may often be detected by pressing somewhat sharply in at various points, and the main mass is usually hard and craggy.

Tumors and cysts (*hydatid* and *simple*) *of the omentum and mesentery* are rare. They must be localized and their nature determined upon general principles, for they give rise to no specific symptoms. Primary tumors are very rare. Meredith lately removed a huge lipoma of the omentum, and Wells reports the successful removal of a tumor of the mesentery, which he could not localize before operation, and the nature of which was not determined.

Phantom tumors are very deceptive at first sight, and the patient may state that she has felt fœtal movements or a hard mass of some kind. They usually occur in hysterical women, but there is often no desire to deceive. The lower part of the abdomen has the shape which is usual in pregnancy at about the sixth month, the muscles are sufficiently tense to give the feeling that they are contracted over a sac of fluid; but this has no distinct outline, fluctuation is very doubtful, no wave is obtainable, and, though the muscles resist very strongly, a hand can often be pressed back well towards the spine, especially when the patient is taken unawares; the whole area is resonant, or subresonant if the patient be fat; under chloroform the swelling disappears, and returns before the patient is really conscious.

In the second group of conditions causing diagnostic difficulties in respect to ovarian tumors, we have a series of cases in which the uterus itself is enlarged by the presence in its cavity of a fœtus, vesicular placenta, retained menses, watery fluid or gas, an interstitial or submucous fibroid tumor or cancer of the body. In all these the first point is to show by bimanual examination that we are dealing with an enlarged uterus, and then comes the question of its cause.

Pregnancy must be carefully considered in every case of pelvic tumor. Until pregnancy has been disproved, a uterine sound should never be used. The diagnosis of the gravid uterus from tumor has not usually to be made until the fourth month, when the uterus rises above the pubes; but unusual symptoms may bring a patient, believing herself to be pregnant, to the surgeon during the early months of gestation, when there are no certain signs of pregnancy and delay in decision may be necessary. In this case a tumor is usually found behind or to one side of the os, and the question is whether this is a retroverted or displaced enlarged uterus, or an extra-uterine gestation, ovarian, fibroid, or other tumor; later on there is a mass in the abdomen. Obviously, every effort must be made to connect or disconnect the uterus from the unusual swelling by abdominal, vaginal, rectal, and bi-manual examination, and the intermittent contraction which occurs in the pregnant or otherwise distended uterus must be carefully felt for. The result may show that: 1. The uterus is enlarged and forms the swelling, the cause of which must then be considered. 2. That the uterus is of normal size and distinct from the swelling, the nature of which must then be made out. 3. That the uterus is enlarged and distinct from the swelling, when the nature both of the enlargement and of the swelling must be decided.

Pregnancy may usually be eliminated before fifteen or after fifty, but has occurred from nine up to sixty. The gravid uterus is characterized by almost always rising in the mid-line; it falls a little to one side in the later months, and usually reaches certain points by certain dates; it may, however, be retained much longer than usual in the pelvis, or be repressed by tight-lacing, and, in the later months, may be smaller or much in excess of what is usual; it is dull, at first rounded, then pyriform, and hard until the fifth month, after which fluctuation becomes more distinct, and it becomes possible to obtain external ballottement, to feel movements, and, finally, to trace the outline of the fœtus. With regard to the signs of pregnancy, very few are certain; cessation of the menses may occur from many causes, and menstruation not rarely occurs twice or thrice after impregnation; changes in the breasts may certainly occur in women believing themselves pregnant, yet not so, and pigmentary changes may also occur, and neither of these signs is of great value except in a first pregnancy, when the presence of milk in the breasts is almost conclusive; vaginal roof-stretching may be produced by anteversion of the uterus from other causes; the purplish color of the vagina is met with in cases of fibroid or other tumors, usually large, obstructing the circulation, and shortening and opening of the os and shortening of the cervix may occur with fibroids; enlargement and increased weight of the uterus has many causes, but the gravid uterus grows more rapidly than most tumors; ballottement, both external and internal, may be very closely simulated by the movements in a cyst of an intracystic mass, by the retroverted uterus, or a small tumor suspended in ascitic fluid; the placental souffle is simulated by a blowing sound heard over some fibroids. There are left, then, the fœtal heart-sounds, fœtal movements, and the hardening from contraction of the uterus every five to ten minutes or oftener (Braxton Hicks). The heart-sounds are not, as a rule, audible through the abdominal wall before the fifth month, and, after this, repeated examinations may be required to detect them. The fœtal movements become distinct even later than the heart-sounds, and women often mistake for them movements of flatus and irregular contraction of the abdominal muscles; even an examining hand has been thus deceived; none may occur for long periods, but, when clearly detected, fœtal heart-sounds or movements are proof positive of pregnancy. They are, of course, absent when the fœtus is dead. The only fallacy connected with the intermittent contractions of the uterus is that they may occur in a uterus distended by something other than a fœtus.

It is obvious that, in the earlier months of pregnancy, it will often be necessary to wait some time before venturing upon a positive diagnosis.

There is one case, however, in which early diagnosis is most desirable, that of *extra-uterine pregnancy*. Practically, this may be divided into *tubal* and *abdominal* in which the fœtus usually occupies Douglas's pouch, but may be in the iliac fossa or attached to pelvic viscera. It may be suspected when, in a woman who presents the symptoms of early pregnancy, severe attacks of pelvic pain and irregular bloody discharges occur, after one or two periods have been missed.

According to Tait (*Brit. Med. Journ.*, Dec. 19, 1885), the subjects of tubal pregnancy either have not been pregnant before or not for a long time, and menstruation for some time previous to this pregnancy, has usually been such as to indicate tubal disease (*i. e.*, obstruction to the passage of the ovum). An examination will show a swelling to one side of or behind the uterus, displacing it, but the recognition of its nature is very difficult.

Attacks both of pain and hemorrhage are commoner in tubal than in abdominal pregnancy, and may, by good luck, bring the patient early under notice, for tubal cases generally rupture before the fourth month.

In enlargement of the uterus from *vesicular mole*, the signs of early pregnancy occur; the uterus increases much more rapidly than in pregnancy, and is doughy and often irregular; ballottement is absent, auscultation is negative, and watery and bloody discharges occur; the diagnosis is rendered certain only by the escape of cysts. Enlargement from blood is almost always due to atresia of the vagina; pains recur monthly, but there is no menstrual flow; the swelling is dull, has the shape of the uterus, and the vaginal obstruction is found. Distention of the uterus by watery fluid, or by gas—usually from decomposition of some contents—giving rise to a resonant swelling, is very rare.

The character, diagnosis, and treatment of tumors of the uterus will be considered in a later section.

The characteristic points in the diagnosis of many of the tumors contained in the third group have already been given, and for our present purpose these must be contrasted with the signs and symptoms of ovarian cyst.

A few diagnostic points of importance in treatment remain for consideration. Upon all of them mistakes are often made.

Is the tumor mono- or poly-cystic?—A smooth surface, very distinct fluctuation, and transmission of a wave in all directions, render it likely that the fluid, or most of it, is contained in one cyst.

Nature of the Cyst?—If the tumor has grown rapidly, and caused but little disturbance, whilst fluid withdrawn has the characters noted at p. 707, the cyst is most likely in the broad ligament and single. On the other hand, *dermoid cysts* usually begin to grow about puberty, are remarkably firm and non-fluctuating, and often irregular in form. They early contract adhesions, and sooner or later usually suppurate, and discharge their peculiar contents through the rectum, vagina, bladder, or skin. These being excluded, a cyst must be multilocular.

Is the Tumor Simple or Malignant?—The physical signs are the same, and age is no help. Malignant growths are almost always solid, though, perhaps, very soft; simple solid tumors of the ovary are very rare; so an apparently solid ovarian tumor must be regarded with grave suspicion, which would be increased or confirmed by cachexia, and physical signs of spread to glands and peritoneum. They usually contract adhesions early.

Are there any Adhesions?—These probably exist, if there is a history of one or more attacks of peritonitis. The observer must notice whether the tumor shifts its place as the patient rolls from side to side, and also whether, if the patient, whilst lying on her back, attempts to raise herself without using her arms, the recti muscles start up into a prominent band; they will do so if they be *not* bound down by adhesions on their peritoneal surface—but not otherwise, unless the adhesions be long, or the cyst flaccid. The surgeon should observe also whether the tumor descends during inspiration. If friction or crackling be heard or felt over a cyst during respiration, it proves that the cyst is not closely adherent, and usually implies either recent lymph, or adhesions stretched somewhat, and allowing more or less free movement. Pelvic adhesions may be diagnosed, if the lower portion of the tumor cannot be displaced by the finger in the vagina or rectum or when the uterus is found to be adherent to the cyst and immobile.

Treatment of Ovarian Tumors.—Many palliative methods were practised in former days, when the mortality after ovariotomy was very high; but as this operation became more and more successful, the palliative methods, many of which were highly dangerous, fell into disuse. At the present day we may almost sum up the treatment of ovarian tumors in the one word—ovariotomy. As, however, some operators regard paracentesis or tapping as suitable in certain cases, we shall first describe this little operation.

Tapping the Cyst.—Place round the abdomen of the patient a flannel bandage—reaching from the pubes to the xiphoid cartilage, long enough to go 2½ times round the body, torn into 3 tails from either end to 9 inches from the middle, and having a hole cut here so as to expose the point at which it is intended to tap (usually midway between the navel and pubes); cross the tails behind, and give the ends to two assistants that they may maintain steady pressure on the abdomen. The patient should lie on one side, with her abdomen projecting over the edge of the bed. An absolutely dull spot over the largest cyst being selected, and *everything being aseptic*, the skin is rendered insensitive with cocaine, a small cut through the skin is made where it is intended to puncture, a large siphon-trocar is thrust into the cyst, and its contents evacuated. If the surgeon can feel other cysts, he may tap them through the cyst first opened, without withdrawing the trocar. When this is removed, the opening in the skin may be pressed together, dried and sealed with wool and collodion; or a stitch may first be inserted. The body-bandage is drawn tight, with a compress beneath it if the abdomen is very lax, and the tails are tied in front. The patient should remain lying for a day or so, and wear the bandage for some days. All tendency to syncope from dilatation of the abdominal veins is thus prevented.

Paracentesis abdominis for ascites is performed in precisely the same way.

Arguments for and Against Tapping.—Some hold that the mortality after ovariotomy is distinctly increased by tapping; so that one occasionally hears great operators say that they have not lost a case lately that had not been tapped, or that it is a "surgical crime" to tap. This is because tapping is, as a rule, merely palliative, probably always causes some local peritonitis, and sometimes a more or less general, and perhaps fatal, attack; sometimes, too, it is followed by suppuration of the cyst, fatal bleeding into the cyst or peritoneum, or a rare accident, like intestinal obstruction. On the other hand, Spencer Wells thinks the mortality is but little increased by one tapping, and he would employ it. (1) Once in cases of simple ovarian or extra-ovarian cysts. It is certain that the latter are not unfrequently cured by one tapping, but they may not be, and removal may be required under more complicated circumstances; and Doran has shown that papillomata may pass out through a puncture in the wall of a true parovarian cyst (p. 703), and spread over the peritoneum. For these reasons Lawson Tait, and others, would not tap even here. (2) In multilocular cysts Wells would occasionally tap a few days before ovariotomy, to allow an exhausted patient to gain strength. It might be necessary, also, when the cyst cannot be removed on account of the state of the patient or the nature of its adhesions. Under other circumstances—*i. e.*, almost always—an ovarian cyst should be removed as soon as it is detected; so, too, a malignant growth, if there are no signs of generalization.

Ovariotomy.—There is certainly no need to retain the arguments employed in the last edition, to prove that ovariotomy is justifiable; for it has become the most successful of the major operations. Scarcely any operator of experience now has a mortality of ten per cent.; some fall as low as four per cent., and Lawson Tait has recently published 139 cases without a death (*Brit. Med. Journ.* vol. i., 1886). It seems scarcely conceivable that, less than thirty years ago, ovariotomists were threatened with an inquest if their patients did not survive.

The first ovariotomy was done by Dr. Robert Houston, of Glasgow, in 1701; but the history of the operation dates from 1809, when Ephraim McDowell, of Kentucky, a pupil of John Bell, who taught that ovariotomy should be done, operated for the first time. Years passed between the recorded operations, but slowly they became more frequent, until Nathan Smith (1822), Clay (1842), Baker Brown, and Spencer Wells (1858), one after the other, came upon the scene, and by their success established the position of ovariotomy. Clay's mortality in 395 completed cases was about 40 per cent.; Baker Brown's, in 68 cases 31.2 per cent.; Spencer Wells's, in his first 500, 25.4 per cent., in his second 599, 21 per cent., but in his last 199 it was only 11 per cent. As above said, many operators both here and on the continent, profiting by Wells's teaching and their own experience, have far surpassed this.

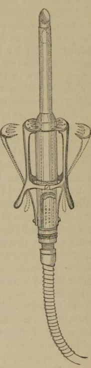
Preparation.—As a rule, none is required beyond clearing out the bowels by a purge the day before, and an enema on the morning of the operation. But in some cases better food, and hygiene, change of air, drug treatment, and perhaps one tapping, may be indicated.

For general points in abdominal operations, see p. 598. Just before the operation, most surgeons have the urine drawn off by a nurse not about to take part in it, but Keith prefers to have the bladder full in laparotomies, that it may be recognized and avoided. The patient should wear a flannel jersey and drawers, and long stockings, and be well covered with blankets; the abdomen, chest and thighs, should be covered by a waterproof sheet with a long central opening, the edges of which are spread with, and stuck to the skin by, lead plaster; when anæsthetized, both hands and legs should be strapped down.

The instruments required are a scalpel, ordinary and hernia director, Sir Spencer Wells's siphon-trocar, fitted with a long rubber tube; 24 clamp-forceps (two or three being large for the pedicle), Nélaton's cyst-forceps, artery-forceps, strong scissors, probe-pointed bistoury, a small cautery, needles and silk, and fine catgut and stout silk ligatures.

Operation.—A 3-inch incision is made in the mid-line through skin and fat, bleeding points clamped, the wound rapidly deepened, through the linea alba, if it be easily found, down to the peritoneum, which is picked up, notched, and opened on the finger to the full length of the wound. As the linea alba is divided, it should be remembered that the bladder may be adherent to, and drawn up above, the pubes by the tumor; care must always be exercised here, and the wound should not be carried within two inches of the pubes without good reason. If the bladder be wounded, it must be separated from the tumor and sutured. Its position can be ascertained before operation by passing a sound. The chief assistant stands opposite the surgeon, and keeps the intestines out of sight. A hand is passed into the abdomen to feel for adhesions to the abdominal wall; should any exist, they may usually be separated by sweeps of the hand, but adhesions to other structures should be left till they can be exposed by drawing out the cyst. Wells's siphon-trocar (Fig. 241) is now thrust into the largest cyst exposed in the wound, and its contents evacuated, the cyst being secured from slipping off the trocar by the clamps on the sides of the latter; and, guided by a hand in the abdomen, other large cysts are tapped through the first. When the whole mass is sufficiently reduced in size, it is drawn through the wound in the wall, retaining adhesions being sought for and dealt with—care being taken that in the process none of the contents of the cyst enter the abdomen, and that the mass is well supported outside, lest its weight tear structures to which it is attached; the first assistant at once closes the wound round the pedicle. This must now be examined and treated according to one or other of the plans given below, after which the cyst is removed; the other ovary is next examined, and treated if diseased; then the abdomen is thoroughly cleansed by sponging or washing, a final examination of the pedicle and points at which adhesions have been separated is made, to see that there is no bleeding, and the wound is closed as usual.

FIG. 241.



Spencer Wells's trocar and hooked canula.

The *length of the incision* necessarily varies with the size of the mass to be brought through it; a 3-inch cut will admit the hand to explore, and is usually first employed; if the growth is solid or, being cystic, cannot be reduced to pass through the wound, this must at once be lengthened upwards with strong scissors protected by fingers in the abdomen. A young operator wants more room than an experienced surgeon, for he must see, where the latter would be guided by his fingers. A few inches in the length of the incision do not make any perceptible difference in mortality, but they considerably increase the tendency to hernia. Tait says that he now does many ovariotomies through a 2-inch incision.

When a tumor is adherent to the abdominal wall all along the incision, it is difficult or impossible to recognize the surface of the mass, and the surgeon will very likely strip the peritoneum from the wall in the attempt to separate the tumor from the peritoneum; in these circumstances it is advised to lengthen the cut upwards till the peritoneal cavity can be opened. A very thick, opaque, non-adherent peritoneum may cause difficulty; and when the membrane is bulged out by ascitic fluid, it has been taken for the cyst.

The *reduction of the size of a polycystic growth* is difficult when it contains many small cysts; it is recommended then to open the largest that can be found for 3–4 inches, to pass in the hand and break down as many cysts as possible, the margins of the cyst-wound being held up outside the abdomen, and sponges being packed around. The bulk may ultimately be still further reduced by opening widely the cyst first tapped, and with a hand in the abdomen raising small cysts into the wound, when they may be opened and their contents sponged away.

Adhesions constitute the most serious complications of ovariotomy, and may occur between the tumor and any of the abdominal viscera, the abdominal wall, or even the great vessels. Adhesions to the abdominal wall may be separated with the hand, and any bleeding arrested by pressure. Omental bands may be clamped, cut through, and the end left after removal of the growth tied. Adhesions to solid viscera can generally be separated by the fingers when the cyst is drawn out, but a knife or scissors may be necessary, and should work in the wall of the cyst, with the idea of leaving adherent the peritoneal coat of the cyst; bleeding must be arrested by simple pressure, pressure with a sponge squeezed out of a very hot antiseptic solution, perchloride, a to-and-fro buried catgut suture, or the actual cautery. Close adhesions to hollow viscera may necessitate closure of the wound, the case being hopeless; if the need for this is discovered early, little harm will have been done, but the mortality is high in cases abandoned after prolonged efforts to complete them. Of course, an experienced ovariotomist would successfully complete many cases which would best be left alone by one lacking experience, and he would probably sooner recognize the impossibility of completing a case. If the operation is to be proceeded with, adhesions to hollow structures may be dealt with—(1) by tearing and dissection, the dangers being laceration of the viscus (to be remedied by suture), or gangrene of it, from extensive bruising and interference with its blood supply; (2) by leaving the whole or part of the thickness of the cyst wall adherent, and cutting the rest away—a method rarely practised; or (3) by enterectomy in the case of the intestine, or removal of part of the bladder or other hollow viscus, and subsequent suture; this has several times been successfully practised.

Management of the Pedicle.—At first (McDowell, Clay) the divided pedicle was put back into the abdomen, and its ligatures brought out through the wound, and ultimately pulled away with the included tissue. In 1822 Nathan Smith introduced the "intra-peritoneal method," by tying the pedicle, and closing the wound over it. He was followed by a few, but by some mischance Duffin's proposal to fix the cut end of the pedicle in the lower angle of the wound (extra-peritoneal method) was for many years almost universally adopted. Hutchinson invented a clamp, which rested on the skin, to compress and retain the pedicle in position; Spencer Wells adopted and improved the clamp, and continued to use it until 1878, maintaining all the while a mortality of over 20 per cent. The intra-peritoneal method, however, always had its advocates, Dr. Keith being perhaps the most prominent and successful; and since 1878, when Spencer Wells adopted it exclusively, it has become practically the only method employed.

The main objection to extra-peritoneal treatment of the pedicle is that, should the wound become septic, the pedicle keeps a track open for spread of septic inflammation, with its many results, to the peritoneum. Minor objections arise from fixation of the pedicle in the wound where it may cause dragging pain, and the frequent escape of menstrual blood for some months from the Fallopian tube.

Hemorrhage from the pedicle is guarded against in two ways: by ligature and by the cautery.

Ligature.—Stout Chinese twist, thoroughly carbolized, is always used. When the pedicle is narrow it may be sufficient to tie it with an ordinary reef knot; but transfixion and ligature in two pieces certainly affords a safeguard against slipping of the ligature. Broad, short pedicles may be tied in sections like omentum (p. 629). Tait always uses the Staffordshire knot, thus made: transfix the pedicle with a long loop of silk, withdraw the needle, and pass the tumor through the noose; bring the noose down on to the pedicle and draw one end through above it, leaving the other below; take the ends from the right and left sides of the pedicle in the left and right hands, draw tight and knot. All ligatures are cut short.

Cautery.—To employ this the pedicle is clamped, the cyst cut off ¼ inch from the clamp, and the remnant is rubbed down slowly with a cautery heated to dull red; the clamp is cautiously undone, and should any bleeding occur the process is repeated. Keith speaks in the highest praise of this method, and his results admit of but little improvement. It takes longer than the ligature, however, with which Tait has attained even better results.

When cysts are encapsuled in the broad ligament they have no true pedicle. They can sometimes be enucleated without giving rise to much hemorrhage. In other cases the broad ligament can be transfixed and tied between them and the uterus, and this, with removal of loose peritoneum, is necessary if hemorrhage occur after enucleation.

Drainage.—Operators vary much in their employment of drainage: some use it frequently, others but little. Where very free oozing from torn surfaces is expected, or where portions of multilocular, suppurating, or dermoid cysts cannot be removed, it seems advisable to insert a tube, the contents of which should be sucked out twice a day or oftener.

For after-treatment see p. 600.

Ovariotomy During Pregnancy.—Four courses are open to the surgeon in cases of pregnancy complicated by ovarian cyst:

1. To abstain from any interference.
2. To induce premature labor, to avoid rupture of the cyst under the pressure of the enlarging uterus.
3. To tap the ovarian cyst, to avoid sacrificing the child.
4. To perform ovariotomy, leaving the uterus untouched.

As a rule, pregnancy cannot go on to a natural termination if complicated with ovarian disease. In simple unilocular cysts Sir Spencer Wells recommends tapping, to be repeated if necessary, as it affords great relief to the patient, no ill effects following.

If ovariotomy should be performed during pregnancy, the latter condition being unknown before the operation, the uterus should be left alone, though abortion may follow. If the uterus should be penetrated by mistake, it should either be removed by Porro's supra-vaginal method, or its contents should be removed and the opening closed by sutures.

"In cases of multilocular cyst or solid tumor, the rule should be to remove the tumor in an early period of pregnancy; and if an ovarian cyst should burst during pregnancy, at any period, removal of the cyst and complete cleansing of the peritoneal cavity, may save the life of the mother, and pregnancy may go on to the full term" (Spencer Wells).

Fibromyoma of the Uterus.

Morbid Anatomy.—In some cases, more like hypertrophies than tumors, there is a diffuse excrescence from the uterus, section revealing no limit between the new growth and the organ whence it springs; or the whole uterus is enlarged, its wall being everywhere more or less thickened. Such growths affect the body of the uterus almost solely; they may attain a large size, and are softer, more muscular, more vascular, more œdematous, and more prone to inflammation and necrosis than the commoner variety (Barnes, *Diseases of Women*, p. 759), into which they pass insensibly, and from which they cannot with certainty be diagnosed.

Usually myomata are fixed, pale, fibrous-looking, distinctly circumscribed, and "shell out" with tolerable ease. They are multiple, as a rule, and may be present in very large numbers; spring from any part of the uterus, but the body is their seat much more commonly than the cervix; and start beneath the peritoneum or mucosa, or in the substance of the uterine wall, receiving the names "sub-peritoneal," "sub-mucous," and "interstitial" respectively. Almost all tumors tend to project upon one or other surface, but the sub-peritoneal and sub-mucous, as a rule, become actually pedunculated and may require long pedicles, the sub-mucous variety, forming the ordinary fibrous "polypus." Interstitial growths tend to project upon the surface to which they are nearest, and may form a huge mass here—absolutely sessile, because either they pass insensibly into the uterus, or are still covered by layers of uterine fibres, or more or less pedunculated as these layers of fibres atrophy and the body of the tumor protrudes. Such growths necessarily enlarge the uterus and its cavity, as also do the sub-mucous, but a pedunculated sub-peritoneal tumor has little or no such effect. Tumors which are in close relation with the uterus, especially if growing actively and projecting into its cavity, necessarily maintain the whole organ in an abnormally hyperæmic state; and, granted suitable size, position, and numbers, these growths will cause any displacement of the uterus, and perhaps render its canal so tortuous or bend it at such an acute angle that a sound cannot be introduced, and fluids accumulate and distend the fundus; similarly the Fallopian tube may be obstructed and become dropsical.

Uterine myomata may be very minute or of enormous size, forming some of the largest abdominal tumors; these huge growths are either "soft" fibroids or fibrocystic.

Myomata may consist of a single rounded mass, and appear on section to have grown from one centre; or, though usually rounded, as a whole, they may be markedly lobulated and upon section present the appearance of a conglomeration of rounded masses closely packed together. As above noted, they vary much in consistence, color, clearness of outline, etc. Not uncommonly they contain cysts (*fibrocystic tumors*), which sometimes hold twenty or thirty pints of clear, slightly viscid fluid, and are probably formed by mucous degeneration. They may suppurate, or hemorrhage may occur into them; as a rule no large vessels enter the encapsuled growths, but a network of large veins in the connective tissue round about gives them when exposed during life a more or less deep red, vascular appearance; soft, uncircumscribed fibroids are very vascular.

Recent tumors in young women contain most muscle; with age, of the tumor and of the patient, fibrous tissue generally increases in quantity, and compresses the muscular fibres and the vessels.

NATURAL HISTORY AND SYMPTOMS OF MYOMA CONTRASTED WITH THOSE OF OVARIAN CYST.—Myomata of the uterus are probably commoner than ovarian cysts, being present, it is said, in from 20–40 per cent. of women dying after 50. They commence during the reproductive period, and, upon the whole, at a somewhat later age than ovarian cysts; they may be met with at any age *after* puberty, but it is doubtful if they ever actually begin growing after the menopause. Having a close histological resemblance to the uterus, they tend to share its period of functional activity and of quiescence; thus they often distinctly enlarge and soften during menstruation, grow rapidly during pregnancy, and not uncommonly degenerate fattily (*i. e.*, undergo "involution"), and decrease or even disappear after delivery; lastly, they usually atrophy after the menopause, but continued growth is apparently not very rare. Their rate of growth is, as a rule, much slower than that of the gravid uterus, or even of an ovarian tumor, but occasionally they increase with great rapidity. Tumors of very large size are rare except near the climacteric. Fortunately a large number of these growths cause no symptoms, but are discovered accidentally during life or *post mortem*. In many cases the symptoms are slight and fairly controllable by non-operative treatment; but in some instances myomata produce such grave phenomena by their bulk, by the bleeding to which they give rise, and in various other ways, that the sufferers are incapacitated from all enjoyment of life and reduced to death's door or actually killed by them. The frequency with which serious symptoms arise is very variously estimated by different gynecologists, but the actual mortality of these tumors seems to be small. The symptoms of myoma differ from those of ovarian tumors in their average frequency and intensity, but not in kind; there is no symptom which may not occur in either disease. The account of the pathology of myoma will have shown that it is the more likely to interfere with the functions of the uterus. Thus, in myoma, menorrhagia and metrorrhagia are much more common and more excessive, especially in the submucous and ill-circumscribed interstitial varieties, but their severity does not vary with the size of the growth—on the contrary, the most severe bleeding, with the spasmodic pain of obstructive dysmenorrhœa, often accompanies a small polyp low down in the uterus; leucorrhœal and watery discharges, perhaps also escaping in gushes with spasmodic pain, and sterility or abortion, are also more frequent. The pressure symptoms, dragging pain, and sense of weight, are the same in both diseases, and vary with the size and position of the tumor; so the diagnosis depends mainly upon physical signs. We must endeavor to show that the tumor is connected with the uterus, and that it is entirely or in great part solid; error may arise to the most skilled from close adhesion of an ovarian growth, especially solid, to the uterus, or from cystic degeneration or pedunculation, or both, of a myoma.

In size, position, character of surface, consistence, or presence of adhesions, there is nothing diagnostic, but the harder and more solid a growth is, the more probable is a uterine origin. Wells states that nearly all uterine tumors, though visibly moving above with respiration, seem to be fixed in the hypogastrium, and that the recti when thrown into action seldom spring so much forwards over a uterine as over a non-adherent ovarian cyst. Uterine growths are, on the whole, more central than ovarian, more often cause disproportionate increase of the measurement from the pubes to the navel, and are less likely to allow a hand to be pressed in below them toward the spine; they are less often accompanied by ascites, subperitoneal growths chiefly giving rise to this complication. Percussion affords no ground of distinction. The presence of a bruit like the placental souffle is strongly in favor of myoma, in which it is often present. On examination by vagina, rectum, by the bimanual method, and with the uterine sound (pregnancy having first been excluded), the following conditions point to myoma: the tumor is protruding from the os or fills the uterine cavity, or it occupies the pelvis largely and appears solid, marked drawing up of the os uteri, shortening of the cervix, and a thrill about it like that of a varicose aneurism (Wells), inseparability of the uterus from the growth, fixation of the uterus, marked lengthening of the uterine cavity or tortuosity of its canal, perhaps preventing the introduction of the sound, and the sense conveyed by this instrument that it is passing a growth projecting into the uterine cavity. With regard to examination by the sound, it must be remembered that pressure of an ovarian cyst on, and adhesion of it to, the uterus, may cause marked lengthening and distortion of the uterine cavity; and, on the other hand, the subperitoneal myomata frequently, and considerable interstitial growths sometimes, leave the length of the cavity unchanged.

If, after a complete examination and careful consideration of its results, it is impossible to make a certain diagnosis, and at the same time it is obvious that something ought to be done, an exploratory incision must be made, everything being in readiness for the treatment of either an ovarian or a uterine growth. An ovarian cyst is usually pearly and non-vascular in appearance, a myoma is more or less vascular-looking; examination by touch and sight will further elucidate matters, though all may not be clear till the mass is out of the abdomen.

We may state shortly that uterine myoma generally kills either by hemorrhage or asphyxia and exhaustion from pressure; but it may slough or ulcerate and cause pyæmia, septicæmia, or peritonitis; or it may exercise fatal pressure on the intestine or uterus. On the other hand, it may be naturally cured by undergoing atrophy and perhaps calcification, by becoming polypoid from squeezing by the hypertrophied uterus and being ultimately extended from the womb, or by inflaming, sloughing, and being cast off—a very dangerous mode of cure.

Treatment.—A large number require none; many more are kept going comfortably by a little rest at the menstrual periods together with medical treatment, into which we cannot here enter; others are cured by removal of a polypus with the écraseur. But there remains a considerable group of cases in which the symptoms are serious, for which the treatment until quite lately has been very unsatisfactory, and about the treatment of which there is still much difference of opinion. Formerly all these cases were treated by rest, ergot, iron, etc., and every effort was made to keep them alive until the menopause, when, in the great majority that reached this point, hemorrhage ceased and the tumor began to shrink—but in some it continued. Some of the cases, however, either died of their sufferings before the climacteric, or were operated upon when it became evident that death was imminent—*i. e.*, when they were in an exceedingly weak condition, and when the myoma had attained a large size and had often obstructed the Fallopian tubes and excited many adhesions round about itself, the uterus, and the tubes.

The operations then possible were: *Enucleation*, where the tumor projected into the cavity of the uterus; removal of the growth (*myomotomy*), and perhaps necessarily of the uterus also (*hysterectomy*), by abdominal section in other cases.

Enucleation is performed by dilating the cervix, incising the capsule of the growth with a knife or cautery and endeavoring to remove it. The attempt may be successful, but obviously has sufficient dangers to account for the exceedingly high mortality of the method. The uterine cavity is septic and likely to become very foul after such a procedure, veins are numerous, and septic poisoning or septic metritis with spread to the peritoneum likely; removal of the growth may leave a mere shell of uterine wall, or may actually open into the peritoneum; and not uncommonly the growth will not "shell out" and has to be left, after much difficulty in checking the bleeding, often to inflame acutely, and perhaps continue sloughing until the surgeon is forced by fever and general disturbance to make other attempts to remove completely, which, whether successful or not, open the way to fresh septic absorption. Besides preliminary attempts to obtain asepsis, iodoform should be freely used on the surface of the wound.

Myomotomy and supravaginal hysterectomy have had a lower mortality than enucleation. Either of these operations is similar in its details to ovariotomy (p. 712), but the abdominal incision must be long in proportion to the size of the irreducible mass which has to come through it, and great care is necessary below, as the bladder is often dragged up; the length of the cut may be kept down sometimes by tapping cysts, and always by having a corkscrew to pierce and drag out the tumor, behind which the wound may at once be in great part closed by sutures; sponges should be packed round the pedicle within the abdomen. Adhesions are less frequently present than in ovarian cysts, and must be similarly dealt with; if the growth extend far between the layers of the broad ligaments, care must be taken not to wound the large veins which will then lie over the tumor. The connection of the tumors with the uterus is examined when they are drawn out; if it have a neck it will be possible to perform myomotomy—sometimes after shaving a growth off level with the surface of the uterus, the segment of it left in the uterine wall has shelled out; if, on the other hand, the uterus is the seat of multiple growths or diffusely fibroid, supravaginal hysterectomy must be done. In either case bleeding is checked during removal of the mass by compression of its neck, when there is one, with Wells's large clamp-forceps, or by putting a Kœberlé's serre-nœud or one of its many modifications, or an elastic cord, round the cervix uteri below the ovaries. In deciding where to make the section, it must be borne in mind that it is a very great disadvantage to open the uterine cavity, which becomes at once a highway for infection. The ovaries and tubes should be removed also in cases in which the uterine cavity is opened or very closely encroached upon, or when small growths are left; when the appendages are removed the broad ligaments should be tied and cut outside the ovary and end of the tube. Great care must be taken that the ureter is not wounded or included in a ligature.

The best mode of treating the pedicle is not yet decided. Guided by arguments for the intraperitoneal treatment of an ovarian pedicle, this method was at first followed, and with unsatisfactory results when the uterine cavity was opened. A narrow pedicle which is to be dropped may be ligatured as a whole; the vessels on a raw surface may be tied separately, and flaps of peritoneum sewn over it, or the surface may be cauterized. At present, the extra-peritoneal method is usually employed, when the stump can be brought into the wound; two long pins are passed transversely through the uterus just above the position of the clamp before the removal of the mass, and these rest upon the skin of the abdomen, keeping the stump in the lower angle of the wound. Most surgeons close the wound completely round about it, passing a stitch below and another above it through the edges of the wound and the uterine wall, so as to hold all close together; some leave a space above the stump, and drain Douglas's pouch with a glass tube. The projecting raw surface is kept dusted with solid perchloride of iron, or, better, with iodoform; a dry dressing is applied and changed frequently when drainage is used. At first the clamp often needs tightening to prevent hemorrhage. Some time in the third week, usually, the pins cut through, the clamp separates, a slough is thrown off, the stump slowly retracts, and the abdominal wall heals over it. The dangers of both methods are shock, septicæmia, peritonitis, and hemorrhage.

The mortality of hysterectomy up to March, 1884, calculated upon 359 recorded operations, was nearly 41 per cent. (Bigelow); no doubt unrecorded cases would have made it even higher. Spencer Wells (loc. cit. p. 164) claims to have removed 50 uterine tumors with 24 deaths; Thornton (Bigelow's table) has lost 1 in every 3 patients; Tait acknowledges a recent mortality of about 20 per cent; Keith (*British Medical Journal*), in January, 1885, had done 38 myomotomies and hysterectomies with the loss of only 3.

It is not surprising that some means of affording relief in serious cases of fibroma, without exposing the patients to the danger of enucleation or hysterectomy, has been sought. The idea of inducing a premature menopause by removing both ovaries occurred to Lawson Tait in 1871, and was carried out by him in February, 1872; later in the latter year the same operation was independently conceived and carried out by Hegar (of Freiburg) and Battey. In August, 1885 (*British Medical Journal*), Tait was able to give the results after the lapse of 13 to 2½ years in his first 50 cases that recovered from the operation. Complete, and in the great majority of cases immediate, arrest of menstruation occurred in 45; in 1 the disease was really cancer, not myoma; 2 had died from other causes; 1 could not be traced; in 1 menstruation continued in diminished quantity and the tumor went on growing = 50. In 13 the tumors disappeared, in 18 they greatly diminished. As to mortality, it at first amounted to 25 per cent.; but since 1883 Tait had operated 108 times with 2 deaths; Imlach mentions 20 cases, and Keith 12, all successful. Tait argues that this operation should be done so soon as a myoma begins to cause symptoms; if not the tumor will grow till it gets too large (over 9 lbs.—Keith) to be thus controlled, or the operation is in many ways rendered difficult or impossible, and hysterectomy has to be done. The operation renders a woman sterile (she usually is so already), almost always arrests menstruation (Wells and Keith say always, unless a bit of ovary is left behind), and rarely, if ever, causes any change in appearance; the evidence as to whether it causes loss of sexual desire is most conflicting—those of largest experience say it does not. A natural repugnance is felt to the operation, which has excited much opposition; but it is now widely admitted to be necessary in suitable cases. For method see p. 700; every particle of ovary should be removed. The treatment of myoma causing serious bleeding, pressure-symptoms, or growing rapidly, may be thus summarized: Remove any polypus with the écraseur; if there be no polyp, remove both ovaries; if this cannot be done, perform supravaginal hysterectomy at once, or—if the case be not very pressing and the menopause be at hand—at a suitable time, should the symptoms continue.

Myoma and Pregnancy.—When a patient having a myoma likely to obstruct labor becomes pregnant, the choice lies between induction of premature labor, which has proved very fatal, removal of the tumor, and Porro's operation—*i. e.*, supravaginal amputation (after emptying) of the pregnant uterus; the two latter methods have been fairly successful.

Cancer of the uterus usually affects the cervix primarily, rarely the fundus. When limited to the cervix, the uterus being mobile, the vaginal part is commonly amputated with an écraseur; but recurrence is almost invariable. The operation may, however, relieve, and scraping away the cancerous surface freely may check bleeding.

Cases of cancer supposed to be limited to the body, and others of the cervix, even when the vagina and bladder and broad ligaments have been involved, have of late years been somewhat frequently treated by removal of the uterus through an abdominal wound, through the vagina, or by a combined abdomino-vaginal method. The vaginal method has yielded the best results in the matter of recovery (20–30 per cent.), but recurrence has almost always followed all three methods, and the operation is with difficulty justified.

Vaginal hysterectomy is thus performed: The patient being in lithotomy position, and an attempt having previously been made to render the vagina aseptic by antiseptic packing and injection, the uterus is forced down as much as possible by a hand above the pubes and drawn down from below by vulsellum forceps. The peritoneum is now opened behind the os and, starting thence, the vagina is cut through all round beyond the new growth, bleeding vessels being clamped or tied. A catheter is introduced and the bladder and ureters are separated from the uterus; if wounded, the bladder must be sutured. The vagina being now cut through all round, two fingers are introduced through the posterior *cul-de-sac* to above the fundus uteri, which is dragged through the wound, the uterus being inverted; this brings the broad ligaments into reach and they are tied and the organ removed. If the uterus cannot be inverted it may be strongly pressed down and the broad ligaments snipped through with scissors, vessels being clamped as they bleed; or the ligaments may be treated through an abdominal incision. The abdominal aorta may be controlled by tourniquet; or, possibly, by the hand of the assistant who forces down the uterus and up the intestine (Wells, p. 177). Some suture the vaginal wound, others drain. Iodoform should be freely used and either frequent wool dressings or continuous boracic irrigation.

(For further information upon ovarian and uterine disease consult the writings of Playfair, Robert Barnes, Sir Spencer Wells, and Lawson Tait; also the medical journals of late years.)

CHAPTER XLIII.

DISEASES AND INJURIES OF THE RECTUM AND ANUS.

Examination of Rectal Cases.—Sir H. Thompson gives four headings for questions to be asked in every case of urinary disease; it is possible similarly to range our inquiries concerning rectal disease round the headings: (1) Pain; (2) Passage of blood; (3) Defecation; (and (4) Character of stools.

(1) Pain.—Is there any? its severity and character; seat; does it radiate thence; constant or intermittent; its time-relation to defecation—during or after; its duration?

(2) Blood.—Ever passed; frequency; quantity; color—bright, dark, tarry, coffee-grounds; with motions or between; if with, whether in streaks on surface, in large quantity on surface, intimately mixed with large stool, dripping away after passage of motion?

(3) Defecation.—Frequency—constipation, diarrhœa, alternation of these; attacks of obstruction; incontinence, complete or partial, of feces and flatus; tenesmus after; descent of anything from anus after; if so, characters; does it bleed, return by itself, or require reduction?

(4) Character of Stools.—Formed and large; small, shaped, scybala; loose; mixed with blood and mucus and pus in varying quantities; presence of worms?

It is useful to know also if there is any *discharge* between stools, and its nature, and if there is any vesical irritability.

After these special questions the patient must be examined. He should lie down on the left side with the anus toward a good light. First, note any change about the anus—laxity, contraction, piles, prolapse, fistulous openings, fissures, swellings of any kind here or in ischio-rectal fossa. Palpate all round the anus for tenderness or induration. Then make a digital examination, telling the patient to bear down : ulcers, abscesses, new growths, are now detected. If you want to reach higher, make the patient stand and bear down. If the rectum is full of feces, or if the case is not cleared up by simple digital examination, give an enema of warm water, and examine patient again immediately it has been expelled.

Mr. Tufnell gives a model hint to surgeons about to explore the rectum or vagina. The interstices between the nail and the skin should be filled with soap, so that nothing offensive can lodge there.

Examination with a probe, a speculum, or a bougie now follows, if required. Several kinds of specula are made, of which the simplest and best for most purposes is Fergusson's silvered glass tube with a terminal aperture and lateral slit. It is an excellent plan to illuminate the rectum from a head-mirror.

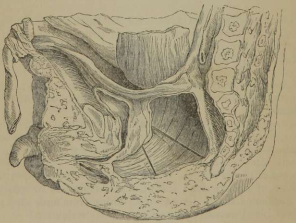
Occasionally in obscure cases of suspected disease high up, it may be necessary to dilate the anus. This is done with the thumbs, the fingers grasping the buttocks ; the muscles are gradually stretched first one way, then another, till in four or five minutes they become quite soft and flaccid, the skin being untorn though ecchymosis appear. Then the patient should be placed on a prone couch with the hips well raised. The anus is held open with retractors and the bowel cleaned out with sponges on holders (Allingham).

Lastly, a small hand may be introduced gradually into the rectum and sigmoid flexure in some cases.

Malformations.—The lower orifice of the rectum may be either partially or completely closed.

Imperforate anus (*atresia ani*) is a congenital closure of the rectum, and

Fig. 242.



Imperforate anus; from the King's College Museum.

may occur in various degrees. The anus may be merely closed by thin skin, which becomes distended with meconium ; or the gut may terminate in a blind pouch at any point from the sigmoid flexure downwards, the anal aperture being altogether wanting, or present and open perhaps for an inch (Fig.

242), so that externally all seems normal, the obstruction being found on digital examination; or the rectum may terminate in the bladder or urethra. In the condition last mentioned, flatus and urine tinged with meconium escape per urethram. In some cases the anus is closed, but there is a fistulous track leading from the rectum just above it, and opening somewhere in the perineum (Case in South's "Chelius," vol. ii. p. 329).

TREATMENT.—If the anus be only narrowed or partially closed, it must be notched with a probe-pointed bistoury, and regularly dilated by tents and bougies, or, better, by the mother's fingers. In cases of complete closure, if the anus bulge when the child cries, a crucial incision is at once to be made through the septum, the flaps removed, and a plug of oiled lint introduced. If no protrusion can be felt and the child be strong and well, the operation may be delayed for a day or two, so that the bowel may become distended with meconium; a silver catheter should then be introduced into the urethra or vagina, and a cautious dissection made in the mid-line, keeping well back in the curve of the sacrum. The superficial incision must be free and its margins may be retraced by threads passed through them. If the bowel be reached it is to be opened, and, if possible, the mucous membrane should be brought down and stitched to the edges of the external wound; the aperture must be kept open by using a bougie. But if the operator fail to reach the bowel at a depth of one to two inches, the rectum is probably absent, and the only resource is the formation of an artificial anus in the left iliac or lumbar region.

In the perineal operation everything depends upon the point of termination of the rectum; this might be determined by pushing a good sized aspirator needle, with the vacuum turned on, into the perineum until meconium or the limit of safety is reached.

When the rectum ends in the urethra or bladder, the usual practice has been to make an artificial anus; but H. Thomas reported a case to the Midland Medical Society, in which he had dissected the rectum from the membranous urethra and stitched it in its normal place; six months after the child had perfect control over its motions, and, though a fistula remained in front of the anus, all urine passed per urethram. A similar operation might more easily be done when the rectum ends in the vagina.

Foreign bodies in the rectum sometimes require to be removed by surgical art. They may consist either of small bones, apple cores, etc., that have descended from above, or of pins, clyster-pipes, or other bodies introduced from below. Substances of extraordinary dimensions (*e. g.*, a blacking-bottle) have been forced into the anus. Enteroliths of large size may also be found in the rectum; Hutchinson mentions one at least fifteen inches round. The chief point is first to dilate the anus well, by passing in several fingers, or by stretching it with the thumbs; and then a proper forceps, or a lithotomy-scoop, may generally be used with success.

Impaction of feces in the rectum is not uncommon in elderly women, and sometimes occurs in young ones, especially hysterical; it is due to *atony of the rectum*, resulting from habitual constipation. A mass of feces of clayey consistence may be formed, as large as a fœtal head, giving rise to pain and tenesmus, sometimes irritative diarrhœa, and occasionally all the symptoms of chronic intestinal obstruction. It must always be borne in mind that one form of diarrhœa is really due to constipation.

TREATMENT.—Anæsthetize the patient, dilate the sphincter well, and break up and remove the fecal mass with a lithotomy scoop or the handle of a spoon; after which use copious enemata. Anæsthesia and dilatation of the sphincter are often unnecessary. Re-accumulation must be prevented by the use of cold enemata, gentle laxatives, suitable diet, and the inculcation of regular habits.

Spasm of the sphincter ani is known by violent pain at the anus, with difficulty in defecation. It is most often associated with ulcer or fissure of the anus, and always exists in cases of fecal impaction, but it may be uncomplicated.

TREATMENT.—Suppositories of morphia or belladonna, with laxatives such as pulv. glycyrrhizæ co., will often relieve; but dilatation of the sphincter may be necessary, the patient being anæsthetized.

Fissure and ulcer of the anus often coexist, but either may occur independently of the other. A *fissure* is simply an ulcer which extends through the anus, and is much commoner than the ulcer confined to the mucous membrane above the sphincter.

Fissure is more common in women than men; it is often caused by the passage of hard dry feces, by injury in parturition, and by syphilis. It is most frequent on the dorsal aspect of the anus, at the junction of the skin and mucous membrane; *ulcer* lies rather higher up, within the internal sphincter.

SYMPTOMS.—Pain *during* defecation may be slight, or absent, but it is characteristic of this malady that pain comes on soon *after* defecation, and often increases for several hours, becoming quite sickening; spasmodic contraction of the sphincter, especially on digital examination; sometimes increased mucous discharge; often a streak or two of blood on the feces. There is often much constitutional suffering. The lower end of a fissure can be seen, and is usually covered by a small red flap of skin like an external pile. A practised finger may detect an ulcer, but a speculum is often needed.

TREATMENT.—Cases of fissure and ulcer of recent origin are often successfully treated by rest in the recumbent position, the bowels being kept open by confection of senna or some other laxative, and an occasional enema; nitrate of silver, sulphate of copper, chloride of zinc (gr. xx ad ℥j), and iodoform, or citrine ointment being applied locally. To relieve spasm of the sphincter, morphia or belladonna suppositories are to be used, or extract of belladonna smeared round the anus.

In established cases—and others are not often seen by surgeons—where recovery is interfered with by the constant action of the sphincter, an incision must be made through the fissure or ulcer so as to divide some of the fibres of the sphincter, and thus set the parts at rest. The rectum must be emptied by an enema; then, the patient being anæsthetized, dilate the anus thoroughly. This is often sufficient to cure the case, but most surgeons now make an incision with a probe-pointed bistoury through the fissure or ulcer and part of the subjacent sphincter; the incision should be one-eighth to one-quarter of an inch deep at right angles to the sphincter. A morphia suppository is then to be introduced, iodoform dusted on the sore, and a small piece of iodoform wool laid on the wound. Any thickened skin or mucous membrane at the lower or upper end must be looked for and clipped off. On the second or third day the bowels may be moved by castor oil, but many surgeons leave them to act naturally.

Cases of fissure of syphilitic origin must receive in addition appropriate specific treatment.

Abscesses near the rectum may be small and *subcutaneous*, lying near the anus, or large and *deep-seated, in the ischio-rectal fossa.* They may be caused by the irritation of foreign bodies within the rectum, or passage of such a body as a fish-bone through the mucous membrane; by septic absorption from an ulcer in the rectum, especially in the neighborhood of a stricture; by exposure to wet or cold, such as sitting on a cold damp seat; by necrosis of an adjacent bone. Many of these abscesses, especially the more chronic, seem to be tubercular. Sometimes a periurethral abscess opens far back; very rarely a spinal abscess points to the side of the rectum.

Ischio-rectal abscesses, which are deep-seated in the ischio-rectal fossa, and therefore external to the sphincter, may be acute or chronic. Acute abscess is attended with great aching, throbbing, fever, and difficulty and pain in defecation; the ischio-rectal fossa is swollen, hard, red, and tender; the introduction of a finger into the rectum causes great pain, and a hard, elastic, or fluctuating swelling is felt pushing inward the mucous membrane. The bowel usually seems very hot, and arteries, apparently of considerable size, are often felt pulsating over the swelling. Chronic ischio-rectal abscess often forms insidiously and painlessly, attaining a considerable size before it is discovered, spreading up along the rectum, and out toward the nates. If ischio-rectal abscess be neglected, it will burst either into the rectum, or by one or more openings through the skin; and not uncommonly they burrow almost all around the anus. The pus contained in these abscesses is always extremely fetid.

TREATMENT.—Fomentations, etc., until pus is certainly formed, Then a free incision must be at once made with a bistoury, and all the pus evacuated, *subcutaneous* abscesses being completely slit up into the rectum; after which the cavity is to be dressed with iodoform or salicylic wool, or boracic lotion and lint.

By early and very free incision and drainage we should always endeavor to prevent the bursting of a *deep* ischio-rectal abscess into the rectum, lest a fistulous track, necessitating complete division of the sphincter, result; for after this operation, scar-contraction usually causes an angular gap at the side of the anus impairing the patient's control over flatus and fluid feces.

In cases of wide burrowing, every part of the cavity must either be laid freely open or thoroughly drained with a tube; slitting up is preferable. Remembering the tubercular nature of many of these cases, it is usually well to apply the sharp spoon, and use iodoform in the dressing.

Fistula in ano is a track by the side of the rectum left by the bursting of an abscess. Its causes are, therefore, those of abscess, as also its relations to the soft parts. Thus it may result from a superficial anal abscess, in which case it passes under at most only a few fibres of the external sphincter, opens just within the anus on the one hand, and usually just external to it on the other, but the opening may be far outside; or it may be the result of a deep abscess, passing through or beneath the sphincter, and opening at some distance up the rectum and well outside the sphincter. Fistula is very common, and more so in men than in women. It is extremely difficult to heal, both because the constant contractions of the sphincter and levator ani interfere with the union of its sides, and because of the passage of fecal matter into it from the bowels. There are three kinds described: By far the most common is (1) the *complete fistula*, which has one opening external to the anus, and another into the bowel above the sphincter, where it may be felt like a small papilla. (2) The *blind external fistula*, which has no opening into the bowel, although it mostly resembles its outer coat. (3) The *blind internal fistula*, which opens into the bowel, but not externally, although its situation is often indicated by redness, pitting on pressure, and hardness near the anus.

The complete fistula is infinitely the most common, though the internal opening is often missed. Injection of the fistula with milk may be practised from the outer opening. Besides the true *fistula* "*in ano*," there may be openings near the anus, leading from the tuber ischii, which may be carious, or from a urethral or perineal abscess constituting a true urinary fistula. Whenever fistulæ are found opening far out on buttocks, stricture of the rectum, simple or malignant, should be thought of; and in all cases the bowel should be digitally explored.

The *symptoms* of a complete case are: Pain—usually slight; some purulent discharge, and involuntary escape of flatus, and occasionally of feces. Pain and purulent or bloody discharge draw attention to a blind internal fistula.

TREATMENT.—It is occasionally possible, especially in blind external fistula, to effect a cure by dilatation of the sphincters and the use of stimulating application, such as carbolic or nitric acid, nitrate of silver, or iodoform. The external aperture must be kept open for drainage by a tube of proper size. But in the great majority of cases the only effective remedy is slitting up of the whole track.

Operation.—The patient lying on his side close to the edge of the bed, and chloroform having been administered, the nates are separated by an assistant, whilst the surgeon introduces one forefinger into the anus, and explores with a probe the whole extent and ramifications of the fistula. If it be of the *blind internal* kind, it must be rendered *complete* by a puncture made into it by the side of the anus, a bent probe passed into it from the bowel serving as a guide; similarly an *external fistula* is rendered complete by thrusting the director through the mucous membrane at the highest point. Then, the surgeon passes a Brodie's probe-pointed director along the whole canal of the fistula, brings the point out at the anus with his finger, and divides the included parts upon the director. Brodie believed that if the inner opening were not slit open the fistula would return. All ramifications and hemorrhage of the fistula under the skin should next be sought for and slit up; Allingham insists on the necessity for slitting up also any *cul-de-sac* that may pass upward from the internal opening. All thin, blue, overhanging edges must be carefully removed, for they will not heal. It is a good plan, especially in old dense fistulæ, to sharp-spoon the whole surface, or to turn the edge of the knife and cut the deeper part of the sinus all along so as to make a raw surface or fresh wound at the very bottom of the cut, to insure the springing up of granulations there. Place a $\frac{1}{4}$–$\frac{1}{2}$ gr. morphia suppository in the rectum. Dust the wound with iodoform, lay a little salicylic wool in it, and apply a good pad firmly to the anus with a T-bandage. The wool comes away when the bowels act. They may be allowed to do so naturally in most cases, if they have been well cleaned out before operation. The subsequent treatment consists in the observation of perfect cleanliness, and, if necessary, the use of stimulating applications, such as sulphate of zinc; but usually the less dressing the better. A probe may be used to prevent premature union of the edges of the wound, so as to secure healing from the bottom by granulation.

Allingham states that incontinence of wind and feces is almost certain to result from complete division of both sphincters in two places; if a small band of the internal can be left on one side the danger is much less. Complete division may be safely practised on one side if the cut be made *at right angles* to the muscular fibres; union is never good after oblique division. Should an angular gap result, the application of a cautery occasionally may cause it to contract up; and it is said that daily passage of a bougie will strengthen a weak sphincter.

If hemorrhage is violent after this operation, and does not yield to the application of cold and styptics, the anus must be well dilated with a speculum, so as to expose the bleeding surface to the air, and any discernible artery may be tied or twisted; or the rectum may be firmly plugged with lint, which is to be secured by a T-bandage.

If a patient will not submit to this operation, or is laboring under disease of the lungs, liver, or kidneys, in an advanced stage, so that it would be unsafe, the treatment must be *palliative* merely. The confect. piperis, or copaiba and tonics, may be administered internally, and stimulating injections and ointments be applied to the fistula. Professor Dittel's elastic India-rubber ligature, introduced with Allingham's needle, may be used for a patient who dreads the knife. It should be $\frac{1}{10}$ inch thick, drawn very tight, and held by a small pewter clamp. It cuts through in 3–14 days, gives little or no pain, and the patient can walk about; for dividing sinuses running high up the bowel it is very valuable as avoiding hemorrhage.

Every now and again one's finger on being passed through the anus slips into a huge sloughy cavity opening into the bowel and lying behind on one side of the mid-line extending up towards the sciatic notches. Though very unlike the general idea one has of a fistula, these cases must be classed among and treated like blind internal fistulæ. Besides severe local symptoms, they are often accompanied by general disturbance from septic absorption. They fill up with feces and either do not heal or spread. The anus must be fully dilated, the cavity opened freely from outside, overhanging mucous membrane divided with bistoury, scissors, or elastic ligature, the interior cleaned and dusted with iodoform. After this the cavity should be thoroughly washed out with warm boracic lotion thrice daily, a tube being passed.

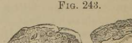
As fistula frequently coexists with phthisis, it is of importance to have some general rule for the selection of cases in which operation is admissible. It should not be performed in cases of rapidly advancing phthisis; but where the lung disease is chronic, and especially if the fistula cause much distress, the operation must be done.

HÆMORRHOIDS, OR PILES, are small tumors situate near or within the anus, they are divided into *external* and *internal.*

External piles may occur either as oblong ridges or folds of skin external to the sphincter, or as round, hard, bluish tumors, just at the margin of the anus. They rarely bleed, and are therefore called *blind* piles.

Internal piles originate within the anus; they consist of vessels covered by thickened mucous and submucous tissue. The vessels are of all three kinds —capillaries, arteries, and veins; and either kind may predominate. The *capillary pile* is small, bright red, granular on the surface, usually situate rather high in the rectum, and bleeds upon the slightest irritation; it is probably a chronically inflamed patch of mucous membrane. Sometimes the patch is scarcely raised at all; at others the whole of the lower end of the bowel is bright red and velvety. The *arterio-venous pile* is not very large, is smooth and red, and has not, as a rule, prolapsed; at its base considerable arteries may be felt pulsating. The *venous pile* is that most commonly seen; purple-red swellings round the margin of the anus, often blue at their lower end from obvious varix, protruded more or less by straining, at first returning of themselves, then only on pressure, and finally remaining almost constantly prolapsed. The vessels are often thrombosed and the clots organized. From the microscopic examination of a large number of piles, Rœckel (*Trans. Path. Soc.*, 1884), believes that the venous and arterio-venous are about equally common. There may be one pile or several; in chronic cases the mucous membrane all round the anus is often thickened, its veins more or less varicose, with special swellings here and there, and it prolapses easily; the spincters are much relaxed.

FIG. 243.



Sections through venous piles.

Causes.—The *predisposing* causes are such as produce fulness of the abdominal vessels, or impede the return of blood from the rectum—*e.g.*, luxurious and sedentary habits of life, pregnancy, habitual constipation, and congestion or cirrhosis of the liver. The *exciting* cause may be anything that irritates the lower bowel—straining at stool, and violent doses of purgative medicines. If the larger bowel contain fecal matter, which from torpidity it does not expel, aloes is an effectual and unirritating remedy ("Aloes," by R. Druitt, *Med. Times and Gaz.*, Jan. 4, 1868). But if these parts are already active and empty, aloes can but irritate them fruitlessly, causing straining and tenesmus, and also, probably, piles. Piles are most frequent in women, and are rare under puberty.

Symptoms—Piles may be met with in two states—*indolent* or *inflamed*. When *indolent*, they produce inconveniences which result from their bulk and situation within the gripe of the sphincter; more or less pain in defecation and immediately afterwards a desire again to go to stool, the rectum not feeling emptied; prolapsed; and pain or an excessively annoying sense of weight and discomfort. Blood may be lost in large quantity at each motion, and it is characteristic that it drips away for some time after the bowels have acted. The bowel is apt to come down when the patient is taking exercise or exerting himself. When *inflamed*, they occasion the following symptoms: Pain, heat, itching, fulness, and throbbing about the anus; a sensation as if there were a foreign body in the rectum, and frequent desire to defecate; pain and straining in passing evacuations, with discharge of mucus, and often of blood. These symptoms may be complicated with irritation of the bladder, frequency of micturition, pain in the back, and aching down the thighs. If there be much burning pain lasting after stool, look for a fissure also among the piles. The patient may not be aware of the nature of his complaint, or through delicacy may abstain from mentioning it. Whenever a patient complains of unusual irritation of the bladder, or of frequent painful and unsatisfactory efforts to pass a motion—the surgeon should make inquiry after piles. In women, piles may cause aching of the back, uterine irritation with mucous discharge, and many anomalous symptoms, which the surgeon will in vain endeavor to cure until he finds out the real cause.

General Treatment.—The first object is to remove the predisposing and exciting cause. The patient, if plethoric and of sedentary habits, ought to live abstemiously, and take plenty of exercise. The bowels should be regulated by some mild aperient, producing daily copious soft evacuations, without straining or griping. Senna, sulphur, and cream of tartar, in the form of electuaries (F. 107, 108, 117, 124, 128, 130), are frequently used for this purpose; or rhubarb with ipecacuanha, or castor oil, or Püllna or Friedrichshalle water (F. 113, 114), in the morning. It is a good plan to inject the rectum with cold water both before and *after* the motions. In some cases it is advisable for the patient to have his evacuation just before bedtime, so that the prolapsed and irritated parts may become quiescent during the night. In cases of long standing, in which the mucous lining of the rectum is relaxed, cubebs, Ward's paste, or confect. piperis. comp. may be given with great benefit. If the patient is advanced in years, and the piles are attended with a flow of mucus, copaiba may be given in gelatine capsules, or thirty or forty drops every morning in milk; and a scruple of common pitch may be taken in pills every night at bedtime.

Local Treatment.—If the *piles are inflamed*, leeches to the anus, followed by hot fomentations, a dose of calomel and opium at bedtime, with castor oil in the morning—milk diet, rest in bed, warm hip-baths, and poultices. Cold lotions of lead, with laudanum, may be substituted for the warm applications, if more comfortable. If there is a tense, bluish, solid tumor, evidently containing coagulated blood, or if there is an abscess, it is to be laid open, and the contents evacuated. Having provided as far as possible against the original causes of the malady, measures should be employed to restore the parts to a healthy condition.

(1) *Cleanliness.*—The anus should be well washed with carbolic soap and water after each motion; and if the piles are internal, and protrude during evacuations, they should be washed before they are returned. Cold bathing should be used night and morning.

(2) *Astringents.*—The zinc lotion (F. 234), or iron lotion (F. 246)—recommended by Mr. Vincent—or alum or tannin (F. 247, 249)—of either of which a drachm or two may be injected into the anus after each motion and allowed to remain—the gall ointment (F. 303), and creasote ointment (F. 304), are often of benefit. An ointment of a drachm of black oxide of mercury to an ounce of lard has also received high commendations.

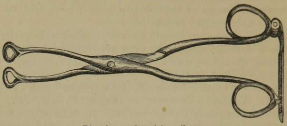
(3) *Pressure,* by means of a bougie introduced occasionally, or a firm pad of flannel covered with oiled silk, or of smooth wood or ivory, made to bear up well against the anus by means of a stout T-bandage (*see* Bandages), or by means of a spring like that of a truss, is often of service. An instrument consisting of a short egg-shaped ivory bougie, which is introduced into the anus, and attached by a slender neck to an ivory pad, so that pressure is thus made both internally and externally, may be useful in cases of internal piles with relaxed mucous membrane and prolapse, when removing the piles is not thought advisable.

(4) *Operation.*—If the piles cause much distress, or if hemorrhage is frequent or profuse, they must be removed by one of the following operations (serious disease, especially of the liver and kidneys, being absent): (1) Excision; (2) ligature; (3) crushing; (4) clamp and cautery; (5) application of caustics.

Excision is generally used only in the case of external piles; if internal piles are cut off, very troublesome hemorrhage ensues. The piles are seized by a hooked forceps and removed by curved scissors; bleeding is usually slight, and easily checked by a pad of salicylic wool. Allingham reports very favorably in favor of excision of internal piles, when they are not more than two to four. He dilates the anus fully, opens it by a retractor, and twists the bleeding vessels. One or two arteries generally require this. All bleeding from one pile must be checked before removing the next. Allingham has had no recurrent hemorrhage, and his cases have been soundly healed in six days on the average.

Ligature is the operation by which internal piles are usually removed, especially if there are actual tumors. The bowels having been well cleared on the previous day, and an enema having been administered an hour or two before the operation, the patient is anæsthetized. The piles are then seized one by one with a ring-forceps (Fig. 244), or with a double sharp hook, and drawn down. A deep cut is now made with scissors through the mucous membrane or muco-cutaneous junction on the outer side of the pile, parallel to its neck. A stout hemp or silk ligature can now be thrown round the very base of the pile where the arteries are entering; it must be tied *as tightly as possible.* The incision lessens the quantity of tissue to be ulcerated through, prevents much pain in cases where skin would be included, and renders removal of the disease complete. All the piles must be thus dealt with; large masses may then be cut off beyond the ligatures, the threads cut short, and the stumps pushed up into the rectum together with a suppository. The bowels should be confined for forty-eight hours; they may then be allowed to act naturally. In the male a catheter is often required for retention.

FIG. 244.



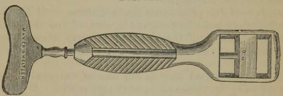
Ring-forceps for seizing piles.

Transfixion of the pile, and its ligature in two halves, which was formerly recommended, should always, if possible, be avoided, as there is considerable risk of transfixing a hemorrhoidal vein, and of consequent septicæmia.

Ligature is probably the safest and best of all the operations done for piles.

Crushing.—Internal piles are now often removed by this operation; the mucous membrane is first cut through as for ligature, and the pile then drawn through and crushed with a strong clamp, of which Allingham's is the best (Fig. 245). The pile is then cut off beyond the clamp, and the latter is re-

FIG. 245.

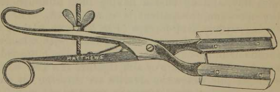


Allingham's scerw crushing clamp.

moved after a minute or so, being pressed toward the wall of the bowel as it is unscrewed. There is rarely any bleeding.

Clamp and Cautery.—Henry Smith employs a clamp, tightened and held by a thumbscrew, acting on a scissors-like hinge; the surfaces of the blades and their outer borders are protected by ivory plates, to prevent the transmission of heat from the cautery, which is applied on the cut edges to the adjacent surface of the bowel (Fig. 246). The pile or mucous membrane is

FIG. 246.



Smith's clamp for the removal of piles.

first taken up between the blades of the clamp, which are then screwed up by the winged screw so tightly as to prevent bleeding and cut off sensation. The included parts are then cut off at a little distance by a pair of scissors bent on the flat. Then to the cut edges the hot-iron cautery is applied at a red heat, slowly and well, so as to sear the parts effectually. Lastly, oil is freely applied, and the parts allowed to pass into the anus. After-bleeding is very rare. But Mr. Smith acknowledges 4 deaths in 530 cases (*Lancet*, April 20, 1878), a high percentage after so slight an operation.

Application of caustics.—This treatment is useful in the capillary or "strawberry" pile, where there is no actual pendulous tumor, but a swollen granular ulcerated surface, often bleeding freely. Nitric acid is most often used, having been first introduced by Houston of Dublin, but pure carbolic acid is also employed.

The bowels having been cleared, a glass speculum with a hole in its side, well oiled, is to be introduced till the pile is seen through the aperture. The acid is then freely applied with a glass rod or piece of stick, any superfluous acid being afterward removed with lint, and oil or vaseline smeared over. There is but little pain, provided that no acid touches the anal skin, which should be oiled before beginning. In a few days a slough separates, leaving an ulcerated surface which generally soon contracts and heals. If there be a pedunculated pile with a granular bleeding surface, caustics may stop the bleeding but will not cure the pile.

Hemorrhage from the rectum is a very frequent concomitant of piles, and may be slight or severe, occurring with every stool. It may be caused by (1) the bursting of a varicose vein—in which case the blood is venous, comes at once in considerable quantity, and may not occur again. This form is rare. Far more frequently it proceeds from (2) the vascular surface of internal piles, which gives way under the straining which accompanies defecation. In the latter case the blood is bright; it is squirted from the anus in jets when the patient is straining, and the bleeding occurs very frequently, especially when the patient is feverish, the bowels disordered, or the piles inflamed. When the piles prolapse or the sphincters are toneless, blood often drips away for some time after stool. Hemorrhage from the rectum may be distinguished from that which has its source higher up, by noticing that the blood is generally of a florid hue, and that it covers the feces but is not intimately mixed with them.

It may be stated that loss of blood from the rectum should always be checked (the chief exceptions are very rare cases of vicarious menstruation), and this should be done at once if the patient is weak and emaciated, with pale lips and feeble pulse. Sometimes feelings of heat, fulness or pain in the head, or similar symptoms about the rectum are aggravated by bleeding; but, as a rule, a moderate loss of blood causes marked relief. It is in these latter cases that doubt may arise as to the propriety of checking it. This may safely be done, however, if the patient, especially if of full habit, will eat sparingly, avoid highly seasoned dishes, all alcohol, strong coffee, and smoking, and live simply, taking plenty of fruit and vegetables; the bowels must be carefully regulated, and cold douching of the anus night and morning should be practised.

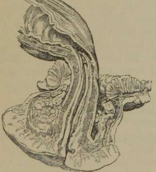
TREATMENT.—The cure of piles, of course, includes that of the hemorrhage which is one of their most ordinary symptoms. The tincture of hamamelis virginica given in ♏xv–xxx doses thrice daily, and used as a lotion diluted with an equal part of water, often acts well. Other internal remedies likely to be of service are sulphuric acid, and the balsams of copaiba and Peru (F. 15, 18, 31, etc.). During an "attack of piles" the patient will obtain much relief from lying prone with the pelvis raised on a double inclined plane. To staunch violent bleeding, it is essential to discover its source. The patient may be placed as above, the sphincters dilated, the rectum opened by retractors or a large speculum, illuminated by direct light, or, better, reflected from a head-mirror, and mopped out thoroughly with sponges on sticks. If a pedunculated pile be found bleeding, remove it; other sources of hemorrhage—*e. g.*, cancer—will probably be traced by the cautery. In secondary hemorrhage after an operation on piles, Allingham at once plugs the rectum in the following manner, alleging that blood and clots fill the bowel so that one cannot see the large vein usually at fault. Under these circumstances he wrings a good-sized, conical, hollow, Turkey sponge out of water, dusts it well with dry subsulphate of iron, ties a stout piece of silk to its apex, and passes it four or five inches up the bowel; fills the bowel below it with cotton-wool similarly dusted, and then pulls the sponge firmly down. The plug is worn for one or two weeks, a tube being run through it centrally to permit escape of flatus, altered blood, etc. The wild use of cold or astringent injections is very poor practice in severe bleeding.

Prolapsus ani is a protrusion of the mucous membrane and submucous tissue of the lower part of the rectum through the anus. It is most common in connection with piles, and must be carefully distinguished from *procidentia* or *prolapsus recti*, which is frequent in young children and by no means rare in adults, especially multiparæ and old men, and differs from prolapsus ani in that it involves the whole thickness of the wall of the bowel (Fig. 247). There is still another displacement of the rectum, differing from the last only in being higher up; the upper part of the rectum is *invaginated* or *intussuscepted* into the lower; this variety is not uncommon in women, is usually associated with polypus, and is distinguished by the presence of a deep groove or *cul-de-sac* all round a central mass having the opening of the bowel at its apex.

CAUSES.—Children thus affected are generally weakly, rickety, or tubercular, often suffering from diarrhœa, from strumous catarrh, or from tenesmus due to thread-worms, polypus recti, stone or phimosis; their sacra are flat, they naturally strain a good deal at stool, and Allingham blames mothers for leaving children too long on the chamber. The same causes act in adults, and now piles, atony of the rectum from chronic constipation, abuse of warm enemata, etc., come in.

SYMPTOMS.—In cases due to piles, the symptoms are those of the piles, and the prolapse of an irregular ring of mucous membrane which swells much if nipped by the sphincter. In prolapsus recti the prolapsus, which may be four or five inches long, is the chief sign; strangulation is very rare, and replacement, as a rule, easy. In old cases there is always more or less incontinence of feces. In adults a hernia containing small intestine may be found in the anterior *cul-de-sac*. Intussusceptio recti may cause great distress, chiefly from frequent and severe tenesmus.

FIG. 247.



Procidentia recti, the whole thickness of the lower part of the bowel being extruded. The mucosa is very thick from irritation and exposure. (King's Coll. Mus.)

TREATMENT.—Removal of any ascertainable cause and improvement of the general health are main points, especially in children. In all cases the protrusion should be well washed with cold water and then with some astringent—*e. g.*, alum. gr. xx ad. ʒj, or ferri sulph. gr. j–iij ad ℥j, then oiled and replaced by pressure with hand or sponge. If there be any difficulty the forefinger should be pushed up into the anus and it will carry the protruded part with it. If, however, a larger portion than usual has come down, or the usual prolapse has become constricted and much swollen, the patient may be anæsthetized and reduction effected; or the prone position with raised pelvis may be prescribed, the swelling punctured in several places, and fomented with either iced or warm water—sometimes one, again the other, gives most relief. It is of great importance to prevent descent of the bowel. Between stools it is a good plan, especially in children, to press the nates together with the forefinger and thumb and carry a broad strip of adhesive plaster from one side to the other, to be kept on till an evacuation is desired, and afterward replaced. A few drachms of an astringent injection may be left in the bowel after a motion; and the motions should be passed either in the standing or lying position. Dr. MacCormac, of Dublin, recommends that when the stools are passed, the skin near the anus should be drawn to one side with the hand, so as to tighten the orifice—an excellent plan. Any irregularity of bowels must be carefully treated. Under such treatment children very generally recover in the course of months. Should they not do so Allingham recommends strongly the administration of chloroform, drying of the prolapse and wiping over its surface with nitric acid, then oiling and returning it. The rectum is now stuffed with wool, and a firm strap passed from buttock to buttock, to prevent protrusion by urgent straining on recovery. This soon ceases. A little opium is given to confine the bowels for four days; then a dose of ol. ricini. The plug comes away and there is no more prolapse. A second cauterization is rarely needed. *In adults*, prolapsus is much more difficult to cure. When due to piles and involving only mucous membrane, ligature of the piles or multiple punctures with Paquelin's cautery will usually cure. But in true prolapsus recti one must be very careful not to open the peritoneum in such procedures. The best way is to make from four to six longitudinal eschars of the mucous membrane with the cautery, to be repeated if necessary. The patient should keep lying till healing is complete. Allingham *partly* divides the external sphincter on each side with the cautery in these cases, to tighten it by the scars. In *intussusception* the motions should be passed lying down to prevent its occurrence.

Stricture of the rectum is either *non-malignant* or *malignant*. That irritation of a sensitive surface will cause contraction, often prolonged, of the rectal muscle is certain; but the name of spasmodic stricture is unnecessary.

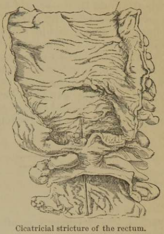
Non-malignant stricture is the result of disease, not the disease itself. It may be produced in many ways. Rarely it is due to congenital malformation; the rest of the cases are due to contraction from changes in the rectal wall, or to compression of the bowel from outside.

Ulceration of the rectum is the pathological change which most commonly leads to stricture, and the causes of such ulceration are in many cases quite doubtful or unknown. Occasionally narrowing of the bowel is due to the operation for imperforate anus (p. 723), to the separation of an invaginated part, to sloughing of prolapsed mucous membrane perhaps after too energetic treatment with ice, to the too free removal of mucous membrane in operations for piles, prolapse, etc.; sometimes ulcers left by ligature of piles, incision of fissures, division of a fistula, will spread instead of healing, and it has been surmised that the irritation of hard retained feces, or of a roughly and frequently used enema tube, may excite ulceration; the onset of symptoms is often referred to a bad labor; the ordinary fissure and painful ulcer frequently commence after labor, after the passage of an unusually large or hard motion during which a crack may be felt, or sometimes after severe diarrhœa. Other causes of rectal ulceration are dysentery and tubercle; it is certain that the former occasionally leads to stricture, and probably that the latter, though it rarely, if ever, heals entirely, does so also; partial healing with contraction may occur, and, in each case, the whole bowel becomes paralyzed and greatly contracted, from inflammatory infiltration of its deeper tissues, so that it forms a passive tube through which feces and discharge are forced or run. In England, non-malignant stricture of the rectum, which is not obviously traumatic, is almost always regarded as syphilitic. Allingham finds that of 99 carefully examined cases in hospital and private practice, 52 were syphilitic, in the remaining 47 there was no reason to suspect syphilis, and in many of them the evidence against it was as nearly conclusive as possible. The diagnosis "syphilitic" is arrived at much too easily by some surgeons. When really syphilitic the pathology is often somewhat uncertain. As a rule, stricture is probably due to gummatous infiltration of the wall and ulceration; but ulceration of mucous plaques is quite possible in early cases. In France and America, on the other hand, many surgeons attribute all, or nearly all, these strictures to the healing of rectal chancroids. Mason (*Am. Journ. Med. Sci.*, Jan. 1873) thinks the rectum becomes inoculated by running backward of secretions of vulvar sores, or by extension of anal sores, or by direct inoculation. Against this may be urged that the perineum and anus rarely shows scars or any sign of irritation; that the stricture does not begin at the anus, but 1 to 3 inches above; in 31 cases, Mason found constitutional syphilis in 14, and the statement that in some of these stricture appeared shortly after chancroids is not satisfactory; lastly, the best syphilographers have never seen infection of the rectum from the vulva take place, and have found that chancres heal as readily as others. Doubtless the rectum might be infected directly, but this will not account for many cases. It is, therefore, probable that soft chancre is very rarely a cause of stricture of the rectum. Gonorrhœa of the rectum has been advanced as another possible cause, and it is only right to mention that ulcers have very rarely been found in the rectum in typhoid. Even taking syphilis as accounting for rather more than half the cases, the other causes mentioned will not account for the remainder. Lastly, the bowel may be compressed, with somewhat similar results, by peritoneal bands, pelvic hæmatoceles, the effusion of pelvic peritonitis and cellulitis, the retroverted uterus, pelvic tumors, etc.

Non-malignant stricture may be single or multiple, strictly localized or involving some inches of the bowel; below it the rectum is contracted, above more or less dilated and filled with feces. There may be no ulceration and no evidence of it; but usually ulceration exists above and also below the narrowing. Frequently perforation or septic absorption from these sores leads to abscess in the walls of, and outside the rectum, ordinary fistulæ and recto-vaginal fistulæ resulting. It is curious that many of these enter the rectum below the stricture. This disease is much commoner among women than men—20 men in 99 cases (Allingham), and most writers make the number much less.

Symptoms.—In many cases increasing difficulty and pain in getting the bowels to act are the symptoms which bring the patient to the surgeon. In the majority the history is as follows: the earliest symptom is morning diarrhœa; the patient desires to go to stool immediately he rises, but passes only wind, a little loose motion, and "coffee grounds," perhaps mucus or pus. Tenesmus probably continues, and a little later, probably whilst dressing, the patient has again to go to stool, and passes more motion, often lumpy, occasionally smeared with blood. Often the bowels act again after breakfast, and then the patient is fairly comfortable for the day. He may suffer from griping and flatulent distention. After some months there is more burning pain after stool, more tenesmus and greater discharge—less mucus, more pus and blood. The diarrhœa comes on in the evening as well as in the morning; dull, wearing pain in the bowel, radiating into the back, thighs, and even penis, is frequent, aggravated, or induced by walking and standing, and may disturb rest at night; dyspeptic troubles often arise. Swollen, club-shaped, tender flaps of skin now form round the anus, and are very characteristic of severe ulceration or malignant disease (Allingham). The above symptoms correspond to spreading ulceration. At first there may be but one, usually posterior, about one and a half inches up; this spreads and others form. Now come symptoms of stricture as ulcers heal in part and the infiltrated wall contracts. There are more pain and straining at stool, constipation is more difficult to overcome and often alternates with diarrhœa, large quantities of feces being passed during the latter periods; in stricture low down the motions may be "shaped,"—*i. e.*, flattened like tape, thin and round like pipe-stems, but much more often they consist of scybala wrapped in mucus or other discharge; bleeding is common but not severe. There is usually some discharge from the anus, and in bad cases always loss of control over fluid motions. The above pain, and sympathetic troubles of the bladder, anus, and uterus continue. Fistulæ form, all the symptoms increase, and in the course of months or years the disease, unless relieved, ends in death from exhaustion from pain, hectic, and profuse suppuration, perforative peritonitis, septic disease, or intestinal obstruction. On passing a finger into the rectum, it meets with a narrowing, usually at one to three inches, sometimes sharp and thin edged, again funnel-shaped and irregular; the finger may be easily passed through it, or be unable to enter, or it gets a short way into a long channel. The examination generally causes a good deal of pain.

Fig. 248.



Cicatricial stricture of the rectum.

Diagnosis.—The only difficulty in diagnosing stricture arises when it is out of reach and out of sight. The finger reaches considerably higher points in the rectum if the patient *stands* and bears down. When one has to trust to sensations conveyed along a well-softened elastic tube, it is easy to fall into error. To pass this, warm water should be slowly injected as the tube is pushed on to undo an invagination and stretch out folds. The natural sharp fold at the junction of the rectum with the sigmoid flexure, and the fact shown by Mr. Earle that the bowel not unfrequently makes a horizontal curve to the right before descending into the pelvis, render the introduction of long tubes or bougies a somewhat hazardous proceeding. The surgeon must not pronounce his patient to have a stricture merely because the point of the bougie catches in the folds of the mucous membrane, or at the promontory of the sacrum. The introduction of a small hand into the rectum is the last resource of diagnosis. As to the diagnosis between non-malignant and malignant stricture, a comparison of the description will sufficiently indicate the points upon which it rests; a mistake is rarely possible.

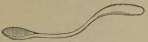
Treatment.—Early in the stage of ulceration a cure may be effected and stricture prevented by treatment for some months. This includes absolute rest, regulation of the bowels, a diet chiefly of milk, the occasional application of caustic, or some stimulant, to the ulcer, or perhaps the division of its base, and the use of bismuth in powder or ointment or morphia suppositories to allay pain.

When stricture has commenced sedative and astringent ointments (ung.

bellad., ung. hydrarg. ox. rub., āā) and solutions (arg. nit. gr. x ad ℥j) must still be used, and in addition gentle dilatation by bougies. A gum-elastic bougie, capable of being passed with moderate facility through the stricture, should be well softened in warm water, oiled, and introduced once in two, three, or four days, and be allowed to remain fifteen or twenty minutes; and its size should be gradually increased when a larger one admits of being passed. But irritation must always be avoided; bleeding and discharge of mucus should not be caused. Instances of fatal perforation by even an enema tube are not wanting.

Mr. Wood devised a bougie with a thick end and a slender stem, with an *f*-like curve, to follow the normal sweep of the bowel, and to give that forward direction to the point of the instrument which the rectum has in its upper part (Fig. 249). When the stricture is placed high, this curve very much lessens the danger of perforating the coats of the bowel below the stricture, which in elderly women and in the cancerous form of stricture is real. The curved bougie is introduced with the concavity directed backward as far as the lower third. It is then gradually turned forward, as in the *tour de maître*, with the catheter. The thin stem much facilitates the handling and movement of the instrument through the contracted sphincter. The thick part of this instrument is often made in sizes to screw upon the slender curved stem.

Fig. 249.



Wood's rectum bougie.

Mr. Tufnell uses a hollow bougie, on the principle of a tubular urethra-dilator. A guiding bougie, just large enough to pass, is carefully guided through the stricture by the left forefinger. Over this a tubular bougie of gutta-percha, well oiled, is made to slide through the stricture; then by withdrawing the guiding bougie, a stream of water may be injected into the dilated bowel above, and flatus and feces let out.

When it can be borne, the tying in during the night of a suitably made tube may act well.

When a stricture is short and annular, and does not readily yield to dilatation, it may be *notched* in three or four directions, just through the indurated tissue, and then cautiously dilated with fingers or bougies; Todd's dilator is much to be dreaded. A good plug of oiled lint is then placed in the stricture for twenty-four hours. Bougies are afterwards continued.

In cases of short stricture rather low down, especially if there be much ulceration, Verneuil's *linear rectotomy* may be done. The patient is placed in lithotomy position, the anus well dilated, a straight bistoury passed well through the stricture, and everything divided down to the bone; keep to the midline, and there is little bleeding. Some surgeons use the écraseur instead of the knife. This operation often gives marked relief; retention of feces above the stricture ceases, remedies can be applied to the surface, and ulceration heals.

In cases of long stricture and widespread ulceration, sometimes involving the whole rectum, usually with widespreading fistulæ, perhaps into the vagina or bladder, attempts to dilate are futile and dangerous, even if pain does not prevent their being made; notching and linear rectotomy cannot possibly relieve, though they are sometimes done when a surgeon fails to appreciate the extent of the disease. To save the patient's life and arrest the pain he suffers, either *inguinal* or *lumbar colotomy* must be done to divert the feces from their natural track. The ulceration may then heal; but it will be very rarely indeed that the state of the rectum will be such as to permit subsequent closure of the colotomy wound.

Considerable relief is often given by the treatment of fistulæ; when these run high the elastic ligature should be used for the upper part, as bleeding may be very troublesome.

Patients are not *cured* of rectal any more than they are of urethral strictures; if taken early, the stricture may be so dilated that by passing a large bougie occasionally (how often is necessary must be found by experience) the patient can keep herself fairly comfortable; this precaution should never be neglected.

Malignant Growths of the Rectum: *Malignant Stricture.*—As would be expected, the malignant growth of the rectum is the columnar epithelioma (p. 144). Sometimes, and chiefly in cases of slow growth, large tubes surrounded by very perfect large columnar cells are found; while in more rapid cases the spaces and cells are small and irregular, and there may be no lumen whatever. When all the spaces are thus filled up the growth has the aspect of an ordinary scirrhus or encephaloid.

Columnar epithelioma of the rectum begins usually two to four inches from the anus, and the junction of the sigmoid flexure and rectum is its next most common seat. It begins as one or more nodules which, until they ulcerate, seem covered by mucous membrane; sometimes the growth spreads horizontally, and perhaps completely surrounds the bowel whilst less than one inch from above down; again, whilst still annular it may be three to four inches from above down; or it may form a rounded, lobulated mass, increasing equally in all directions, projecting into the lumen, and perhaps distending it or becoming pedunculated. Sometimes ulceration is slow in occurring, at other times it almost keeps pace with the spread of the growth; this may be rapid, or very slow and accompanied by much cicatricial contraction. Outside the new growth the muscular coat usually seems greatly thickened, and the perirectal fat may be too adherent to it; the microscope will show the tumor-cells extending between bundles of muscular fibres into the perirectal tissues. As a rule, the sacral and coccygeal glands are not involved till late, and wide generalization is very uncommon, but secondary nodules in the liver are not very rare.

Colloid degeneration of columnar epithelioma occurs more frequently in the rectum than elsewhere.

Sarcoma of the rectum, even melanotic, is occasionally met with, and is clinically indistinguishable from cancer.

Malignant growths of the rectum are rarely met with before middle life, but Gowlland, Allingham, and Curling respectively record cases at 13, 17, and 23.

The symptoms are usually those of non-malignant ulceration and stricture intensified, especially, as regards radiating pain, suffering during defecation, frequency and amount of bleeding, tendency to bloody and purulent discharge, to the formation of recto-vesical, -urethral, or -vaginal fistulæ, and early appearance of cachexia. Rectal examination usually renders the diagnosis certain. The finger comes into contact with a hard, rugged mass, which when annular often has much the shape of a cervix uteri; if the finger-tip is pushed through the central opening—this may cause extreme pain—it enters a very hard-walled, ulcerating cavity; the upper border of the growth is similar to the lower. Should the growth not surround the bowel, an ulcerated surface with a thick, hard edge and hard base constricting the bowel will be felt, or a firm or soft, rounded, nodulated tumor, varying much in size. The symptoms vary much. Pain may be slight or excruciating; hemorrhage may be very free, and the first—and for months the only—sign; constipation may be troublesome and increase to complete chronic obstruction; occasionally complete obstruction is the first sign of cancer high in the rectum; painful diarrhœa is commonly met with, and incontinence from infiltration of the sphincter, or possibly from pressure on its nerves.

The disease kills by cachexia, perforative peritonitis, hemorrhage, or fecal impaction. It may be fatal a few months after the first symptoms, or last as long as four years.

Cancer of the anus is much less common than that of the rectum. It is always squamous. Beginning as a hard-edged ulcer, it spreads up the bowel and out into the ischio-rectal fossæ, infiltrating the sphincter and causing incontinence. Sinuses discharging epithelial *débris* often form in numbers. Excision is the treatment, if any is possible.

Treatment.—This, until quite recently, might have been summed up thus: Treat symptoms and relieve pain as long as possible; as a last resource do colotomy. Some surgeons performed colotomy as soon as pain became severe. Of late years the idea of extirpating the disease has naturally arisen, and the old operation of excision of the rectum has been revived.

Mitigation of pain is obtained by rest, easily digested food with a good deal of milk, and the use of anodynes locally, subcutaneously, and by mouth. Morphia is the best, but morphia-hunger is easily induced, and may be as bad to some patients as the physical pain.

Marked relief has been given in many cases of cancer low down by division of all the tissues in the midline between the coccyx and anus and of the stricture by means of the thermo-cautery, or the chain écraseur (Verneuil); and in cases of large, soft, fungating growths, by their removal with the fingers or sharp spoon—an operation which, if done boldly and quickly, causes surprisingly little hemorrhage, easily stopped by pressure or the cautery (Simon).

The operation of *colotomy*—which is, of course, simply palliative—may be performed either in the left groin (*inguinal*), or in either loin (*lumbar*).

Inguinal colotomy.—An incision is made one inch above and parallel to Poupart's ligament, extending from one-half inch outside the vessels to one-half inch inside the anterior spine; the external oblique, internal oblique, and transversalis are divided by strokes of the knife to the same extent as the skin; all bleeding points are tied or twisted; the transversalis fascia is picked up with forceps, notched with a knife on the flat, and divided all along the incision, and then the subperitoneal tissue and peritoneum are similarly treated. Usually the sigmoid flexure presents; if not, a finger is passed in to the right side of the pelvis, swept across the sacrum to the left sacro-iliac joint, and brought out along the pelvic brim; the bowel can thus hardly be missed. It is recognized by the longitudinal bands and appendices epiplöicæ. When found, it is to be examined to see if anything abnormal can be felt; if not, draw it out sufficiently to kink it, attach it to the peritoneum, and skin by numerous fine silk stitches, passing through only the serous and muscular coats of the bowel, and close up the ends of the wound. Unless done for obstruction, the bowel should not be opened until the third or fourth day, an antiseptic dressing being meanwhile applied. In any case, the operation should be conducted antiseptically up to the opening of the gut, and the suturing of peritoneum to peritoneum should, when the bowel is opened, be most careful.

Lumbar colotomy is thus performed: Supposing that it is to be done on the left side; the surgeon stands behind the patient, who lies upon the right side slightly rolled forward, the left loin being stretched by a round sand-bag under the right loin. The superficial guide to the colon is a line, which should be marked with iodine, ascending vertically from a spot one-half inch behind the midpoint between the anterior and posterior spines; the deep guide is the edge of the quadratus lumborum. An oblique incision is made three to four inches long, having its centre at the above line and sloping from the last rib toward the anterior spine, and is deepened by successive strokes of the knife through the fat, external oblique and latissimus, and internal oblique; the last dorsal nerve and its vessels should be seen and drawn aside if possible; the posterior tendon of the transversalis is now picked up, notched and divided to the full length of the wound, and if the edge of the quadratus is exposed notch it to the depth of an inch. Now tear through the transversalis fascia, if recognized as a distinct membrane, between the fingers and thumbs, and treat the subperitoneal tissue, which varies much in amount, in the same way, proceeding very carefully until the peritoneum is reached. Just in front of the edge of the quadratus lies the colon, a little external to the lower end of the kidney, which is plainly felt and seen moving up and down. If the bowel is full, it at once presents and has a greenish color; but if empty, or if it has a mesentery (much more likely on the right), there may be difficulty in finding it. Often, surgeons insert their fingers deeply into the wound, making large cavities in the subperitoneal tissue, in which discharges subsequently bag, and picking up piece after piece of peritoneum in the hope of finding the gut between their fingers. A better plan is to place the forefinger in front of the quadratus just below the kidney, and have the patient turned on to his back; seize whatever falls on to the finger: it will probably be the colon. A plan which answers admirably in some cases is to blow up the intestine with air by means of a Higginson's syringe, return of the air *per anum* being prevented by an India-rubber collar introduced by Lund (Fig. 237) round the tube; this often causes the colon to protrude through the wound, but sometimes fails unaccountably. When found, the bowel is to be seized at its *inner and posterior part*, which is free from peritoneum, and brought into the wound; and, having been recognized by the presence of a longitudinal band or of distinct lumps of feces in it, it is drawn well out and sewn to the skin by silk sutures, not piercing its mucous membrane. The wound is carefully brought together in front and behind, and it is probable that buried catgut sutures would act well here, if the operation be done antiseptically; but if the bowel is to be opened at once, it is certainly best to put in a large tube at the posterior end of the wound. Most surgeons, in this case, secure the gut primarily by two stout silk sutures passed first through skin, then through gut, then again through the skin; the opening is then made transversely or longitudinally, the loops of silk drawn out, divided so as to make four sutures, and tied; finer intermediate sutures are added. In all these steps we are warned to take care not to wound the peritoneum, which is easier in theory than in practice. Where the operation can be done aseptically, sooner than bruise and separate the deep tissues in a prolonged search for the colon, it is better deliberately to open the peritoneum outside the bowel, to draw the latter well out and fix it carefully to the skin. An antiseptic dressing is applied and the patient placed in bed on the left side. The bowel is opened on the third or fourth day.

When the colon is opened the smell of the feces is much lessened by giving the patient charcoal internally; the best dressing is lint, with a hole in it, covered with an antiseptic ointment or oil, and over this a large pad of oakum in gauze.

The patient, when very weak, may never rally from the operation, but the most frequent cause of death is septic peritonitis; an occasional one is suppuration in the planes of areolar tissue of the abdominal wall, generally from bagging at the posterior end of the wound.

Sometimes soon, later in cases done through small wounds, the mucous membrane prolapses more or less largely; it must be reduced like prolapsus ani. In a good many cases, feces continue to pass *per rectum*, and of course to give pain; the bowel must then be washed out. To prevent this the colon should be drawn well out at the operation, so as to kink it or form a spur before it is sewn to the skin. It has been proposed to divide the colon, the lower end being either sutured in the wound or closed and dropped.

The advantages claimed for colotomy are that it retards the growth of the disease, relieves pain, wards off obstruction, and therefore prolongs life. Allingham is inclined to doubt that life is lengthened.

It is affirmed that the anus in inguinal colotomy is more comfortably placed for the patient, that it is an easier operation, and that its mortality is less. The first two statements are probably true. As to the mortality, comparable modern statistics are not forthcoming. The mortality after lumbar colotomy is certainly heavy. Bryant (Copenhagen Congress) reported 60 cases of colotomy for malignant, 19 for non-malignant ulceration and stricture; 43 per cent. cancerous and 31.5 simple cases died within a month. Reeves (*Brit. Med. Journ.*, 1884, vol. i. p. 1253) records 39 cases of lumbar colotomy, of which 36 lived "some months;" and 11 cases of the inguinal operation, of which 1, done *in extremis*, died on the third day, the rest living some months. These results are unusually good. Post-peritoneal colotomy is generally credited with a mortality of 35 to 45 per cent. (p. 672), which is somewhat less than that of septic operations through the peritoneum.

When done for imperforate anus, both of these operations are frequently fatal; but, in 100 cases collected by Curling, the iliac has decidedly the best of it.

EXCISION OF THE RECTUM has been practised on the continent much more largely than in England, Volkmann, Esmarch, and Harrison Cripps being some of the most experienced operators; it is the natural outcome of the determination to treat all cancer by radical means. The cases favorable for removal are those in which the growth is limited to one side of the bowel, movable over the adjacent parts, so low down that its upper edge can be felt, and unaccompanied by any sign of glandular or visceral infection. Very grave cases, involving removal of the prostate and parts of the bladder, have been undertaken, but the advantage of such operations has yet to be shown. The following points in these operations may first be mentioned as generally applicable; they are results of the work of the above-mentioned surgeons. For some days before operation the patient should be kept upon fluid diet leaving little residue, and the bowels should be emptied as far as possible by laxatives and enemata. Before operation, the patient being under chloroform, large enemata of salicylic lotion should be given, and every endeavor made to render the bowel aseptic. The patient should be placed for operation in lithotomy position, with the pelvis raised and the thighs strongly flexed. The bowel-tube should not be opened in complete excision, and during the operation the wound should be frequently washed with carbolic. All bleeding should be stopped at once by clamping, oozing by a hot sponge. After the operation all surfaces should be dusted with iodoform. If the peritoneum be opened it should be closed with carbolized silk sutures, if possible; if not, a tube should lead from the wound to the exterior. All raw surfaces should be covered by approximation and careful suture of the cut edges of mucous membrane (longitudinally, if possible) or of mucosa and skin. To permit this, drainage of the wound is necessary, and is usually best arranged for by bringing 2 or 3 tubes out through punctures in the skin on either side, in front of or behind the anus; the tubes may be retained by a stitch to the skin. After operation a pad of gauze or absorbent wool or oakum should be applied, and the patient placed in the semi-recumbent position upon a ring water-pillow. Inflammation and fever must be met by cleansing the tubes with a feather and by gentle injection. In serious cases, constant boracic or salicylic irrigation may be used for 5 or 6 days. The operations practised vary much in different cases according to the extent and situation of the disease; but all may be classed as complete or partial excision, the former implying removal of the whole circumference, but not of the whole length of the rectum. It is a great advantage when even a narrow strip of bowel can be left untouched.

Partial Excision.—The anus when involved may require partial excision by a wedge incision or semilunar cut on one side, or complete removal by a semilunar cut on either side; the incisions being made to include as much of the adjacent rectum as may be diseased.

When the anus is not involved, removal of a cancerous plaque or nodule may be effected after full dilatation of the sphincter, or, when this is insufficient, after section of the bowel and all the tissues up to the tip of the coccyx, removal of the coccyx, and, finally, division of the anterior commissure of the anus to the central point of the perineum. The margins of the anus being drawn apart by properly shaped, long-handled retractors, pressure with a hand in the left iliac fossa and traction with hook-forceps on the growth as it is separated will enable the surgeon to reach very high up the rectum. Sutures high up may be passed as in cleft palate. The wounds made to permit access to the growth must be carefully sutured, and the posterior is very serviceable in allowing a tube draining the excision wound to be brought out close to the coccyx.

Complete Excision of Rectum and Anus.—Surround the anus by two semilunar cuts, carried well into the fat of the ischio-rectal fossæ, and secure the inferior hemorrhoidal vessels; seize the anus with hook-forceps, and with stout, slightly curved scissors snip through all fat down to the levator ani, leaving the anterior connections for awhile; now snip through the levators on the sides and behind, and with the fingers and scissors clear the rectum as high as may be needed on these aspects; wash the wound out with carbolic; in the male a large catheter should now be passed and held up under the pubes whilst the rectum is cautiously separated snip by snip from the bulb, membranous urethra, prostate, and bladder, if need be; in the female an assistant should place his finger in the vagina and warn the operator of his approach to the mucous membrane or to the peritoneum in the upper fourth, if it is not intended to open this; the rectum being well free all round, two stout silk sutures are passed through it laterally well above the growth, so as to keep a hold upon it, and the bowel is snipped across transversely below them, vessels being clamped as sprung; enlarged glands are felt for and enucleated, the attachments of the rectum are still further cleared, and the bowel drawn down (no easy task, and often impossible) so that it can be sewn to skin; but before this is done the peritoneum is closed, and arrangements for drainage are made.

When the anus is healthy, it should be spared. The incision back to the coccyx is made, as usual, the rectum cut through below the growth, and separation commenced here; the mucosa above the growth must finally be united to that below. Hüter used in these cases to raise the anal skin, whole sphincter, and lower end of the rectum in a flap hinged at the coccyx: he says that thereby the patient retained sphincter power.

The mortality has been high after this operation; its causes are septic pelvic cellulitis, septic peritonitis, and septic poisoning. Cases have been recorded by Volkmann, König, and others, in which the disease has not recurred for some years.

Simple Growths.—*Nævus* is very rare; the most characteristic point is a history of occasional hemorrhage from childhood. Examination by speculum is helpful. Treatment is very difficult; electrolysis or setons would probably succeed best.

Warts are rare. The *villous tumor*, remarkable for the ease with which it bleeds, is of this sort. H. Cripps has recorded (*Path. Soc. Trans.*, 1882) two cases in a brother and sister of multiple, small villous growths. Hemorrhage was their trouble.

Glandular polypus (p. 140) is fairly common, more so in children than adults. It is a pedunculated growth from the mucous membrane of the rectum, usually from one to two inches from the anus; it may be multiple. The symptoms are tenesmus, discharge of mucus, more or less hemorrhage, and often prolapse of the rectum; if the pedicle is long, the polypus may protrude during defecation as a round and velvety mass like a strawberry.

Treatment.—Removal by ligature, or by torsion of the pedicle, the anus being held open by retractors.

A *fibrous polypus* also is described, firm and lobulated, occurring in adults.

CHAPTER XLIV.

DISEASES OF THE URINARY ORGANS.

Examination of Cases and General Points in Diagnosis.

There are three methods of obtaining evidence of disease of the urinary organs: (1) history; (2) physical examination; (3) naked eye, chemical, and microscopical examination of the secretions.

1. With regard to the history, Sir H. Thompson (*Diseases of the Urinary Organs*) has some excellent remarks. He always asks four main questions, and in the same order. These are: (1) *How often do you pass water?* Frequency of micturition is increased more or less in almost every morbid condition of the urinary organs above the membranous urethra. It is important to obtain separate statements of the frequency by day and by night, and to know whether it is affected by movement or other circumstances. Drink often causes marked increased frequency in stricture; and intermittent attacks occur frequently in some people from the excretion of pale, watery ("hysterical") urine, which is very irritating to the bladder.

(2) *Is there any pain connected with micturition*—before, during, or after? or at any other time? Its character and exact seat? The effect of movement upon it? A tender urethra causes pain (scalding or cutting *during* micturition, at a tender spot or all along; a tender prostate may cause aching and weight in the perineum, but most characteristic is a sharp cutting pain at the end of the penis, on the lower aspect, *at the end* of micturition, when the bladder contracts upon the prostate or forces a stone on to it; a tender bladder causes, *before* micturition, a tensive pain above the pubes, with urgent desire to pass water, also some perineal aching, and bladder pain is frequently accompanied by prostatic—the two organs are so closely associated; kidney pain has no relation to micturition, is constant

with exacerbations, or intermittent, usually felt in the loins, radiating thence toward the groin, but irritation of the kidney often causes only remote symptoms.

(3) *Is the urine altered in character, or is there anything unusual in the stream?* With regard to the *urine:* is there any deposit? is it present when passed, or only after standing and cooling; like more or less pink, fine sand (urates)? cayenne pepper grains (uric acid)? jelly, adhering to the chamber (ropy mucus)? matter (pus)? The quantity and color of the urine may be noted. As to the *stream:* is it smaller than natural? twisted, forked, issuing in drops only? does a full stream ever stop suddenly, or is any special position necessary to pass water? is the stream projected well, or does it fall straight from the penis, and perhaps stop altogether on straining? does it take too long to empty the bladder?

(4) *Do you pass, or have you ever passed, blood in the urine?* amount, estimated by color of urine? does it come before micturition (urethra), or intimately mixed with the urine (bladder or kidney), or at the end of micturition, after apparently normal urine (bladder or prostate)? or does it issue independent of micturition (urethra)? It must be noted that, in patients lying quiet upon their backs, red corpuscles tend to settle to the hinder and lower part of the bladder, and that, consequently, blood really intimately mixed with urine may, under these circumstances, appear to come at the end of micturition.

2. Physical examination is best begun—at all events in a case in which the history has left the surgeon in doubt—by inspection and palpation of the line of the urethra, the scrotum and its contents, the hypogastrium and renal regions, followed by percussion of the abdomen; we may thus find urethral discharge, tenderness or thickening, peri-urethral abscesses, or fistulæ left by them, a distended bladder, a renal tumor. Next the prostate is examined per rectum, regular or irregular enlargement, tenderness, induration, fluctuation, or concealment of the organ by a new growth or fluid collection being noted; the vesiculæ seminales cannot be felt distinctly unless they are indurated and swollen; the base of the bladder forms a soft, bulging swelling above the prostate, but it may be found indurated by new growth, or a calculus may be felt, and its size and position determined, especially in children. Examination by a finger in the rectum and hand above the pubes may possibly reveal a tumor of the bladder, and is the best method of examining an unusually large calculus. The urethra may next be explored by bougies, which may reveal stricture or false passages, or by the urethrometer, if slight narrowing is suspected and accurate measurement required; a finger in the rectum greatly aids the discovery and localization of false passages. The bladder may be examined by a sound for stone, irregularity of, or phosphatic deposits on, its surface, thickening of its base (felt between finger and sound), or the height above the pubes of the apex may be found by feeling the sound through the abdominal wall. A simple endoscope, like a long ear-speculum, may occasionally help in the discovery of the opening of a stricture, in revealing a papilloma, etc.; but in the bladder of the male the more complicated endoscopes have as yet but little value. Lastly, it is sometimes necessary to ascertain whether both kidneys are diseased, when one obviously is, and its removal is contemplated. We have no certain means to this end, and some suggested are either very dangerous or very difficult, or applicable only in the female. The simplest is—compression of the ureter on the diseased side, through the abdominal wall, in thin patients, by means of Davy's rectal lever, or by a hand in the rectum; then washing out of the bladder with boracic lotion, and with-

drawal and examination of the urine that flows whilst compression is maintained.

3. Examination of the Urine.—We can find room here only for a few practical remarks upon this subject. Mistakes may be avoided by instructing a patient to pass water for examination in two parts—about an ounce, which washes out the urethra, into one vessel, the rest into another. The first will contain pus or blood from the urethra, mucous shreds from a stricture or from the prostate; the latter contains only kidney and bladder products (Thompson), and is that which should be examined chemically.

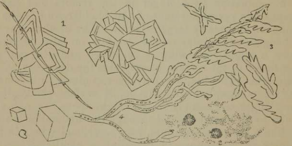
The urine carries off from the bloodvessels the refuse matters derived from digestion, assimilation, and the wear and tear of the body. Any deviation from a healthy state of digestion and nutrition is followed by a deviation from the healthy properties of the urine.

Since the urine varies extremely in its properties at various hours of the day, that which is passed before eating in the morning (*urina sanguinis*) becomes the most accurate criterion of the results of destruction of the tissues, and should be examined separately, especially for albumen and blood-changes, while that which is passed after eating (*urina potus et cibi*) best indicates departure from healthy digestion and assimilation. For estimating the total quantity the whole passed during twenty-four hours should be collected into one vessel; quantity, acidity, specific gravity, and percentage of urea should be estimated and compared day by day from this collection.

A precipitate let fall from the urine after it has been voided is called a *sediment:* when precipitated in the bladder or kidneys, it is called *gravel;* and gravel lodging in any part of the urinary passages may concrete into *stone.* When the urine habitually presents any one kind of deposit, the patient is often said to have a corresponding *diathesis*—as the lithic diathesis; but the term implies nothing exact. The principal *sediments* are—first, *uric* or *lithic acid;* secondly, *oxalate of lime;* and thirdly, *phosphates.*

(1) Uric or Lithic Acid, or Red Gravel.—This is deposited at once, on passing, in the form of minute red-brown crystals, tinged with the coloring matter of the urine (Fig. 250, 1). It generally indicates a highly acid

Fig. 250.



1. Lithic acid. 2. Lithates in powder, and spherules of lithic acid or lithate. 3. Basic phosphate. 4. Torula.

state of the urine, by which it is precipitated from the ammonia and other substances which ought to hold it in solution.

The amorphous *lithates of ammonia, soda,* and *lime* form a very common sediment, usually pink, but varying in color from nearly white to dark red or yellow. The urine from which it is deposited is acid; clear when passed; but clouded as it cools; and the sediment dissolves when heated slightly (Fig. 250, 2).

Lithates form the sediments observed in fever, gout, chronic diseases of the liver, and various forms of indigestion.

(2) Oxalate of lime (Fig. 251, 1 and 2) is generally deposited from urine which is acid and contains much lithate. It is in the form of minute octahedral crystals, seen only by the microscope. The dumb-bell form is rare, and is another form of oxalate. (Dr. Beale.)

(3) Phosphatic deposits may, but do not necessarily, arise whenever the urine becomes alkaline, as it commonly does after full meals. In certain forms of indigestion stellar crystals of phosphate of lime are frequently present.

In such a case the urine is alkaline from preponderance of fixed alkali, potassa or soda. On heating clear urine in which phosphates are present in excess a dense cloud often forms which consists of finer particles and is denser than albumen similarly precipitated; it dissolves at once on addition of a

Fig. 251.

1. Oxalate of lime crystals. 2. Oxalate of lime in pellucid spherules; single, double (dumb-bells), and quadruple—from the urine of a woman whose only symptom was extremely distressing palpitation. 3. Cystine.

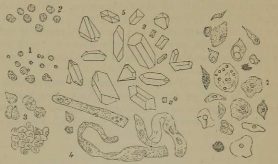
little acetic acid, and not uncommonly there is brisk effervescence from decomposition of alkaline carbonates, also present in excess. The ammoniacal urine, loaded with ropy mucus, which is commonly found in chronic cystitis, in disease or injury of the spinal cord, and under any circumstances which cause habitual retention of urine, is the result of decomposition whilst in the bladder. When urine is alkaline from ammonia, reddened litmus-paper changed by it, and afterwards heated, recovers its red color, which is not the case when alkalescence arises from the presence of fixed alkali. The varieties of phosphatic deposit are—(1) The *triple phosphate* of ammonia and magnesia, which appears in sparkling prismatic crystals on the surface of the urine (Fig. 252, 5); (2) The phosphate of lime in stellar crystals; and (3) an amorphous precipitate consisting of mixed alkaline phosphates, amorphous or forming branched figures (Fig. 250, 3).

Pathological Relations.—Lithic sediments, crystalline or amorphous, often accompany gout, and may exist with a highly sthenic and plethoric condition; but may, on the other hand, indicate debility, mal-assimilation, or excessive fatigue, and rapid or destructive change of tissue. The oxalic generally indicate feeble powers of assimilation, and exhaustion of the nervous system. The phosphatic, when not arising from changes in the bladder, usually indicate anæmic dyspepsia, or undue wear and tear of the brain, from overwork. The constant or abundant presence of the deposits becomes an important evidence of disease.

When a patient is passing red crystalline gravel (has a *fit of the gravel*) he usually complains of great pain in the loins and bladder, frequent desire to make water, and aching of the testicles and hips. Sometimes these symptoms are attended with great feverishness—sometimes with languor and dyspepsia—sometimes marked improvement of health accompanies such a discharge.

When oxalate of lime is abundant, the urinary organs are apt to suffer—with frequent micturition, aching in the loins and bladder, and great irritation of the genital organs. Often these symptoms are combined with peculiar lassitude, fits of headache, sour perspiration, nettle-rash, extreme despon-

FIG. 252.



Urinary desposits—viz. : 1. Small globules ; blood, nuclei, small epithelial cells, and spherules of oxalate of lime. 2. Pus. 3. Epithelium from the bladder ; the typical form, a long oval, pointed at each extremity with central nucleus ; the younger cells spherical and pellucid ; the older ones flattened, often full of granules or oil. 4. Small casts from the kidney consisting of fibrinous matter entangling a few epithelial cells—two of these cells distinct. 5. Triple phosphate.

dency, and other signs of indigestion and of a disordered condition of the blood. Aching of the eyeballs is often noticed.

TREATMENT.—The treatment of urinary disorders is often made too dependent on a superficial chemical examination of the urine; it being the custom to give acids if the urine is alkaline, without sufficient regard to all the circumstances. Such summary treatment is essentially erroneous; and the author would advise, under all circumstances, to treat the patient on general principles, and with less regard to the state of the urine.

The first thing to ascertain is the patient's blood-making powers, and his habits. If lusty and red-lipped, living highly, and troubled with lithic gravel of no long duration, he will generally be speedily relieved by Friedrichshalle water (℥vij or less) every morning, warm baths, and liq. potassæ, ʒj, thrice daily after meals. The diathesis will be corrected by early rising; by exercise enough to make the skin eliminate freely; by temperance in meat, by abstinence from alcohol in all its forms, by freely eating fresh green vegetables, watercress, and fruit containing little sugar—*e. g.*, apples—in short, by temperance in all things, and avoiding alcohol, sugar, starch, and fats; by alkaline or saline medicines, F. 106, 110, 113, 143, 150, 151, 158, etc., and by hot air or vapor baths.

But far different must be the treatment if the urinary deposit be caused, not by an excess of material in the system, but by feebleness of the powers which ought to convert the food into healthy flesh and blood, or by overwork of mind or body. In such cases the prime object must be to strengthen the digestion by the following means: (1) It is often beneficial to begin the cure by relieving the bowels of offensive scybalous matter, by calomel, with colocynth, or some tonic purge (F. 112, 122, etc.). The motions should be inspected, and the medicine repeated at discretion till they are rendered healthy. (2) There are few remedies comparable to *change of air*, including, as it must, change of diet, water, habits, and occupation, for the cure of all disorders of mal-assimilation. (3) *Alkalies*, such as F. 154 *et seq.*, may be given in small doses after meals. If the patient complain of sour eructations, flushed face, flatulence, etc., whether the urine be ammoniacal or not. (4) But the most important medicines are *tonics*. Of these, one of the most useful is the nitro-muriatic acid (F. 4), which may be given with benefit on an empty stomach, if the patient feel that it takes away that nauseous, flabby, alkaline condition of mouth which so commonly accompanies a low digestive power. The other mineral acids, bark, quinine, nux vomica, and bitters, the sulphates of zinc and iron, and the muriated tincture of iron, will all be found useful. (5) *Conium or opium*, in a suppository, is sometimes necessary to allay local irritation, especially in phosphatic and oxalic cases. The chloral hydrate or croton-chloral may also be necessary as a means of procuring sleep, and preventing the nervous system from being worn out by its own irritability. (6) The *diet* should consist of those substances which are most readily convertible into nutriment, and least liable to undergo degeneration during their solution in the stomach. Meat, soup, milk, eggs, good wheaten bread, cruciferous vegetables—brandy and water, pale sherry, good Bordeaux, and bitter ale—are to be preferred; and pastry, slops, and bad wine the things to be avoided.

ALBUMEN is very frequently mixed with the urine (*albuminuria*); when the kidneys are inflamed, acutely or chronically; or when they are exceedingly congested from pregnancy, disease of the heart, great external cold, or any other cause. It is not at all infrequent in the urine of children at the commencement of the exanthemata, or of other acute diseases, and is met with temporarily in a large proportion of students and candidates for the public services.

To detect albumen, heat the upper portion of some filtered urine to the boiling-point in a test-tube over a spirit-lamp, when the albumen will coagulate, and, according to its quantity, either produce a mere opacity, or even solidify the entire specimen; by heating the upper portion of the urine only a slight cloudiness, due to albumen, may be detected by contact with the unboiled urine beneath. If the urine be alkaline, this test will fail, because then heat alone will not coagulate the albumen, and may cause a deposit of white phosphates; therefore, a few drops of acetic acid should be added after the boiling, which will dissolve the precipitate if phosphatic, but not if albuminous. Nitric acid alone is a useful test for albumen, but as a definite proportion of the acid is necessary for the success of the test, the acid should be first poured into the test-tube and the urine on the top of the acid; by this means, owing to the diffusion of the two liquids, the proper relative proportion must be somewhere obtained, and a white cloudy ring of coagulated albumen will appear at the *junction of the two liquids*.

BLOOD in the urine (*hæmaturia*) in large quantities may usually be recognized by the color which it imparts to it; if in large amounts and quickly poured out into otherwise healthy urine, the color will be bright red; if it be poured out slowly and in smaller quantities the urine will have a brown color, and will deposit a sediment something like that which settles from unstrained beef-tea; if the quantity of blood be still smaller and discharged from the higher urinary tracts, the urine often has a "smoky" tint; if the urine be putrid, the blood often acquires a dark and almost tarry appearance. Albumen is always present in the urine, when it contains blood, and on boiling the urine a brown coagulum forms and settles to the bottom of the test-tube, leaving the urine clear above. Traces of blood may be recognized by microscopical examination, or by a chemical test thus: Shake up a little urine with some tincture of guaiacum, and pour a little ozonic ether on to the top of the solution; the presence of blood is recognized by the appearance of a blue ring where the two meet.

Blood in the urine may come from the kidney, the pelvis of the kidney and ureter, the bladder, the prostate, or the urethra, or may result from constitutional causes independently of any local disease of the urinary tract; of these the most important is scurvy. *Hemorrhage from the kidneys* may result from the acute congestion produced by turpentine or cantharides, from acute Bright's disease, malignant disease, tubercle, and renal embolism occasionally. In renal hæmaturia the blood and urine are evenly mixed, and the color usually smoky; under the microscope blood casts may be seen, and after the discharge of blood has ceased epithelial and hyaline casts of the renal tubules may be seen in the urine; the presence of albumen in the urine after the cessation of the hæmaturia and in a non-purulent urine is a valuable diagnostic sign of the renal origin of the blood. *Hemorrhage from the pelvis of the kidney or ureter* results from malignant disease, tubercle, calculus, or from the presence of the parasite—bilharzia hæmatobia—which affects the mucous membrane of the pelvis of the kidney and the bladder. The diagnosis of hemorrhage from the renal pelvis from that from the kidney is hardly possible from an examination of the urine alone, as in both cases the blood is evenly mixed with the urine; the presence of blood casts of the ureter would be of value, though they may be equally formed in cases of profuse bleeding from the kidney; the associated symptoms, as, for instance, those of renal calculus, will do most to assist the diagnosis.

The bleeding is usually but slight in calculus and tubercle; if it be abundant it is most probably due to malignant disease.

Hemorrhage from the bladder may be due to acute cystitis, calculus, villous tumor, malignant growths, tubercle, varicose veins; or due to rupture from external injury; blood from the bladder is usually most abundant towards the end of micturition, particularly when due to villous growth, and then clots of blood are also often passed. In cystitis, calculus, and tubercle the amount of blood is much smaller and more evenly mixed with urine.

Hemorrhage from the prostate is most frequently due to congestion of an enlarged prostate which is thereby relieved; the blood does not flow out by the urethra, but passes backwards into the bladder, where it may become mixed with the urine or settle down to the bottom of the bladder, and be passed towards the end of micturition, and so simulate hemorrhage from that viscus; the urine drawn off in prostatic retention is often evenly colored and almost black from the admixture of decomposed blood which has been discharged into the bladder from the prostate. Hemorrhage from the prostate may occur also from tubercle or calculus of that organ, and from the rough passage of instruments.

Hemorrhage from the urethra may result from laceration from external violence or from the passage of instruments, from patches of congestion of the mucous membrane in gleet, from a chancre in the urethra, or from impaction of a calculus in it, or gonorrhœa; when due to laceration of the mucous membrane, the bleeding occurs independently of micturition, and in gonorrhœa or gleet the blood flows either with the first or last portion of urine.

Treatment.—The treatment of hæmaturia, of course, varies with its cause, in a manner sufficiently described under the different diseases; it will be necessary here to allude only to the treatment required to combat the individual symptom—hemorrhage. When hemorrhage from the kidneys is attended with inflammatory symptoms, cupping, purging, and the reduction of the albuminous constituents of the food to a minimum are indicated; when with symptoms of debility, the dilute sulphuric acid, tinct. ferri. perchloridi, gallic acid, or small doses of turpentine. In hemorrhage from the bladder a large-eyed, full-sized catheter should be passed, to prevent accumulation of clots in the bladder, and straining efforts at micturition. If the hemorrhage is obstinate, the bladder may be injected with cold water containing a drachm of the tincture of the perchloride of iron to the ounce; and if much blood is coagulated in the bladder, it may be necessary to break it down by repeated injections of tepid water with a Bigelow's evacuator. Hemorrhage from the urethra may be checked by cold or pressure.

Fibrine in the urine, when present in large flocculi from any ulcerated surface in the bladder, is readily distinguished. Sometimes it is moulded in the tubules of the kidney, accompanying albuminous urine; and thus gives evidence of the seat of the effusion. These fibrinous casts of the *tubuli uriniferi* may vary much in size and appearance. They may be small or large, and transparent, or containing kidney epithelium, in large or small quantity. When small, they show that they have been moulded in tubules *not deprived of epithelium* (Fig. 252, 4).

Epithelium, from any part of the urinary organs, may be present in urine. Under irritation the uniting medium of the epithelial layers becomes loosened, the epithelium is formed in greater abundance, and is shed or *desquamated* more rapidly than natural. In higher degrees of irritation or inflammation, the entire epithelial covering is stripped off or the membrane becomes *excoriated*—a state of things usually followed by the escape of pus-cells from on the inflamed surface. (*a*) The small, round, gland-epithelium from the *kidney*, and the nuclei of disintegrated cells, are often found in small quantity in the urine when containing oxalate of lime. (*b*) The kidney-epithelium may be agglutinated by fibrinous effusion, and may be found in the sediment of albuminous urine in the form of *epithelial casts*, under any inflammatory or congested condition of the kidneys. (*c*) Epithelial cells and casts may be found loaded with oil-globules in certain stages of some varieties of Bright's disease. (*d*) The epithelium from the *pelvis of the kidney*, and especially from the *bladder*, is often found in great abundance when these parts are irritated by the urine, or by any other cause, as after difficult labors; it presents itself as a purulent-looking deposit, seen under the microscope to consist of a columnar or pear-shaped, of very various shapes and sizes, with simple nuclei—the larger and older cells often full of granular matter, and almost disintegrated. The urine is not necessarily albuminous. (Fig. 252, 3.)

Mucus is found as a viscid, stringy, structureless substance, coagulated by acetic acid; alkaline in its reaction, when proceeding from the bladder; acid, when coming from the vagina; not coagulable by heat; often containing large quantities of phosphate of lime, and frequently associated with ammoniacal urine and an abundant precipitate of triple phosphate. It usually contains some amount of desquamated epithelium, and a few nuclei, perhaps epithelial.

Pus may be present in the urine from suppurative catarrh of any part of the mucous lining of the urinary passages, or from an abscess in some contiguous part which has burst into them. It generally falls to the bottom of the vessel, forming a dense homogeneous layer of a pale greenish cream color, seldom hanging in ropes in the fluid, like mucus, and becoming, by agitation, completely diffused through it. Acetic acid neither prevents this diffusion no dissolves the deposit. Some of the deposit agitated with an equal quantity of liquor potassæ forms a dense, translucent, gelatinous mass. On decanting some clear urine the presence of albumen may be detected. Pus-cells are seen under the microscope, and acetic acid reveals their characteristic nuclei. (*a*) When pus-cells come from the *uriniferous tubes*, they may sometimes be found moulded in the form of the tubules—pus-casts, at all events, pus may be presumed to come from the kidney or its pelvis if constantly present in the urine, and equally diffused through it. (*b*) Pus from the *bladder* will probably be mixed with large quantities of mucus constituting muco-purulent matter. (*c*) Pus from an *abscess* will be variable in quantity, and not equally diffused. A few pus-cells are often mixed with epithelial *débris* without the urine being albuminous.

Nephritis secondary to Disease of the lower Urinary Tract.

Interstitial Nephritis (*Surgical Kidney*).—Whenever the lower urinary tract has been for a considerable time diseased so as to interfere with the proper discharge of urine, or to call for frequent instrumental interference, the kidneys are liable to chronic disease, consisting in an overgrowth of the interstitial tissue of the organ. If the disease have been one of uncomplicated obstruction to the discharge of urine, the back pressure telling on the kidneys causes dilatation of the renal pelves, and atrophy of the pyramids, as was described in hydronephrosis, but in addition to these gross changes, there will be found a great increase of fibrous tissue between the tubules and many of the tubules and Malpighian corpuscles will be destroyed by the pressure of the new tissue. These changes are most marked in the cortex, on the surface of which also numerous cysts may be found. Marcus Beck has shown that mechanical injuries to the neck of the bladder and the posterior part of the urethra are attended with congestion of the kidney, evidenced by the hematuria which often follows them, and repeated attacks of congestion of organs are followed by overgrowth of interstitial connective tissue; so it is very probable that the irritation of the parts above the neck of the bladder and deep part of the urethra, which results from passage of instruments and the flow of urine through a tight stricture, may lead to interstitial nephritis. After repeated irritation, the inflammation of the kidney may assume a more acute form, and then the new tissue is not fibrous, but a small-celled inflammatory tissue—the cells in some parts being so closely aggregated as to form microscopic abscesses. If to the above-mentioned conditions there be added the presence of septic matter in the pelvis of the kidney, particularly if this be pent up under considerable pressure, it is highly probable that a still more acute and septic inflammation of the renal connective tissue will occur, and then the surface of the kidney will be found strewn with raised yellow spots, each surrounded by a ring of redness, and usually collected in groups; they contain pus, and many are continued through the cortex into the medullary yellow streaks; the lesions, both microscopic and gross, are very irregularly distributed. It will be seen, therefore, that there are three causes of this interstitial nephritis: tension, reflex irritation from the bladder and proximal part of the urethra, and the presence of decomposing—not necessarily putrid—urine in the pelvis of the kidney; it is fairly certain that abscesses are due to the invasion of the urinary tubules by cocci which creep along them from the urine in the pelvis, their paths being often marked by the yellow streaks above noted. This etiology accounts also for the irregular distribution of the lesions. This most acute form of the affection has been called the "surgical kidney;" but the term is particularly bad, seeing that the condition resulted from the want of surgical treatment of some preëxisting disease of the bladder or urethra.

Symptoms.—The detection of interstitial nephritis is most important, for its presence adds largely to the gravity of any operation on the urinary organs. In *chronic interstitial nephritis* the quantity of urine passed is increased, and the specific gravity is diminished; the total quantity of urea excreted is not diminished; a slight quantity of albumen and a few hyaline casts may be found in the urine. There is a great tendency to exacerbations, and a patient with old-standing obstruction often states that he has repeatedly suffered from chills or even rigors with nausea, vomiting, aching across the loins, and frequently has no appetite for breakfast; he is emaciated;

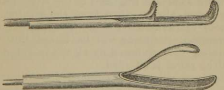
and it will be found that his tongue is often dry and raw-ham-colored, and that his temperature is usually raised 1° to 3° at night. Such a patient is in a most perilous condition for treatment, which is absolutely necessary; the most favorable time must be chosen for it. The *acute suppurative form* of the disease often occurs after some operation performed on a patient who is the subject of chronic or subacute interstitial inflammation, particularly if at the same time the pelvis of the kidney contain septic urine. The disease commences with a rigor, which may be repeated later on; the temperature rises to 104° F., or 105° F. The patient suffers from nausea or even from vomiting; occasionally tenderness in the loins is detected, then he becomes drowsy and delirious, and sordes collect about his lips and teeth; the tongue may be brown or raw-ham-colored; diarrhœa is often a prominent symptom, rendering diagnosis from typhoid necessary; the urine may be bloody, but it always deposits a quantity of pus. Toward the end the patient passes into a typhoid state, and his temperature falls sometimes below normal, his skin is cold and clammy, and finally almost complete insensibility comes on, but convulsions are exceptional.

TREATMENT.—When interstitial nephritis has set in but little can be done. The skin and bowels should be acted upon in order to relieve the kidneys. The most important aim is the early relief of the diseases of the lower urinary track, which, if neglected, are so *liable to produce nephritis*.

(For a full account of these most important conditions, the reader should consult Marcus Beck's articles in Erichsen's *Surgery*, and Reynolds's *System of Medicine*.)

FOREIGN BODIES IN THE URETHRA may consist of pieces of bougies, straws, slate-pencil, or other bodies introduced from without; of calculi, clots of blood, mucus, or, in rare cases, portions of fecal matter or worms, that have passed into the bladder from the intestines through a fistulous opening. They may, perhaps, be pushed forward by the fingers pressed along the bulb in the perineum under the penis, aided by the patient's strainings; and then may be brought out through the orifice, divided downwards if necessary, by a suitable instrument, of which many have been invented (Fig. 253).

FIG. 253.



Urethra scoops for removing foreign bodies.

A common scoop with a long, slender handle, a loop of fine wire, and a pair of very fine polypus, or similarly constructed urethra forceps, may also be found effective. During the necessary manipulations a finger or thumb should be pressed on the urethra behind the foreign body—on the penis or perineum, or through the rectum if needful—to prevent it from slipping backwards into the bladder. With this precaution, it may answer to inject a good stream of water from a syringe, so as to dilate the passage. But if these means fail, the substance must be pushed back into the membranous portion, and extracted by an incision in the perineum. Incisions into the front part of the urethra, anterior to the scrotum, should be avoided, for they are apt to leave irremediable fistulæ; and if too near the scrotum, they may occasion infiltration of urine into its loose areolar tissue.

A FALSE PASSAGE is produced by pushing some instrument out of the urethra, usually bulbous or membranous, into the surrounding tissues. It usually happens during the use of small metal catheters, but may occur even with a lithotrite. Extremely insensitive patients have occasionally pushed catheters through into the rectum without suffering much. When the surgeon suspects that he has made a false passage, from the pain, free bleeding, and sudden slip, with deviation of the shaft of the catheter from the median line and obliquity of its side-rings, and verifies the diagnosis by feeling the end of the catheter on one or other side of the midline beneath the mucous membrane of the rectum, he ought to leave the urethra untouched for at least a week, when the false passage will frequently become healed. Injudicious meddling with a small catheter will cause the false passage to remain open for a long time, secreting a small quantity of pus, and simulating gonorrhœa. The difficulty of relieving retention, after one or more false passages have been made, is greatly increased. In prostatic cases, however, a large, soft instrument should be got in and left. In stricture, it is often best to relieve in some other way.

HEMORRHAGE FROM THE URETHRA may be caused by the introduction of bougies, by a false passage, by injuries from without; by separation of a slough formed by the caustic bougie; by rupture of bloodvessels during acute chordee; or, lastly, at the end of micturition in gonorrhœa, due to compression of the inflamed mucous membrane by the ejaculator urinæ. If the recumbent posture and the application of cold does not check it, pressure may be tried. A flat piece of cork should be pressed by the patient against the perineum far back, and be gradually moved forward till it lights on the right spot, and the dripping of blood ceases. If these means fail, a catheter should be passed, and compression of the urethra made against it. Gallic acid, or a solution of tannin in iced water, used as an injection, may be of service.

LACERATION OF THE URETHRA usually results from blows and falls upon the perineum (*e. g.*, astride a beam), driving the urethra against the pubic arch; it frequently occurs also from fracture of the pelvis through the pubic arch, in which case a displaced fragment of the latter tears the membranous portion. Blood almost always drips from the meatus, and the perineum usually swells from extravasated blood. The patient is unable to make water; if he attempt it, the urine will be forced into the perineum and scrotum, with scalding pain, followed by all the symptoms of urinary extravasation (*q. v.*) if no relief is afforded.

TREATMENT.—If possible, a *large* catheter should be passed and tied in, but this is often impossible, the urethra being torn across and the ends separated. In some cases perseverance finds a guide, probably some untorn shred of the roof, to the proximal end, when the catheter should at once be tied in securely. Failing this, pass the catheter as far as it will go, and cut down on the end of it by a free median incision, clear out clots, seek the proximal end of the urethra, using urine squeezed from the bladder as a guide, and pass a catheter along the whole track. Whether a catheter is or is not introduced, any extravasation of urine must be treated by free incisions. The result of this treatment is very unsatisfactory; if the catheter is introduced and worn, healing will probably occur, and the patient will be left with the most inveterate form of stricture—the *traumatic;* if no instrument can be passed, there will remain one or more permanent fistula in the perineum. Probably the safest result after a badly ruptured urethra is a fistula leading direct from the perineum to the bladder, so that it can be easily kept dilated. A continuous urethra with a traumatic stricture in it is a very doubtful advantage, for the patient has constant difficulty in micturition; is condemned to life-long instrumentation, sooner or later the upper portions of the urinary tract are sure to inflame, and he is often quite as sterile as if he had a perineal fistula.

The mortality varies greatly with the pelvic injury and amount of extravasation that has occurred.

Acute and chronic urethritis have been described under "Gonorrhœa" (p. 104), where it has been noted that non-gonorrhœal discharges, such as those due to the irritation of pessaries and tents, sometimes prove very irritating to the male urethra. Occasionally too, especially after separation from her for some time, a man seems to get a purulent urethritis from a leucorrhœal discharge which has long been present in his wife.

Contraction of the meatus may be a congenital affection, or caused by the cicatrization of chancrous and syphilitic ulcers, or by gleet. It should be prevented by the daily passage of a short bougie, or it may produce all the evil consequences of stricture further back. If the contraction is great, or causes retention of urine, the orifice must be sufficiently enlarged by a cut downward, after the bladder has been emptied.

Stricture of the urethra is said to be of three kinds: Spasmodic, inflammatory or congestive, and permanent, organic, or cicatricial. Of these the latter is by far the most important, and considerable doubt has been expressed about the existence of the former; but when we consider the large amount of voluntary and involuntary muscular fibre that exists about the urethra, we should expect spasms to occur. It is difficult and unnecessary to separate spasm and congestive swelling: whether pure spasm occurs is doubtful.

Spasmodic stricture generally affects persons laboring under some slight degree of permanent stricture, or in whom the urethra has been rendered irritable by attacks of gonorrhœa, or by a morbid condition of the urine; these, therefore, are the *predisposing causes*. The usual *exciting causes* are, exposure to cold and wet, and indulgence in liquor, which disorders the stomach, and renders the urine irritating. Hence an attack of spasmodic stricture generally comes on at night. It may be caused by cantharides, whether taken by the mouth or absorbed from blisters applied to the skin. Like irritation of the bladder, it may be a symptom of gout. It may also be caused by sexual excitement, and by piles, ascarides, and other sources of irritation of the rectum and neighboring parts, as evidenced by the frequent occurrence of retention of urine after operations on those regions and fractures of the femora, in which also the bladder is often inhibited from contracting.

Symptoms.—The patient finds himself unable to pass his water, although he has a great desire, and makes repeated straining efforts. to do so. The bladder soon becomes distended, and can be felt as a tense round tumor above the pubes; and, unless relief be given, the countenance becomes anxious, the pulse quick, and the skin hot. The straining efforts at micturition become more frequent and violent, and the distress and restlessness are extreme. In this way the patient may, perhaps, go on for days—a little urine passing occasionally when the spasm is less urgent, but the bladder remaining loaded till relieved by treatment.

The *inflammatory stricture*, in which great pain and tenderness of the perineum, and swelling and redness of the lips of the urethra, are combined with spasm, is generally caused by abuse of injections, or by exposure and intemperance during acute gonorrhœa. The obstruction occurs most frequently in the membranous and prostatic portions of the urethra, the mucous membrane of the verumontanum being particularly prone to congestion. The *treatment* of this and of the spasmodic variety is the same. If the symptoms are not extreme, if they have been brought on by cold or conviviality, and there is no history of old stricture, a hot bath or continued fomentations, with a full dose of opium, and followed by castor oil, will usually relieve the patient. In cases in which there is no need of an aperient, opium, or Dover's powder by mouth, or an opium enema or suppository, will suffice to stop all violent voluntary efforts, and when these are discontinued the bladder will often empty itself. In inflammatory cases it may be requisite to leech the perineum. Soda water, with a teaspoonful of the bicarbonate added, and other alkaline liquids, are often of great service in cases of no great urgency arising from errors in diet. The muriated tincture of iron, in doses of ♏x every ten minutes, is a remedy which is often successful. (For further treatment, see "Retention.")

Cicatricial stricture is caused by inflammatory infiltration, and often ulceration of the urethral mucosa, formation, and subsequent shrinking of scar tissue, with consequent narrowing of the canal. The mucous membrane at the strictured portion is paler and less elastic than natural, and firmly adherent to the deeper parts; the submucous tissue is increased in amount and density, and in well-marked cases the corpus spongiosum has lost its cavernous structure, and is replaced by dense fibroid tissue, which extends to a greater or less depth, and sometimes implicates the tissues outside it.

FIG. 254.

The urethra laid open; a stricture in the membranous portion in front of the verumontanum.—King's College Museum.

In some cases a small portion of the mucous membrane, perhaps only a line or two in extent, is found thickened, and deprived of its natural elasticity for half or two-thirds of the circumference of the canal (*bridle stricture*); or contracted so as to form a sharp fold, as if tied with a thread (*packthread stricture*). But in old neglected cases, the canal with the *corpus spongiosum* around may be converted into a thick gristly mass (Fig. 254) several inches in extent (*cartilaginous stricture*). The most frequent *situation* of stricture—which causes serious symptoms at all events—is in the close neighborhood of the triangular ligament, or a little anterior to it.

Sir H. Thompson divides the urethra into three regions, and finds that of 270 specimens 215 (or 67 per cent.) are situate in the first region—which comprises an inch of the canal before (bulbous urethra), and three-quarters of an inch behind (membranous), the anterior layer of the triangular ligament. The part of the urethra which is most frequently affected with stricture is the bulbous portion. Pearce Gould explains the frequency of granular urethritis and subsequent stricture here, by the fact that the bulb and membranous part are the lowest portion of the urethra, both in standing and lying, and that pus would therefore bag in the angle they form. The second region, comprising two and a half or three inches in front of the first, was the seat of 51 strictures, or 16 per cent.; and the third region, consisting of the anterior two and a half inches of the urethra, of 54, or 17 per cent. Otis states, as the result of exact measurements, that strictures increase in frequency toward the meatus, and that it is usual, in cases of stricture far back, to find an anterior narrowing; but he includes very slight narrowings under the heading of "stricture." Frequently two or more strictures co-exist in these several parts of the canal (*double* or *multiple stricture*).

The *causes* of stricture are—(1) repeated attacks of gonorrhœa, or rather of prolonged gleet, for it is the duration of the inflammation more than its intensity or frequency which causes fibroid thickening; (2) cicatrization of a chancre, which may give rise to a stricture at the external meatus, or in the first inch of the urethra; (3) rupture of the urethra from external injury, which is always followed by a most inveterate form of stricture—the *traumatic;* (4) injury to the urethra from instruments or foreign bodies passed into it, or from lodgement of a calculus within it, which is almost the sole cause of organic stricture of the urethra in a child.

SYMPTOMS.—In what may be called the *first stage*, the patient finds that he wants to make water oftener than usual, and has an uneasy sensation in the perineum after doing so; a few drops hang in the urethra, and dribble from it after he has buttoned up. Then he observes that the stream of water is smaller than usual, perhaps forked, scattered, or twisted, and that he requires a longer time and greater effort than usual to pass it. Itching of the end of the penis and gleety discharge are frequent concomitants.

In the *second stage* of the disease the bladder becomes irritable, so that the patient is forced to rise at night to void his urine, and is liable to attacks of spasm with complete retention. In one of these the urethra may ulcerate or burst, giving rise to urinary abscess, or to extravasation of urine, as described in the next section. Rigors occurring in paroxysms like ague fits, are not uncommon.

Finally, if the complaint is permitted to continue, the health suffers from constant irritation and want of sleep; the bladder becomes inflamed and hypertrophied, the kidneys, pelvis, ureters inflamed and dilated, the complexion becomes wan, the appetite fails, the patient complains of chills and flushes, of aching and weakness in the back, and of great languor and depression of spirits; and the urine is frequently loaded with fetid mucus. The patient finally sinks from interstitial nephritis, septicæmia, retention and extravasation, or uræmic poisoning from suppression. After death, the urethra behind the stricture is found greatly dilated; the prostate with its ducts dilated and suppurating, or containing small circumscribed abscesses; the bladder, full of putrid, mucous urine, shows the hyperæmic or pigmented rugæ of acute or chronic cystitis, and is sometimes dilated, but more frequently contracted and enormously thickened—sometimes sacculated, from a protrusion of its mucous coat between the fibres of the muscular tissue; the ureters dilated, and converted into subsidiary receptacles for the urine; and the kidneys in a state of acute suppurative interstitial nephritis, and perhaps more or less dilated also.

The DIAGNOSIS of stricture in any case is completed by examining the urethra. A full-sized English catheter or bougie should be taken, and having warmed, oiled, and passed it through his hand, the surgeon introduces it into the urethra. If it meet with an obstruction, it should be drawn a little backward to see if it will enter the stricture and be grasped by it. If not, it may be exchanged for smaller ones, with which similar trials are made. In this way two or three strictures may be found between the meatus and the bulb, and their distances from the meatus are noted. For the recognition of slight narrowings olive-headed bougies are very useful; their stems are slender and flexible, the heads shortly conical, attached by their bases and made in various sizes; they pass easily through a stricture, but catch as they are withdrawn. With Otis's urethrometer the whole urethra may be calibrated.

Treatment.—*In every case admitting of delay* the surgeon should see how much may be done by relief of congestion and spasm; many a stricture which is impassable when a patient is first seen admits an instrument easily after a few days of absolute rest in bed, a warm bath night and morning, a free action of the bowels twice a day, slop diet, and cessation of all meddling with the stricture; a morphia suppository to procure rest from straining is often useful, but, as elsewhere, we must be careful not to be deluded by any false relief which it may give.

Once an instrument has been introduced we proceed to treatment of the stricture by *mechanical means*, all of which have the same objects in view—viz., the widening of the canal and the absorption of the chronic inflammatory products round about it. Pressure is one of the most potent agents in causing the absorption of inflammatory materials, and we rely on this in the treatment of stricture. The so-called "dilatation" of stricture acts largely by pressure, the mere presence of a small catheter in the urethra for twenty-four or forty-eight hours often causing such increase in the calibre of the strictured canal as is quite inexplicable on the theory of dilatation; it acts also by causing an inflammation in the dense fibroid tissue, which produces a softening of their texture and renders them more amenable to true dilatation. Longitudinal division of a stricture acts by inserting a width of scar-tissue in the cicatricial ring, and this must be prevented by dilatation from contracting. In the treatment of strictures of the urethra it should always be kept prominently in mind that we have to do with a highly sensitive tube, irritation of which frequently causes severe constitutional disturbance; no undue violence should be used, and the simplest effectual means should always be adopted. On the other hand, a stricture of the urethra is itself a most serious disease, which if allowed to run its course unchecked will undoubtedly, sooner or later, cause still more serious affections of the higher urinary tract; so that whilst treating the urethra with the utmost care and gentleness it is most important that effectual measures for removing the obstruction should not be neglected.

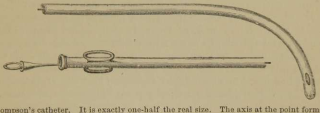
There are several methods by which the direct treatment of stricture may be practised: 1. Slow occasional dilatation by bougies. 2. Rapid continuous dilatation by the retained catheter. 3. Forcible dilatation by expanding instruments. 4. Division from within. 5. Division from the perineum. 6. Electrolysis.

1. Intermittent dilatation may be carried out with catheters or bougies, the latter being the better instruments because stronger, for they have no eyes. Bougies, like catheters, may be either soft and flexible, or made of metal and rigid. In the great majority of cases soft instruments are preferable, not merely in the hands of the unskilful but in those of the skilful also, for they cause much less pain and irritation, as any one may prove upon himself, are much less liable than rigid instruments to make false passages, and frequently find their way easily when a metal sound hitches in some tortuous deviation of the canal. An instrument passed upon himself by a patient should always be flexible. Soft catheters are of two sorts, English and French. Both are made of linen or silk, impregnated with some elastic waterproof material which takes a high polish; and both are softened by heat; but the English instrument when cold is tolerably stiff and retains any shape given to it when hot, and has the cylindrical shape and blunt end of the silver catheter (Fig. 255), whilst the French instrument is always quite flexible and has a point shaped as in Fig. 256. A good French instrument is smooth and polished, free from cracks, and tapers gently (not suddenly) to the bulb, which is relatively small and long; and when its point is strongly curved by the finger it does not crack, but rises

up well when released. French bougies, containing a lead stylet reaching two to three inches from the point, are very useful for purposes of dilatation, but even when thus loaded they sometimes fail for want of backbone. It may be said, however, that French instruments should always be tried; if a stouter instrument is required we can turn to the English catheter, and we take this also when we wish to curve it specially.

Catheterization is best practised with the patient lying flat on his back, with his legs slightly separated; he is more under control in this position, but sometimes an instrument slips in more easily when a patient stands with his back against a wall. The surgeon stands on the left side of a recumbent patient; sits in front of one standing. To pass a rigid instrument, hold it

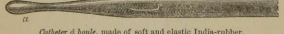
FIG. 255.



Sir H. Thompson's catheter. It is exactly one-half the real size. The axis at the point forms a little more than a right angle to that of the shaft.

(warmed and oiled) in the right hand, with its shaft over the fold of the left groin and its point toward the penis, which is raised by the left hand and drawn on to the bougie; the right hand now carries the instrument in toward the mid-line, keeping the handle close to the belly wall, but all the while pushing the point gently on toward the perineum—the penis being still drawn on to the catheter; the handle having reached the mid-line and the point having been passed *as far as possible* into the perineum, the right

FIG. 256.



Catheter à boule, made of soft and elastic India-rubber.

hand is raised and the handle of the catheter carried slowly down between the legs and in the mesial plane, the point being still pushed steadily but gently on, whilst the left fingers are transferred from the penis to the perineum, where they often afford assistance by raising the point of the instrument a little (it seems, sometimes, to get into the fossa of the bulb below the opening in the triangular ligament); the bladder will thus be reached.

At first the tip of the catheter should run along the floor of the urethra to avoid the *locuna magna*, a large follicle in the roof about 1½ inches from the meatus, which might catch a small instrument; but after this the point should be kept close to the roof, as it is the smoothest and most fixed part of the channel—false passages rarely start from it—and it is least likely to be torn in falls on the perineum.

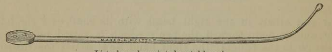
Some difficulty is very common in passing the triangular ligament, and a little pain is often caused here, if anywhere. A finger in the rectum is often of great use in keeping the point in the mid-line, raising it toward the roof, and guiding it to the apex of the prostate. Thompson states that the curve of the fixed portion of the urethra is 0.3 of a circle, 3.25 inches in diameter; but this curve is sharper in thin than in stout persons, and in children the elevation of the bladder produces a greater curve of the urethra.

An English soft catheter is passed like a silver one. A French one is introduced with a slight twirling movement of the finger and thumb whilst the penis is gently stretched and straightened; the bulb finds its own way round the curve of the fixed part. Before use, a soft instrument should always be passed through the hand to see that it is free from cracks and smooth, and the point of a French instrument should be well examined, lest a bit come off in the bladder.

Very fine instruments, known as filiform bougies, are made of whalebone, gum-elastic, and catgut, for the treatment of very narrow strictures.

Metallic bougies, or *sounds* made of silver, or steel-plated, are preferable to those of soft materials, under the following circumstances: First, if the stricture is old, and very hard and gristly; secondly, when a stricture has been dilated up to No. 4 or 5, as there is then little danger of making a false passage; and thirdly, in cases where a false passage has been formed, which such instruments, as they can be directed with greater precision, can be better made to avoid. The best instruments for this purpose are the conical steel bougies, known as *Lister's sounds* (Fig. 257): they are made of highly polished nickel-plated steel; the point is bulbous and well rounded,

FIG. 257.



Lister's probe-pointed metal bougie.

there is a difference of three sizes between the points and the thickest part which commences at the bend of the instrument, and the disk-like handle gives great precision in directing the point of the instrument. Owing to the increase in size of the instrument, it acts as a true dilator, so care must be taken not to proceed too rapidly through the scale of instruments, lest severe pain and urethral irritation be produced. If there be more than one stricture, a Lister's sound may be of use, as, owing to the constriction beyond the point, it may not be held tightly by the first stricture after the bulb has passed it.

Now, as to the use of these instruments in dilatation of a stricture on the intermittent plan: general treatment having been attended to—we must proceed with a French bougie first, just as if we were searching for a stricture, and carefully and systematically probe about all over the face of any obstruction we may meet with, and using successively smaller instruments until one slips through; if this is not tightly gripped, it may be withdrawn, and the next size larger quickly substituted. Some surgeons like to leave an instrument in a stricture for a few minutes or even an hour or two, but Sir H. Thompson says that the effects of continuous dilatation do not begin so soon as this, and, regarding such treatment as the above as merely irritating, advises the immediate withdrawal of the instrument. It is thought by some that in cases of tight stricture, the occasional insertion of an instrument into, but not through, the narrowing will ultimately overcome the difficulty: it does yield sometimes, but whether as a result of the treatment is doubtful. Once the point of an instrument is known to be in a stricture by that "gripping" which the hand soon gets to know, it may be pushed on steadily, and the back of a French instrument may be strengthened if necessary by a stylet of some kind, or a stouter instrument may be used. Should it be necessary to have recourse to very fine instruments, it will generally be best not to withdraw one that may be passed, but to begin dilatation by tying it in (see below).

Twice or thrice a week instruments are thus introduced—one or two sizes being gained each time. Dilating too fast generally turns out the slowest way, for rigors, hemorrhage, urethritis, retention, peri-urethral abscess, orchitis, or other complications, result and stop the treatment.

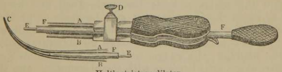
2. Continuous Dilatation.—*If a small catheter is retained in the bladder* for two or three days, the stricture suppurates and dilates remarkably—just as the lachrymal duct from the presence of a style. This method of cure may be attempted when the stricture is very hard and gristly, or very difficult to pass, or complicated by false passages. The catheter should be of gum-elastic, and retained by tying on each side to a bundle of pubic hair. It should be removed in two or three days, and a larger catheter passed and subsequently introduced often enough to keep up the dilatation. In some cases it may be impossible to introduce even a small catheter; but if a small filiform bougie only can be passed, it should be tied in for twelve or twenty-four hours; the urine will find its way along the side of the bougie, and at the end of that time a small gum-elastic catheter will usually pass. But the continued presence of the catheter is liable to cause so great an amount of irritation that it cannot always be borne, even with the aid of opium. And the presence of the catheter in the bladder, or, rather, the air to which it gives such ready entrance, often causes decomposition of the urine and cystitis, if this treatment be prolonged for more than three or four days.

It is, however, often very valuable when much difficulty has been experienced in introducing the first instrument. The complications are the same as in intermittent dilatation, but cystitis and perineal abscess are more frequent.

3. Forcible Dilatation.—The good effects of the bougie are owing to the stimulus of gentle pressure. To accelerate the cure, various p ans have been proposed for effecting dilatation, with or without actual laceration or splitting of the stricture. Such are the instruments of Wakley, Holt, Thompson, and Hill. That in most general use is

Holt's Adaptation of Perrève's Instrument.—This consists of a staff (Fig. 258) formed of two blades, A and B, joined at the smaller extremity C, and

Fig. 258.



Holt's stricture dilator.

capable of diverging by means of a screw, D, at the handle. Between them is a directing-rod, E, and on this, between the two separate blades, a dilating tube, F, can be passed down to and within the stricture, after the staff in its closed condition has been passed. The directing-rod, E, may be made hollow, with an opening at the back of the curve of the dilator, and fitted with a stylet (Smyly). The urine will flow through it, showing when it has reached the bladder.

First, the permeability of the canal, and the gauge of a sound that will fit the orifice of the urethra, should be ascertained. A dilating tube of the same size is then chosen, and a screw in the handle, D, is *set* at such a distance as to let the dilating tube pass, but not to allow the urethra to be stretched further. The instrument is then introduced closed. When the bladder is reached, the dilating tube is pushed home quickly, so as to *split* as well as *dilate* the stricture. The dilator is a little rotated, to insure separation of the split, and then withdrawn; a catheter introduced to draw off the water, and the patient sent to bed, with directions to take every four hours two grains of quinine and ♏x of laudanum. A large soft catheter should be introduced once a day for a week, and then occasionally to keep the passage open.

These instruments should not be used if the patient show any symptoms of interstitial nephritis, for which every stricture patient should be carefully examined both before and during treatment. Many deaths have resulted from shock and suppression of urine after this operation. On the other hand, many strictures of a purely spasmodic or inflammatory character have been treated unnecessarily by immediate dilatation.

Division of the stricture may be performed either from within the urethra—*internal urethrotomy;* or from the perineum—*external urethrotomy.*

4. INTERNAL URETHROTOMY is by some regarded as the safest and best treatment of all strictures, safer than dilatation; others cut cases of so-called *resilient* stricture, which are quickly dilated, but as quickly contract; also cases in which the urethra is very irritable and rigors frequent. It may be performed in two ways, either by dividing the stricture from before backward or behind forward. In the first method it is only necessary that the urethra should be capable of admitting a fine filiform bougie, but in the second the stricture must be dilated up to No. 5 or No. 6, for the bulbous end of the instrument in which the knife is ensheathed has to be first passed through the stricture.

Strictures of the urethra used to be divided from before backward without a guide, and instruments for that purpose were described in the last edition of this work. The practice itself, however, was so haphazard and the results so disastrous that it has been abandoned. The best guide to the bladder consists of a fine filiform bougie, aptly termed a *ferret* or *bougie conductrice,* provided with a male screw at the end, by means of which it can be connected with the urethrotome. The best urethrotome for this purpose is that of Berkeley Hill, which is a combination of a dilator and a urethrotome (Fig. 259); it consists of a split sound about the size of a No. 2 or 3 catheter. The two halves of the sound can be separated by passing between them a wedge, sliding in slots, which effectually prevents its passing from the proper course; within this wedge a knife lies ensheathed, and by pressing on a button at the hilt of the instrument it may be made to project. The conducting bougie is first passed into the bladder and the split sound is then screwed on to it and passed forward through the stricture, whilst the bougie coils up in the bladder; the wedge, containing the hidden knife, is passed along the instrument until it meets with the obstruction, and then, by pressing a button in the top of the instrument the knife is projected and the stricture, tensely stretched by the wedge, is divided; the knife should be sheathed at once and the wedge passed on; if it meet with no further obstruction the instrument may be withdrawn; but if it is again obstructed the knife must be once more projected; by these precautions the urethra is cut only opposite the stricture, and no further injury is inflicted than is absolutely necessary. The stricture is divided on the floor of the urethra. Some operators like Teevan's modification of Maisonneuve's urethrotome, an instrument similar in principle to Hill's.

Division of the stricture from behind forwards may be done by means of Civiale's urethrotome, an instrument with a bulbous extremity within which a knife is contained; the stricture must be dilated up to No. 5 or sufficiently wide to admit the bulb of the instrument. The bulb being passed beyond the stricture, the knife is projected against the floor of the urethra, and, as the instrument is withdrawn, the knife is pressed forcibly against the stricture.

After either operation a full-sized catheter should be at once passed into the bladder, but need not be tied in. For the next few days it should be passed daily, and then every second or third day for three or four weeks; after which time it will suffice if the patient continue to pass an instrument for himself once every two to four weeks; a special day should be fixed, that this part of the treatment may not be forgotten.

Fig. 259.

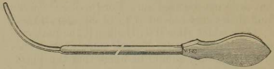
Hill's urethrotome.

Results.—Division of a stricture of the urethra like dilatation or rupture does not effect a permanent cure: unless a catheter be passed at intervals the stricture will certainly recur. That this is the case is frequently seen in hospital practice, in which patients after urethrotomy are met with who state that for a year or two they continued to pass an instrument, but, after that time, thinking themselves cured, omitted to do so, and when, sooner or later, after a time difficult micturition recurred. There are few reliable statistics with regard to the relative advantages of the different operations for stricture of the urethra. As to internal urethrotomy, Marcus Beck has collected from the "Surgical Reports of University College Hospital" the results of 76 operations: 4 died, one from tubercular disease of kidneys, lungs, etc., one from pleurisy, one from septicæmia, and one from suppurative nephritis. Perineal abscess occurred in 8 cases, extravasation of urine in 1, and epididymitis in 4. There was hemorrhage in 5, and in 2 the patient was left with permanent chordee during erection.

5. External urethrotomy.—Division of the stricture from the perineum may be done in two ways according as an instrument can or cannot be passed through the stricture; in the first case Syme's operation of perineal section may be performed, and, in the second, the operation known as Wheelhouse's, or *la boutonnière,* may be done.

Perineal Section for Permeable Stricture.—Professor Syme (*On Stricture of the Urethra,* 1849) recommended this operation, not for cases of impassable and complicated stricture, in which incision is commonly considered necessary, but for those in which, *although an instrument can be passed,* the stricture is excessively irritable, and resists the common treatment by dilatation, or contracts again perpetually, and is wearing out the patient's health by pain, rigors, fever, etc., but in which his condition is such as to render an operation safe. Nowadays cases with fistulæ are generally chosen for the external operation. The patient having been put under the influence of chloroform, a grooved director slightly curved, and small enough at the curved portion to pass readily through the stricture, but thicker in the shaft (Fig. 260), is introduced and held by an assistant so that its shoulder rests on the face of the stricture; the patient is then placed in lithotomy position. The surgeon now makes an incision in the middle line of the perineum over the situation of the stricture. It should be about an inch and a half long, and extend through all the textures external to the urethra. The operator, then taking the handle of the director in his left, and a small straight bistoury in his right hand, feels, with his forefinger guarding the blade, for the director,

FIG. 260.

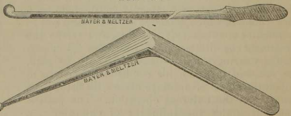


Syme's grooved director for perineal section,

pushes the point of his knife into the groove *behind* the stricture, and runs the knife forward so as to divide the whole stricture. This, the original plan, is much more difficult than that of leaving the shaft entirely to an assistant, feeling its shoulder with the left forefinger, opening the urethra here and dividing the stricture from *before*, using a narrow blade and keeping a finger on the apex of the prostate. A full-sized catheter should be tied in. The mortality attending such an operation must be difficult to estimate precisely; it will be less in private than in hospital practice, and in proportion as the patients are free from renal disease. Out of 219 cases collected by Sir H. Thompson, 15 deaths occurred within two or three months of operation; and of these, 9 were hospital cases, which proved fatal by pyæmia. This is the greatest danger; hemorrhage seems not to be so great a source of risk. There is an impartial summary of the value of this operation in Sir H. Thompson's work on "stricture."

WHEELHOUSE'S OPERATION—*la boutonnière*—or opening of the urethra in front of the stricture and dividing this from before backwards is requisite in cases of stricture, whether complicated with fistulæ or not, when no instrument can be passed; and an operation similar to it in principle may be needed in some cases of rupture of the urethra with extravasation of urine. It is performed thus: The patient is placed in the lithotomy position, and Wheelhouse's staff (Fig. 261) is passed down to the stricture; the end of the staff is grooved on one side and notched so as to form a hook on the other; the staff is first held so that the grooved side of the end presents towards the perineum, and upon this the surgeon cuts so as to open the urethra in front of the stricture; the assistant then turns the staff round and at the same time draws it up so that the hook catches in the upper end of the incision by

FIG. 261.



Wheelhouse's staff and gorget.

which it may be held upwards and the urethra steadied; the edges of the wound in the urethra are seized by artery forceps and held aside so as to expose the strictured portion of the urethra, and every pit in it must then be explored with a fine probe until the passage through the stricture is found.

Wheelhouse's hollow probe has the advantage that when the bladder is reached the urine will flow through it and show that it has entered the proper track. When the opening has been found and the probe passed into the bladder the stricture must be divided along it. Wheelhouse's gorget (Fig. 261) or a flat director should then be passed along the probe into the posterior part of the urethra so as to serve as a guide for a full sized catheter, which should now be passed along the urethra and into the bladder, where it must be retained for three days. The stricture should be thoroughly divided and all sinuses laid open. The wound should be cleaned, mopped over with a solution of chloride of zinc, and dusted with iodoform crystals.

6. Electrolysis.—Steavenson and Bruce Clarke have recently advocated the treatment of strictures by this method, an electrode in the form of a catheter being used. Little or no pain is caused, and in slight cases the patient can go about during treatment. They stated, on the strength of one year's experience, that absorption of the inflammatory tissue resulted, and that the strictures were permanently cured. This is entirely opposed to current belief and requires confirmation.

For the present we must adhere to the statement that in whatever manner a stricture has been treated, the bougie or catheter should still be used at intervals to prevent a fresh contraction, which will almost surely occur if this precaution be neglected.

In cases of retention in which no instrument can be passed, it is usually best to perform Cock's, or some other palliative operation, in place of Wheelhouse's, reserving the stricture for subsequent treatment.

Accidents after Urethrotomy and Catheterism.—The introduction of instruments into the urethra for the treatment of stricture or other purposes is liable to be followed by various accidents, often of a dangerous character.

Hemorrhage may follow the introduction of a catheter, but is more frequently met with after the operation of internal urethrotomy, owing to the urethra being too freely divided; an ice-bag to the perineum, or, if it be severe, pressure on the perineum, will restrain it.

Perineal abscess may follow urethrotomy, and is, usually, owing to a too free section of the urethra; a little urine escapes from the urethra, between it and the ejaculator, and excites suppuration, which tends to spread forward toward the root of the penis. An abscess should be opened as soon as detected.

Extravasation of urine has been met with in some cases of internal urethrotomy; it is usually quite local in the perineum.

Orchitis sometimes occurs after operation on the urethra or after the passage of a catheter; in the latter case it is due to excessive violence, the use of too large instruments—*i. e.*, too rapid dilatation, to exertion on the part of patient too soon after the passage of an instrument. Further irritation of the urethra must be avoided, and the testicle treated as usual (*see* Orchitis).

Rigors are very alarming complications of operations on the urethra; when there is no disease of the kidneys they usually subside without causing any serious consequences beyond severe exhaustion. They are more liable to follow the use of metallic than of soft instruments. They occur more frequently after attempts to pass instruments through tight strictures, but may occur after the stricture has been dilated so as to admit a full-sized sound. There appears to be a peculiar idiosyncrasy in some patients which renders them liable to rigors when no signs of renal disease or other obvious causes exist. There is no constant relation between the pain caused by the passage of an instrument and the liability to rigors. The cause of them is most obscure; they occur too quickly after the instrumentation to be due to septic causes, and it would appear that they are due to some reflex nervous effect, the mechanism of which is not understood. The rigor may set in soon after the passage of the instrument or not until many hours afterwards, when it is often ascribed by the patient to a chill, and certainly occurs frequently in relation with the first act of micturition, which should always be postponed as long as possible, and then performed in a warm bath. The rigor has the usual three stages (p. 57). If the patient be the subject of renal disease a fatal issue may occur.

After the passage of an instrument or an operation on the urethra the patient should avoid all exposure to chills; but if a rigor occur he should be wrapped up in blankets during the cold stage and take a glass of hot brandy and water or a cup of hot coffee; a full dose of quinine should also be administered.

Suppression of urine is fortunately a rare complication of operations on the urethra; Marcus Beck has shown that in some cases of operation on the urethra, when uncomplicated by rigor or suppression of urine, blood has been found in the urine for a few hours, after an interval between the operation and the onset of hæmaturia, during which the urine was normal. These observations point to the frequent occurrence of intense congestion of the kidney after operations on the urethra, and in some cases, fatal from suppression of urine, the kidneys have been found intensely congested—a condition which may be looked upon as an exaggeration of what is frequently met with in less severe cases. The TREATMENT consists in dry-cupping the loins, encouraging the action of the skin by hot-air baths, and opening the bowels freely by a saline purge.

Pyæmia may be mentioned as a fortunately rare complication: it has followed forcible dilatation of the urethra more frequently than division.

Local Complications of Stricture.

Urinary abscess is a frequent consequence of stricture. Either a follicular abscess forms, spreads in the tissues close to the urethra, and after a time opens into that canal; or a peri-urethral abscess results from absorption of septic material from an ulcerated surface; or one or two drops of urine escape into the areolar tissue, in consequence of ulceration of the urethra behind the stricture, and produce suppuration, the pus being often dark-colored and putrid. It may make its way behind the pubes, or between the bladder and rectum and point above the pubes, in the groin, or even on the thigh; but usually it produces a tumor in the perineum, around the bulb, between it and the ejaculator in front of the triangular ligament.

SYMPTOMS.—A patient with old stricture complains of rather more difficulty in micturition than usual, and there is some amount of obscure swelling around the perineal or scrotal urethra. There may be little or no pain and little inflammation for the first 24 hours, after this the swelling increases—if in the scrotum, rapidly; if in the perineum, it will be deep, hard, and painful, but not prominent. Shivering, hot skin, and dry tongue follow.

TREATMENT.—The abscess should be opened immediately by a free incision in the median line of the perineum. It will, in some cases, be expedient to cut at the same time through the stricture, as directed in the last section, and pass a catheter into the bladder (Syme's operation).

EXTRAVASATION OF URINE.—This is another consequence of old stricture, and generally happens as follows: A patient, who has long been laboring under difficulty of micturition, has a fit of spasmodic retention more obstinate than usual. He is repeatedly getting out of bed, and straining with all his might to pass his water. At last, during a violent effort, he feels something give way; his painful sense of distention becomes immediately less, and he thinks himself better—perhaps he is now able to make a little water by the natural passage, because the stricture generally relaxes when it is relieved from pressure. But at the time when something seemed to yield, the urethra burst, and urine was forced by the power of the abdominal cles into the areolar tissue of the scrotum, perineum, and groins. The urethra usually gives way in the membranous portion, and the urine gets extravasated beneath the deep layer of the superficial perineal fascia; from the attachment of this to the triangular ligament, the ascending rami of the pubes, and the deep fascia of the thigh, just below Poupart's ligament, the only course open to the urine is to pass forwards through loose connective tissue of the scrotum along the cords to the anterior wall of the abdomen: it sometimes, however, escapes into the ischio-rectal fossæ. The patient soon complains of a smarting or tingling about the anus and perineum. The urine, which is often putrid and always more or less concentrated from long confinement in the bladder, speedily causes inflammation and sloughing; the skin over the infiltrated parts displays a reddish blush, which is soon succeeded by black spots of gangrene; low typhoid symptoms appear; the tongue becomes brown and dry, the pulse fast and small, the skin clammy; low muttering delirium and hiccup come on; and the patient succumbs, unless proper measures are taken for his relief. A black spot on the glans penis, indicating that the urine has penetrated the corpus spongiosum, is a very bad sign.

TREATMENT.—A catheter may sometimes be passed into the bladder under these conditions, because, as was observed above, the stricture generally relaxes after the bladder is relieved from over-distention. If this can be done, the perineum must be freely incised in the mid-line, and at the same time free incisions made in any parts that are swollen or emphysematous, showing that they have been invaded by urine. Incisions are usually required on each side of the septum at the most dependent part of the scrotum, as well as over the cord, in the groin, and sometimes even in the lumbar or the axillary regions, in all of which parts the subcutaneous tissues may be invaded by the extravasated urine, conducted by the attachments and continuity of the deeper layer of the superficial fascia of the perineum. In the swollen œdematous parts, especially the scrotum, these cuts appear alarmingly large and deep. After the bleeding from them has ceased they should be dusted with iodoform and covered with boracic fomentations. But if no catheter can be passed, the central perineal incision should open the urethra immediately in front of the prostate, as advocated by Cock, that a tube may be passed into the bladder; otherwise, the urine may escape through circuitous routes in the subcutaneous tissue, favoring sloughing, and possibly leaving perineal fistulæ.

FIG. 262.

A stricture at the commencement of the bulbous urethra; and false passages, one of which leads into an abscess around the membranous portion.

Fistula in perineo (or *urinary fistula*) signifies a sinuous and suppurating opening from the perineum into the urethra, through which the urine dribbles when the patient makes water. It is a frequent consequence of urinary abscess and extravasation. There may be only one fistula, or several openings form, through which urine spurts as from the rose of a watering-pot, very little coming *per urethram*.

Treatment.—The first and most essential measure is to dilate fully, or otherwise deal with any strictures that exist, and to teach the patient to draw off his urine; for urine always dribbles by the side of a catheter tied in, and it is essential to success in many cases that not a drop shall pass through the fistulæ. When this has been done, a fistula usually heals; should it not do so, it may be stimulated to granulate by injections of strong solutions of arg. nit., or by passing a heated wire or the galvanic cautery into it; but in really bad cases, it is often best at once to perform Syme's operation (p. 761), or, if no staff can be passed, Wheelhouse's (p. 762).

Sometimes there is a *blind* fistula *in perineo*—that is, a narrow fistula opening into the urethra, but not externally. It is occasionally inflamed and tender, and may be felt as a small tumor in the perineum. It is attended with more or less discharge from the urethra. The treatment consists in laying the tumor open, and dilating any stricture that exists.

A fistulous communication may form between the urethra and rectum—gas, and sometimes liquid feces, passing through the urethra, or urine by the rectum. It is treated by dilating any stricture, and causing the patient to draw off his urine. If necessary, a heated wire may be introduced into the fistula through a rectal speculum.

Small *papillomata* rarely form within the urethra, and keep up a gleety discharge. They are usually within an inch of the meatus, and may often be seen by opening the orifice, or with a short speculum. They should be snipped off.

Diseases of the Prostate.

Acute inflammation and abscess of the prostate is generally a consequence of acute gonorrhœa, but may be caused by stricture, calculus, or other sources of irritation. The *symptoms* are: Sense of weight, pain, and throbbing at the neck of the bladder, and tenderness of the perineum; there are frequent, violent, and painful efforts to make water, followed by some pain at the end of the penis, when the bladder contracts on the tender prostate; there may be a little blood in the urine toward the end of micturition in the early stages of the disease; the gland feels swollen, and is tender. As the disease subsides, a grayish viscid, muco-pus is voided with the urine. If suppuration ensue, all the symptoms become aggravated; rigors, fever, and throbbing pain in the perineum and about the rectum, with violet straining and futile efforts at micturition. The finger passed into the rectum feels an elastic, tense, fluctuating swelling of the prostate, which may burst into the urethra, producing a considerable flow of pus during the efforts at micturition, and relief of all the symptoms.

Treatment.—Rest in bed; leeches to the perineum; hot baths, fomentations, and poultices; morphia hypodermically at night. If the urine cannot be passed without it, a small and very flexible soft catheter may be introduced; but it should be avoided if possible. If an abscess point toward the rectum, relief may be given by puncture of the swelling from the rectum, with a long narrow-bladed knife, cutting only at the point; but if, as sometimes happens, the pus makes its way toward the perineum, indicated by much tenderness and brawny induration here, the surgeon should make a cautious incision in the median raphé, and endeavor thus to let out the pus.

Chronic inflammation of the prostate, with enlargement from interstitial infiltration, may be a sequel of the acute, or the case may be chronic from the start. The symptoms are often so like those of stone, particularly the pain and blood at the end of micturition and aggravation of symptoms by active exercise, that the distinction can be made only by sounding; a glairy secretion may escape from the urethra; enlargement and tenderness of the gland are usually slight.

The *treatment* consists of rest, warm baths, counter-irritation of the perineum, attention to any irritant quality in the urine; and regulation of the bowels. Small doses of mercury and iodide of potassium are given, but do not seem to do any good.

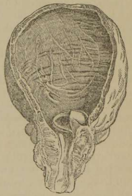
Chronic abscess of the prostate is occasionally met with, usually in scrofulous subjects. It may be suspected if rigors, obscure swelling in the perineum, with an evident elastic enlargement felt by the finger in the rectum, and tenderness on pressure, follow the symptoms of inflammation. The dorsal vein of the penis is often distended; there may be some œdema of the prepuce, and semi-erection of the penis from pressure upon the prostatic plexus of veins. In such case, the swelling should at once be punctured through the rectum. If left to itself, the abscess may burst into the rectum or the urethra, which latter circumstance will be indicated by a sudden discharge of pus with the urine and a stinging pain, and usually more or less hemorrhage accompanying the discharge of the last few drops. If the signs of its having opened into the urethra are present, no opening should be made through the rectum or perineum, lest a urinary fistula ensue. If the case is chronic and the habit scrofulous, quinine and tonics, and small doses of cubebs as a stimulant to the parts, will be of service.

Chronic Enlargement, or Hypertrophy of the Prostate.—The prostate is a circular involuntary sphincter to the neck of the bladder, and assists in expelling the seminal fluid; it contains many mucous glands and follicles, intermixed with the muscular fibres, which are directly continuous behind with the circular fibres of the bladder, and in front with the muscular layer round the urethra. It contains, further, a small utricle (*sinus pocularis*)—the male homologue of the uterus—at the mouth of which the ejaculatory ducts open.

Fig. 263

Enlarged prostate.

Fig. 264.



Cyst of the prostate, projecting like a third lobe into the bladder cavity, from the King's College Collection.

The affection now treated of is almost peculiar to advanced life, and consists in hypertrophy of the muscular, and incidentally of the glandular, structure. Sir H. Thompson has never seen a case before the age of fifty-four; it usually begins between fifty-seven and sixty, and if a man escapes till he is sixty-five, he will either escape altogether, or suffer but slightly. It is not, as has been supposed, a senile change, for the prostates of many old men do not hypertrophy. The causes of the change are unknown.

The increase may be little more than the ordinary size of the gland, or may be as large as a man's fist. It may affect the whole organ, especially the lateral lobes, pretty uniformly—in which case the prostatic portion of the urethra is lengthened; or it may affect one side more than the other, and then the canal will be tortuous; or the so-called *middle lobe*, lying between the ejaculatory ducts and the urethra, which does not normally exist, may enlarge—either alone, or with the lateral lobes—and form a more or less pedunculated projection at the very orifice of the urethra, acting like a ball-valve, and causing a most serious impediment to the issue of the urine (see Fig. 264). Enlargement may be due, not only to an increase of the organ generally, but also to the development of one or many tumor-like, encapsuled masses of muscle and gland-tissue, analogous to fibro-myomata of the womb. One or more of these masses may be developed alone—either projecting as a pedunculated tumor or contained wholly within the prostate, capable of enucleation, and constituting the whole disease; or they may coexist with general hypertrophy. By these changes the prostatic portion of the urethra may be lengthened, twisted, obstructed narrowed, or expanded into a sort of pouch, which may communicate with cavities formed by the dilated ducts of the gland and containing calculi. Large size of the prostate does not imply obstruction. Hypertrophy of the muscular fibres, at and near the *trigone*, may produce a transverse bar at the neck of the bladder.

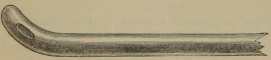
The *symptoms* which the patient describes are slowness and difficulty in making water, sense of weight in the perineum and tenesmus; so that he often believes he has internal piles. In the next place, the bladder becomes irritable, and the calls to make water become more frequent both by day and night, but particularly by night, and in the morning immediately after rising. Then, as the patient cannot empty the organ completely in consequence of the tumor, an increasing quantity of urine remains behind, and micturition becomes more and more frequent, while the bladder rises above the pubes. The patients now often complain that urine escapes from them during sleep or some violent effort; also that the stream, which is of fair size, falls straight from the penis, and is stopped altogether by straining. So far the urine is clear. Now a fit of complete retention may ensue, brought on, perhaps, by exposure to cold, or sexual excitement; for this or some other reason a catheter is passed, without due precautions as to cleanliness, the causes of decomposition are conveyed into the bladder, and the retained urine putrefies. This appears to be the commonest way in which putrefaction is induced, but sometimes it cannot be thus accounted for. Its onset greatly aggravates the patient's sufferings, for acute cystitis is excited by the ammoniacal urine, and not uncommonly the septic inflammation extends rapidly up to the kidneys, leading to fatal pyelonephritis (p. 750). If this is escaped, the cystitis becomes chronic, and the urine is loaded with muco-pus. What with the frequent, painful straining of cystitis, and over-distention of the bladder, constant dribbling of offensive urine, and soreness of the urethra from catheterization, the patient's life becomes miserable in the extreme; death occurs from exhaustion, septic poisoning, or acute suppurative interstitial nephritis.

Above the pubes the bladder is found more or less distended. On examination by rectum the surgeon ascertains the existence of prostatic enlargement, uniform or unilateral, except in cases limited to the middle lobe, or those of small tumor projecting into the urethra; in these, on using the catheter, he finds an obstruction at the neck of the bladder. After the patient has voided all the urine he can, and is convinced that he has emptied his bladder, the catheter will relieve him of a further quantity, varying from a few ounces to two or three pints: the amount should be noted, and also the character of the urine.

TREATMENT.—This is palliative only. The patient should avoid irregular habits, fatigue, and exposure to cold. The bowels must be kept easy by diet or mild laxatives, so that there may be no straining at stool; irritation of the bladder must be alleviated by the measures indicated in the next section; and occasional fits of pain or congestion, by leeching, and rest in the recumbent posture with the foot of the couch or bed slightly raised.

But the chief means of treating prostatic hypertrophy is the catheter: with it we endeavor to prevent dilatation of the bladder, and that increased frequency of micturition, especially nocturnal, which is so great a trouble. Its use should be commenced so soon as it is found that there are three or four ounces of residual urine, or earlier if the patient is suffering from increased frequency. It is usually sufficient to pass the instrument once a day—the last thing at night—with four to six ounces of residual urine, twice with six to eight ounces, thrice with eight to twelve. In severe cases, all urine must be drawn off by catheter. When two pints or more are found in the bladder, it is advised not to withdraw more than half at first, but to remove the whole in the course of two or three days, the patient, if possible, being kept recumbent; for the sudden removal of a large quantity of urine from the bladder allows its vessels to become intensely congested, hemorrhage is not uncommon, and the urine may become cloudy from vesical catarrh. Similarly, the abdominal veins become congested, and fatal syncope has followed the sudden removal of several pints of urine from patients in the upright position. To avoid the dangers of septic urine referred to above, all catheters should be scrupulously cleaned before use; for soft instruments thymol or boracic lotion for washing, and salicylic cream or eucalyptized olive oil for lubricating, are perhaps the best. Carbolic lotion can be used for metal instruments. As the best instrument to use, there is no doubt that in the great majority a coudée or elbowed gum catheter (Fig. 265) made on silk webbing, which is very flexible, and No. 8 or 9 in size, is

FIG. 265.



Mercier's coudée, or elbowed catheter.

the best; its ruptured point rides over an enlarged middle lobe—a bi-coudée is rarely required. If this does not answer, a *catheter à boule* (Fig. 256) of the same size may be tried, a spiral motion being given to the point as it is pushed on; or an English gum catheter, which has been kept upon a stylet much over-curved, so that when the stylet is withdrawn and the instrument passed, its point curls up against the roof of the urethra, especially as the handle is depressed between the legs. Another device is to pass a well-curved English gum catheter on its stylet down to the obstruction, and then to withdraw the stylet a little, and thus tilt up the point strongly. Occasionally, a 14-inch strongly curved silver catheter answers best.

At the commencement of catheter life, the surgeon should use the instrument, and the patient should, if possible, remain at rest until he has been well trained in passing the catheter upon himself, and in keeping it clean.

It is not always possible to empty the bladder with a catheter, for when one or more large sacculi protrude from it they do not contract.

Whenever the urine is foul, the bladder should be regularly washed out with some antiseptic, such as permanganate of potash, boracic acid, or iodoform suspended in mucilage. Morphia at night to procure rest is often invaluable, due regard being had to digestion and bowels.

A few cases are met with in which the pain of passing a catheter becomes so great that relief must be given. Sir H. Thompson, in a few such cases, has performed suprapubic tapping, and inserted a silver tube with a stop-cock, which the patient wore permanently, and through which he passed all his water with tolerable comfort. Reginald Harrison has employed a similar method, only he tapped from the perineum through the prostate; he says that after this treatment he has seen the hypertrophled gland shrink, and the urine pass again by the urethra. When a pedunculated middle lobe or tumor projecting into the urethra can be diagnosed, it might be very easily removed by a median cystotomy. Simple prostatic tumors obstructing the way have occasionally been shelled out by the pressure of the forceps in lithotomy.

Calculi of the prostate are composed, like other calculous concretions on mucous membranes, of phosphate of lime mixed with triple phosphate, and may be deposited either in the dilated urethral canal of an enlarged prostate, or in the ducts and follicles of the gland, or in both. The most remarkable instance of prostatic calculus on record is given by the late Dr. Herbert Barker, of Bedford, who kindly furnished the accompanying figure. The entire calculus is nearly $4\frac{7}{8}$ inches in length, and, at its broadest extremity, $4\frac{5}{8}$ inches in circumference, and weighs 1681 grains. It is com-

Fig. 266.

Compound stone in prostate (Herbert Barker).

posed of twenty-nine separate portions, slightly adhering by conchoidal surfaces, no doubt originally deposited in separate follicles of the prostate, and the whole agglomerated into one mass by the absorption of the intervening tissue.

The symptoms of these concretions are irritation of the neck of the bladder and difficulty of micturition, as in other cases of enlarged prostate; the calculi may also be probably felt with the sound, or by the finger in the rectum. For treatment in some cases it may suffice to keep the urethra well dilated, so as to favor spontaneous escape; or it may be possible to remove one or more with the urethral forceps; but should they cause great irritation, abscess, or retention of urine, it will be necessary to cut down on them from the perineum, and remove them, as was successfully done by Dr. Barker, in the preceding case.

Tubercle of the prostate is met with in conjunction with a similar disease in the testicles, vesiculæ seminales, bladder, or kidney. There is irritability of the bladder, and the prostate may be enlarged and nodular; chronic abscess of the prostate may be set up around a tubercular focus.

The disease admits of nothing more than palliative treatment, median cystotomy and drainage being the last resource.

Cancer of the prostate is very rare; scirrhus is more common than encephaloid; in the *Path. Soc. Trans.*, 1882, I described the only recorded case of colloid degeneration of a prostatic cancer. The symptoms are vesical irritability, hæmaturia, increasing obstruction to micturition, great pain in the perineum, radiating into the groins, and, later, cancerous cachexia; the gland is considerably enlarged, and of stony hardness. The symptoms are nearly the same as those of cancer of the bladder, and must be relieved by the catheter (especially the soft rubber) and opium.

Sarcoma of the prostate is even more rare.

Retention of Urine.

The term signifies inability to pass urine from the bladder—presupposing, therefore, that there is urine to pass. It must be carefully distinguished, both in theory and in practice, from *suppression* of urine, in which no urine is passed because the kidney has ceased to secrete, and, as a consequence, the urea and other urinary constituents accumulate in the blood, and give rise to headache, repeated attacks of vomiting, and, after four or five days, coma, with or without convulsions, followed by speedy death. In retention there is no arrest of the functions of the kidney, which goes on secreting urine, but owing to some obstruction to its exit from the bladder it accumulates and dilates that organ, which may be felt tensely distended above the pubes; in suppression of urine, on the other hand, the bladder is empty, or contains only a few drachms of urine. Suppression is a frequent cause of death in cases of interstitial nephritis in which much of the kidney substance disappears before a growth of interstitial fibrous tissue (p. 750), and operations on the urethra or bladder are liable to cause a reflex congestion of the kidney, and arrest the functions of the secreting structure left. Suppression occurs also if, when one kidney is disabled from previous disease, a calculus becomes impacted in the ureter of the other (p. 687).

Causes of Retention.—These may be *functional* or *organic*. *Functional* causes are spasm and congestion of the urethra, atony of the bladder from over-distention, paralysis of the bladder from interference with its nerve supply, hysteria; affections of, and painful operations on, the rectum (p. 728), and fractures of the lower extremity, especially the thigh, often induce retention reflexly. *Organic* causes are a long and adherent *prepuce*; obstruction of the *urethra* by calculi or foreign bodies coming from the bladder or introduced from without, or by cicatricial stricture; compression of the urethra by strings or rings—which children occasionally place round the penis, fail to remove when swelling occurs, and are afraid to speak of—by fractured and displaced bones, by extravasated blood, abscesses, and tumors, by scars external to the urethra; rupture of the urethra; inflammatory swelling, abscess, hypertrophy or new growth of the *prostate;* or by rupture of the bladder, or tumors growing within it and obstructing the entrance to the urethra.

Complete retention coming on suddenly, during the course of gonorrhœa, or from any other cause, in a man previously unused to urinary trouble induces the most acute suffering, already described under "spasmodic stricture." On the other hand, when retention supervenes more or less gradually in a patient who has long suffered from stricture, enlarged prostate, or some slowly increasing obstruction, the symptoms are comparatively slight; not uncommonly, indeed, in these cases the chief complaint is inability to hold the water, which escapes either continuously or very frequently in small quantities—a state of matters which should always lead to an examination of the hypogastrium, where it is more than likely that the distended bladder will be recognized, by sight, palpation, and percussion, as a tumor shaped like the gravid uterus rising from behind the pubes and reaching commonly to the navel, sometimes even to the xiphoid cartilage.

DIAGNOSIS OF THE CAUSE of retention in any given case. The first guide is the age of the patient. Retention in a child is almost always due either to something constricting the penis, phimosis, or, more often, to a calculus impacted in the urethra; rarely to an abscess pressing on the urethra. Retention in a man under twenty-five is due in the great majority of cases to gonorrhœa; after this age, up to fifty-five, stricture becomes increasingly frequent as a cause; after sixty, enlarged prostate and attacks of congestion of the gland brought on by exposure or debauchery may be expected. If the patient be a woman, retention is probably hysterical, but retroversion of the pregnant and non-pregnant uterus and pelvic tumors must be remembered, stricture of the female urethra being rare, and due usually to healing of a chancre at the meatus.

A few questions will often confirm a suspicion founded upon the above considerations, or will point to atony from over-distention. Examination along the line of the urethra will reveal any impacted body, compressing scar, or swelling, and the prostate may be explored *per rectum*, though an enlarged middle lobe may not thus be discovered. The bladder is never paralyzed whilst the lower limbs are normal.

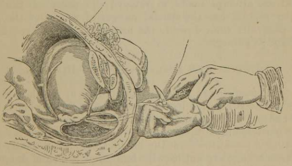
TREATMENT.—In almost all cases this begins with the attempt to pass a catheter; but there are two noteworthy exceptions. In hysterical retention the use of the catheter often leads to continuance of the symptoms; there is a deficiency of will in these patients rather than of power—they can empty the bladder if they try, but they are unable to try. Persuasion—but no fuss—anti-hysterical drugs, turpentine stupes over the hypogastrium, a warm hip-bath during which an unexpected cold douche is given, are remedies which usually succeed; but should the distention be great, the catheter must be used to prevent atony. In the male, when the urethra is acutely inflamed and the obstruction is due to swelling and spasm, passing a catheter may increase the irritation; hence, when the case is not urgent, the remedies prescribed under "Spasmodic Stricture" should be tried; should they not succeed, a No. 5 or 6 soft catheter must be passed with all possible gentleness, slight pressure overcoming the obstruction. The treatment of calculus or foreign body impacted in, or of abscess compressing, the urethra, has been detailed, but a catheter may be necessary to diagnose the former. In all other cases a No. 8 or 9 catheter may be introduced at once both to relieve the patient and to complete the diagnosis. It may meet with no obstruction, the cause being functional and usually atony—in which case the urine is not forcibly expelled and the effect of respiration upon the stream is very marked. Usually an obstruction is found in the urethra or prostate.

When a stricture of the urethra is found, we must endeavor with catheters of small size and of various kinds to enter the bladder; even a filiform bougie tied in for a few hours will cause dribbling of urine along it and cause such dilatation of the stricture that a small catheter may be passed. In some cases success may follow distention of the urethra with oil by means of a syringe, a fine instrument being then passed through the meatus, which is clipped by the fingers. Another plan is to pass down to the stricture a large instrument having a small eccentric terminal opening through which a filiform bougie works; by turning the instrument round the whole face of the stricture can be systematically explored. The administration of chloroform is very valuable in relaxing spasm. When false passages are present, it is well to leave an instrument in each, in the hope that, when they are blocked, a catheter will enter the orifice of the stricture. In a few cases the endoscope has shown the opening. If no instrument can be passed the surgeon must decide whether to wait or not. The symptoms may not be urgent, the bladder not large, and some relief may be obtained in a warm bath; with restriction of drink and diet, rest, elevation of the pelvis, sweating, purgation, and morphia, it is likely that success will attend an attempt twenty-four hours later. If need for relief be urgent, we have the choice between: (1) Aspiration of the bladder above the pubes; (2) Puncture of the bladder through the rectum; (3) Opening the membranous urethra behind the stricture; and (4) Wheelhouse's operation (p. 762). The latter is rarely done for retention, because, when the stricture is let alone for a few days, free from straining and instrumentation, and the patient is at perfect rest, a stricture usually dilates so that an instrument can be passed, when less severe and difficult methods of treatment can be adopted.

(1) ASPIRATION ABOVE THE PUBES is performed without previous incision of the skin, and with a medium-sized needle, exactly in the mid-line just above the pubes, so that the bladder is punctured where uncovered by peritoneum; the point should be directed backward and slightly downward toward the sacrum and well into the bladder. Very little, if any, aspiration should be used until the needle is being withdrawn, when there is danger of the escape of putrid urine into the tissues outside the bladder. This operation may be repeated once or twice daily, suitable general treatment being employed meanwhile, until the stricture becomes passable: the puncture should be repeated before the bladder becomes very much distended, for, though the opening is usually quickly closed by lymph, it may gape a little under tension. I have seen one or two fatal cases from septic cellulitis after aspiration.

(2) PUNCTURE THROUGH THE RECTUM.—First clear the rectum by an enema; then place the patient in lithotomy position close to the edge of the bed; have the bladder steadied above pubes and pushed down; the surgeon should then introduce the left forefinger into the anus, and pass a special long curved trocar and canula by its side, the point of the trocar being withdrawn slightly within the canula (Fig. 367); then feel for, and make

FIG. 267.



Puncture of the bladder through the rectum. The position of the hands should be reversed.

sure of, the distended bladder one-half inch behind the prostate, and exactly in the middle line, protrude the trocar and push it with a sharp thrust into the bladder in a direction toward the umbilicus—leaving the canula for four-and-twenty hours or more, according to the requirements of the case.

The canula should be tied in by means of four tapes, of which two are carried in front and two behind the thighs and fastened to a waistband, or a broad flange may be fixed by stitches to the skin. The object in view in this method, as in aspiration of the bladder above the pubes, is, in addition to relieving the retention, to give rest to the urethra; it is, therefore, necessary to keep the canula in the bladder until a catheter can be passed through the stricture.

Emphysema, peritonitis from puncture of the peritoneum, extravasation of urine, pelvic cellulitis and its dangers, may follow; a man at University College under C. Heath died of hemorrhage from the rectum; a fistula may remain if the canula be long retained.

Opening the membranous urethra is often spoken of as Cock's operation, having been strongly recommended by Cock, of Guy's. It suggested itself to and was performed by Sir A. Cooper, who, when examining the perineum in a case of retention, felt a rush of urine into the urethra as the man strained. The patient is placed in lithotomy position, and a finger point passed into the rectum rests upon the apex of the prostate and perhaps feels the distended urethra; a bistoury with its back toward the rectum is passed boldly into the perineal raphé, so as to strike the urethra just above the finger, and by a cut upward to make an incision in it sufficient to allow a large catheter to be passed into the bladder and tied in for some days.

When the obstruction is in the prostate, if there are inflammatory symptoms the bladder should be emptied gently by catheter and the treatment of prostatitis carried out. In cases of retention from hypertrophied prostate every endeavor should be made to introduce an instrument, and preferably a soft one. If very great difficulty is experienced the instrument must be tied in, though it is an irritant; if it can be introduced, either by short sharp pushes or on a stylet, Hutchinson's red rubber catheter causes less irritation than any other. The operation of "tunnelling" the prostate—*i.e.*, guided by a finger in the rectum, forcing a catheter through the gland into the bladder, should never be done. If no catheter can be passed we have the choice between puncture above the pubes, puncture per rectum (when the prostate is not so large but that its hinder border can be plainly felt), puncture through the perineum (p. 770), and opening the membranous urethra from the perineum, after which the finger may be passed into the bladder and an attempt made to remove the cause of the obstruction. Puncture per rectum has the special danger of wound of the peritoneum, which may naturally come down to the prostate, and is more likely to do so when the gland is enlarged.

Injuries and Diseases of the Bladder.

Wounds of the bladder are generally punctured or gunshot, and the latter especially may be complicated by the presence of a foreign body, bullet, bone, or piece of cloth. With regard to their mortality every thing depends upon whether the peritoneum is injured, and whether the wound is such that free escape of urine is permitted from the bladder through the skin opening; for shock and hemorrhage are not usually fatal, and the chief dangers are peritonitis, extravasation of urine, septic pelvic cellulitis, and septic disease of various kinds. Cases of uninterrupted recovery from bullet wounds traversing the pelvis and bladder from side to side, or from lance or sword thrusts from above the pubes out through the perineum, have been not rarely recorded.

The *diagnosis* hinges upon the position of the wound or wounds, and upon the escape of urine from them.

TREATMENT.—Examine the bladder carefully by sound and finger, if possible, for a foreign body, and remove it if found. If the peritoneum is wounded three courses are open: (1) Should it happen that there is a wound of the base of the bladder, a tube may be inserted here and effectual drainage thus established; (2) the membranous urethra may be opened, a tube inserted, and the patient raised almost to a sitting posture; or (3) we may open the abdomen, swab out the peritoneum, and suture the opening—an operation of great difficulty when the wound is low down on the back of the bladder, the unstretched abdominal muscles permitting very imperfect access to the part. The first course will rarely be possible, and there is as yet no sufficient record of cases to decide between the second and the third, but the latter would seem to be indicated specially when the bladder has been wounded from the peritoneal surface, when there is a foreign body in the peritoneum, when peritonitis is present, or when it is probable that intestine also has been injured. Enlargement of the superficial opening will often render danger of extravasation less. When there is a wound of the recto-vesical septum, it should be carefully sewn up, the sphincter having been fully dilated or even divided backward, the bladder drained by a rubber catheter and long tube, and the patient kept prone with the pelvis raised. To prevent decomposition of urine the administration of large doses of salicylic acid has been strongly recommended. Once the wounds begin to granulate the main danger will be over.

Rupture of the bladder is a much more common accident than wound. It can occur only when the bladder is distended, and is sometimes due to incredibly slight violence, even a strong contraction of the abdominal muscles having produced it; but the most common cause is probably a blow or fall in a drunken scuffle. Laceration of the bladder may occur, even though the viscus be not distended, from fractured pelvis. The rupture may be either upon the peritoneal or non-peritoneal surface; the latter are the less serious, peritonitis being the danger in the first, extravasation and cellulitis, which may be relieved by early and free incisions, in the second. The *symptoms* are retention of urine, with increasing pain in the hypogastrium, where dulness may become evident; there is no escape of blood from the urethra, and a catheter passes easily into the bladder, which is empty or contains only a little bloody urine. Movement of the catheter about in the bladder has sometimes caused its point to slip through the abnormal opening and draw off more or less bloody fluid from the peritoneum. A history or evidence of injury to the hypogastrium, and negativing injury to either kidney, where it can be obtained (in drunken cases, buffer accidents, and the like, it usually can not), is in favor of rupture of the bladder. Occasionally a patient with a hole through the peritoneal surface of his bladder passes urine with some force, and it must be admitted that the diagnosis is often very difficult.

TREATMENT.—Rupture through the non-peritoneal surface will probably not be recognized until cellulitis arises and demands free incision. Tears of the peritoneal surface were formerly treated by drainage with a catheter, which proved exceedingly unsatisfactory. Cystotomy and drainage was introduced by Mason, and has so far yielded results decidedly better than those of laparotomy and suture of the bladder wound, which has been performed by C. Heath, Willett, and others. But it is too soon to decide upon the relative merits of these methods.

Foreign bodies are not uncommonly introduced into the urethra both by men and women, and slipping from the fingers find their way into the bladder: hairpins, straws, pencil and penholders, bits of pipe-stem, and various things used as bougies; bits of instruments may break off in the bladder, or foreign bodies may be introduced through a wound and remain undetected till the wound heals. They excite cystitis, and in a very short time become the nucleus of a calculus, usually phosphatic; rarely, they pierce the bladder and cause peritonitis or a circumscribed abscess. They should be extracted as soon as possible, and there will rarely be much difficulty in the female; a pair of dressing forceps, guided by a finger in the vagina, being the handiest instrument, and the urethra being dilated if necessary. In the male a small lithotrite is the best weapon, a long body being caught by one end; extraction by such means failing median cystotomy must be done.

Irritable Bladder.—Many cases described under this title are cases of gout or of simple cystitis. Simple irritability—that is, a frequent inclination to pass the urine, with or without spasm, but without inflammation or organic disease—may be caused (1) by an irritating state of the urine—its qualities should be carefully ascertained and anything abnormal treated; (2) by mere nervousness, not uncommonly in elderly people, or mental agitation; (3) by irritation of the rectum, womb, or other adjacent organs; in children by the irritation of ascarides in the rectum or of preputial secretion retained under a tight foreskin; (4) by exposure to cold. The surgeon should examine for these causes, and also make an examination of the entire urinary tract, for there is no disease of the urinary organs which may not be accompanied by irritability of the bladder. Anodyne medicines, such as belladonna (F. 268), may be of use in nervous cases. In cases with alkaline urine, salicylic or benzoic acid (grs. x) is useful. In piles or ascarides remove the cause. Iron, tonics, and tincture of nux vomica are often indicated. (F. 2, 4, 18, 21, 33, etc.)

Incontinence of Urine (*enuresis*).—Involuntary flow of urine is common in delicate children, especially during the night. The surgeon is consulted on account of its continuing to an age at which such an infirmity becomes troublesome and degrading. Any such case should be carefully studied and inquired into. (1) See whether the urine is irritating in quality or excessive in quantity. It will often be found that the malady is aggravated when the bowels are confined, the diet unwholesome, saccharine drinks used too freely, much drink taken in the evening, or when there has been too much fatigue; all which circumstances must be avoided. (2) In males a long foreskin sometimes seems to be the irritant or to conceal it; circumcision often cures. Any kind of irritation may keep up the trouble, *e. g.*, worms. (3) The habit must be attacked; the patient should be awakened at a certain hour so that he may void his urine of his own accord, but on no account should a child be punished for a disease over which it has no control; children under such circumstances sometimes do themselves much injury by tying string round the penis to prevent involuntary escape of urine. The discharge not infrequently occurs when the patient is lying upon his back asleep. By turning him on the side or face, or applying blisters over the sacrum, this may be avoided. The best medicinal treatment for children is tr. belladonnæ, ♏x–xx, thrice daily. Cod-liver oil, tonics, and especially nux vomica, may be of much service. In males, sealing the orifice of the foreskin with collodion has been recommended to keep the bladder full for a few consecutive nights; if the habit of emptying itself at a certain degree of fulness can be broken, permanent cure is likely to result. Less commonly the urine dribbles away both night and day, a condition which small doses of strychnia often cures.

Incontinence and dribbling of urine from overflow deserves special mention, it has so often led to error. Patients say they are making water "too freely," and believe that they empty their bladders perfectly; but these symptoms should always cause the surgeon to examine the hypogastrium, which, in the majority of cases, will be occupied by a bladder distended behind some obstruction or atonied. For treatment, see "Retention."

Atony and paralysis of the bladder are two totally different conditions, which are frequently confused. The former term implies that the muscle of the bladder wall is unable to contract under the normal stimulus, the latter that this stimulus is wanting, owing to some abnormality in its nerve-supply, which may come on quite suddenly from injury to the central nervous system, before it is possible for any weakness of the muscular substance to be produced. *Atony* usually results from long distention of the bladder, from prostatic disease or stricture, and is met with particularly in old age, when the ability of the bladder muscle to hypertrophy and overcome an obstacle is diminished. In a young subject stricture usually leads to hypertrophy. Dilatation of the bladder begins when the obstruction becomes so great, that the hypertrophy of the muscular wall possible in the particular patient fails to overcome it. Atony sometimes occurs acutely, as the result of a prolonged forced retention of urine; it may occur also after the operation of lithotrity, and from irritation and inflammation of the bladder set up by retained fragments of stone; and it is often met with in acute specific fevers of a low type, such as typhus. *Paralysis of the bladder* results from disease or injury of the spinal cord, which interferes with the centres controlling micturition; perhaps inhibition of the action of the bladder, which often follows operations in the rectum and injuries of the lower extremities, should be placed here. Its symptoms are either retention, the patient not passing water at all, or overflow, the water dribbling away when over-distention of the bladder overcomes the elastic contractility of its neck. Differences between retention from either of the above causes and that due to obstruction are—that the former comes on suddenly, and is accompanied by other paralyses; there is no obstacle to the introduction of a catheter, and the urine flows through a catheter in an intermittent stream, keeping time with the respiratory movements, instead of in the continuous and forcible stream which issues from a healthy or hypertrophied bladder behind an obstruction.

Treatment of atony consists in affording rest to the bladder, by drawing off the urine as often as required; the tincture of perchloride of iron, strychnia, and faradization of the bladder, may be of use. In paralysis of the bladder the only local treatment possible is to prevent the decomposition of the urine, which is so liable to occur, by regularly emptying and washing out the bladder with an antiseptic solution.

Retention has been made the subject of a special section (p. 771).

Acute inflammation of the bladder (cystitis) may be due to gonorrhœa, its commonest cause in young adults; to stricture, enlarged prostate, stone, atony, or paralysis, and rough instrumentation, especially the performance of lithotrity, followed by imperfect removal of fragments; but in all these latter cases, it is more than probable that the only or chief cause of inflammation is the presence in the urine (especially residual) of septic organisms, often carried in by instruments, but the mode of entry of which is not always clear. Cantharides, even from a blister, turpentine, and some other drugs cause severe but short-lived cystitis; rarely no explanation of cystitis, other than cold and wet, or gout, can be found. An acutely inflamed bladder, when seen *post mortem*, contains turbid or blood-stained urine; the wall is thick, chiefly from swelling of the mucosa, which is of deep purple color, with ecchymoses, and perhaps small ulcers and patches of fibrinous membrane here and there; in the hollows between the rugæ these changes are much less marked than on their summits. The *symptoms*, in the most acute and often fatal cases, are high fever with rigors, extreme vesical irritability, hypogastric tenderness, and pain, which latter spreads also to the perineum, rectum, and groins; the urine is bloody. In the more usual form micturition is very frequent, preceded by suprapubic pain, accompanied by straining and scalding, followed by temporary relief; there is aching in the perineum; the urine is cloudy from excess of mucus and leucocytes; there is some fever, and general disturbance.

TREATMENT.—Remove any irritant. In the gentlest manner possible wash out the bladder with boracic lotion, boroglyceride, Condy's fluid, or some mild antiseptic, and follow this up with an ounce of mucilage containing five grains of iodoform—to be left in; foment the hypogastrium, give hot baths regularly, relieve pain and strangury by morphia, regulate the bowels, and render the urine but faintly acid, or even alkaline, with liq. potassæ given in barley water, or other diluent, which should be drunk freely. If the urine is septic, give salicylic or benzoic acid.

CHRONIC INFLAMMATION OF THE BLADDER is very frequent, as a sequel of acute catarrh, or as a primary affection; it almost always appears, sooner or later, in stricture, enlarged prostate, stone, atony, and paralysis, and frequently with sepsis of the urine.

The *post-mortem appearances* are slate-gray pigmentation of the mucosa, especially the summits of the rugæ, together with more or less purple injection; ulceration is frequent, the mucosa being sometimes clearly dissected from the muscularis over large areæ. The surface is often covered by a fibrinous layer infiltrated with calcareous salts. The inflammation *per se* tends to thicken the bladder wall, and to render it fibroid; but it may be thinned or greatly hypertrophied from other causes, and in the latter case it is often sacculated—*i. e.*, pouches of mucous membrane have been driven by the force of contraction between the prominent fasciculi of the muscular coat. These saccules may be numerous and of large size; they do not empty themselves, but remain full of putrid urine, containing so much shed epithelium that it sometimes looks like pus, and phosphatic stones not uncommonly form in them. These reservoirs of foul urine often effectually frustrate our best endeavors to render a bladder aseptic, and they may lead to localized, or even general peritonitis. Kidney complications generally prove fatal.

In cases of *tubercular disease* of the kidney or prostate, the bladder may be similarly affected, with symptoms of chronic cystitis.

SYMPTOMS.—The same as in the acute form, but less severe, there being no fever or general disturbance, except that induced by broken rest; pain and frequency of micturition may be extreme; the urine is to some extent characteristic. In the early stages there is but little mucus, and the urine may be acid; but as the disease advances, the urine is voided of a brownish hue, of a most offensive ammoniacal odor, loaded with muco-pus, occasionally tinged with blood, sometimes yellowish and puriform—but more generally grayish, streaked with white, alkaline, and so viscid that it sticks to the bottom of the vessel. This mucus may occasionally block the urethra, and cause retention, which is difficult to manage, because the mucus clogs up the eyes of the catheter. The white streaks in the mucus are *phosphate of lime*, which is apt to collect and form a stone in the bladder.

TREATMENT.—If there be a stricture, enlarged prostate, or stone in the bladder, proper measures should be taken for their relief or removal. If the symptoms be at all severe, the patient should keep recumbent, with the pelvis elevated. As a general rule, all lowering measures are injurious.

Pain and irritation are to be allayed by the hip-bath, and by morphia. The bowels should be kept properly open by mild aperients. The diet should be nourishing, but plain—with weak spirits-and-water, or dry wine.

Of medicines, the most useful, according to Brodie, is *pareira brava*. Uva ursi or buchu tea, in large quantities, Chian turpentine, cubebs, copaiba, and tinct. ferri perchlor. in small doses three times a day, are also reputed remedies. Hyoscyamus and salicylic or benzoic acid, if the urine be alkaline, may be added to any of them. The sulphate of zinc may also be useful. (F. 4, 18, 336, *et seq.*)

Injections into the bladder are highly serviceable in chronic cases, by washing out the decomposed urine and mucus. Injections of a saturated solution of boracic acid, of boroglyceride (1 in 20), of sulphate of quinine (grs. ij to the ounce), or, when the urine is very foul, of Condy's fluid, may be used with advantage; very dilute nitric acid (♏j–ij ad ℥iss aq. destil.) acts well when the urine is highly ammoniacal, and the bladder coated with phosphates. The bladder may be gently irrigated by a caoutchouc tube attached to each orifice of a double-current catheter—one being dipped into a basin containing the injection, the other into a receiver. But it is more effectual simply to inject 1–2 oz. very gently, allow it to escape, and repeat three or four times once or twice a day. Some of the injection may often be left in with advantage; but for this purpose there is none equal to iodoform (grs. v ad ℥j) in mucilage.

In very obstinate cases, usually of doubtful etiology, relief may be given by dilating the female urethra, or performing median cystotomy in the male; to this, swabbing the vesical surface over with a solution (grs. v ad ℥j) of nitrate of silver may with advantage be added.

Tumors of the Bladder.

The bladder may be the seat of both *simple* and *malignant* growths. Of simple growths the most common is the *villous tumor or papilloma*, which consists of numerous simple or branched processes springing from the submucous connective tissue; each process is composed of a delicate stroma of connective tissue, supporting fine bloodvessels, and covered by two or three layers of narrow, elongated, epithelial cells. Villous growths may be single or multiple, small, or as large as a big walnut, sessile or pediculated; they have a soft consistence and a reddish-yellow appearance; if immersed in water, they swell, and send out floating filaments resembling a sea-anemone; the branches are sometimes more than two inches in length. Sometimes the villi are not nearly so long, and are so closely set, that the tumor is of a much more solid consistence, and, on microscopical examination, the abundance of epithelium lying between the connective tissue of the closely packed villi is liable to make it simulate a malignant growth. In other cases, the connective tissue groundwork is much increased in amount, and the papillation of the surface reduced to a minimum; such tumors should be described as *fibromata* or *papillary fibromata*. Mucous polypi (*i. e.*, soft fibromata), closely resembling ordinary nasal mucous polypi, have been met with in the bladders of children; they may consist of a number of polypoid tumors connected together like a bunch of grapes, and are often of large size. Plain *myomata* or *fibromyomata* have been met with. Sir H. Thompson (*Tumors of the Bladder*) describes a "transitional tumor," which he regards as occupying a position midway between fibromata and sarcomata. The most common locality for simple tumor of the bladder is within the trigone, and the neighborhood of the urinary orifices is their favorite site, though they may spring from the sides of the bladder.

SYMPTOMS.—The earliest symptom in simple tumors of the bladder is undoubtedly hemorrhage, and for a long time it may be the only one. In some cases, especially after exercise, the blood is evenly distributed in the urine, to which it gives a uniform red color; at other times the urine may be free from blood at the commencement of micturition, but deeply tinged with almost pure blood at the end, when the bladder contracts on the delicate villous growths; at this period clots are frequently passed, and may be the cause of much suffering. Exercise often has a marked effect in causing the hæmaturia. Later on micturition becomes painful and frequent; the growth may interfere with the escape of the urine from the bladder, causing retention and dilatation of the viscus. The urine should always be carefully and repeatedly examined for fragments of new growths, such as minute tufts of branched villi, which from time to time become detached from the main growth, and Sir H. Thompson recommends that the bladder should be washed out with warm boracic acid, and the washings examined. A catheter with large eyes should always be used, and anything contained in the apertures should be examined, for villi often float into them, and are torn off as the catheter is withdrawn with its outer end closed by the thumb. But little information can usually be gained by sounding the bladder; sometimes, when the growth is encrusted with phosphates, it may be felt, and an encysted calculus be suspected, or some roughness of the wall, or a feeling as though the sound were moving through a mass of floating hair, or on a velvety surface, may be detected. Great care should be exercised in this method of examination, as fatal hemorrhages have followed the use of catheters in such cases. Examination of the rectum, or even bimanual palpation under chloroform, has not been of much value in cases of simple tumor. If, however, with the symptoms above described, no rational diagnosis can be made by the more ordinary means of diagnosis, there can be no doubt that the correct practice is to make a digital exploration of the bladder, as advocated by Sir H. Thompson. In past times many patients were allowed to die from hemorrhage from tumors of the bladder, which might easily have been removed, if only their presence had been ascertained.

TREATMENT of simple vesical tumor till recently consisted in giving medicines, such as gallic acid, to restrain bleeding; and operative measures, though adopted by Warner as early as 1747, by Crosse in 1834, and by other surgeons at later dates, have been much employed only since their advocation by Sir H. Thompson in 1882. His operation consists in opening, upon a staff, the membranous urethra through the mid-line of the perineum, passing the finger into the bladder, examining its surface thoroughly, whilst pressure above the pubes brings it within reach, detecting the tumor and removing it by properly constructed forceps, or the écraseur, or scraping it away with a sharp spoon. If severe hemorrhage occur, it may be checked by injecting into the bladder cold water, or a dilute solution of perchloride of iron. An India-rubber tube should be retained in the bladder till all hemorrhage ceases, and then removed.

In the removal of simple tumors from the *female* bladder, the urethra should be rapidly dilated, and the growth removed as in the male.

In some cases, after exploration of the male bladder from the perineum, it may appear necessary for the removal of the tumor to have a larger opening into the bladder in the suprapubic region, but then the perineal opening is of much service as a means of draining the bladder.

There is doubtless danger of tearing through the bladder in removing growths with toothed forceps through the perineum, and also of missing small portions or multiple growths, causing some surgeons to prefer suprapubic cystotomy; it is a question which results—as regards mortality and recurrence—must decide. Recurrence has been very frequent, and the mortality high after the perineal operation.

MALIGNANT DISEASE of the bladder is most commonly squamous epithelioma, but both scirrhus and sarcoma have been met with; primary sarcomata do not seem to be very rare. These growths may spring from any part and often occupy the anterior and posterior walls. The bladder may be infiltrated by malignant growths which have spread to it from the rectum or uterus. The ordinary SYMPTOMS are frequent desire to make water, uneasiness in the region of the bladder, aggravated after micturition, and extending to the glans penis, perineum, rectum, and groins. The urine is usually turbid, and very frequently mixed with blood. Sir H. Thompson lays much stress on the diagnostic importance of pain and increased frequency of micturition preceding hemorrhage in malignant disease of the bladder, whilst in simple tumors hemorrhage is always the first symptom, and may occur at intervals for as long a time as seven years, in some cases, before any other symptom occurs. As a rule, the examination of the urinary deposit does not give much information; epithelial cells of many shapes may be met with in other diseases besides epithelioma; in one case, under the care of Mr. Berkeley Hill, at University College Hospital, I detected in the urine bits of tissue, showing the nested arrangement of epithelium characteristic of epithelioma; and observation of this nature of course renders the diagnosis of epithelioma a certainty.

The TREATMENT is mainly palliative, and directed toward relieving pain, cystitis, and hemorrhage; internal remedies have little or no effect on bleeding from the bladder, but styptic injections, gently syringed into the bladder through a soft catheter, are of much service; Sir H. Thompson has employed an injection of from ♏ xx–lx of the tincture of perchloride of iron in four ounces of water; if this is effectual, of course a stronger solution will be unnecessary, but Whitehead has used an injection of one part of the solution of perchloride of iron to four of water, with the very best results. The question of operation in cases of malignant disease of the bladder, is debatable; Sir H. Thompson recommends that if the tumor be recognized as malignant, and have a broad base, no attempts should be made to remove it; on the other hand, partial removal has been performed with much relief to the patient, though as a means of permanent cure it will of course be unsuccessful. The tendency to bleeding is far greater from the superficial ulcerated surface than from the base; and if only a portion of the growth be removed, and the base from which it springs be left, hemorrhage will be diminished. This result was unquestionably shown in three cases operated upon by Whitehead, of Manchester (Whitehead and Pollard *On Tumors of the Bladder*). Drainage has a like effect.

STONE IN THE BLADDER.

One-half of all cases of stone occur in children under thirteen, but in proportion to the number of people living at various ages, stone is most common between fifty-five and seventy-five. The children who suffer are almost all the children of the poor, whilst the adults are largely drawn from the well-to-do classes (Thompson). Women are affected much less frequently (1 in 20, Norwich statistics) than men, in whom the passage of a calculus from the bladder is more difficult, and gout, to which the uric acid stone is distinctly related, is much more frequent. Like gout, the tendency to uric acid calculus and gravel is strongly hereditary. Beyond this we know very little of the *etiology* of stone; it is certain, however, that it is very much commoner in some parts than in others (in England it is much more frequent in Norfolk than elsewhere), and the proportion between uric acid and oxalate stones varies in different places. There are fourteen species of calculi, but many are very rare. Practically, uric acid and uratic stones form three-fifths of all, phosphatic nearly two-fifths, and oxalate of lime about three per cent. (Thompson). All uric acid and oxalate stones form in the kidney, phosphatic generally in the bladder and from alkaline urine. A little blood clot, or mucus, or some foreign body, often serves as the nucleus upon which the calculous material in excess in the urine is deposited. In the great majority of cases renal calculi of uric acid or oxalate pass down the ureter, with or without symptoms, and also escape from the bladder, but they may remain and grow in either viscus.

The Various Kinds of Stone.—*Uric acid stones* are generally oval, flattened, fawn or mahogany colored, and, on section, exhibit concentric laminæ. *Tests.*—This stone may be dissolved by boiling in *liquor potassæ*; it burns away almost entirely before the blowpipe with an odor of burnt horn; and if digested in a small quantity of nitric acid, and evaporated at a *very gentle* heat, it leaves a residue, which, when cold, becomes purple (*murexide*) if exposed to the vapor of ammonia.

Mixed urates—ammonia, potash, and soda—rarely form the whole of a calculus, because they are tolerably soluble in warm urine. *Tests.*—They are known by the same tests as the preceding, and evolving ammonia when treated by liquor potassæ.

Phosphate of lime (or *bone-earth*) *stones* are rare. They are pale brown, friable, and laminated. *Tests.*—Soluble in nitric or hydrochloric acid, and precipitated by liquor ammoniæ; quite infusible.

Triple phosphate (*of ammonia and magnesia*) forms white or pale gray stones, composed of small brilliant crystals; they are very friable. *Tests.*—Evolves ammonia when treated with liquor potassæ; is soluble in acetic or hydrochloric acid; precipitated again by ammonia in form of crystals of basic phosphate; fusible under the blowpipe.

The *fusible calculus* is formed of the phosphate of lime and triple phosphate mixed. It forms a white friable mass, like mortar, and is very fusible, its fusibility varying with the amount of triple phosphate.

The *mulberry stone* is composed of oxalate of lime. It is dark red or brown, rough, tuberculated, and exceedingly hard. *Tests.*—Not dissolved by boiling in potash; soluble in nitric acid; if exposed to the blowpipe the acid is burned off and quicklime is left, which, if moistened, reddens turmeric-paper.

Besides the above, stones are sometimes composed of *cystine*, a peculiar animal substance, containing much sulphur, soluble both in alkalies and dilute mineral acids, but not in acetic acid; precipitable in peculiar six-sided crystals by acetic acid from its solution in ammonia (Figs. 251, 253); they may be formed also of *carbonate of lime*, of the *fibrine* of the blood, and of *xanthic* or *uric oxide*, a peculiar animal matter allied to uric acid. The urate of soda, the urate and carbonate of magnesia, and silica, are also rare ingredients in calculi.

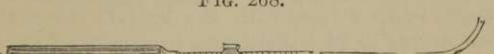
Alternating calculi.—Sometimes stones are composed of alternate layers of uric acid and oxalate of lime; and very commonly the outer layers of a stone are phosphatic, the nucleus uric or oxalate of lime. This occurs when cystitis is set up, and the urine becomes ammoniacal; but uric acid and oxalate never succeed the phosphates.

Diagnosis.—*History.* In a large number of adult cases there will be a history of stone, gravel, or gout in the family, and a personal history of long-continued uratic deposit from the urine, and often of uric acid. Renal colic may have occurred once or oftener.

Symptoms.—(1) Irritability of the bladder, with frequent irresistible desire to make water, especially during the day when moving about; sudden stoppage of the stream of water during micturition, from the stone falling upon the orifice of the urethra, the stream probably flowing again if the patient throws himself on his hands and knees, is a very rare symptom. (2) Sharp, cutting pain in the glans penis felt after micturition, when the bladder contracts on to the stone and drives this against the trigone and prostate, the most sensitive parts. It is usually felt for some minutes. If the patient be a child he will pass water as seldom as possible, often cries after micturition, and is always attempting to alleviate the pain by pulling at the prepuce, which becomes extremely long. This pain may be absent; or extremely severe, when it is often accompanied by much aching in the perineum and frequently also by the suprapubic pain before, and the straining during and after, micturition of cystitis. The straining is so severe that prolapsus ani not uncommonly results in children. (3) Blood is usually passed at times, especially in adults; it appears at the end of micturition and in small quantity, as a rule, but may be present in large amount and frequently, or be entirely absent. (4) In uric or oxalic stones the urine is usually somewhat clouded by mucus or muco-pus, sometimes streaked with blood. Of course, when cystitis is present the urine is characteristic of that state. All the symptoms are greatly aggravated by movement; on the other hand they are much modified by fixation of the stone in a sacculus, and seem to have been astonishingly slight in cases of calculi so large as almost to fill the bladder. They are usually more severe with a rough (oxalic) than with a smooth stone. In some cases, without obvious reason, the symptoms may be very slight for years, perhaps only a little pain, frequency, and blood after jolting; but sooner or later, cystitis with alkaline urine is induced, secondary changes in ureters and kidneys (p. 750) occur, and at last, after much suffering, the patient sinks.

Physical examination: sounding.—None of the above symptoms can be depended on alone or in combination. The presence of the stone must be made evident to the ear and fingers, and the instrument employed for this purpose is a *sound* (Fig. 268), the shaft of which is not large enough to distend the urethra, that it may move easily in the urethra; the surgeon should possess several, of various lengths, sizes, and curves.

Fig. 268.



Sir H. Thompson's improved sound; the handle is cylindrical and grooved; and the shaft is hollow, to allow withdrawal of urine, and graduated, with an indicating slide, for measurement of a stone.

The sound should, when possible, be introduced when the urinary organs are comparatively free from irritation, and the health from disturbance. The patient should lie on his back with the pelvis raised three inches on a pillow, and the bladder containing a few ounces. To insure perfect quietness, and to prevent pain, chloroform may be used; and if the bladder be empty and the stone is not found at the neck, a little tepid boracic lotion may be injected. The sound should first be pushed as far as possible along the base of the bladder and withdrawn to the neck, so as to examine the base on the right of the midline; the upright beak is rotated through 90° in either direction and the back to the vertical between each withdrawal of $\frac{1}{4}$–$\frac{1}{2}$ inch; the left base is then similarly examined, and in the great majority of cases of stone the calculus will be struck in this part of the examination; if not, the beak is turned down and the region behind the prostate explored, as a calculus may lodge in a fossa here when the prostate is enlarged; lastly, the posterior surface and postpubic region must be examined for a more or less completely encysted stone. A finger *in recto* may be an aid, and with a hand above the pubes is sometimes the best means of detecting, and always of estimating, the size of a very large stone; in children also this method may be practised. If the patient change his position a little, sit up or walk about a bit, a stone may come within reach of the sound; varying the quantity of fluid in the bladder may act well, the stone may strike the sound as the bladder is emptied.

When a stone is found it may be measured roughly by tapping along the bladder till the far end of the stone is reached, pushing down the indicator to the meatus, and then tapping over the stone till it is lost, the penis being fixed; or a small measuring lithotrite may be passed, and the stone grasped in several diameters. Whilst sounding we can estimate also the weight of the stone, and whether it is fixed or movable. Any of the results, even death, which occasionally follow catheterization may follow sounding; as a precaution, advise rest for some hours after. If the symptoms be well marked, the surgeon must not be content with one unsuccessful exploration.

Errors in Sounding.—These are of two kinds: *first*, that of assuming that there is no stone when none can be felt. The chief circumstances which occasion difficulty in this respect are enlarged prostate, the dilated sinus of which may be sounded, the bladder being regarded as contracted (Cadge, *British Medical Journal*, 1886, vol. i. p. 1150), whereas it really is not reached; cysts or pouches in which the stone is held; small size of the stone, especially in a full bladder.

The *second* error is that of taking something for a stone which is not one. Thus, polypi or pendulous growths, portions of the bladder hardened or rough from thickening or ulceration, or encrusted with phosphates—hard scybala in the intestines, the spine of the ischium in children, especially when phimosis simulates the symptoms of stone, exostoses, and tumors of neighboring parts, have at times been mistaken for stone. It is admitted that mistakes are not infrequent, even by skilled hands.

The *composition* of a stone may be guessed at from the history, from the habitual state of the urine (acid or alkaline), and any deposit from it, or from its roughness and hardness. Phosphatic stones are of quickest growth, the softest, and the most friable. Uric and oxalic stones are of slow growth; they are hard, break into sharp fragments, and give a clearer *ring* or *click* than the phosphatic when struck with the sound. Stones have varied in *weight* from a few grains to 44 ounces, and in number from one to some hundreds, when multiple facets are often present. C. Mayo, of Winchester, extracted one weighing 14½ ounces, but it was broken; the patient lived several years. Harmer, of Norwich, in the year 1746, extracted one entire, which weighed nearly 15 ounces, and the patient lived five years. Sir A. Cooper extracted one entire, weighing 16 ounces, and Mott, of New York, in 1834, another, weighing over 17 ounces, from a man of twenty-one, but the patients died, and this has been the result in several cases of removal of heavy stones (23–25 ounces)—lately recorded exceptions being Mr. T. Smith's case (*Lancet*, August, 1886), with a stone of 24½ ounces, and Thompson's, with one of 14 ounces.

Treatment.—The indications are: (1) To remove the stone, in the way which involves least risk to the patient; (2) to get rid of the morbid state of the urine, that the stone may not recur (p. 746); and (3) to cure or alleviate any local disease of the bladder which the stone may have excited; this often follows removal of the cause, but the remedies for cystitis (p. 777) may be required. Three methods have been employed for the removal of stones: (1) Solution; (2) Lithotrity; and (3) Lithotomy.

(1) Litholysis, or Solution of Stone.—Sir B. Brodie long since showed that *phosphatic* calculi may sometimes be dissolved altogether, and sometimes be so disintegrated or reduced in size that they may escape through the urethra, by means of injections of very dilute nitric acid, as recommended for chronic cystitis. Sir W. Roberts, in his *Diseases of the Urinary Organs*, gives the results of his experiments on the solution of uric stones, but they are not encouraging, and, in face of the success attending modern lithotrity, litholysis may now be disregarded.

(2) Lithotrity.—*Definition:* Lithotrity is an operation for crushing a stone in the bladder into fragments of such small size that they may be removed through the urethra without the use of the knife.

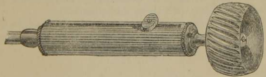
In 1878, Prof. Bigelow, of Boston, United States, introduced a most important modification of the previous practice of lithotrity. Up to that time it had been customary to prolong the operation over a number of sittings, each of only a few minutes' duration, chloroform being often unnecessary. It was thought that by a number of short sittings the effect of instrumental violence on the bladder would be reduced to a minimum; and after each operation the patient was kept very quiet, that the irritation from the fragments might be as slight as possible. Bigelow did not consider these arguments well founded, and urged that whatever the size or nature of the stone, if only it were considered possible to crush it, it should be removed at one operation; he considered that retention of the broken fragments in the bladder was far more likely to set up cystitis and other complications than was a prolonged sitting and the use of large and powerful instruments, provided that *all* the fragments were removed at the same time.

Great and startling as was this change, it appeared so rational that other surgeons were not slow to adopt it, and now Bigelow's operation (*litholapaxy*) may be looked upon as *the* operation of lithotrity.

Instruments: (1) Lithotrites; (2) evacuating catheters; (3) an aspirating bottle.

The *lithotrite* (Fig. 269) will vary in size and power with the amount of work required of it, and should *never be larger than is really necessary*. For very large, hard stones instruments of the greatest power and strength are required, and Dr. Freyer has suggested the addition of a crossbar to the wheel of the instrument for use in such cases; but usually the broad-edged

Fig. 269.



(This, and Figs. 270, 271, lent by Sir H. Thompson.)

wheel (Fig. 269) of Sir H. Thompson's lithotrite gives ample power. To seize and break a large stone into fragments a lithotrite is employed of which the female blade is largely fenestrated (Fig. 270), so that the well-serrated male blade passes deeply into it when screwed home; then the large fragments are broken up again and again by a lighter instrument of which the female blade is perforated rather largely at its heel (to allow detritus to escape), and the male blade is wide, roughened, and flat, or very slightly wedge-shaped. Medium-sized uric acid stones and large fragments of hard calculi may be treated by one lithotrite—the "semi-fenestrated" (Fig. 271)

Fig. 270.

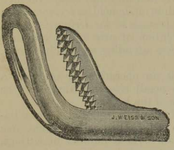
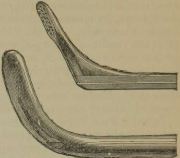
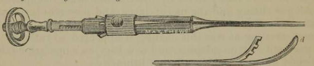


Fig. 271.



—which is a compromise between the above, the female blade being fenestrated and the male blade being wedge-shaped at the heel where it fits into a cleft in the female blade, both being wide and solid, for pulverizing, in front. The handle is either round and fluted (Thompson), or octagonal (Teevan), and of sufficient size to afford a firm hold. The button (*a*, Fig. 272)

Fig. 272.



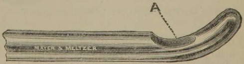
Matthews's screw lithotrite.

a, thumb-plate; *b*, screw; *c*, wheel. The angle of the female blade, *d*, is represented much too open.

when down acts upon the screw-catches (*b*), and thus connects the two blades; when pushed up by the thumb of the left hand, which grips the handle in crushing, it permits a free sliding movement of the male within the female blade, used for opening the blades and closing them upon the stone; when the stone is seized, the thumb-plate is drawn down, and now only a screw-movement, produced by turns of the wheel (*c*) on top of the male blade, is possible; this is used in crushing. The student should render himself practically familiar with these movements.

The blades should not fit so closely as to render it possible for the mucous membrane of the bladder to be nipped between them when they are closed;

Fig. 273.



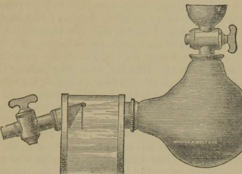
Evacuating catheter.

their margins should be well bevelled, and the sliding movement should be perfectly free.

The *evacuating catheter* (Fig. 273) should vary in size from No. 14 to 18, according to the size of the stone and of the urethra, and should be made of silver, and slightly curved at the end; the eye (A) should be large and placed near the extremity of the catheter on the upper surface.

The Aspirator.—Many forms are used; the desiderata are that it be easy of manipulation, that the fragments removed be visible, and that it be impossible to return them into the bladder when once they have been removed. Sir H. Thompson's aspirator (Fig. 274) meets these and others.

Fig. 274.



Sir Henry Thompson's aspirator.

The *preparatory treatment* consists in correcting disorder of the digestive organs, and allaying irritation of the urinary organs, by hip-baths, opiates, and the recumbent posture.

The danger of the operation is mechanical injury to the urethra and bladder. The great aim should be gentleness. An anæsthetic should always be given for Bigelow's operation.

Operation.—The patient should be placed as for sounding (p. 783). The pelvis should be raised four to six inches if the prostate be much enlarged. The object of raising the pelvis is to get the stone away from the neck of the bladder, the part most liable to injury: and especially if the prostate be enlarged, otherwise it cannot be reached at all. "The centre of the cavity, and space beneath it," says Sir H. Thompson, "form the area of operation." The bladder should contain a little water; it usually suffices to desire the patient to hold it for a couple of hours before the operation. Thompson does not consider the presence of water in the bladder to be essential.

The lithotrite, warmed and oiled, is now most gently introduced. After it has entered the fixed urethra it should be held in the mid-line, somewhat inclined toward the abdomen, and allowed to sink by its own weight into the membranous part; then with slight rocking movements its handle is cautiously lowered between the thighs and the instrument simultaneously pushed on. Difficulty must *never* be overcome by force, or the heavy instrument will leave the urethra. When in the bladder the lithotrite is used as a sound to find the stone. The next step is to seize it. There are two ways of doing this: (1) If the lithotrite with the blades pointing upward be pressed upon the floor of the bladder, so as to make a fossa there, the male blade drawn out gently and then pushed down, the stone will usually be caught at once; and after it has been crushed this process may be successfully repeated again and again with the fragments (Thompson). (2) Should this method not succeed, and, ultimately, when but few fragments remain, use the lithotrite as a sound till the stone is found; then cautiously open the blades, keeping the female blade fixed, seize the stone, draw down the thumb-plate, and rotate the lithotrite till the blades point upward; in this latter position, with the blades surrounded by urine, all crushing is done. Supposing the stone to be thus caught, the screw is gently turned till the grip is secure; then a sharp turn should be given to the wheel, and the stone will break into four or five pieces; the male blade must then be withdrawn and one of the fragments picked up and similarly crushed. Having once found the whereabouts of the fragments, little movement, other than rotatory, of the lithotrite should be permitted by the left hand. When all the larger fragments appear to have been broken up it is well to remove as much of the débris as possible before proceeding further; the male blade of the lithotrite should be screwed well home, and the instrument removed. The evacuating catheter is introduced into the bladder, the aspirator bottle charged with warm boracic lotion adjusted to it, the bottle squeezed, a current of lotion injected into the bladder, and, on relaxing the pressure, the bottle sucks out the lotion from the bladder, and with it numerous fragments of stone; this is repeated so long as the result is satisfactory. A lighter flat-bladed, or semi-fenestrated instrument may then be introduced, and the fragments still remaining in the bladder thoroughly pulverized; another aspiration may remove all the débris, but if any fragment be felt rattling against the evacuating catheter but not passing along it, the lithotrite must be introduced once more. The evacuating catheter and aspirator form a very efficient means of detecting the last fragment, for the suction draws all fragments toward the eye of the catheter, and if they are too large to pass they will be felt rattling against it; but it is generally admitted that in fasciculated and sacculated bladders the last fragment may be missed, from its not being drawn out of some recess into which it has fallen.

The *after-treatment* is in most cases limited to that of a slight subacute cystitis; sometimes the patient complains early of pain about the bladder; this is best allayed by a hot hip-bath and a morphia suppository; with the view of preventing cystitis, the patient should keep in the recumbent position for the first five or six days, and should take frequent doses of potash solution in barley water to neutralize the acidity of the urine; frequent hot hip-baths are also of much value. Sir H. Thompson states that the urine is frequently clear till the fourth or fifth day, and that then the cystitis commences; great care should, therefore, be taken until this period has been passed.

Besides cystitis other *complications* may arise. The most common are: an attack of rigors, like those after operations for stricture (p. 763); prostatitis or orchitis, for the treatment of which see pp. 766 and 811; atony of the bladder, which becomes full and overflows, considerable distress and constitutional disturbance often resulting before the state of the bladder is detected. A rubber catheter must be passed thrice a day, or tied in if its passage cause much pain, till the bladder regains power.

If death occur it will usually be from interstitial nephritis; pyæmia, exhaustion, and peritonitis, usually from a sacculus or from injury, are other causes. Before the patient is discharged cured, he should be most carefully sounded, and sent on a jolting journey.

Since the introduction of the "single-sitting" operation the *contra-indications* of lithotrity have been lessened in number; it may be stated that for patients of any age above puberty, not suffering from any obstruction of the urethra or prostate preventing the introduction of instruments of sufficient size, litholapaxy is the best operation, provided the calculus be not of extreme hardness or gigantic size. Sir H. Thompson states that the largest stone he has yet crushed weighed two and three-quarters ounces, and was composed of uric acid; the operation lasted seventy minutes. In India, Keegan crushed a stone of three and half ounces, and the patient went home on the fourth day; Freyer also successfully crushed a uric acid and an oxalate stone, each weighing over three ounces.

Lithotrity in Children.—The success of lithotomy in children is so great that for a long time surgeons hesitated to apply lithotrity to them, fearing that the injury done to their delicate and small urinary passages by such rough instrumentation would cause a high mortality; but apparently theory led them as much astray here as in lithotrity at several sittings. Litholapaxy has been practised extensively during the last few years, and with excellent results, by Keegan and other Indian army surgeons. Keegan (*Ind. Med. Gaz.*, June, 1885) reports 42 cases, aged 2–11 years, with 1 death; the stones varied from 5–308 grains (average 128 grains), and the average stay in hospital was less than one week. He states that boys of 4–6 years will usually bear a No. 7–8 lithotrite, and of 8–10 years a No. 8–10 lithotrite, the evacuating catheter being one or two sizes larger. He uses small fenestrated lithotrites which pass *easily*, and crush fine, so that a large catheter may not be wanted, and employs the aspirator freely; he deprecates all force and hurry. Some cases in which no lithotrite, however small, can be used with safety, will remain for lithotomy; probably also cases of large oxalic stones. Cadge (*loc. cit.*) thinks the advantages of litholapaxy as compared with cutting in boys will be: a mortality of not more than two or three per cent.; no risk of bleeding, wound of rectum, or seminal ducts; quicker recovery, and probably greater ease.

Freyer has used litholapaxy with much success in girls.

It must be observed, in conclusion, that the benefits of lithotrity are most fully shown when patients apply for relief at the earliest possible period after the descent of the stone into the bladder.

(3) LITHOTOMY.—*Definition:* The best definition of lithotomy is the homely English phrase, *cutting for the stone*.

The *indication* for this operation may be defined to be, the presence of a stone in the bladder which it is not judged expedient to remove by lithotrity.

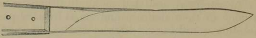
The only *contraindication* is the presence of such serious organic disease, especially of the kidneys, as would render death the almost inevitable result of the operation. But the surgeon is not justified in withholding the only means of relief, if the patient desire it, merely out of regard to his own mortality statistics.

Lithotomy in the male may be either *perineal* or *suprapubic*, and the perineal operations are divided into *lateral* and *median*. The *lateral* operation provides an exit for the stone where there is most space—through the lateral lobe of the prostate and ischio-rectal fossa; it cuts many bloodvessels, and involves free division of its prostate gland. The *median* operations have been devised to avoid these dangers; in them the incisions "are limited to the central part of the perineum, and are made in the line of the raphé itself or transverse to it, and lie mainly between the anus and the symphysis pubis. They do not approach the rami or the great vessels, nor do they run transversely near to the origin of the branches from the pudic artery. In no case do the incisions reach the external limits of the prostate gland." (Thompson.)

The *lateral operation* is doubtless the safest, if one operation be applied indiscriminately to all cases. There are many variations in the manner of performing it, and in the instruments employed by different surgeons.

LATERAL LITHOTOMY,—Instruments: a sharp-pointed lithotomy-knife (Fig. 275); a straight probe-pointed knife, to enlarge the internal incision, if necessary; a curved staff, deeply and widely grooved below and to the left, along the whole curve, and as large as the urethra will take; forceps (Fig. 276), straight and curved, of various sizes; and scoops (Fig. 277) for ex-

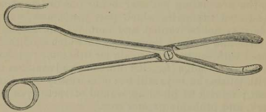
FIG. 275.



Sir W. Fergusson's lithotomy-knife.

tracting the stone; one or two sounds; artery and clamp-forceps, an air-tampon or petticoated tube, and a 4-ounce brass syringe. The forceps should have long blades, curved so as to retain the stone without undue pressure,

FIG. 276.



Walton's lithotomy-forceps; the blades are solid.

and largely fenestrated, the openings being filled with a bit of linen sewn in; such afford a firmer hold, take up less room, and are less likely than solid blades to crush the stone. Richard Davy's fishing-net forceps are very ingenious, add less to the bulk of the stone than even the scoop, and they catch

FIG. 277.

Lithotomy-scoop.

débris in case of fracture. A table about 2½ feet high, properly covered, should be placed with one end toward a good light.

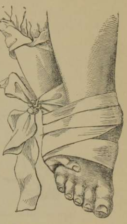
The bladder may contain a *little* urine—as much as would collect in an hour; it is better empty than full, for if the bladder be empty the stone will be close to its neck; if full when cut into, instead of contracting regularly, it falls together in folds, which may entangle the stone.

The bowels should be cleared the day before by castor-oil, and on the morning of operation by a simple enema.

The anæsthetic is given. Then the staff is introduced, and made to touch the stone if possible, to make it clear to the operator and his assistants. If the staff does not do so, a sound must be used, and should this not strike the stone, the operation must be postponed, for the stone may have been passed since it was last detected, or some mistake may have been made on previous occasions.

When satisfactorily introduced, the staff is held by the most trustworthy assistant, standing on the patient's left; his right fingers grasp the shaft, and keep the penis up, the right thumb rests against its handle, and his left fingers raise the scrotum; the concavity of the staff bears firmly at some point against the pubes. The staff should not be allowed to vary from the position in which the surgeon ultimately places it. Operators differ as to the best position; some hook it up under the pubes, with the handle vertical, to diminish the lateral bulging of the rectal ampulla; some press it down into the perineum, and often a little to the left of the raphé, that its groove may be the more easily reached; others render the membranous urethra accessible by inclining the handle of the staff, hooked under the pubes, strongly toward the abdomen, the penis being moderately stretched. We think that the latter position is best until the staff is reached (Cadge), but that for the second stage it should be hooked up strongly, with the handle vertical (Fig. 279). To expose the perineum thoroughly, flex and separate the thighs, bend the knees, and place each heel in the corresponding palm; the hand and foot should then be firmly bound together by a bandage (Fig. 278) about 1½ yards long, the centre of which is fixed by a clove-hitch around the wrist, whilst the ends are carried, in figure-8, round the ankle and foot, and include the hand. Pritchard's anklet and bracelet, buckled round ankle and wrist, can be securely hooked together or unhooked in an instant. Clover's knee-crutch and sling also act well. Next bring the buttocks to the edge of the table, and shave the perineum. An assistant on each side faces the surgeon, throws an arm over each leg, grasps the foot on the inner side, presses the knee into his axilla, and thus flexes and holds apart the thighs; they should be held symmetrically, and by their leverage the perineum should be steadied in the position desired by the surgeon. The assistant on the surgeon's right may sponge, if necessary. The surgeon now sits, with his back to the light, in front of the perineum, and sees that it is square before him. He then makes out the position of the pubic arch and the tubera ischii, and, lastly, passes his left forefinger, well oiled, into the rectum, to ascertain the size of the prostate, and its depth from the surface, and to arrange the staff as he wishes. This exploration further makes the rectum contract to the smallest bulk. The finger, when withdrawn, should be thoroughly cleansed in strong sublimate lotion; or the right forefinger may be used.

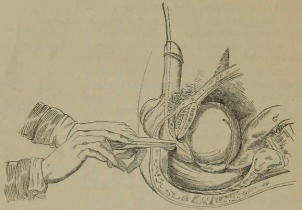
Fig. 278.



Hand and foot secured for lithotomy.

Everything being now prepared, and the surgeon having his instruments at his right hand, he fixes and steadies the skin of the perineum with the fingers of the left hand, taking care not to draw it up. Then he commences by a free division of the skin and fat, entering his knife just on the left side of the raphé, in the adult, about one and three-quarter inch in front of the anus, cutting downward with a sawing motion, to midway between the anus and the left tuberosity; this incision is shallow above, but enters more and more deeply into the ischio-rectal fossa. The blade of the knife should next be run along the surface of the exposed fat and cellular tissue, and then the forefinger of the left hand is thrust into the wound, about its middle, to feel the staff in the membranous urethra. Guided by the finger-nail, which is toward it, the knife divides, by a touch or two, the base of the triangular ligament, the fibres of the transversus, or any other tissue covering the staff, until the finger feels the groove of the staff in the membranous urethra. There should be no hurry to reach the urethra, no attempt to touch the staff with the knife-point in the first puncture; such will almost certainly lead to opening the bulb instead of the membranous part, which must be approached somewhat from below; but slight division of the bulb is probably frequent and harmless. This is the first stage of the operation.

FIG. 279.



Mode of cutting into the bladder, and of holding the knife—"like a dinner-knife."

The left forefinger-nail is now to be well fixed in the groove of the staff; the knife is slipped in over it, with its flat surface placed at an angle of at least 45° with the raphé; its point is made to pierce the tissue covering the staff, to enter the groove and to slide along the groove towards the bladder, dividing the membranous part of the urethra and the edge of the prostate. Some surgeons advise that the length of the cut in the prostate be regulated by the angle of the blade with the staff as it enters, and that the knife should be withdrawn *in* the groove of the staff; but practised lithotomists usually prefer to make their prostatic wound by cutting down and out as the knife is withdrawn. Until this is done, the left forefinger remains in the wound pushing the rectum back and to the right. This completes the second part.

Now the left forefinger is gently insinuated along the staff into the bladder with a rotatory kind of motion, dilating the parts as it enters, and feels for the stone. Next, the assistant removes the staff, and the surgeon cautiously introduces the forceps over the finger into the bladder—the finger being withdrawn as the instrument enters; at this moment, the forceps are opened, and with a turn of the wrist, giving a *scooping* motion to the open blades, the stone is caught as it is brought within their jaws by the gush of urine that escapes. The sides of the wound fall together so closely, that little urine escapes till the finger is withdrawn.

If the stone be not caught in this way, the forceps must be closed, brought into contact with it, the blades opened and made to grasp it; if seized apparently across its long axis, it is relinquished and seized again—then it is extracted by cautious, screwlike, and rocking movements of the forceps, *in the axis of the pelvic outlet*—down and back, where the interval between the bones is largest. The forceps should be withdrawn with their greatest width in the length of the prostatic incision, and the surgeon should try to make the parts gradually yield and dilate; but more or less tearing is very common, if not constant.

The prostate must not be dragged down in front of the stone and jammed against the pubic arch; it is sometimes necessary to push it back over the forceps with the left forefinger. Great care should be taken not to crush the stone.

When the stone is extracted, the bladder must in all cases be *most carefully* explored by the finger and hand above the pubes, and, if this be unsatisfactory, by the sound, for other stones or fragments; if the bladder contain much clot, it should be washed out with boracic lotion. The greatest care is necessary when the stone has broken or chipped, when multiple stones have been removed, and especially when, under these circumstances, the bladder is fasciculated.

Lastly, all bleeding having ceased, the wound should be thoroughly swabbed with chloride of zinc (grs. xl ad ℥j) and then covered with iodoform; for twelve to fourteen hours a large gum elastic or stout rubber tube may be desirable.

Difficulties and dangers in the operation.—(1) The external incision should be free, and brought low enough down, that the urine may subsequently escape freely without infiltrating the cellular tissue; it must not be deep high up over the bulb.

(2) In small, fat children it is sometimes a little difficult to distinguish between the staff and the left pubic arch, and I have seen the latter cut upon for some time.

(3) The urethra must not be opened too much in front; the membranous part is to be aimed at, though wound of the bulb is probably frequent and usually harmless.

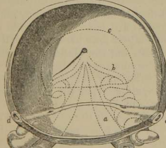
(4) Great care must be taken that the knife is well in the groove of the staff and properly lateralized, before pushing it through the prostate, and that during this act its point does not leave the groove for an instant.

(5) Wound of the rectum is most likely to occur in this deep incision, when the knife blade is too vertical.

(6) Wound of the trunk of the pudic, on the other hand, may occur if the blade is too horizontal. It is scarcely possible to wound this vessel by the superficial cut in an adult, so deeply is it placed on the obturator; but in a child, I have seen it wounded by a cut ending too near the tuber; it was easily secured.

(7) Wound of the back of the bladder may occur if the knife point is permitted to leave the staff in the onward thrust; the staff may be driven through it, usually by an accidental blow on the handle; and it must be regarded as possible from the most violent use of the forceps.

FIG. 280.



An internal view of the parts at the neck of the bladder concerned in lithotomy: *a a*, vasa deferentia; *b*, vesiculæ seminales; *c*, prostate with cut in the left lobe; *d d*, ureters. (Bryant, in *Lancet*, Feb. 11, 1843.)

(8) The incision in the prostate is important from several points of view. The direction of the incision is that in which the longest cut—about three-

quarters of an inch—within the limits of the gland is possible (Fig. 280). If the incision be too short to permit the passage of the stone, the gland is almost necessarily torn (usually down toward the rectum), both it and the surrounding tissues are more or less bruised, and are, therefore, more liable to inflame and slough under the irritation of urine; whence it follows that the mortality after perineal lithotomy increases rapidly with the size of the stone. What then should be done if, in a lateral lithotomy, the stone cannot be extracted easily through an incision within the limits of the left lobe of the prostate? Practice differs. Some would dilate—*i. e.*, tear, the prostate as much as possible, in the hope that the stone might be dragged through; others upon finding a real difficulty would divide the right lobe like the left; others again, and among them Cadge may be mentioned, prefer to extend the wound in the left lobe beyond the prostatic capsule. The dangers of the latter course are said to be hemorrhage and extravasation of urine into the pelvic connective tissue. Hemorrhage from the prostatic plexus is certainly a risk, especially in the old; but infiltration of urine is unlikely so long as an easier way out of the bladder is provided. After the extraction of large stones, the prostatic capsule having perhaps ultimately been divided, suppurative pelvic cellulitis has no doubt been frequent, but evidence of extravasation has been unusual, whilst that of bruising and sepsis has been ample. It would seem best, therefore, when there is difficulty, on account of its size, in extracting a stone, even with the scoop or fishing-net forceps, to notch the right lobe so far as it is possible from a left wound; and, if this does not give room enough, to extend the left incision sufficiently to do so. The question is not now so important, for stones above two ounces in the adult male ought, where crushing is impossible, to be extracted by the suprapubic and not by a perineal operation; indeed, the high operation has been successfully done by a surgeon who found, on performing lateral lithotomy, that the stone was larger than he thought. This course would certainly be preferable to introducing one of the formidable stone-crushers formerly employed to break up calculi which could not be dragged whole through the perineum.

(9) Difficulty in reaching the bladder with the finger may be due to a fat deep perineum or to a large prostate; the stone is not then felt, and there may be some difficulty in introducing the forceps. Some surgeons employ a blunt gorget, the point of which runs in the groove, to dilate the wound, and pass the forceps in the hollow of the gorget; but usually these enter easily if guided by a finger to the prostatic wound. If the stone be very large in such cases the difficulty may be extreme, and if it break it is hard to be sure that all fragments are out. But there is another way in which difficulty in entering the bladder may arise, especially in children in whom the parts are small and soft, and the bladder is more an abdominal than a pelvic organ. Instead of insinuating his finger *through* a wound in the prostate, *between* the latter and the staff, the surgeon pushes the bladder before him, perhaps tears it altogether from the membranous urethra, forces his way between the bladder and rectum, and makes a space, which has been taken for the contracted bladder, in the recto-vesical connective tissue. But he will be conscious that his finger has never passed through the tight ring of the neck of the bladder. If the mistake is discovered before the staff is withdrawn it is easy to enlarge the wound in the prostate, but when the staff has been withdrawn it has usually been found impossible to reintroduce it, and the stone has been left in the bladder. This accident would never occur if, after the deep incision, a long slender director (C. Heath) were passed along the groove into the bladder, the staff withdrawn, and the finger insinuated into the bladder between the director and the urethral roof; or

if a pair of dressing-forceps were similarly introduced and used to dilate the opening, and even to remove the stone (Cadge).

(10) Difficulty in seizing the stone will arise when the stone is *encysted* in a sacculus, from the mouth of which a small portion only, often encrusted with a cap of phosphates, protrudes. This cap may break off and form a separate stone, which is removed easily, the encysted calculus remaining undiscovered. In dealing with an encysted stone the surgeon must endeavor with finger nail and scoop, aided by a finger in the rectum, to dislodge it; notching the margin of the sac is even more perilous than the above procedures. Should careful sounding reveal the state of matters, the suprapubic operation should be selected, that direct vision may guide. Encysted stone is likely to be met with only in elderly men, behind an obstructing prostate; but it has been found even in women, in sacculi which very likely are congenital. If the stone lie in a vaginal cystocele or a cystocele behind the prostate, a finger in the vagina or rectum may lift it within reach of the forceps.

(11) Fracture of the stone and multiple calculi have been alluded to.

The *varieties of this operation* are the following: Many surgeons have made unimportant changes in the operation as above described. But the following seem to rank as varieties: *Buchanan*, of Glasgow, employs a rectangular staff, with the shorter branch grooved at the side. The surgeon passes the left forefinger into the rectum (where he keeps it during the whole operation), feels that the prostate is between his finger and the short branch of the sound, keeps the angle of the staff just in front of the gland, and depresses the handle, so that the angle may project in the perineum between the anus and the bulb, and that the left thumb may feel the groove. The handle is now committed to an assistant with instructions to depress it steadily and keep it in the same position. The surgeon then plunges a bistoury into the groove of the staff in the mid-line just in front of the anus. The bistoury (a straight instrument whose blade, cutting on both edges near the point, is of the same length as the short branch of the staff) is pushed to the extremity of the groove, being kept strictly at right angles to the handle of the staff. In withdrawing it, it is made to cut at first outward and downward, then directly downward, so that the incision turns, as it were, round the finger in the rectum. The advantages of this operation are said to be that it is simple, easy, free from hemorrhage, because removed from the transverse vessels of the perineum; that the incisions are small, and yet the wound is roomy, from the extensibility of the rectum.

Avery, of Charing Cross, invented an ingenious staff from which, by turning a handle, a trocar was made to pierce the perineum from within, thus making it impossible to miss the bladder; but his instrument has been surpassed by that of Smith, which has often been highly spoken of as rendering the operation very easy and certain.

AFTER-TREATMENT.—A suppository of morphia may be introduced before the patient is removed to bed. The patient should lie upon a mackintosh on his back with his shoulders elevated; large sponges (changed every six hours, washed in water, then in boracic lotion, before they are dried) should be used to soak up the urine. Some surgeons introduce a large gum-elastic tube through the wound into the bladder for the urine to flow through for the first twenty-four hours, or the surgeon may introduce his finger after a few hours to clear the wound of coagula. Pain must be allayed by morphia, the wound kept perfectly clean, the diet nourishing, and then in favorable cases the urine begins to flow by the urethra in about one week (sometimes in two or three days), and the wound heals completely in four or five. It often becomes covered by a membrane (p. 154).

Complications.—(1) Severe *hemorrhage* may proceed at the time of the operation, or after it, from the superficial or transverse artery of the perineum, from the artery of the bulb, or from the prostatic plexus of veins; rarely from the pudic. The bleeding orifice should be secured with a ligature if possible; by drawing the wound well open or pressing up its floor with a finger in the rectum, we may be able to seize the vessel with clamp-forceps, which may be left on the vessel for a few hours; if this be impossible, the bleeding point must be compressed as long as may be necessary with the finger. A general venous or arterial oozing must be checked by ice in the wound, or, better, by a sponge in hot water; these failing, by plugging the wound. The best plug is the "air-tampon" of Buckston Brown; it consists of a gum-elastic tube surrounded by an India-rubber bag, which can be distended with air through a stop-cock; the tube is placed in the bladder and the bag blown up. An efficient substitute may be extemporized by putting a "petticoat" of linen round the tube, and after the latter is placed in the bladder, plugging the space between it and the petticoat with pieces of boracic lint. In forty-eight hours the tube and plug may be removed together. Plugging should never be resorted to lightly; the blood is often forced into the pelvic connective tissue, and even up to the kidneys, there to decompose and excite suppuration. Care should be taken that blood does not accumulate in the bladder. This may be suspected if the patient become pale and exhausted, the bladder full, and painful straining set in, for naturally there is but little pain after lithotomy; and it must be combated by washing out clots with boracic lotion, and then inserting a tube to keep the bladder empty and at rest. If the bleeding is severe it must be dealt with as above. Primary hemorrhage and shock and secondary hemorrhage cause a good many deaths. Urine may be similarly retained in atonied bladders and cause much suffering before it is found out.

(2) Pelvic cellulitis, usually suppurative, is often indicated by adynamic fever, and even this may be low. I have once or twice found a slightly tender swelling in the mid-line above the pubes, which turned out to be an abscess. Cadge has noted the presence of urine of fecal smell as a sign of abscess near the rectum. The wound should be explored with a finger, that any pus in its neighborhood may be let out. A swelling such as the above should be aspirated and incised if pus be found.

(3) *Simple peritonitis* is recognized and treated as usual. It may rise from wound of the bladder, extension from a sacculus, or pyæmia.

(4) *Pyæmia* accounts for one-fourth of the deaths.

(5) *Interstitial nephritis*, as usual, is chiefly responsible for the mortality; about one-third of the deaths seem to fall to its share.

Median Lithotomy.—The *bilateral operation* is performed by making a curved incision, with the convexity upwards, from one side of the perineum to the other, between the anus and bulb of the urethra; opening the membranous portion of the urethra upon a median staff, and then pushing a double *bistouri caché* into the bladder, by which both sides of the prostate may be divided.

Allarton's operation.—An operation on the same principle was proposed by Allarton (*Lithotomy Simplified*, 1854; *A Treatise on Modern Median Lithotomy*, 1863). A staff with a *central* groove is introduced and held firmly against the pubes. The operator introduces his left forefinger into the anus, and pressing its point against the staff into the prostate, passes a long-handled straight-pointed knife into the perineum, exactly in the mid-line, about half an inch above the anus, till it hits the groove in the staff. Then he moves the point of the knife a few lines towards the bladder and next withdraws it, enlarging the incision upward as he does so to the extent of from three-quarters of an inch to an inch and a half. Next he passes a long probe along the groove of the staff quite into the bladder, withdraws the staff, and insinuates his left forefinger through the prostate, which is not cut but dilated, above the probe. Now, if the stone be small, it probably comes in contact with the finger, and may be withdrawn with forceps. If not, the wound in the prostate may be further dilated, or, in cases of difficulty, the stone may be crushed, or the operation converted into the bilateral one. Among the advantages of this operation Allarton enumerates the impossibility of missing the bladder, the small amount of cutting and of danger of bleeding. According to Sir Henry Thompson, this operation "appears to become dangerous, just in proportion as injury by laceration or overpressure, under the name of dilatation, is superadded to the incisions." Want of space is the failing of median operations; they are, therefore, not adapted for children, nor for large stones, nor for large and rigid prostates; it is better to incise both sides of the prostate than to dilate beyond passing the finger into the bladder. But for foreign bodies not otherwise removable and for examination of the bladder this operation has many applications.

Suprapubic Lithotomy, or the High Operation.—In this the bladder is opened where uncovered by peritoneum in the hypogastrium. Its *advantages* are: Ease of performance, greater space afforded for the removal of large stone, less danger of hemorrhage, of wound of the rectum, of the ejaculatory ducts (leading to sterility), of fistula—though the wound has often been long in healing, of breaking the stone, or of leaving fragments behind.

The bladder must first be washed out if the urine be foul, and then well distended with boracic lotion, to raise the line of reflection of the peritoneum as much as possible and bring a large non-peritoneal surface of the bladder in contact with the abdominal wall; the penis must be clamped to prevent escape of the fluid. Petersen advises that the rectum shall next be distended by means of 14–16 ounces of water in an India-rubber bag; he supports Garson in the statement that this raises the peritoneum still above the pubes, whilst Barwell and Cadge maintain that scarcely one-half an inch more is thus gained; but all are agreed that distention of the rectum steadies the bladder and renders it more prominent. Both of these injections must be cautiously practised, for the bladder has been ruptured, Polaillon thinks dilated ureters have been injected, and the rectum has been torn.

An incision 2–3 inches long is made in the mid-line, starting from the pubes, and deepened to the linea alba, which is opened for 2 inches, and the edges retracted; now the bladder is cautiously exposed with two forceps, or some blunt instrument, the peritoneum being recognized, if exposed, and pushed up; the bladder is fixed by two sutures passed well through it on either side of the mid-line that it may not disappear behind the pubes when the fluid escapes. A small opening is next made in the mid-line of the bladder, a finger passed in and the stone examined, and such enlargement as may be found necessary is made chiefly toward the pubes, though when the peritoneum is clear there is no reason why its line should not be approached; if possible, the wound should permit extraction of the stone without bruising of the edges. A finger in the rectum or vagina is of much assistance in removing the stone. When this is effected the bladder wound should be accurately closed by catgut sutures passed through its muscular coat. The superficial wound may be closed above, a large tube being inserted below to make ample provision for the escape of urine should the stitches give way, or the whole wound may be left open; the bladder must be constantly drained by a soft rubber catheter, from which a weighted tube is carried into a basin of carbolic beneath the bed. An antiseptic dressing should be kept on the wound; and some antiseptic wool, changed every few hours, applied round the junction of the penis and catheter. The *dangers* of the operation are: rupture of the bladder or rectum, to be treated by sutures; wound of the peritoneum—if this occur before the bladder is opened the surgeon must decide whether he will proceed or wait; peritonitis from wound, extension, or pyæmia; pelvic cellulltis, septic or from extravasation; pyæmia, and interstitial nephritis.

The special *indications* for this operation are: a stone too large or hard to be crushed; an encysted stone; perhaps some cases of recurrence apparently traceable to non-removal of the last fragment after crushing. It was formerly preferred to lateral lithotomy in cases of greatly enlarged prostate, when the tubera ischii were too close to permit extraction of the stone, or the hips so ankylosed that the perineum could not be exposed.

Choice of Operation in Cases of Stone.—The answer which must now be returned to this question is very different from that which would have been given ten years ago, but it is not yet settled. Speaking of *stone in the male*, it may be said that *litholapaxy*, as the least dangerous operation, should, whenever possible, be performed. Apparently, it cannot be done in certain cases in children because a sufficiently powerful lithotrite cannot with safety be introduced, but the limits of possibility in this respect may perhaps be extended. Stones of 3–4 ounces in the adult have been successfully attacked, but an inexperienced operator would be wiser to cut in such cases; below this weight, crushing should certainly be done—above it, cutting. Stricture is no bar to crushing, unless it cannot be so treated as to allow the introduction of instruments, as might happen, especially in some traumatic cases; but it is probable that a perineal lithotomy with division of the stricture from outside would be less likely in many cases to excite kidney complications. An encysted stone cannot be crushed.

In the cases above mentioned some cutting operation must be done; lateral lithotomy will in children always be preferred to median or suprapubic, unless litholapaxy is abandoned because of the large size of the stone, when suprapubic must be done. In adults suprapubic lithotomy should be done in all cases unfit for crushing, except in the case of severe stricture, when the choice between median and lateral lithotomy will depend on the size of the stone.

There are two other points of view from which this question may be considered: 1. The success of the various procedures. As regards *mortality*, litholapaxy in children, according to Cadge, will *probably* have a mortality of 2–3 per cent.; in 112 cases of adults, whose mean age was 62½, Sir H. Thompson lost 3 cases, or 2¾ per cent. Perineal lithotomy in children has a mortality of 5 or 6 per cent.; up to 50 its mortality is probably not more than 10 per cent., but after this it becomes serious—for example, of 169 cases Cadge lost 29, 16 being 60–70, and 10 over 70. Further, the mortality of the lateral operation has been 40–45 per cent. with stones over 2 ounces. Suprapubic lithotomy according to Tuffier (Ashhurst's *Encyclopædia*, vol. vi.) has had a mortality of 27 per cent. in 120 cases at all ages.

2. According to Cadge, *recurrence* of stone from descent of a fresh calculus occurs about once in 50 cases; but from leaving behind a fragment, and from phosphatic deposit it is much more frequent after lithotrity than lithotomy, and here the suprapubic operation should have the advantage. Including phosphatic masses, very probably forming on small fragments left in sacs, pouches, and recesses in large prostates, Cadge thinks that probably 1 in 5 patients suffer relapse after lithotrity; but this includes careless hospital patients. After lithotomy, recurrence at Norwich has occurred in rather more than 5 per cent.

Stone in Women.

Stone in women is much less frequent than in men. The symptoms are much the same. Several operations are practised.

Litholapaxy should be practised both in children and in adults if the stone is not too hard or too large. *Suprapubic lithotomy* will probably prove the best operation for those left, especially in girls; but, in adults, *vaginal* or *urethro-vaginal lithotomy* may prove better than suprapubic for stones of two to four ounces, which can be thus removed without much bruising, and consequent non-union or sloughing of the edges.

Rapid dilatation of the urethra, by Weiss's dilator, followed by the finger, has hitherto been preferred for stones up to one-half ounce, even in children; this rarely leaves incontinence, but the danger of it will probably bring litholapaxy to the fore for these cases. Division of the outer half inch (the least dilatable part of the urethra) was combined with dilatation by Sir W. Fergusson, who thus extracted a stone three inches in circumference, and the woman had control of her urine immediately afterward.

Vaginal and *urethro-vaginal lithotomy* are performed by cutting from the vagina on to a median staff and dividing upon it the vesico-vaginal, and, if necessary, the deep part of the urethro-vaginal septum. After removal the wound is carefully sutured like a vesico-vaginal fistula (*q. v.*).

CHAPTER XLV.

DISEASES OF THE MALE GENITALS.

Diseases of the Penis.

Phimosis is a constriction of the orifice of the foreskin, so that the glans cannot be uncovered without difficulty, if at all; it is often combined with adhesion of the prepuce to the glans. It may be congenital or caused by inflammatory swelling or scar-contraction. Besides the obstruction which it occasions to the functions of the organ, it prevents the washing-away of the secretions of the glands around the corona glandis, and thus renders the patient liable to frequent *balanitis*, and in advanced age, it is thought, to epithelioma; it is a source of great trouble if venereal disease be contracted.

Treatment.—In young children the orifice of the prepuce is very dilatable, and if the prepuce be forcibly retracted and any adhesions torn through further operation may be avoided by directing the nurse to retract the prepuce at least once a day. Unless this treatment be adopted whilst the child is only a few months old, the orifice of the prepuce becomes too rigid to admit of it; and then, in order to produce a radical cure, the surgeon must *circumcise*.

Circumcision.—Wash the parts. Clip the prepuce just where the tip of the glans lies with a pair of polypus forceps applying them rather obliquely, parallel to the corona; then hold the prepuce with forceps, slide a knife down the polypus forceps and remove the part beyond them; retract the skin, slit up the mucosa along the dorsum to the corona and expose the glans completely; wash away all secretion and scrub with an antiseptic. Then trim the mucous membrane off parallel with the corona and about one-twelfth of an inch from it, leaving the frænum entire. All bleeding must be stopped (there is usually little in children) and then the skin of the penis should be accurately sewn to the mucous membrane by eight interrupted catgut sutures, or by a continuous suture, starting at the frænum.

In adults the operation is easily conducted antiseptically. After the operation is completed the penis should be washed with carbolic lotion, sprinkled with iodoform crystals, and dressed with iodoform wool, which should be fixed to the (dried) penis, and water-proofed with collodion. The dressing may be left on a week, unless there be pain, redness, or swelling; the wound will usually be found healed, and the portion of the catgut sutures within the wound will often be absorbed. Another wool and collodion dressing should be applied for a few days longer. In chancrous and gonorrhœal cases disinfection should be most careful immediately the mucosa is slit up.

In babies, wash and apply iodoform as above, then stretch the penis, and apply a narrow strip of linen, spread with boracic ointment, tightly enough to check bleeding into the areolar tissue or œdema; apply plenty of boracic ointment around this, and have the dressing changed after each act of micturition, keeping the parts well greased.

It would certainly be a good thing if the Hebrew custom were generally adhered to; retraction should never be practised, on a fairly healthy child, when consent to circumcision can be obtained.

Paraphimosis exists when a tight prepuce is pulled back over the glans, constricting it and causing it to swell. It is most commonly a result of inflammation following impure connection.

Treatment.—The surgeon first compresses the glans, well oiled and covered with a bit of lint, between the thumbs, so as to squeeze the blood out of it, whilst he draws the prepuce forward with his fingers. If this fail, or the attempt prove very painful, the constricting band, which is at the orifice of the prepuce, must be divided freely in the middle line on the dorsum. The constriction lies above the roll of swollen tissue which surrounds the corona. If this operation be delayed, the tissues will become so matted together, that the prepuce cannot be drawn forward at once, even after the division of the constricting band, but all pain will be relieved. In a few days the tight band usually ulcerates through in the furrow in the dorsum; such a thing as gangrene of the glans is almost unheard of.

Epithelioma of the penis (squamous) generally begins as a warty excrescence on the inner surface of the prepuce, which increases, and after a time ulcerates. Fresh warty growths sprout up, and the body of the organ is invaded; ulceration spreads with fetid discharge; the urine irritates greatly; the glands in the groin and iliac fossæ become affected, and the patient dies exhausted.

This disease may be complicated with syphilis; it may, in its earlier stages, be indistinguishable from vascular warts, or condylomata, if ulcerated; induration of the penis at the base of the wart points strongly to epithelioma. The rule hence deducible is, that free and early extirpation should be performed in all doubtful cases; and that if the disease return the part should be amputated.

Amputation of the Penis.—When only the glans is involved, stretch the penis, and tie a small drainage tube around its root; divide the skin all around the organ, at the level at which it is intended to amputate, and then beginning above, cut straight through the corpora cavernosa down to the spongy body—the sheath of which is easily recognized; half an inch or so of the spongy body can easily be separated, before it is cut through, from the part to be removed, and left projecting from the stump. The two dorsal arteries and two arteries of the corpora cavernosa (in the centres of the bodies) are tied, the tourniquet is removed, any other bleeding vessels ligatured, the skin brought together loosely across the stump, the projecting urethra is slit up a little along its lower wall, and stitched thus open to the skin around; plenty of iodoform constitutes the best dressing. A bougie should be passed into the urethral orifice occasionally, when healing is well established. This is the best way to prevent a most troublesome stricture, and burying of the urethral orifice as scar-contraction proceeds. It can be done only in early cases limited to the glans. When the disease is more extensive, less corpus spongiosum can be saved. Professor Lister modifies this operation by forming antero-posterior skin flaps, which are sutured together, and the urethra is stitched to the margins of a slit in the posterior flap.

When the penis is involved as far back as the scrotum, remove the entire organ with its crura, as advocated by Pearce Gould (*Lancet*, May 20, 1882, p. 821). The patient is placed in lithotomy position, the scrotum divided all along the raphé, the corpus spongiosum exposed, separated from the corpora cavernosa back to the triangular ligament, and then divided so as to leave a stump of sufficient length to be brought out of the wound in the perineum. The crura penis are separated with a raspatory from the rami of the pubes, and the incision should be carried around the penis, so as to divide the suspensory ligament, the dorsal arteries being secured. The whole penis is now removed. The end of the corpus spongiosum is cut up and stitched to the posterior part of the scrotal incision, the rest of the wound closed, and a tube inserted.

Epispadias.—As the front parts of the segments of the cranium, and the soft parts covering them, may be imperfectly developed, leaving the fissures known as *cleft-palate* and *hare-lip*, so the corresponding parts of the sacral series, if arrested in development, will leave fissures. The pubic bones may be imperfect at the symphysis, leaving a gap, completed by ligament; or there may be complete absence of the anterior wall of the bladder, the abdominal wall, the pubic symphysis, and of the upper wall of the urethra. There is then a wide gap at the lower part of the abdomen, from which the red mucous membrane of the bladder protrudes, like a hernial or vascular tumor. At the lower part the papillary orifices of the ureters may be seen, from which the urine is incessantly dribbling. The umbilical cicatrix is always wanting, being blended in a scar which surrounds the protruding and everted bladder. This condition is called *ectopia* or *extroversio vesicæ*. The testicles and scrotum may be well developed. If the penis is present, the urethra is open all along the dorsum.

The surgeon may, under such circumstances, content himself with mechanical appliances for palliating the patient's distressing inconveniences; or he may attempt a radical cure.

Wood's Operation (*Med.-Chir. Trans.*, vol. lii. p. 85).—A square skin-flap is raised from the abdominal wall above and large enough to cover the protruding mucosa; and a pear-shaped flap is cut in either groin with its neck toward the pubes, the two together being large enough to cover the square flap; the former is turned down, and the latter are twisted in over it, and fixed by sutures, their raw surfaces lying against that of the square flap, whilst its skin surface only is exposed to the urine. All the raw surfaces whence flaps were raised are drawn together by sutures, and the child is kept lying with the shoulders raised and the knees flexed over a pillow. All the flaps should be ample, as contraction, leaving the mucosa exposed below, is frequent in cases that heal. Where this exposure is only slight, it may be remedied by twisting in flaps from the upper ends of the labia, or labia-like surfaces covering the testes, and uniting them to the original flaps; or, when the penis is present, by roofing over the urethra with a flap raised like an arch from the scrotum, or by two flaps raised from the penis, so that when covering in the urethra their raw surfaces shall touch. A urinal is fitted, and the escape of urine in all directions prevented by this operation, which has been successful in many cases operated on by Professor Wood and others. Contact of clothes with the tender mucosa is also prevented. Much suffering has sometimes been caused by growth of hair into the artificial bladder, and phosphatic accumulation upon it.

Hypospadias is a deficiency of the parts constituting the under-surface of the urethra. In the first degree, which is very common, the urethra ends at the base of the glans, the frænum being absent; this requires no treatment. In the second degree, the urethra ends in the scroto-penile angle, rendering the projection of urine impossible, and causing sterility. In the third degree, the urethra opens in the perineum, the scrotum is split, the testes being in labia-like folds, and the penis very small; these cases often give rise to errors as to sex, and admit of no relief.

Wood's operation for the relief of hypospadias of the second degree consists in transplanting the upper part of the prepuce (which in these cases is usually abundant, and shaped like a hood) by means of a button-hole aperture, through which the glans penis is pushed, so as to bring a bridge-like flap of the skin over the deficient urethra. The skin surrounding the latter is turned up so as to form reversed flaps, an elongated one being taken from the front of the scrotum. Upon these the raw surface of the prepuce is placed, and becomes united so as to form a continuation of the urethra. This operation has been performed in a good number of cases and with very satisfactory results.

A condition which often accompanies these cases is more difficult of cure, viz., a downward curvature of the *corpora cavernosa* during erection. It is caused by the unyielding nature of the cicatricial tissue which forms in the site of the deficient *corpus spongiosum*. Mr. Wood has improved several cases in which this condition has been present by section of the cicatrix in several places or by dissecting it away, and applying a thin metal splint during and after healing.

Penile fistulæ are exceedingly difficult to cure, unless all urine be prevented from passing through them. This may be done by teaching the patient how to pass a soft catheter, and after the operation causing him to draw off all his urine; this method is applicable even to fistulæ, through the prostate, from bursting of an abscess in both directions. For penile and scroto-penile fistulæ we can open the membranous urethra and drain the bladder. Then a flap may be glided or twisted so as to cover the opening.

Diseases of the Testis.

Examination of Cases of Intra-scrotal Tumor.—Let the patient stand before the surgeon.

(1) Inspect the scrotum, noting any abnormal redness, swelling on one or both sides, the shape and situation of any swelling, and whether it has a neck running up to the inguinal ring.

(2) Take one side of the scrotum in either hand and press the forefinger and thumb together at the top of the scrotum, above the swelling, so as to grasp the cord, and determine carefully whether the elements of the cord can be felt with equal distinctness upon the two sides, for if there is any

viscus coming down from the abdomen into the scrotum it will necessarily conceal the cord more or less. If the cord is concealed the surgeon at once thinks of hernia, reducible or irreducible, and looks for impulse, reducibility, gurgling, resonance, and traces the swelling to the abdominal ring. But the cord may be thicker than normal and yet its individual elements are quite distinct; we must then make out whether the thickening is due to thickening of the vas or to swelling of the connective tissue, muscle, and vessels. This is done by taking the cords between the points of the fingers and thumbs and letting their constituent elements escape bit by bit from the grasp; the firm, cord-like vasa will soon be felt, their diameters can be compared, and we can soon tell whether any enlargement is uniform or irregular, giving rise to bossy swellings. If the vas is not enlarged, and the cord is, the fault must lie with the softer parts only.

(3) Slip the hands down so that the swelling and testicle lie in the hollow between the fingers and thumbs, the latter being outside. The whole surface of the mass can now be explored by slight movements of the fingers and thumbs, and compared with the other side. The practised hand will, in most cases, at once tell whether the swelling is due to some effusion into the tunica vaginalis or to enlargement of the testis itself. It notes: the shape of the swelling, its exact situation in relation to the testis and cord, whether concealing these parts or not: the involvement of skin; the character of the surface—smooth, irregular, or bossy; the consistence of the mass and of any prominent parts; fluctuation; pain; tenderness and testicular sensation; weight; impulse and translucency. The latter point is best tested by pressing the finger and thumb in upon the cord and thus squeezing down the swelling and rendering the scrotum tense over it; then looking through the almost closed fist, a roll of paper or a stethoscope placed upon the scrotum, whilst an assistant holds a candle close to the other side. When the testis is enlarged, the first question is whether the body or epididymis is chiefly affected, and this is often quickly decided by the thumb, which in gliding over the outer surface as the testis is pressed gently forwards, strikes against the hard crescentic mass of a swollen epididymis, or feels the hard globus minor below.

(4) Percussion is required only for the elimination of irreducible hernia.

(5) Exploratory puncture and examination of fluid, if any escapes, are sometimes useful.

(6) It is now often necessary to go into the history and make a physical examination of other parts, to find out the cause of the disease. The points of chief importance are: injury, direct or to the urethra; gonorrhœa, syphilis, and tubercle.

Development and Descent of the Testis.—The testis is developed from the genital ridge, situate internal to the Wolffian body from which the kidney is formed. At the beginning of the seventh month the testis enters the internal abdominal ring and passes through the inguinal canal, so as usually to reach the bottom of the scrotum by the end of the eighth month. It is *preceded* by a pouch of peritoneum, into the back of which it protrudes largely. This movement usually takes place against gravity; the gubernaculum shortens as the movement proceeds, and Curling regards it as drawing upon the testis, but Allen Thomson denied this, leaving the matter doubtful.

Normally, the peritoneal pouch shortly before birth closes from the internal abdominal ring down to a point a little above the testis, the intervening portion remaining as a fine cord or disappearing.

Anomalies of development are numerous. The whole seminal apparatus may be absent; both testes may be absent, they may be fused together with the kidneys, or there may be but one testis; in the former case the genital organs remain undeveloped, there is no sexual desire or power, the larynx remains small, the voice unbroken, growth of hair on the face and body is scanty, and the limbs tend to remain round and fat; but with one healthy testicle the man is practically normal. A supernumerary testis has never been found, but has been simulated by some cyst or tumor of the cord or bit of omentum. More or less of the vas or epididymis may be absent, but the testis in this case is generally fully developed, and the characteristics of the male present.

Anomalies in Descent.—The testis may be retained in the abdomen, in the inguinal canal, or just outside the external ring; or it may pass into the pelvis, through the femoral ring on to the thigh or up on to the abdomen, or into the perineum—on one or both sides. The testis may lie *in front* of the tunica vaginalis, with its non-serous surface looking forward, or it may be turned upside down, the vas coming straight off from the globus minor, which is above the major.

Of 103 children, Curling says that 5 had both, 7 the right, and 9 the left, testis in the groin, and 4 had both, 3 the right, and 5 the left, in the abdomen; 10 came down in 3 weeks, the rest were not down by the fifth week. If not down within 12 months, the descent is rarely completed later without rupture. A testis within the abdomen is more likely to develop fully and is much less trouble than one in the inguinal canal, where its enlargement at puberty is resisted, where it is liable to violent compression and other injuries, and occasionally to protrusion (often with a hernia) through the external ring—the result being great pain and inflammation, with symptoms of strangulation. When just outside the external ring, in the perineum, or, indeed, anywhere but in the scrotum, the testis is very liable to injury. When both testes are retained, the patient is not impotent, but is, in the great majority of cases (Curling), sterile, the semen containing no spermatozoa. It is said that a retained testis is specially liable to malignant disease. When one testis is down it *may* hypertrophy. The clew to the diagnosis of all these cases is absence of the testis from the scrotum, and imperfect development of the latter; the shape, consistence, and peculiar pain caused by pressure, will help.

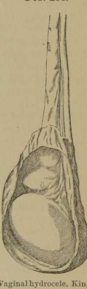
Treatment.—If a testis is not down at the end of twelve months Curling advises that a truss be applied to keep it and the threatened or existent hernia up. When a testis lies just outside the external ring, it may sometimes be pressed and drawn toward the scrotum out of harm's way; if not, Wood's recommendation of a truss with a ring pad covered by a water cushion may be followed; the testis lies in the aperture, and is protected by the edge, which keeps up any hernia. But this state is not at all likely to prove satisfactory. When retained in the canal and liable to occasional protrusion, truss treatment is scarcely possible; and at puberty other measures will very likely be rendered necessary. The surgeon will in many of these cases in children feel justified in making an attempt to place the testicle in the scrotum, at the same time performing a radical cure of any hernia. In older patients frequent pain may necessitate castration. From the perineum a testis with its cord should be lifted out through an incision starting from the ring, and transplanted bodily into the scrotum laid open from the ring to its lower end.

Neuralgia produces fits of excruciating pain, which leaves the parts tender and slightly swollen. The treatment must be that of neuralgia generally. A few leeches, ice, or evaporating lotion, and opiate or belladonna plasters or liniments, sometimes afford relief. The internal remedies most likely to do good are steel, quinine, and other tonics. Extreme sensitiveness of the testis, so that it cannot bear the slightest touch—the representative of irritable ovaries—is another form of this disorder sometimes met with in nervous hypochondriacal subjects, at puberty, after inflammation, and in persons who suffer from any prostatic irritation or spermatorrhœa. Tonics and cold applications may be tried. The cause of the affection should be ascertained, and, if possible, removed. It may be associated with mental disease and epilepsy, and the *aura epileptica* may arise in the diseased testicle, and in such cases castration would probably be advisable.

HYPERTROPHY of one testis rarely results from retention (Wood, *Path. Soc. Trans.*, vol. 28) or loss, by injury or disease in early life, of the other.

ATROPHY is more common and may result from senile degeneration or wasting disease; excessive use; or impaired blood supply, which may be caused in many ways. The spermatic artery may be compressed or thrombosed, the spermatic veins may be varicose—a badly fitting truss may sometimes compress the cord; a large hydrocele or hæmatocele may compress the gland constantly and uniformly; but by far the most frequent cause of any marked atrophy is orchitis from various causes, especially mumps, the wasting in these cases being sometimes so rapid that the process might be an acute fatty degeneration with absorption of the products, whilst in others the shrinking of inflammatory fibroid tissue is obviously the pathology. The testis may thus dwindle to the size of a pea. There is no cure. Rarely shrinking epididymitis leads to atrophy, the fibrous body of Highmore being probably also involved and the entering vessels constricted.

FIG. 281.



Vaginal hydrocele. King's College Museum.

HYDROCELE signifies a collection of serous fluid in connection with the tunica vaginalis, testicle, or cord. There are several varieties, some of which are common and important, others rare and unimportant. They may be thus classified: *Hydroceles of the tunica vaginalis;* common, congenital, or inguinal. *Hydroceles of the testis;* encysted hydrocele of the epididymis, hydroceles of the tunica albuginea. *Hydroceles of the cord;* encysted, congenital, or diffused.

In the COMMON VAGINAL HYDROCELE fluid collects in the tunica vaginalis (Fig. 281) usually on one side only, forming a pyriform swelling, with the large end down, which begins below and grows upward, slowly as a rule, but sometimes rapidly, perhaps reaching an enormous size, but usually smaller than a cocoanut; it is heavy, fluctuating, tolerably tense and smooth; the testicle cannot be felt distinctly unless the sac is unusually lax, but it lies behind and below, and sharp pressure here detects an obscure firm mass, and excites the peculiar sickening testicular pain. As a rule there is no spontaneous pain, but merely a sense of dragging from the loin or groin, proportionate to the weight of the mass; the cord is plain above it; there is no impulse, the swelling is irreducible and translucent, and the fluid is usually clear, yellow, highly albuminous, and contains fibrinogen.

In some cases the sac is of hour-glass form, being constricted either where the skin of scrotum and groin unite or just above testis where the funicular process should be obliterated (Curling), and the presence of adhesions may greatly modify the shape; it may be so tense that fluctuation is doubtful, or so lax that the testis is plain; hernial protrusions or adhesions may rarely render the surface irregular; the testis may lie in front (p. 804) or be adherent to the anterior wall of the sac; somewhat severe pain may occur when effusion is rapid; the cord may be concealed and an impulse be present when the funicular process has remained open as high as the inguinal canal or internal ring, for then the fluid distends the external ring and canal, and may even form a swelling in the iliac fossa; on tapping such a hydrocele a hernia may descend; translucency may be lost on account of opacity of the fluid or thickening of the sac. Admixture of blood with the fluid, which becomes chocolate, is not uncommon; sometimes cholesterine is present in large quantity. The sac may be densely fibroid in old cases and in those of syphilitic origin; it may even calcify.

Causes.—Hydrocele occurs at all ages and is specially common in hot climates; it may be hereditary. Often no cause is evident; blows, strains of the groin, and fatigue are sometimes assigned; the irritation of loose fibroid bodies sometimes found in the tunica vaginalis, of an encysted hydrocele of the epididymis, or of iodine injection; any inflammation of the testis, but especially the acute gonorrhœal epididymitis and the chronic simple and syphilitic orchitis; blocking of lymphatics in lymph-scrotum (p. 224).

Diagnosis: from irreducible hernia (p. 636); from tumors of the testicle —*e. g.*, cystic disease, by pyriform shape, more distinct fluctuation, presence of testicular sensation below and behind, less weight, translucency, and the results of tapping.

Treatment.—In children many hydroceles disappear spontaneously, so evaporating lotions, collodion, and weak iodine, sometimes get undeserved credit. One tapping rarely cures, repeated tapping is rather more often successful. In children, multiple puncture of the sac with a lance-headed needle, repeated once or twice, is usually successful; the fluid escapes through the punctures into the areolar tissue, the scrotum, and even penis, becoming œdematous, and is thence absorbed. In adults somewhat more serious treatment is generally required to bring about a *radical cure*. This may be effected by the injection of irritant fluids, the passage of a seton through the sac, or aseptic incision and drainage. It is obvious that a radical cure must not be attempted whilst disease of the testicle, causing the effusion, persists, nor indeed until many months after cure of such disease.

Tapping.—The surgeon makes out the position of the testis by feeling its resisting mass, exciting testicular pain, and noting the shadow cast by it on examining the scrotum by transmitted light. He then grasps the scrotum above the swelling, stretches the skin over it, selects a point in front, at or below the middle, free from veins, and thrusts a trocar and canula—guarded by the forefinger half an inch from its point—into the swelling; after penetration, the instrument is turned slightly upward above the testis; as he withdraws the trocar he pushes the canula with his thumb-nail well into the sac and allows the fluid to escape.

Injection of iodine was first practised by Sir Ranald Martin with much success upon thousands in Calcutta. The fluid having been drawn off as above with a platinum canula, ʒj–ij of tinct. iodi mixed with an equal quantity of water are injected with a syringe made to fit the canula. Some pain, inflammation, and effusion follow, and when they subside, the sac generally secretes no longer; if it does, the operation may be repeated with a stronger solution of iodine, having again made certain that the sac contains no loose bodies, encysted hydrocele, or diseased testis. Too little action is commoner than too much, and may be increased after twenty-four hours' waiting, by causing the patient to move about; excessive inflammation may be limited by rest, elevation, and fomentation of the part, and removal of the fluid. The injection sometimes causes extreme pain. In the old and feeble, sloughing of the scrotum may occur. Recurrence of the hydrocele is not uncommon.

Pure carbolic acid deliquesced in glycerine has recently been recommended as an injection by Dr. Keyes (*New York Med. Record*, Feb. 10, 1886), who had successfully employed it in more than fifty cases without any serious accident. It was not always necessary to keep the patient in bed, but occasionally sharp inflammation and prompt reaccumulation of fluid (requiring to be drawn off with the aspirator) occurred on the second day. Berkeley Hill has published two successful cases (*Brit. Med. Journ.*, June 19, 1886). The injection causes little or no pain.

An ordinary *seton* or bit of *silver wire* may be passed through the sac and kept in till sufficient inflammation is excited; but suppuration may follow this treatment.

Antiseptic drainage (Volkmann) is very successful and safe. Cut down upon the lower part of the sac (which appears pearly) through a one-inch incision, clamp it with two artery forceps, and incise between them; sew the edge of the tunica vaginalis to the skin with catgut, insert and retain a tube for six or seven days, and dress antiseptically (p. 624). Some make a longer incision and use no tube.

Congenital vaginal hydrocele differs from the common form in that the funicular process has not become obliterated and the tunica vaginalis communicates with the peritoneum by an opening which may be free or very small. The distinguishing point is that pressure on the swelling reduces the fluid into the abdomen, though sometimes only very slowly; the swelling is larger at night than in the morning, but such variations are noticed in the common vaginal hydrocele; if the swelling enters the canal an impulse will be present. Like the corresponding hernia, this form of hydrocele may occur in adults, and, on the other hand, irreducible hydroceles are common in infants.

Diagnosis: chiefly from reducible hernia (p. 636).

Treatment.—A truss should be worn to prevent the descent of a hernia and to cause closure of the neck of the sac; in children this is usually successful. If not, try multiple puncture or tapping. After puberty, these plans usually fail, and iodine injection, with a finger over the ring, has been practised. Southam cured an obstinate case by ligature of the neck of the sac; and this, with the suture of the ring, would be the best treatment for cases complicated by hernia.

Inguinal hydrocele, due to distention of the sac round a testis retained in the groin is rare, for the tunica vaginalis in these cases usually communicates freely with the peritoneum.

Fig. 282.

Encysted hydrocele of the epididymis. Middlesex Hospital Museum.

In encysted hydrocele of the epididymis (Fig. 282) fluid collects beneath the serosa and usually below the head of the epididymis (Curling). There is generally but one cyst, but may be two or three, or, rarely, many; their mode of origin is unknown. Both sides may be affected. A single cyst is oval or round, rarely holds more than three or four ounces, but may contain forty; tense, fluctuating, smooth (unless lobulated from multiple cysts), and the normal testis is felt below, in front and to the inner side (usually); there is no tenderness, but may be a good deal of pain; the cord is clear above; the swelling is irreducible and translucent; the fluid is clear, colorless, and almost free from albumen, or milky from the presence of spermatozoa (Liston), and containing a cloud of albumen. Spermatozoa are rare in small, and may be absent in large cysts, which, as Curling remarks, shows that the cysts are not due to rupture or dilatation of a duct; but rupture of a duct into a cyst and escape of spermatozoa is frequent and sometimes obvious to the naked eye.

DIAGNOSIS: from vaginal hydrocele is simple and obvious; from encysted hydrocele of the cord, low down, impossible, unless spermatozoa are present.

TREATMENT.—The same as vaginal hydrocele, if any is necessary.

HYDROCELE OF THE TESTIS, small, thick-walled sacs beneath the tunica albuginea, are very rare, and of merely pathological interest.

ENCYSTED HYDROCELE OF THE CORD is common in young children, and usually unilateral; the fluid probably collects in unobliterated portions of the funicular process, but some of the smaller cysts are perhaps due to distention of the tubes of the organ of Giraldès. One, two, or sometimes a chain of round or oval, tense, elastic, smooth swellings, rarely so large as a hen's egg, form on the cord either in the canal or scrotum; the testis is free, unless the cyst is so low as to overhang the epididymis; the cord is healthy above and below the cyst, if it can be felt; the cysts have no true impulse, and are irreducible and translucent, if they can be examined; the fluid is like that of vaginal hydrocele, and never contains spermatozoa (Curling).

DIAGNOSIS: from encysted hydrocele of epididymis—see above; from nodule of omentum—translucency, fluctuation, cord healthy above, puncture; from reducible hernia—it cannot be wholly reduced, when pushed up slips down again without cause, teneseness remains the same, and there is no true impulse; from irreducible hernia in the canal it is very difficult.

TREATMENT: as vaginal.

CONGENITAL ENCYSTED HYDROCELE, in which the cyst opens into the peritoneum, is very rare.

DIFFUSED HYDROCELE OF THE CORD.—A colorless, or yellow clear, albuminous fluid sometimes collects in large quantity apparently in the connective tissue of the cord, forming a diffuse, smooth, lax, cylindrical swelling, reaching upward from the testis—which is plain below it—toward or into the canal; the cord is healthy, if it can be felt; the swelling is often pyramidal with the large end down and fluctuates here, but the shape varies if the testis is raised.

The DIAGNOSIS from irreducible omental hernia is said to be very difficult when the cord cannot be felt above.

TREATMENT.—Counter-irritation, tapping, drainage.

HÆMATOCELE signifies an extravasation of blood in connection with the tunica vaginalis, testis, or cord. It occupies most of the positions that a hydrocele may occupy, and very commonly supervenes upon hydrocele. It may, however, be primary, from injury or some obscure cause. When it supervenes upon hydrocele there may have been some blow or strain, some injury to vessels in tapping, or, as Gosselin suggests, some delicate vessels in recent adhesions may give way.

Vaginal hæmatocele is the most important: encysted hæmatocele of the epididymis and of the cord, and diffuse hæmatocele of the cord are all rare. The signs are similar to those of the corresponding hydroceles, but there are certain differences. The traumatic form will be of acute origin, there is often more or less bruising of the skin; in the non-traumatic form, a hydrocele has usually enlarged and become hot and painful somewhat suddenly—these symptoms perhaps running on to suppuration, perhaps subsiding; but in the most difficult cases the history is simply that of steady, rapid, apparently causeless enlargement of the testis—in fact, that of malignant growth. As compared with hydrocele, the swelling grows more rapidly, is heavier, more solid, more painful, opaque, and prone to suppurate. The diagnosis of vaginal hæmatocele from malignant disease of testis depends chiefly on the history, signs of glandular or general infection, and the results of puncture; a malignant tumor would probably bleed freely, the blood would be bright, and no diminution in the size of the mass would occur; a hæmatocele would yield dark and altered blood, and would diminish.

TREATMENT.—At first, rest, the recumbent posture, elevation of the scrotum, and ice, to prevent or allay inflammation, and allow the blood to be absorbed. When bleeding has ceased for forty-eight hours, an attempt may be made to draw off the blood with a large aspirator needle, using little suction, and maintaining uniform pressure on the scrotum; after which continue the ice. Should suppuration occur, make a free incision to allow pus to escape. Some old cases form ponderous tumors, consisting of the distended tunica vaginalis, lined with clot and layers of fibrine, and filled with bloody serum. If tapped, they probably fill again. For such cases, make a free incision, turn out the clot, suture, drain, and dress antiseptically; in all such incisions a small puncture should first be made high up, the finger introduced, and the scrotum slit down upon it—for the testis may be in front and has been divided. If the testicle itself is wasted and indistinguishable among the fibrinous layers, the whole mass must be extirpated; and this may be done without hesitation in elderly men, as it will render recovery more speedy.[1]

The author saw a large number of these cases at Madras under Dr. Paul. The tumors were mostly as large as cocoanuts; the tunica vaginalis exceedingly thick and rigid, and in some cases actually converted into bone. The natives of India possess wonderful power of recovery after injury or operation, but their blood seems deficient in self-staunching quality, so that bruises are apt to lead to very extensive extravasation, and slow, persistent hemorrhage is liable to occur into the sacs of abscesses and serous cavities, including the tunica vaginalis. (See Letter from Madras in *Medical Times and Gazette*, 1874, vol. i. p. 486.)

VARICOCELE signifies a varicose state of the veins of the spermatic cord. It is induced by various causes of *varix* (p. 410), and usually appears in young adults. It is much more common on the left side than on the right; the traditional explanation of which is that the left spermatic vein is pressed upon by fecal accumulations, is longer than the right vein, and opens at right angles into the renal vein. The swollen veins form a pyriform mass with the large end down, which has been aptly compared, as regards feel, to a bundle of worms; their irregular coils can often be seen through the skin, which also may contain varicose veins; there is an impulse on coughing; the swelling disappears when the patient lies and the scrotum is raised. The left testis, which is usually the larger, is often under these conditions the smaller, and its circulation must be very faulty; dragging pain is often severe, especially in hot weather, and there may be neuralgia (p. 804); hypochondriasis is sometimes induced. (For the diagnosis from hernia, see p. 637.)

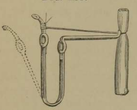
TREATMENT.—In many cases sufficient relief may be obtained by attention to the bowels, frequently washing the scrotum with cold water or astringent lotions to constringe the skin, and supporting it with a light, suspensory bandage, braced firmly to a band passing round the pelvis ("Bandages"). When the symptoms are more severe, or when the patient wishes to enter the public services, something more must be done. Numberless methods have been employed to obliterate the veins, but the part being difficult to render and keep aseptic, septic cellulitis, thrombosis, pyæ-

[1] See case by Bowman, Lancet, 1853, vol. i. p. 177.

mia, septicæmia, and tetanus, have arisen occasionally with all, frequently with some. Operations which merely cause thrombosis are valueless as a means of cure, so the veins are now always divided, tied, or excised.

Two of the simplest operations are those of Henry Lee and John Wood. Lee's method is to separate the veins from the vas in the usual way (p. 803), to bring the veins close up under the skin, and pass two pins, about three-quarters of an inch apart, behind them. The veins are compressed at these points by twisted silk, and divided subcutaneously between them with a tenotome. The pins are removed in three or four days, when danger of bleeding is over. Wood passes a loop of annealed iron wire subcutaneously round the veins (first between them and the vas, then back, through the same holes, between veins and skin), and connects it with his spring tractor, as shown in Fig. 283. It would probably be better for this to have a broad plate to rest against the scrotum, and the instrument might easily be made to work through an antiseptic wool-dressing. A. E. Barker obtained satisfactory results with sunken subcutaneous carbolized silk ligatures at one or two spots.

Fig. 283.



Wood's spring tractor for varicocele.

In cases of very large veins, Lee cut out a considerable length of the veins and skin with them, between ligatures. Free hemorrhage and sloughing, however, have occasionally followed this practice. But since the employment of antiseptics has reduced the danger of septic inflammation of veins to a minimum, this plan has been often and successfully followed: An assistant holds the veins between his fingers and thumb—the vas being separated from them—whilst the surgeon makes a 1-inch longitudinal incision through the superficial tissues, exposes the veins, and places two catgut ligatures round them with an aneurism needle; he then cuts across the veins between the ligatures, removing a length if he pleases, closes the wound, and dresses it antiseptically (see p. 625). Retention is not uncommon after these operations. Even after the last, enlargement of other veins may occur, but does not generally cause trouble. Atrophy of the testis has very rarely occurred, probably from section or inclusion in a ligature of the vas. The spermatic artery usually clings to the vas, and is separated with it, but it is probably not uncommonly included with the veins, when the deferential and other arteries supply the testis.

Inflammation of the Testicle.—The two portions of which the testicle is composed—epididymis and body—are frequently diseased, independently of each other, and in the diagnosis of diseases of this organ it is well to bear this fact prominently in mind. In the healthy state the epididymis can be only indistinctly felt at the outer posterior part of the ovoid, smooth, elastic body, which constitutes the mass of the organ. Inflammation in earlier stages may be almost limited to one or other of these parts, but later on it often spreads and involves both, the part first affected usually suffering chiefly.

Inflammation of the entire organ is well designated *testitis*; inflammation of the epididymis, *epididymitis;* and inflammation of the body of the testicle, *orchitis.*

Acute epididymitis is caused by some irritation in the urethra, such as gonorrhœa, impaction of a calculus, or the passage of instruments, and is probably due in most cases to extension of inflammation from the urethra along the vas.

The disease is most frequently met with as a complication of gonorrhœa—often after injury, strain, or fatigue—and on its appearance the urethral discharge generally lessens or ceases, to return again as the inflammation subsides. Of 1342 cases, about two-thirds were on the left side and one-third on the right; in seven per cent. of hospital and four per cent. of private cases, both sides were affected (Sigmund). The onset is usually sudden and accompanied by febrile symptoms of variable intensity; vomiting or nausea is not uncommon, and the bowels are often obstinately confined. The patient complains of great pain in the testicle and groin. The scrotum is usually red (this is very characteristic) and obviously swollen: examination shows that the enlargement is due to swelling of the epididymis, which is more or less distinctly felt as a hard crescentic mass at the outer posterior part of the testicle, the body of which lies in its concavity. Acute epididymitis is usually complicated by some reddish fluid in the tunica vaginalis (*acute hydrocele*), forming a swelling which is softer than and conceals the body; the part is very tender. The whole of the structures of the cord are swollen and tender, and the vas is thickened. The inflammation sometimes spreads forward to the body, and *testitis* results. In rare cases *acute abscess* forms, being characterized by fever, much local pain and tenderness, and ultimately involvement of the skin over a softening swelling, usually in the globus minor. Often a hard knot occupies the position of the globus minor for months or permanently; it is due to fibroid infiltration, often producing obstruction of the epididymis—so that double epididymitis is not an infrequent cause of sterility; the testes remain well developed, except in rare cases in which the fibrous tissue shrinks so as apparently to constrict the vessels entering the testis.

Acute orchitis, or inflammation of the body of the testicle, usually results from a blow or wound, or occurs as a "metastasis" in mumps; more or less rare causes are pyæmia, gout, and rheumatism; it may arise by extension of inflammation from the epididymis. The *symptoms*—general and local—are the same as in epididymitis; but it is the body of the testicle which is now enlarged, forming a smooth, ovoid, very tender swelling upon which the epididymis can scarcely be felt; the pain is said to be more severe than in epididymitis, but the cord is not so much affected, the vas especially is not enlarged, and acute hydrocele is quite the exception.

Orchitis (especially pyæmic, which causes few or no symptoms) may end in abscess, or even in sloughing of the whole gland. Non-pyæmic abscess is slow in reaching the surface, the testis remains swollen, tender, and acute exacerbations of pain occur. In other cases orchitis leads to rapid atrophy (p. 805), and this is more common after the orchitis of mumps than after any other variety. Mumps affects the testis only after puberty, and usually on one side only, the testis becomes affected as the parotid swelling subsides (about sixth to eighth day), sometimes with high fever and delirium, though the inflammation is mild and soon reaches its height. It is said that orchitis, without affection of the parotid, may arise during epidemics of mumps. I have known two cases which commenced distinctly in the epididymis, but this, Rilliet says, is quite unusual.

The occurrence of acute inflammation in an undescended testis, especially in the abdomen, or in a testis with which a congenital hernia is in contact, may lead to peritonitis; fatal peritonitis following a blow on a testis in the groin is one of the most difficult questions which the infective theory of spreading inflammations has to explain.

The distinction between acute epididymitis and orchitis is anything but sharp, either clinically or etiologically; we sometimes get orchitis without any involvement of the vas in gonorrhœa, and epididymitis may follow a blow. The orchitis of mumps or of pyæmia would seem to be surely due to infective embolism, and it seems likely enough that this may sometimes occur in gonorrhœa—the orchitis being then comparable to the synovitis.

Treatment.—Absolute rest, recumbent posture, and a strap across the thighs, or a small pillow between them, to raise the parts; leeches along the cord—not on the scrotum—followed by assiduous fomentation; morphia at night to allay pain, and laxatives. Ice packed round the testis, or still better, a coil of Leiter's tube with iced irrigation, applied within twenty-four hours of the onset, is often very effective in relieving pain and preventing and reducing swelling. Some hardness and swelling always remain after the acute attack. As soon as the very acute stage has subsided, *compression* will be found a useful means of reducing the swelling. The affected testicle is separated from its fellow, pressed down from the ring, and encircled with strips of adhesive plaster, one-half inch wide, applied as tightly as the patient can bear. A long strap is first applied round the spermatic cord immediately above the testicle, the skin being protected by a strip of lint to prevent cutting; and then, from this, overlapping straps are applied in the long axis of the testis, so as to cover the whole organ. These are to be held in place, finally, by another long circular strap placed over the one first applied.

Acute inflammation of the testicle is sometimes treated on the plan of Leroy d'Etiolles, of making a deep puncture with a thin sharp knife into the body of the testis. By this incision a small quantity of serum and blood are emitted, and almost instantaneous relief is given to the pain. Scarcely any other means, beyond a little aperient medicine or the use of a cooling lotion, are required. Prof. Henry Smith, who follows this practice extensively, thinks that its efficacy is due mainly to the tension being taken off the compressed tubes of the testicle through the division of the tunica albuginea. Slight hernia of the tubules often occurs, and it is said that so many have protruded as to lead to atrophy of the gland.

Prof. Wood punctures the tunica vaginalis when much distended, believing that the speedy relief of pain is owing to the evacuation of the effusion from this cavity, and that it is unnecessary to wound the tunica albuginea, since the swelling and pain mainly result from the effusion into the epididymis and its serous covering.

Chronic Inflammation of the Testicle.—Chronic inflammation of the testicle is said to be of three kinds: simple, syphilitic, and tubercular—the first two of which usually affect the body of the testicle, and the last in the first instance usually the epididymis. The real pathology of cases placed in the first group is unknown.

Simple chronic orchitis may follow the acute affection or may be due to injury, and chronic from the first; it is said to occur also as a gouty affection. When it follows the acute disease both epididymis and body may be involved. The patient complains of some pain in the testis, and there is some tenderness on manipulation, testicular sensation being retained. The epididymis, the body of the testicle, or both, can be made out to be enlarged; the cord as a whole is enlarged; hydrocele is common, obscuring the shape of the enlargement. Suppuration may take place, and after escape of the pus, a mass of granulation tissue and testicle substance may protrude through the tunica albuginea and skin (*hernia testis*). In other cases the inflammatory tissue may become fibroid and cause such pressure on the testicles as to lead to their destruction and permanent atrophy of the organ.

Treatment.—Walking should be limited and avoided for a time if it aggravate the pain. Of internal remedies mercury and iodide of potassium are the most useful, either singly or in combination. Tonics are also of use.

Inunction of the scrotum with mercury ointment or the oleate of mercury (five per cent.) is very serviceable, but of local means careful strapping, as above described, is the best; if the orchitis be complicated with hydrocele of the tunica vaginalis, draw off the fluid that the pressure may be effectually applied.

SYPHILITIC INFLAMMATION OF THE TESTICLE occurs in two forms—either as a diffuse infiltration of the body of the testicle with a fibroid material, or as a more localized deposit in the form of gummata. The first form of the disease is met with as a, usually, late secondary symptom, the second as a tertiary symptom of syphilis. The part affected is the body of the testicle, which in the diffuse early form becomes much and rapidly enlarged and indurated, often reaching the size of a goose-egg; the diffuse affection is often bilateral, the gummatous less commonly, and its growth is much slower, occupying many months. As a rule, the shape of the swelling is ovoid, the epididymis cannot be felt, and the surface is smooth; but if the testicle be the seat of the gummata, or if shrinking fibroid bands be irregularly distributed through the organ, the surface will be uneven—in one case from the projection of gummata, and in the other from the projection of testicle substance between the depressed cicatrices; there is neither pain (other than dragging) nor tenderness; testicular sensation also is lost. The cord is normal and the vas especially is not thickened. There is almost always a hydrocele, and the serosa often adheres to the lower part of the testis. The fluid then lies above the testis, and the two together may form one ovid mass, the fluid being indistinguishable from the solid, for the tunica vaginalis is usually thick and opaque, and may be so tensely filled as to be merely elastic.

An early syphilitic *epididymitis* occurs, but is rare.

Under proper treatment resolution almost always occurs, but in some cases atrophy of the organ results; rarely, suppuration round a gumma occurs, the superficial tissues become implicated, the pus is discharged, and a hernia testis may follow. This is quite a rare and late complication of syphilitic testicle.

As to *morbid anatomy:* the body of the testis is the seat of a more or less diffuse interstitial round-celled infiltration, which where most dense undergoes fatty degeneration and presents to the naked eye the appearance of a gumma. The tunica vaginalis is thick and more or less adherent.

TREATMENT.—This consists in administering mercury, or iodide of potassium, according to the stage of the disease in which the affection of the testicle occurs; in the early enlargement from diffuse fibrous infiltration, mercury will be found the most effectual drug, and in the gummatous form of the disease full doses of iodide of potassium may cause the absorption of the syphilitic growths; but in many cases a prolonged administration of the drug is followed by little or no change. After apparent cure, recurrence is not infrequent. Locally the hydrocele may be tapped and the testis strapped over Scott's dressing. If suppuration take place the pus should be let out as soon as detected.

TUBERCULAR DISEASE OF THE TESTICLE usually occurs in feeble and cachectic individuals of young adult age, but it is sometimes met with in the robust and apparently healthy; in children, and after middle age. It is frequent in the subjects of phthisis, but it may occur independently; it usually affects both testes, though one is often much worse than the other. The disease first affects the epididymis, commencing in the globus minor or major; it extends thence along the vas, implicating the vesiculæ seminales, and perhaps the prostate, bladder, etc., and may spread also to the body of the testicle, as gray granulations radiating from the mediastinum. The affection begins insidiously, and, being unattended with pain, it may be only accidentally discovered by the patient as a hard lump at the back of the testicle, which reaches its full size in a few weeks (8–10), after which softening usually begins. In a well-marked case the epididymis is enlarged, hard, craggy, and has a hard crescentic shape; perhaps patches of softer consistence, due to degeneration, may be scattered here and there throughout it; the body of the testicle is usually soft and normal in size. There is no pain or tenderness; testicular sense is preserved. There is no general thickening of the cord, but the vas is enlarged and often irregular; by rectal examination the vesiculæ seminales may be felt enlarged and indurated. There is usually no fluid in the tunica vaginalis. There may be signs of tubercle in other parts of the genito-urinary apparatus and in the lungs. Later on in the disease patches of softening appear in the indurated epididymis, and the skin over them may become implicated, and finally it may give way and the tubercular matter may be discharged. If an abscess occur in the body of the testicle its discharge may be followed by a hernia testis as in chronic orchitis. A testis with one or two fistulæ may remain stationary for months or years; or fresh sinuses may keep forming whilst the disease spreads up the vas to the prostate and bladder, and the health fails progressively. Suppuration in a few cases does not occur, but fibroid thickening.

Treatment.—This consists in maintaining the health and general condition of the patient by the general means given at page 98; any softening caseous masses being scraped out and iodoformed.

König would castrate when the disease appears limited to the testis, as a prophylactic measure against extension or generalization; the operation might be done even in the presence of early phthisis, the patient being fairly strong; but advanced phthisis or general affection of the genito-urinary tract prohibits the operation, unless the testicle be a source of great trouble. König thinks double castration rarely justifiable, the vasa and vesiculæ being generally involved.

Fungus or Hernia Testis.—When the fibrous tunic of the testis has been perforated by abscess, a soft fungus, composed of the tubuli seminiferi and granulation-tissue, is apt to protrude; in rare cases a fungus springs from the tunica albuginea. This, if small, should be dusted with iodoform and repressed by pressure with lint and strapping; bichloride of mercury or iodide of potassium with tonics may be given, if there is a syphilitic history. Should this fail, Syme's operation should be resorted to, of making two semi-elliptical incisions ( ), one on either side of the fungus, removing the narrow edge of unhealthy skin round the fungus, and then bringing the skin from either side over it and employing sutures and other measures for procuring adhesion. In tubercular cases free use of the sharp spoon or castration is indicated.

New Growths.—The new growth most common in the testicle is sarcoma, but enchondroma and carcinoma also may be found, and teratomata rarely occur.

Enchondroma is rarely met with as the sole element in any tumor of the testicle, but there is an apparently pure enchondroma in the Museum of the College of Surgeons. Cartilage occurs in cystic sarcoma as above mentioned; it may largely occur also in sarcomata of rapid growth (*chondro-sarcomata*).

Sarcoma is usually said to occur in two forms: 1. Cystic sarcoma—the commoner variety, by many called an adenoma; 2. Pure sarcoma.

1. *Cystic sarcoma* or *adenoma* contains a large number of cysts, full of brownish fluid, in the fibrous-looking matrix; its growth is not very rapid, it reaches a large size and has been known to generalize only in rare instances. In minute structure it much resembles the mixed parotid tumor

(page 549), for it consists of various forms of connective tissue—fibrous, mucous, and cartilaginous—with round and spindle cells. The cysts are probably due to dilatation of the tubuli testis or the ducts of the rete testis, for numbers of smaller spaces lined with epithelium are visible in other parts; intracystic growths are sometimes met with.

2. *Pure sarcomata* are fortunately less common: they are round, spindle, or mixed-celled, sometimes melanotic, and in young children may contain muscle-cells; they develop in the tissue between the tubules, which are compressed and soon destroyed. They begin in the body, rarely in the epididymis. Their growth is usually very rapid, but some of the mixed forms (fibro-sarcoma) may increase comparatively slowly. It usually infects the iliac glands (Butlin) like cancer. Both testes are rarely affected.

Carcinoma is rare and is almost always of the soft variety and of rapid growth; it is indistinguishable, except microscopically, from sarcoma.

Congenital tumors—chiefly dermoid cysts, are described, myosarcomata have been mentioned before.

The *symptoms* and *signs* of the sarcomata and carcinoma may be given together and the differential diagnosis then considered. The gland swells more or less rapidly and forms a firm, heavy, smooth, elastic swelling, usually ovoid in shape with flattened sides, scarcely, if at all, painful or tender, and causing by its weight merely slight aching or dragging in loins. After a time it enlarges rapidly, sometimes reaches a great size and feels soft; the surface often becomes bossy, the prominences being softer than the rest of the mass; large and tortuous vessels appear under the skin; the cord swells; there are progressively severe and darting pains along the cord into the loins, with a heavy dragging sensation in the gland, but tenderness is absent and testicular sensation is lost early; the iliac and lumbar glands become affected, generalization occurs, and emaciation, exhaustion, and death soon follow.

Diagnosis.—New growths in their early stages are distinguished from inflammatory enlargements (chiefly syphilitic) by their tendency to grow continuously instead of resolving, suppurating, sloughing, or producing fibrous tissue. In very early cases, therefore, it will be necessary to watch the effect of anti-syphilitic treatment.

Next comes the diagnosis from fluid swellings—hydrocele with opaque coats and hæmatocele: the history, pyriform shape, fluctuation, lesser weight of these and the presence (if demonstrable) of the testis at the hinder and lower part of the swelling will be the first points to look to, but exploratory aspiration is the best means of diagnosis. In hydrocele we shall draw off serous fluid (p. 806), in hæmatocele altered blood, and the tumor will diminish in size; in cystic disease, some brownish, mucous or blood-tinged fluid, and there will be evidence of collapse of a cyst; in sarcoma or cancer bright blood in quantity will escape, but the mass will not diminish, and cells may be found in the needle. From hæmatocele the diagnosis of malignant growth may still be doubtful.

With regard to the differentiation of cystic disease from sarcoma and cancer (which are indistinguishable), we must rely upon the slower, steadier growth, roundness, smoothness, and fluctuation of any bosses, the healthy state of the cord, and absence of glandular enlargement, and of cachexia, even with a large tumor; twenty-nine of thirty-two cases of cystic disease occurred between twenty and forty (König).

Treatment.—If the result of the above examination show the disease to be either cystic adenoma, sarcoma, or cancer, the iliac glands being normal and signs of generalization absent, castration should be at once performed. In cystic adenoma the prognosis is very good, in sarcoma cases of cure have been recorded, but in cancer Kocher has been unable to find a single case in which there was not more or less speedy recurrence.

Castration is performed thus: The scrotum being shaved, the surgeon grasps behind the tumor, stretches the skin and, *in all cases, makes an incision into the tunica vaginalis*, to examine the testis, lest there be an error in diagnosis. He next extends the cut from the external abdominal ring to the very bottom of the scrotum. If the skin be adherent, or diseased, or if the tumor be very large, two elliptical incisions may be made, so as to remove a portion of skin between them. Then he separates the cord from its attachments, and an assistant holds it firmly between his finger and thumb, or with a stout pair of hooked forceps, to prevent it from retracting when divided. He now passes his bistoury behind the cord, and divides it; and seizing the lower portion, dissects out the testicle. The spermatic and deferential arteries, and any others requiring it, are then to be carefully tied; and the wound must not be closed till all the bleeding has ceased, as this operation is often followed by secondary hemorrhage. It is well to wash out the wound with chloride of zinc (gr. xx ad ℥j); drain and dress as after herniotomy (p. 624).

In cases of malignant disease, the inguinal canal may be laid open, the cord followed up and cut again as high as possible; and in tubercular disease the vas may thus be removed.

Of 98 English, French, and German cases, 7 died: 2 of peritonitis, 3 of tetanus, 1 of septicæmia, 1 not stated. This statement is probably too high for the results of recent years.

Diseases of the Scrotum.

Œdema of the Scrotum.—The loose cellular tissue of this part is liable to distention from dropsy. Punctures with a needle will relieve it. If great and tense œdema, from erysipelas or diffuse cellulitis, should threaten sloughing, a free incision should be made (Liston, "Acute Œdema of the Scrotum," *Med.-Chir. Trans.*, vol. xxii.). The latter case very much resembles extravasation of urine, but may be distinguished by the absence of swelling in the perineum, or of obstruction in micturition.

Epithelioma scroti is commonly called the *chimney-sweep's cancer*, because it is said to be due to the irritation of soot and to be seldom met with except amongst that class of men. Some other irritants are believed to have the same effect on the scrotun. Thus, it is stated by Dr. Paris that smelters are liable to a similar disease. And, on the other hand, it is said that soot may produce this disease on other parts beside the scrotum.

It commences usually as a florid vascular wart, called the *soot-wart*. This gradually spreads, affects the whole scrotum and neighboring parts of the penis, and ulcerates, producing a fungous sore with ragged edges, discharging a thin offensive matter, and causing much pain and constitutional disturbance. The superficial inguinal glands become secondarily affected.

Free and early excision should be adopted, and the wound should be afterwards freely swabbed with a solution of chloride of zinc, and dressed as after herniotomy (p. 624). Advise the early removal of all warty growths of the scrotum or prepuce.

Impotence and Syphilophobia.

Impotence in the male may be due to a variety of causes:

1. Excessive youth or senility. Capability for intercourse and for procreation neither appears nor disappears at a fixed time. If the genital organs

are well developed, fitness for intercourse may be assumed in spite of youth. Sexual power fails rapidly after fifty in most men, but even power of procreation may be continued up to eighty or longer in unusually robust subjects.

2. Absence, infantile condition, malformation (epispadias and second and third degrees of hypospadias), or mutilation of the penis.

3. Absence (congenital or acquired), imperfect development, or such extensive disease as to destroy all secreting substance of the testes. Sterility may be due to tight phimosis, to stricture on both sides, in the course of the vas or epididymis, chiefly from gonorrhœa, obstructing the passage of semen; most cases of retained testis also cause it.

4. Mechanical obstacles to intercourse, such as excessive obesity, large irreducible scrotal herniæ, or elephantiasis.

5. Debility from any acute or wasting disease may lead to temporary impotence, which may, however, remain long after restoration of health and strength in other respects. Steel and other tonics, with cantharides, musk, nux vomica, Indian hemp, galvanism cautiously applied to the spine, spices, eggs, and oysters, and above all, *time*, and abstinence from attempts at connection till the strength is fully restored, are the remedies. Phosphorus is said to be a potent *aphrodisiac*.

6. Lesions of the nervous centres—blows, especially upon the occipital region of the head and dorso-lumbar region of the spine, are apt to be followed by impotence which is not infrequently permanent. Apoplexy may lead to a similar result.

7. Mental perturbation. It sometimes happens that a youth, on his first attempt at coition, finds himself incapable of accomplishing his wishes—through awkwardness, timidity, over-anxiety, some sense of disappointment, or a consciousness of guilt. He straightway fancies himself impotent. The surgeon should inform him that his case is by no means uncommon; he should advise him, if married, to banish his fears, and trust to time and increased familiarity; if single, to wait till he can indulge legitimately.

8. Lastly, impotence may be produced by *premature and excessive venery or self-pollution*. Such cases not infrequently come under the observation of the practitioner. The sexual organs have been rendered so weak and irritable that the least excitement, from an idea or the mere friction of the clothes, brings on an imperfect erection, followed immediately by the discharge of a thin fluid. The erection is so imperfect, and followed so soon by the discharge, that the patient is incompetent for sexual connection; and the frequent and abundant loss of seminal fluid (*spermatorrhœa*), together with the patient's morbid consciousness, brings on a most miserable state of bodily weakness and mental despondency. Of course the evil habit should be at once abandoned. Then general tonics and cold bathing, or any other measure calculated to improve the health, will be useful. Suppers should be avoided, and the patient should sleep, lightly covered, on a hard mattress. The emissions generally occur when the patient lies on his back, and it is useful to fix a reel over the sacrum at night to prevent the assumption of this position. But the most essential point is *chastity of idea*, that all excitement may be avoided until the generative organs have lost their morbid irritability. It is usually, however, of little value to advise a boy or man suffering from spermatorrhœa to be chaste in thought; the surgeon must insist upon his undertaking really hard work, mental and physical, the most interesting that can be found, that both body and mind may be healthily fatigued, and the latter diverted from its morbid paths. Bromide of sodium in 20-grain doses at bedtime, to promote sleep and quiet sexual excitement, should not be given if it can be avoided. The author has seen cases in which a preternatural irritability of the ejaculatory apparatus, with involuntary nocturnal

emissions, even of a bloody fluid, together with great pain in the back, languor, and despondency, have been caused by irritating urine containing oxalate of lime, and cured by the means described at p. 746. Lastly, there is the application of nitrate of silver to the prostatic portion of the urethra by Lallemand's *porte-caustique*, of which it may be said that if sometimes useful, it is often useless, and may certainly be mischievous. All tampering with, or directing the patient's thoughts to, the genital organs should be avoided, if possible.

For self-abuse beyond the patient's control, Dr. Ramskill recommends painting the penis with iodine; a blister is another effective means of stopping the practice.

Sexual Hypochondriasis.—There is a very frequent and distressing class of cases, in which the patients, generally young men of good education and refined feelings, and with strongly developed genital organs, believe themselves to be impotent or to have spermatorrhœa, because of the occasional occurrence of emissions. Sometimes they think themselves the victims of secondary syphilis (*syphilophobia*). These cases require skilful and kind treatment. The malady is really mental—caused often by the struggle between natural passion and religious sentiment, aggravated usually by some disorder of bodily health, such as oxaluria, or other form of dyspepsia. If the surgeon make light of the case, or try to argue the patient out of his malady, the victim is apt to fall into the hands of the advertising quacks, to the great detriment of mind, body, and estate. The proper course to pursue is to attend to the general health, insist upon ample healthy occupation and exercise, and to endeavor to secure healthy society. The patient should be instructed that a periodic discharge of seminal fluid, at intervals of three weeks or a month, is as natural a phenomenon as ovulation and menstruation in the female.

CHAPTER XLVI.

INJURIES AND SURGICAL DISEASES OF THE FEMALE GENITALS.

Injuries.

Bruising, laceration, and severe hemorrhage from the vulva are not uncommon from kicks. The bleeding can rarely be stopped by ligature; the surface must be thoroughly purified and dusted with iodoform, the bladder drained, and firm compression made with antiseptic wool-pads and a T-bandage. Great cleanliness must subsequently be observed.

There may be no external hemorrhage, but a large labial hæmatoma may form from blows, forcible intercourse, during labor, or from rupture during some effort of a varicose vein. Rest, elevation of the pelvis, and uniform pressure on the swelling, should be employed; and after two or three days blood may be gently withdrawn by an aspirator needle introduced through the skin at some distance. Unless suppuration occur—when a free incision is required—the swelling should not be opened.

Dangerous wounds sometimes occur from falls upon upright stakes which are forced through the vagina into the abdomen, and from the breaking of chambers upon which the patient is sitting. Rarely, wounds are inflicted here with intent to murder.

Rupture of the vagina and protrusion of the intestine may occur during labor from disproportion of parts, from the unskilful use of forceps, or from the introduction of the hand to turn. Perforating wounds of the vagina should be sutured, and abdominal complications must be treated according to the principles laid down in Chapter XXXVI.

Foreign bodies of various kinds are occasionally introduced into the vagina by children and young women, and keep up discharge with much irritation, which cannot be accounted for. When of large size, *e. g.*, pessaries—and retained for years together, they may ulcerate into the bladder, rectum, or both.

Vesico-vaginal fistulæ almost always result from sloughing, more or less extensive, of the vesico-vaginal septum, from compression, usually prolonged, of the part between the descending head and the pubic arch; the slough separates, and urine begins to dribble from the vagina a few days after delivery. A few cases are due to laceration, to ulceration over a foreign body, or to cancer—the latter being, of course, irremediable.

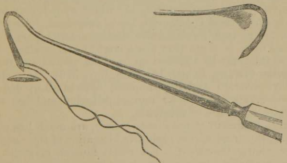
A fistula from laceration should be at once accurately closed, and the patient treated as hereafter recommended.

So soon as an ordinary fistula from sloughing reveals itself, turn the patient on her face, raise the pelvis, drain the bladder, and enforce the utmost cleanliness by means of regular antiseptic injections. During the period of the lochial discharges a small aperture may actually close, but such a result is rare. Usually as soon as the lochia have ceased, and health is restored, some operation becomes necessary.

Before this is undertaken, endeavors should be made to cure any vaginal discharge. The bowels must be well cleared by a purgative and subsequent injection, the effects of which should have ceased before the operation.

The application to the edges of the fissure, at intervals of ten to thirty days, of a cautery at a black heat, causing them to slough little, granulate freely, and contract, was used, with very excellent results, by Dr. Arthur Farre, both in the vesico- and recto-vaginal fistulæ, and in lacerations of the perineum. It is now employed only in small openings.

Fig. 284.



Druitt's "fish-hook" needles for vesico-vaginal fistulæ.

In most cases the following *operation* should be performed: The patient is placed in the lithotomy position and anæsthetized; the operator sits on a rather low chair, the light should be very good and come from behind him, and the pelvis should be so raised that the light falls on the anterior vaginal wall. To expose this, Sims's large duck-bill speculum is inserted and kept in position by hand, or by a fenestrated blade which fits upon the sacrum. Before its introduction the bladder and vagina are well washed out with salicylic lotion or sublimate lotion (1 in 2000). The aperture being clearly visible—to render it so it is sometimes necessary to drag the cervix down and back with vulsellum forceps—the surgeon, with long-toothed forceps and a long-handled straight or suitably curved knife or scissors, vivifies the whole edge, being especially careful at the angles; the strip removed should be continuous, and include the whole thickness of the wall; at no point should an islet of epithelium be left. A sufficient number of wire sutures to bring the edges accurately together are now passed with Smith's cleft-palate needle, or with the much cheaper "fish-hook" needle devised by the author, which passes a ligature first through the farther, then through the nearer, edge, whilst the operator's hand does not get in the way of his eyes. The mucous membrane of the bladder should not be included, for it tends to prolapse and intervene between the raw surfaces. The wires may be secured by twisting, or by *large* split shot (which are better than Sims's continuous metal bars) clamped on to them, first on the far, then on the near, side of the wound. The ureters have been wounded and included in the stitches.

After the operation Sims's S-shaped metal or some self-retaining soft-rubber catheter should be placed in the bladder, and a tube carried thence to a basin under the bed. This operation must be carefully watched, for nothing can do more harm than accumulation of urine in the bladder. The prone position, with the pelvis a little raised, is the best, and it is well to accustom the patient to it before operation; if she will not assume it, she must lie on either side, inclined toward the face. Every six hours a soft tube should be gently passed to the top of the vagina and gentle irrigation with salicylic lotion practised. Morphia or other anodynes must be used if the patient is restless. The wound should not be examined, nor the sutures disturbed, for at least a week. The bowels may be kept open by enema.

In some cases, the fistula is placed so high that an attempt has to be made to attach the anterior lip of the os to the lower edge of the aperture; or, this failing, to close the vagina below the fistula and allow menstruation to take place through the bladder. When the fistula is utero-vesical, passing from the cervix, this plan, or Jobert de Lamballe's of slitting up the cervix into the fistula, vivifying this, and suturing the whole wound, may be followed.

For cases in which there is extensive loss of substance, Jobert de Lamballe detached the vagina from its attachment to the anterior part of the neck of the womb, and drew it down that there might be no strain on the stitches; or the vaginal tube may be dissected up from the vesical, and the split edges brought together (Druitt, *Lancet*, 1852, vol. ii. p. 576). In such cases Prof. Wood employs reversed and superimposed flaps to fill up deficiencies and insure extensive raw surfaces for mutual adhesion, and has succeeded in many cases with much loss of substance.

RECTO-VAGINAL FISTULÆ, not due to cancer, are much less common than vesico-vaginal; they result from syphilitic ulceration of the rectum as a rule. They require similar treatment. The rectal mucosa must not be included in the sutures, and here even more than in vesico-vaginal cases the diet should be carefully chosen and limited. Some surgeons confine the bowels by opium for ten to fourteen days, others give an enema very carefully twice a day, others again divide the sphincters subcutaneously that there may be no resistance to overcome, and that the lower end of the rectum may be at rest.

Wood's system of reversed and superimposed flaps may be employed here in cases with much loss of substance. In otherwise irremediable cases, the vagina has been closed below the fistula.

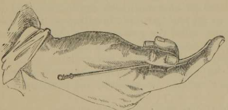
Lacerations of the perineum during labor, as far as, but not through, the anus, will generally heal, if the patient's legs be tied together, and the lateral position, iodoform, and frequent gentle irrigation be employed; the usual plan is to confine the bowels, but some give a small enema daily; the catheter should be passed three or four times a day. The accident is very likely to recur in subsequent confinements.

Complete laceration into the anus is attended with distressing incontinence of feces and flatus, and prolapse of the rectum. It should be remedied immediately. Everything must be rendered as clean as possible, and the surfaces thinly iodoformed; a deep wire button-suture must be passed from buttock to buttock through the septum above the rent. Before it is drawn quite tight the rectal mucosa is united by a continuous horse-hair suture; then the button suture is adjusted and the vaginal mucosa and skin are united. After-treatment as above.

If this treatment is not carried out or is unsuccessful (as it frequently is, the tissue being much bruised), operation must be postponed until the lochia have ceased and the health is restored. Prepare for it as usual. The patient being in lithotomy position, on each side make an incision about one and a quarter inches long into the subcutaneous tissue, at the junction of skin and scar-tissue, to mark the base of the perineal triangle; at right angles to the centres of these cuts make two others of similar depth meeting in the angle of the rent; the two triangular flaps upon either side are to be raised, of *good thickness*, and during this bleeding is often free. A button suture is now introduced as above, with a stout, strongly curved-handled needle; and others, if they seem advisable, behind or in front of it; one in front may cross the vagina. Before they are tightened the rectal flaps are united by a continuous suture, and afterwards, the vaginal flaps and skin. Leave the stitches in for two or three weeks.

The catheter may be easily introduced into the female urethra with one hand, thus: The surgeon, holding it like a pen, with its point on the tip

Fig. 285.



Mode of introducing the female catheter.

of the forefinger, passes the finger between the labia, feels for the ridge of the urethra, and traces it forward to the nodular projection at the entrance to the vagina, behind the meatus. The catheter, guided upon the finger, is then easily slipped into the orifice. Either hand may be used, according to the patient's position in bed.

Malformations and Deformities.

Adhesion of the labia is common, and is generally discovered in children whilst still infants. No vaginal orifice can be seen on separating the labia, for it is covered by a membrane, stretching from labium to labium, which is usually so thin as to appear bluish. It is easily torn by a thumb on either labium, and often scarcely bleeds; a little oiled lint will prevent reunion.

IMPERFORATE HYMEN.—This septum is placed higher than the above—just within the orifice of the vagina. It is discovered usually at puberty, when severe pains recur monthly, but no discharge appears. The child is sometimes allowed to suffer thus until the uterus distended by blood forms a large abdominal tumor. The hymen forms a tense, bulging, bluish membrane.

TREATMENT.—Make a free crucial incision in the hymen, and gently wash out the uterus with warm boracic lotion, until all the dark treacly blood is got rid of, and repeat the injection daily until there is no longer any fear of retention. The patient must remain recumbent till the uterus is of normal size. The mortality after this little operation has been high—from septicæmia, septic metritis, and septicæmia. Repeated aspiration has been employed as a substitute, but even more dangerous sepsis is likely to occur if the hymen is the seat of puncture. When the vagina is absent, hæmatometra is rare (see below); should it occur, Tait advises that an opening be made through the rectum, and gives a successful case.

CONGENITAL ABSENCE OF THE VAGINA is occasionally found, and usually the uterus in such cases is also wanting. Mr. Wood has operated successfully on two of these cases for the formation of a vagina. In one the uterus was felt in an atrophied state, and in the other it was not present in any shape. A catheter was first passed into the bladder, and then a small transverse cut was made in the bottom of the *cul-de-sac*, representing the orifice of the vagina, and carried carefully down, guided by the left forefinger in the rectum, and by the catheter in the urethra, to about four inches from the surface. This was afterwards kept well cleansed by carbolic lotion, and dilated with a clean, smooth, glass bougie of proper size. The patients did well, and recovered without bad symptoms; one, on being examined eight months afterwards, was found to have a fairly roomy passage. In these cases the patients were anxious to have the operation done before marriage. Similar operations, however, have frequently proved fatal from peritonitis, and great care must be taken not to open, in the deep incision, the recto-vesical pouch of the peritoneum, which comes unusually low down in these cases, as well as to prevent putrefaction during the subsequent treatment. Other surgeons have found the process of keeping the tube patent very difficult and painful, and in a case in which impregnation would seem possible, Tait's advice had certainly better be followed.

ATRESIA VAGINÆ, usually from sloughing after labor, and leading to hæmatometra, may usually be relieved by cautious lateral notching and dilatation.

PROLAPSE OF THE VAGINA is a consequence of structural debility, and is liable to follow parturition, and to accompany and aggravate congestive diseases of the womb. When the posterior wall prolapses, bringing with it the rectum (*rectocele*), there is great distress and difficulty in getting rid of the motions; when the anterior wall with the bladder (*cystocele*) prolapses, there is great irritability of the bladder, difficulty of emptying it, decomposition of residual urine and other ill-consequences. Cold, strong, astringent injections, tonics, and a firm perineal bandage, cold enemata, and suitable treatment for chronic constipation in rectocele, the avoidance of overdistention of the bladder and treatment for cystitis in cystocele, are the first set of remedies. Should these fail, a Hodge's ring pessary may be tried. In aggravated cases an operation may be done to contract the vagina and bring forward the perineum by denuding a longitudinal slip on each side of the vagina, bringing the cut surfaces together longitudinally and uniting them by suture, and by vivifying and uniting the inner surfaces of the posterior halves of the labia, as in the operation for ruptured perineum.

Diseases.

Acute Vulvitis and Vaginitis.—Although in the enormous majority of cases these are of gonorrhœal nature, it is certain that purulent catarrhs, which are not due to contagion, do occur; and they are tolerably frequent in children, generally strumous and sometimes suffering from worms in the rectum. Foreign bodies, injuries, and some acute specific fevers are occasional causes. There is no subject upon which more caution is necessary than in expressing an opinion as to the nature of a vaginal discharge. The more intense the inflammation, the more probably is it gonorrhœal; probably the best test is the presence or absence of gonococci.

Treatment.—Absolute rest and acetate of lead and opium, fomentations in acute stages, then mild, and finally strong astringents (p. 106).

Labial abscess is usually acute and situate in the gland of Bartholin close to the orifice of the vagina. The signs are typical and the pain great; the cause usually an acute vulvitis, especially gonorrhœal, sometimes injury or none is discoverable. It should be freely opened in the vaginal aspect; the pus is exceedingly foul.

Noma signifies a phagedænic affection of the *labia pudendi* of young female children, precisely resembling the *cancrum oris* (p. 540) in its causes, nature, symptoms, fatality, and treatment required. The surgeon must be very careful not to mistake this affection for venereal diseases—an error common enough among parents. In 1853 there were several criminal trials at Dublin of persons falsely accused of tampering with children.

Great hypertrophy of the labia majora may result from advanced syphilis (rare) and from elephantiasis (p. 223). The *nymphæ* are not uncommonly much too large and solid, gonorrhœa and chancre being sometimes the cause. Sometimes only one is affected; the *clitoris* may also be of inconvenient size. Should circumstances require it, there is no difficulty in removing any of these parts.

Varicose veins may form huge masses, rendering the labia very large, pendulous, and often exceedingly painful; impeding locomotion, and, when they rupture, endangering life by hemorrhage. They are usually found in multiparæ, and are much aggravated by pregnancy. Recumbency and great cleanliness give most relief; some may be found in a kind of bag truss. Removal by ligature has been successful; the cautery might be used, and inversion of the patient would very likely allow the knife to be employed.

New growths of various kinds are met with in the vulva and vagina. *Fibromata* and *myofibromata* occasionally form pedunculated outgrowths from the labia majora or the vaginal wall; *lipoma* is occasionally met with about the mons; *nævi* occur rarely in the labia majora; simple *warts* are common on the labia, and *condylomata* sometimes forming huge cauliflower-like masses are still more so; racemose *adenomata* and cysts from dilatation of mucous glands occur here as on other mucosæ; sebaceous cysts may be met with on the outer aspects of the labia majora; but the cystic growth of the vulva is an adenoma of Bartholin's gland, usually on the left side. *Sarcoma* is rarely seen in the vagina. *Epithelioma* of the vulva, especially the clitoris and nymphæ, is common, but this growth is rarely primary in the vagina; its appearance is characteristic, and early free removal the treatment—preferably with the knife, clamp forceps being at hand to stop bleeding which often gives no trouble. The inguinal glands suffer secondarily. Here, as elsewhere, recurrence is the usual result.

The VASCULAR GROWTH of the female urethra is simply a vascular wart, of bright red color, varying in size from a large pin's head to a horsebean, protruding from the meatus, and though sometimes painless, usually causing great distress from its exquisite sensitiveness. It is easily torn and bleeds freely. It may be cut off and the base touched with a cautery or caustic, or both it and its base may be removed with scissors, cocaine being used. Recurrence is frequent, time after time.

CHAPTER XLVII.

DISEASES OF THE BREAST.

DEVELOPMENTAL ERRORS may occur in either sex. Congenital *absence* (*amastia*) of one breast has very rarely been seen; also rarely both breasts remain puerile, usually with absence or non-development of the ovaries. Three to five breasts (*polymastia*) occur more frequently. Leichtenstern says that the great majority have been found below and slightly internal to the normal breasts, a few in the axillæ; elsewhere (groin, thigh, shoulder) they are very rare. Nipples without any gland substance may occur at the same spots, or a normal breast may have two or three nipples (*polythelia*). It is, however, much more common for the nipples to be absent or small; they may protrude during pregnancy. These abnormal breasts and nipples show no special tendency to disease and should not be interfered with unless they are a source of inconvenience. Hare (*Lancet*, 1860) recorded a case of dilatation by milk of an axillary mamma, the nipple of which was imperfect.

EARLY DEVELOPMENT.—In cases of early sexual maturity, the breasts may be well developed in children; much more rarely they enlarge without the general changes of puberty.

DIFFUSE HYPERTROPHY of both breasts, occurring at or within two or three years of the first menstruation, is very rare; cause unknown. The breasts, as a rule, increase so rapidly in size that in two to four months they may reach far below the navel; they then cease growing, perhaps enlarge again with the first pregnancy and then cease finally; continuous growth has not been observed, nor any affection of the general health beyond such as the weight of the breasts and incapacity for work would account for. There may be a milky discharge, but it is not usual. The skin is often thick and œdematous and the veins large; in the tumor hard nodules may be felt—fibro-adenomata having the usual structure; whilst the mass of breast is highly glandular.

TREATMENT.—Pressure and iodine have no effect; amputation of both breasts has been thrice successful.

Sometimes the breasts reach a great size in the early months of pregnancy.

This is the best place to note that one or both breasts may enlarge after puberty in man to quite the size of a virgin breast (*gynæcomastia*).

Neuralgia of the breast may exist alone, or (as more frequently happens) be superadded to a small adenoma or chronic mastitis. Extreme pain, aggravated at each monthly period, and out of proportion to the local structural disease (if any), and superficial tenderness are the characteristics. The health generally admits of improvement, anæmia with constipation, disordered menstruation and hysteria being frequently present. Velpeau states that, in 40 cases, both breasts were affected only twice; 15 of the patients were 30, the rest varied in age from 30 to over 70; in 10 slight thickening and nodules could be made out in the gland substance. For treatment see p. 419.

Lacteal calculus is very rare, produced by absorption of the fluid part of the milk in an obstructed lacteal duct and calcareous infiltration of its solid ingredients. It is probable that some calcareous masses are similarly formed by the inspissation of pus or tubercular masses. Calcification of the septa of the breast has been described in old women. Unless suppuration should occur no treatment would be required.

Abnormalities of Secretion.—The breast should secrete milk in quantity only after delivery, and then only for a short time, unless suckling is practised. Suckling should keep up the secretion for seven or eight months and not uncommonly does so for eighteen to twenty-four. In a first pregnancy the expression of a little milk is a very valuable sign; but in later pregnancies it is unreliable, as after pregnancy the breast may contain a little milk for many years.

After delivery there may be no secretion (*agalaktia*), a very uncommon thing; a very slight secretion for only a few days or weeks is much more frequent. In other cases the secretion is so excessive that it runs continually from the breasts (*galaktorrhœa*) for weeks or months, although suckling may be discontinued. Montgomery quotes a case in which this lasted for three years, and the breasts contained milk after five. The patients are often delicate, nervous, and weakly, and they lose much flesh, though their appetite may be good. Galaktorrhœa must be treated by attention to the general health; by strapping the breasts or applying glycerine and belladonna, and by the internal administration of belladonna or iodide of potassium in full doses. The amount of drink may be limited, and the bowels should be kept open.

Secretion may occur at unusual times. A viscid, milky fluid is not at all uncommonly formed by the breasts of newborn infants; in the first few days after birth the breasts may swell and become tender, and on compression yield this fluid, which is usually naturally got rid of in a few days. Many nurses are in the habit of employing pressure regularly, and the not infrequent abscesses in breasts of babies may be due to neglect of this precaution. A few cases are recorded in which virgins and even children (perhaps cases of early puberty) have, by repatedly applying a child to their breasts, excited sufficient secretion to suckle; and women long past the menopause have done the same. Milk has been found in the breasts of very old women; but we must not mistake for it a greenish or brownish, thin or mucoid fluid which frequently forms in dilated milk-ducts of aged breasts and escapes from the nipple.

Lastly, milk in considerable quantity has been secreted by the mammæ of boys and men.

Lacteal Tumor or Galaktocele.—Rarely a lacteal duct is strictured or obstructed, by a small calculus, when, if pregnancy occur, the milk accumulates in it, forming an oblong fluctuating tumor, first perceptible near the nipple, but ultimately, in the course of some months, it may reach a large size; the skin is normal, the veins large, pain is slight—chiefly from dragging, there is no tenderness and no fever. Scarpa's case is the most celebrated; ten days after her second confinement, a woman of twenty noticed a swelling in the left breast which increased the more the child was put to it; in two months the gland measured thirty-four inches around; Scarpa drew off ten quarts of milk; the cavity suppurated, but the patient recovered, and nothing abnormal occurred after her third pregnancy.

The cyst should be punctured, when creamy milk, usually with a quantity of yellow-brown oil, escapes; or the milk may be curdled. A drainage tube must be inserted and an antiseptic dressing applied; it will need frequent changing as milk will escape during lactation; suckling should be ceased as soon as possible and the milk dried up.

Sore Nipples.—Suckling, especially a first child, often causes the nipples to inflame; they become swollen, intensely red, hot, painful, and tender. In other cases, excoriations, cracks, and deep fissures, form, mostly toward the base of the nipple, and cause pain, which may really be extreme whenever suckling is attempted. Many think that infection of slight cracks with the thrush parasite from the mouth of the child is the cause of those painful fissures, which are often the forerunner of mammary abscess.

Treatment.—If both nipples are not affected, let the child suck the healthy and draw off the milk from the diseased side with a breast-pump. Simple inflammation may be met with tannic lotion (F. 249), alum lotion, or other astringent, frequently applied and carefully washed off before the child sucks if the breast is used. Some paint the nipple with flexible collodion, or, better, Richardson's styptic colloid (F. 340). When fissures are present the same treatment may suffice, but usually cure will be more rapid if a fine point of lunar caustic be occasionally run along the whole length of the opened fissure or its base be divided with a knife, after cocaine has been applied. In slight cases affecting both nipples these may be sufficiently protected from the clothes and the child's mouth by rubber shields; but in severe cases, suckling must be given up so soon as the child can be safely weaned, if not sooner; after the first six weeks it is much more easy than earlier to feed a child artificially. Sometimes it is well to feed the child with milk drawn from the breasts by a pump. By way of prophylaxis, pregnant women should every night wash the nipples with a solution of alum (grs. xx ad ℥j) and apply a liniment of sp. rect. and ol. olivæ āā.

Mucous tubercles occur on the nipple, and fissures in a syphilitic woman would probably become tubercles and infect a healthy child. Similarly a syphilitic child would probably infect the nipple of a healthy woman from tubercles in its mouth, a primary sore of the nipple resulting. Hence both child and wet-nurse must be either syphilitic or healthy.

Areolar abscess is not uncommon during suckling. It must be opened parallel to the ducts converging to the nipple, and dressed with boracic lotion.

Chronic eczema not uncommonly affects one or both nipples. It generally occurs before the menopause, especially during lactation, and is often associated with uncleanliness or scabies; the surface is pinkish-red, not raw-looking or granular, but often punctate; there is no superficial induration, and the edge is not sharply defined and is not raised, and, though often obstinate, it yields to treatment with astringent ointments or lotions of lead, zinc, mercury, and oil. In all these points it differs from *Paget's disease*, often called *eczema*, of the nipple, which so often foreruns cancer (McCall Anderson).

Slowly growing *epitheliomata* develop but rarely in the areola. *Sebaceous cysts*, too, have been met with.

ACUTE INFLAMMATION OF THE BREAST (*mastitis*) occurs so frequently in connection with the puerperal state, that *puerperal mastitis* is almost synonymous with the above heading. Inflammation and abscess may, however, result from injury; it is met with occasionally in newborn children in connection with milk-secretion (p. 825), and also at puberty a painful swelling which may run on to suppuration occurs in both sexes, but most often in girls. Erysipelas passing over the breast, or caries of the ribs beneath it, may also cause abscesses in relation with the gland. Of 228 cases collected by Billroth, 181 occurred during lactation, 13 during pregnancy, and 34 were unconnected with the puerperal state; apparently abscesses in infants and at puberty were not included.

Puerperal mastitis occurs in about six per cent. of all nursing women (Winckel), is especially frequent with first children, and is rare when the child is not suckled; 508 cases show that the right breast was affected 256, the left 192, and both breasts 65 times (Billroth); the lower and lower and outer parts of the mamma are most often its seat. It commences most frequently in the first four weeks after delivery, especially in the third and fourth, and very frequently three or four days after fissures have appeared upon the nipple; but it is well known in women who suckle their children for a year or two and get much below par.

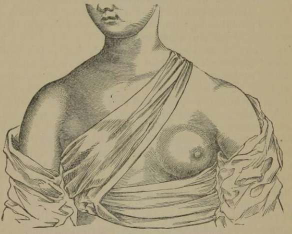
Many CAUSES have been assigned, especially retention of milk from accidental closure of a duct; but we have specially noted the absence of signs of inflammation in galaktocele, and in cases in which the breasts become very tense and full, and then empty themselves owing to death of the child. It seems almost certain, therefore, that these abscesses are due to the entry of organisms into the breast, either into the lymphatics from fissures, or into the gland-spaces along the ducts, where no fissures exist. Against this view is the absence of powers of locomotion among bacteria; still it seems probable that they do enter, cause swelling of the mucosa, obstruction of the duct, and retention of milk, irritant decomposition of which most likely follows. The effect of this is a dense round-celled infiltration about the acini, where the vessels are most numerous, rapidly running on to destruction of tissue. The process may be diffuse, leading to multiple abscess, or rarely to sloughing of large portions of the breast tissue; usually it is localized to one part, though secondary abscess from imperfect drainage, burrowing, and sepsis is frequent. The abscess may form deeply in the breast substance; or superficially, soon presenting beneath the skin—or perhaps forming in the subcutaneous layer; or the deepest portions may suppurate and burst into or otherwise infect the loose tissue between the breast and the pectoral, and around about the gland (*retro-* and *para-mastitis*). A *chronic* abscess behind the gland is in all probability due to caries of a rib.

The SYMPTOMS often appear suddenly. They are: high fever, often with rigors, and perhaps delirium, severe pain, great tenderness and rapid swelling of the breast, which is hot and tense; the time of appearance of œdema and redness of the skin of course varies with the depth of the pus—it may be many days before fluctuation is apparent; when the pus forms behind the breast the whole gland is pushed bodily forward. The axillary glands are enlarged but rarely suppurate.

TREATMENT.—In many cases a quickly acting purgative, the administration of aconite in minim doses till the pulse is reduced, assiduous fomentation over belladonna, removal of milk by the pump from both breasts, fixation of the arm and absolute rest will cut short the inflammation. When success does not attend these measures, continue the belladonna fomentation and the use of the pump, for putting the child to the healthy breast will cause painful hyperæmia of the inflamed one. If the symptoms persist under this treatment, suppuration is almost certainly present, and so soon as it can be localized, and often before fluctuation appears, an exploratory puncture should be made and lengthened into an incision, radiating from the nipple, if pus be found; the abscess is emptied, a tube inserted, a large antiseptic wool-dressing is applied, and light uniform compression of the whole breast is made with a stocking bandage. If the case be severe the patient should remain in bed; but if it be slight she may walk about with her breast well bandaged and arm fixed—this being of much importance in all cases. Great care should be taken about the antiseptics and drainage; when they are neglected, terrible burrowing may occur, ruining the structure of the breast, perhaps necessitating even its removal. Should there be burrowing, early counter-openings should be made.

The sling shown in Fig. 286 will do very well to keep a poultice on in bed, but to compress the breast a turn of bandage should be taken round

FIG. 286.



Four-tailed sling for the breast; two are fastened around the waist, whilst the others support the breast, pass over the opposite shoulder, and are fixed to the first, behind.

the trunk below both breasts, the roller coming *forward* beneath the diseased breast; the second loop of a figure-8 is made by carrying the second turn under the diseased breast, so as to raise it strongly, and over the opposite shoulder; this is crossed at the axilla and fixed by the third turn round the trunk below the sound breast, and so the turns go on mounting higher and higher on the diseased breast, the lower raising it and the upper pressing it rather down. The limbs of the sling (Fig. 286) show the direction of the first two turns of the bandage. To give rest in cases of chronic sinuses some prefer long strips of strapping laid like the bandage-turns on the breast, holes being cut for the tubes.

Chronic abscess of the breast has caused many diagnostic errors, for it forms a hard or indistinctly fluctuating, irregular, ill-defined mass of moderate size, not movable in the substance of the gland, enlarging slowly in the course of many months, not tender, and either causing no pain or only occasional fits; round-celled infiltration often extends along the ducts, and causes retraction of the nipple. In almost all cases the formation of a chronic abscess is connected with pregnancy, labor, or miscarriage, but as cancer also may complicate these states, the above fact is by no means diagnostic. When there is any doubt about the diagnosis, an exploratory puncture should be made; it may be done when everything is ready to proceed further should the disease turn out to be cancer.

Abscess should be opened antiseptically and drained; it is said that a section right through the induration facilitates its absorption.

CHRONIC INTERSTITIAL MASTITIS.—Sometimes a chronic inflammatory infiltration forms round the acini in certain lobules of the breast, and by its presence and shrinking renders these parts different from the rest of the breast so that they are felt like one or more tumors in it. Section through the part shows a densely fibroid, quite uncircumscribed, mass, in which small cysts (dilated ducts) with yellowish or greenish contents may be seen.

This process gives rise to one or several rounded nodules in the breast, quite inseparable from its substance, and when pulled upon, dragging on the nipple; they are not tender, or painful, as a rule, but may be accompanied by severe neuralgia; and their surface is usually finely nodular, and the skin when pinched up over them may dimple, being connected with the mass by a fibroid band. In the other cases a tough wedge-shaped piece of the gland, with the apex towards the nipple, is involved, and in rare instances the whole breast may be affected; it becomes greatly shrunken as the inflammatory tissue shrinks, the nipple and skin are drawn in and become more or less fixed to the chest wall, and the axillary glands may be slightly enlarged. Billroth gives an illustration of chronic shrinking mastitis, but it is difficult to see from the account how the diagnosis was made from atrophic scirrhus.

From small adenoma deep in the breast and covered by breast-substance, so that its mobility in the breast and smooth surface cannot be made out, *diagnosis* may be impossible. Similarly its distinction from cancer when the patient has reached the cancer age may be impossible. Suspicion of the latter should be set at rest by exploratory incision and microscopic examination of a frozen section. Multiple nodules are strongly in favor of mastitis.

Belladonna, warmth, and gentle pressure may be used to relieve pain and the general health must be looked to. Small portions of the breast causing much pain and anxiety may be removed. The surgeon must decide whether it is ever right to remove the whole mamma for this disease.

Tumors of the breast are both numerous and frequent. Pure *fibromata* are very rare and scarcely capable of recognition; *lipomata* may occur in the fat over, or in the connective tissue behind, the mamma, and have in a few instances in the latter situation reached an enormous size; *enchondroma, simple* or *ossifying*, is very rare in women, but is said to be comparatively common in bitches; *nævus* of the subcutaneous tissue may seem to involve the breast. But the tumors of real importance, on account of their frequency, in the breast are *adenoma, adeno-fibroma, adeno-sarcoma*, and *cysto-sarcoma, sarcoma*, and *cancer*.

ADENOMA, ADENO-FIBROMA, ADENO-SARCOMA and CYSTO-SARCOMA have been briefly described at p. 139. The adenoma, or adeno-fibroma, as many prefer to call it, is an encapsuled tumor of rounded form and smooth surface —though sometimes considerable rounded masses may project from the main —and is unconnected with the breast proper except by a little loose areolar tissue. It has a fibrous aspect and a convex surface on section; upon close examination of this a number of slit-like, sometimes branching, spaces (Fig. 287, upper part) can be seen, and the microscopic sections drawn in Figs. 29 and 30 explain their nature. The stroma may be almost pure fibrous tissue, or this richly strewn with spindle-cells, or there may be scarcely any actual fibres, the whole matrix being cellular. The latter kinds are often spoken of as adeno-sarcoma; upon the whole they grow more rapidly and reach a larger size than the adeno-fibroma. Sometimes the stroma is myxomatous—*myxo-adenoma*. Turning to the epithelium-lined spaces, these sometimes become distended with mucoid or serous fluid, and into them papillary cellular masses may grow, when the fluid is very liable to be rendered red or brown from hemorrhage; cysts from the size of an orange downward may thus form; the skin may thin and inflame over them until they burst, when hemorrhage is likely to occur from the papillary masses which protrude and increase into a large, fungating, easily bleeding growth. Growths of this kind are called *cysto-sarcomata* (Fig. 287). Adeno- and cysto-sarcomata

FIG. 287.

Cysto-sarcoma of the breast. Some of the cysts are empty, some partially, and others entirely filled with papillary masses. Above is a solid portion having the appearance of a simple adeno-fibroma (King's College Museum).

have occasionally reached an enormous size. I saw C. Heath successfully remove from a woman aged sixty an adeno-sarcoma weighing 5 lbs. 10 oz., which had grown in three and a half years, the chief increase having taken place in the last six months, and this is a common history; Velpeau has recorded a case of cysto-sarcoma of four years' growth (slow for the first year) which weighed 20 lbs. after death of the patient from marasmus; Fergusson, in 1853, removed one of 27 lbs.

The use of the word "sarcoma" would seem to indicate malignancy, yet even local recurrence of these growths is very rare. I have seen one instance in a woman aged forty-eight: sixteen years earlier a mass of four years' growth was excised; it recurred, and the breast was amputated two years later; after twelve years a recurrence in the scar was removed, and she then had a rather large axillary gland; two years later another nodule was removed from the scar, and the gland, being unchanged, was left. Microscopically the last nodule showed a good many spindle-cells in the stroma, but could not have been distinguished from an ordinary *fibro-adenoma*.

Cases have been recorded by Rushton Parker and others in which *scirrhous cancer* has started from an adeno-fibroma.

No age is exempt, yet the great majority of cases occur from sixteen to thirty-five. The origin of these, as of all mammary growths, is frequently referred to injury—slight blows. Cysto-sarcomata usually occur in multiparæ at about thirty-five or later. The tumor may be situate anywhere in the breast, but is most often peripheral; when small it is a smooth, firm, rounded mass, moving freely in the breast or actually pedunculated, not involving the skin or lymphatic glands in any way, not causing retraction of the nipple nor seeming connected with it by a cord (duct) when the nipple is held and the tumor pressed away from it; as a rule, tenderness and pain are slight or absent, but both may be acute, especially at menstrual periods, when both breast and tumor swell; these tumors may disappear after lactation, and they always give most trouble when the health is low.

Growth is usually slow, for a time, at all events, and the mass becomes more plain beneath the skin which it raises; cysts may now be detected by their elasticity and projection, sometimes also by a brownish or bloody discharge from the nipple. The tumor may remain stationary for months or years, or may grow rapidly to a huge size; bursting of a cyst has been mentioned above. The general health is affected only by the weight of the growth, anxiety, and sometimes neuralgic pain.

Mistakes arise when the tumor is buried in the central part of the breast; we then cannot make out what the surface is like; it may appear fixed, and a tumor of this kind may seem to drag on the nipple.

Diagnosis.—Chronic interstitial mastitis, simple cysts, and cancer, are distinguished by their close connection with, mobility in, and inseparability from the breast, usually shown by their dragging on the nipple. The age of a patient with adenoma is often much against cancer.

Treatment.—If the tumor be small and give no trouble, or only a little pain during the menses, belladonna may be used locally to give ease, and the general health must be kept as good as possible; but if growth be steady or rapid, excision is proper, and it is of course right when the mass is already large when first seen by the surgeon. To excise: seize the breast with the left fingers and thumb so as to fix the growth, press it up toward the skin and render this tense over it, and make a clean cut, radiating from the nipple right down upon the mass, opening its capsule widely; a little pressure will now often cause the tumor to start out; if not, seize it with hook-forceps and dissect it out with a few touches of the knife; bleeding is slight. Never try to dissect down on to one of these tumors, but remove them just like lipomata. In the larger growths no breast can be found, and the whole mass is amputated.

Sarcomata.—Pure, soft sarcomata occur in the mamma, but are uncommon. Billroth mentions only four cases—of myo-sarcoma, lympho-sarcoma of both breasts beginning during pregnancy, melanotic alveolar sarcoma and giant-celled sarcoma; he states that he has not seen a pure spindle-celled or a myxo-sarcoma, though they would seem to be the commonest varieties in this situation; Bowlby (*Trans. Path. Soc.*, 1882) describes a case of chondro-sarcoma, fatal, by recurrence, in eighteen months.

These growths may apparently begin at any age after puberty; Billroth's cases ranged from fifteen to sixty-five, but by far the greater number that I can find occurred after thirty. Usually they begin as single, rounded masses, firm, well-defined, movable in the substance of the breast and beneath the skin, exercising no traction on the nipple; sometimes they grow rapidly from the first, again very slowly, and in other cases rapid increase supervenes upon months or even many years of slow growth; as they enlarge, the consistence usually becomes unequal from the formation of mucous or blood cysts; they usually retain their apparent encapsulation for a long time; sometimes they affect the axillary glands, but, as a rule, they do not; recurrence may be slow or rapid, local or in the internal organs; the whole course may be only twelve or eighteen months, or more than twenty years.

It will be seen that the difficulty is to diagnose these growths from fibro-adenomata; frequently they have been shelled out, the breast being removed only after recurrence. But in rare cases, the new growth infiltrates the breast widely from the first and involves surrounding parts early, thus coming to resemble soft acinous cancer; the diagnosis here is not important, the treatment being the same.

I have seen two cases: a woman, aged thirty-eight, under Mr. C. Heath, had a tumor of left breast (attributed to a blow) removed in 1864; the breast was amputated in 1868, a growth removed from the scar in 1870 and again fifteen months later; recurrence was almost immediate, but growth was so slow, that in six years the mass reached only the size of a fist; it was removed; in the next fifteen months, three recurrences were partially removed, a large bleeding fungus formed, the axilla was invaded by extension and the nerves pressed upon. The woman died exhausted fourteen years from the beginning. The growth was a small spindle-celled sarcoma ("recurrent fibroid") and the supraclavicular glands were healthy.

Mr. Beck removed an encapsuled mass of six pounds weight from a healthy woman aged forty-nine; it was of twenty years' growth, increase being specially rapid in the last five years; it consisted of branched and spindle cells, and contained numerous cysts; some normal breast was detected. Twenty months later her health was broken, she had a doubtful recurrence beneath the scar, and a larger mass in the left kidney region—after an attempt to remove which she died.

The TREATMENT is obviously early and free removal of both tumor and breast; it is doubtful whether the axilla should be opened up as a matter of course.

Cancer of the breast is, in the vast majority of cases, of the hard acinous variety, forming in fact the type of this disease; relatively very few cases of the soft form (encephaloid) are met with, and colloid degeneration in an advanced stage is even more rare. The naked eye and microscopic appearances of these forms have been described at pp. 145–147. In addition to these there is a rare form of cancer said by Cornil and Ranvier to begin in relation with the ducts; it has the clinical signs and course, and the naked eye appearance, with abundant juice, of encephaloid, but it contains a number of very small cysts into which project delicate villous growths that bleed easily. The growth has the microscopic structure of a columnar epithelioma, and the cysts are said to be dilated ducts; the secondary deposits are of similar nature. In cases of scirrhus we sometimes see the terminal portions of ducts dilated into small cysts with milky contents; rarely large cysts, usually containing a bloody fluid, form and cause the growth to simulate a cysto-sarcoma; a bloody discharge from the nipple may occur in such cases.

CAUSES.—Very little is known. The greater number of cases occur between forty-five and fifty-five, but cancer commences frequently between thirty-five and sixty-five; after this it is rare, and before thirty very rare —yet it has been met with as early as twenty-three. About two or three per cent. of the cases occur in males. It is believed by many that cancer is relatively more frequent in the single than in the married, and among the latter in the sterile. The younger the patient, the more malignant, as a rule, is the disease. The women attacked by cancer are frequently in robust health. A family history of phthisis or of insanity is believed to be specially frequent in cases of cancer, and a period of mental trouble or anxiety not uncommonly precedes the discovery of a cancer. An endeavor is being at present made by the Collective Investigation Committee of the Brit. Med. Assoc. to test the truth of the statements: that cancer is very frequent along the course of rivers subject to seasonal overflow, but infrequent in high and mountainous parts (Havilland); that large eaters, and especially large meat-eaters, are more liable to cancer than small eaters and vegetarians (Humphry and

Beneke); and, lastly, that cancer is hereditary. The belief that cancer is hereditary is at present strongly held by most surgeons of large experience; but it has been urged that cancer does not occur more frequently among the children of the cancerous than among those of the non-cancerous; that a great deal of the evidence does not point to heredity, consisting as it does of cases in which several members of the same generation are affected by it; and that it is very difficult to show that cancer in the child is not acquired, being due to the action of influences similar to those to which the parent was exposed. Injury is frequently assigned as the cause of cancer, and not uncommonly the disease does appear in tolerably distinct connection with a blow. An indurated, persistent scar from previous abscess or an adenoma seems in rare instances to have been the starting-point of cancer. Lastly, Sir James Paget some years ago drew attention to the fact that the development of cancer was occasionally preceded for some months or years by a diseased condition of the nipple which he called *eczema of the nipple* (*Med.-Chir. Trans.*, vols. lix. and lx.). The nipple and an area round about it are covered with scabs, and when these are removed the diseased surface is bright red, raw, and granular in appearance, has a well-marked outline, often a slightly thickened, raised margin, and feels somewhat indurated when pinched from side to side. According to Thin, this disease often begins at the orifice of a milk duct. He states (*British Med. Journ.*, 1881, vol. i. p. 860) that the essential lesion is a destructive infiltration of the papillary layer of the skin, causing disappearance of the connective tissue here, and of the cells of the superadjacent Malpighian layer—neither of which changes occurs in true eczema (p. 826); he therefore suggests the name of *malignant papillary dermatitis* for this morbid process.

The cancer which, sooner or later, supervenes is, according to Thin, due to filling first of the main and then of the smaller ducts with epithelial cells, so that round columns of these are seen growing down into the breast, increasing in size by peripheral addition and by blending. The central cells of large columns degenerate and, from the falling out of the débris, spaces appear in sections, as if tubes had been cut across. Further, columns of cells burst here and there through the elastic sheaths of the ducts, and grow in the surrounding connective tissue. The tendency of the cells in this form of cancer is to grow in columns and not to form the irregular masses seen in scirrhus.

The CLINICAL COURSE AND SIGNS OF CANCER of the breast vary greatly—not only in cases which may be classed as soft, hard, colloid, or duct cancer, but also in cases owning the same histological structure.

The type of scirrhous cancer may be described as follows: usually, the patient's attention is drawn to the breast by some slight pain, or a blow, or she accidentally feels, or even sees, a lump in it; occasionally severe pain, retraction of the nipple, or a slight discharge from it of serous brownish or reddish fluid is the first sign noticed. The surgeon finds a mass in size usually between that of a bantam's egg and that of an orange, occupying some part of the mammary gland (the outer part in 54 per cent., v. Winiwarter); it is very hard, irregular, sometimes quite craggy, ill-circumscribed, immovable in the substance of the breast, and draws upon the nipple when an attempt is made to drag the tumor and nipple apart; the nipple, however, is often so much retracted that it is impossible to seize it; there is usually more or less tenderness about the tumor; pain is often slight, though in some cases it is very severe, shooting up the neck, down the arm, or in some other direction. If the skin be pinched up over the tumor, it may be freely movable, but often it dimples at one or more spots, being attached by fibrous bands to the growth; and after a time it becomes totally adherent, covering a smooth rounded prominence separated from the healthy skin by a kind of fossa. In early stages the mass is freely movable across and along the length of the pectoral fibres, but, sooner or later, it becomes adherent to them. To discover this the arm should be abducted and the patient made alternately to adduct it against some resistance and to slack off, whilst the growth is pushed to and fro—the effect of the contraction in fixing the growth is then easily observed. Sooner or later, too, the glands behind the edge of the pectoral and on the thoracic wall of the axilla become perceptible as hard nodules or masses, at first freely movable, but after a time the whole axilla may be filled with a mass of cancer in which no glands can be made out.

The case may end in many ways: all the above signs may appear in rapid succession—the tumor grows fast, involves more and more of the breast, implicates the skin and adheres to the deep parts early; the skin becomes smooth, shiny, bluish-red, and finally ulcerates, forming a crater-like opening with hard everted margins, from which a thin, often very fetid, discharge exudes; the axillary glands swell greatly, as also do those beneath the pectorals along the great vessels, the subclavicular region becomes prominent, the axilla hard and full, and glandular swellings appear above the clavicle; the subcutaneous veins show plainly through the skin, the hand and arm swell as pressure on the axillary vein increases, and extreme constant pain is excited by pressure on the brachial plexus. For months the health remains good, but when ulceration leads to septic absorption and fetid inhalations, and constant pain prevents sleep, emaciation and pallor soon appear, and the patient dies worn out in two or three years from the onset of the disease. *Post mortem*, secondary nodules are found in the pleura, lung, liver, bones, or elsewhere.

Soft cancer may run its whole course in a year or even less. The tumor is softer (though still firm), less uneven, grows and infiltrates the breast, skin, and deeper parts more rapidly, ulcerates early, and often fungates through the opening, affects the glands early, but does not, as a rule, produce very marked pressure symptoms—it kills too early by marasmus and generalization.

On the other hand, the course of hard cancer may occupy five to ten to twenty years, or even longer. It may remain almost quiescent, as a lump in the breast, exciting no alarm. A woman was admitted under Dr. W. Fox at University College for a liver greatly enlarged by cancer; in seeking for any primary growth elsewhere, a mass, said to have been present twelve years, was found in the breast, and *post mortem*, strange to say, it had microscopic appearances of fairly rapid growth.

Much more often cancer causes atrophy of the breast, great retraction of the nipple, puckering of the skin and binding of everything to the chest-wall (*atrophic scirrhus*); small cancerous nodules appear in the skin round about the breast, and slowly the skin and all the tissues on the chest-wall are converted into a dense, unyielding mass of fibroid cancer (*en cuirasse*); ulceration usually occurs over some nodules in the breast, or in the scar left by removal of the breast; and round about this and elsewhere the effects of scar-contraction are evident. The axilla, perhaps after many years, becomes full and hard, and ulceration may occur over a mass here; pressure symptoms are not usually severe, for the slow growth allows the parts to accommodate themselves to pressure. Death occurs from marasmus and repeated small bleedings, and the disease is often found to be quite local, or there are but few metastases. It is in more or less chronic cases, however, that spontaneous fractures of long bones and spinal symptoms from pressure on the cord are especially likely to arise. By far the commonest seat of secondary deposit after breast-cancer is the liver, then lungs, bones, and kidneys; the bones seem to be quite commonly affected.

The DIAGNOSIS of cancer is usually easy, but in early stages, when most important, it may be very difficult. A soft, rapidly growing cancer may at first sight simulate an acute mastitis, and, indeed, may be complicated by abscess; but such an error cannot possibly be of long duration. The clinical diagnosis from a soft sarcoma cannot be made with certainty, and is unimportant.

An adenoma in a woman over thirty-five too deep in the breast to permit the recognition of its clear outline and mobility, possibly dragging on the nipple, and causing a good deal of shooting pain, may present insuperable difficulty; so, too, may a simple cyst of small size and so deeply placed that fluctuation cannot be distinguished; but should suspicion be entertained on account of smoothness, tension, or multiplicity of the swellings, an explo-ratory puncture should be made. A slowly growing cysto-sarcoma may rarely be simulated by a cystic cancer; involvement of glands, great hardness of the solid part, irregular puckering of the skin, and retraction of the nipple, are all in favor of cancer. Chronic interstitial mastitis produces one or more hard, irregular masses in the substance of the breast, from which fibrous cords may extend to and dimple the skin; these masses, when of any size, are leathery rather than hard; in the rare cases which, it is said, resemble atrophic scirrhus and cause induration of the axillary glands, the difficulty of diagnosis reaches its maximum. A chronic abscess may also give rise to error; its connection with pregnancy, any sign of inflammation, such as œdema of the skin over it, and the occurrence of occasional attacks of pain with slight rise of temperature, are the points chiefly to be relied on. In any of the above instances the patient may be so young that cancer is almost or quite out of the question. Multiplicity of points of disease which may occur in adenoma, simple cyst, and chronic interstitial mastitis, is strongly against cancer, but does not absolutely exclude it. I have seen one case of scirrhus in which the breast seemed to contain several small distinct nodules; after removal these were found to be connected. Whenever there is doubt, and the possibility of cancer must be entertained, the surgeon should tell the patient that an exploratory incision is necessary, and should obtain her consent to carry out at the same time whatever treatment may be necessary. A cut must then be made into the mass, and if the eye cannot decide upon its nature a thin slice must be removed, placed in gum, frozen, and a section cut and examined.

PROGNOSIS.—As regards cure, there is, even yet, but little hope to be given to a patient with cancer of the breast. Still it will be seen, from results given later on, that in favorable cases we are justified in speaking of the possibility of freedom from recurrence for many years, perhaps of permanent cure. Cases favorable for operation are those in which the tumor has been discovered early, whilst small and hard, not involving the skin in any way, not adherent to the deep parts, and before the axillary glands are perceptibly affected; in all cases of cancer a complete physical examination should be made, before giving a prognosis; some secondary growth may thus be unexpectedly found, especially in the liver or much more rarely in the lung, being revealed here, perhaps, by rapid pleuritic effusion.

With regard to the probable duration of life, we can judge only by the previous rate of growth and development of symptoms, the state of the disease when the patient is seen, and the bodily strength and health. When a growth has only just been discovered it is difficult to say that it may not prove atrophic, yet this is extremely unlikely if the mass is soft or the patient young. It is always wise to watch for a few months before speaking, except in the most guarded and general way. Rarely cases which are following the course of an atrophic scirrhus end rapidly from development of pleurisy or some fatal complication.

Early softening, involvement of skin, ulceration and fungation, fixation of the growth to the pectoral, involvement of glands above the lower axillary, early formation of secondary nodules in the skin around the breast, the involvement of both breasts or affection of any internal organ are all more or less unfavorable signs.

Treatment may be radical or palliative.

Radical treatment should be adopted in every case in which the surgeon believes that he can remove *all* the disease; and here considerable latitude must be permitted, one surgeon apparently succeeding where another has declined to interfere. But with a view to *cure*, operation upon advanced cases is useless; it is hard enough to remove *all* the disease in favorable cases, and next to impossible in unfavorable. Nevertheless, the breast should be removed in spite of simple adhesion to the skin or to the pectoral, or of enlargement of the axillary glands when these remain movable.

Here or elsewhere the great point in the treatment of cancer is to remove it *early*, taking away also, *in all cases*, the skin over it and the axillary glands—when they cannot be felt with even more care than when they can. For if the skin over the growth be not widely removed, recurrence in the scar is certain, and almost always, when the axilla is left untouched because the fingers could not feel glands, the result sooner or later shows that they were at fault: the glands enlarge, and removal then fails to arrest the disease. Manifestly the severity of the operation is much increased and the mortality is proportionately heavier; but if the patient is fit for operation at all, it is worth while to run the extra risk. In carrying out this operation the surgeon should work as quickly as possible, consistent with the careful removal of all growth; there should be no niggling, scraping, and shaving, followed by the remark, "I think I have got it all away"—so long as there is plenty of apparently sound tissue to cut into, there should be no reasonable doubt about having gone well beyond the limits of the disease.

Operation.—The patient is stripped to the waist, lies on her back, and has the arm on the diseased side abducted by an assistant or tied to the bed-post. The axilla is shaved beforehand and the part rendered aseptic. Either the spray is not used at all or only at the end of the operation, as the wound is being carbolized, and during the dressing. The surgeon, standing on the side of the breast to be removed, makes a long, almost semicircular, cut below the breast, starting near the sternum and ending somewhat higher up on the edge of the pectoral and just overlapping the margin of the gland (unless the growth lies here, when the incisions must be otherwise placed); raising the little flap whilst an assistant pulls the breast upward, rapidly cutting through the fat, but carefully avoiding the breast, he exposes the pectoral and muscles of the chest-wall, and, seizing the lower margin of the breast, he tears it up, touching with a knife any of the loose areolar tissue that resists. The upper border of the breast can usually thus be reached. The gland is now laid down, and a small upper flap raised up by a cut corresponding to the first, which it meets at both ends; then, starting at the inner angle, the breast is freed and removed—on the *left* side the gland is more easily separated from the pectoral from above, but the lower cut is made first that blood may not conceal its site. When the tumor is upon one side of the nipple the flap upon the opposite side may often by larger than that indicated, but it is far better to have it smaller than necessary than containing cancer-cells. An assistant may now bring the wound together as far as possible with button-sutures and cover it with a guard, whilst the surgeon carries a cut from the outer angle of the wound horizontally back to the posterior axillary fold, and then makes another at right angles to this in the mid-line of the axilla up to the pectoral tendon. The anterior skin-flap thus marked out is raised to the edge of the pectoral, which is bared, and a systematic dissection of the axilla is begun here, the muscular fascia and all the fat (and glands) superficial to it being turned backward by the fingers with an occasional touch with a knife or scissors; the interval between the edges of the great and small pectorals is cleaned, for a few glands lie here; the long thoracic vessels need not be wounded; the attachment of the fascia of the floor of the axilla to the serratus must be cut after it has been separated from the chest-wall and the nerve to the muscle rendered safe. With the fingers working up along the great vessels the soft fat and glands can, in early cases, now be pulled easily from below the clavicle and the whole mass can be turned down and back; the intercosto-humeral and third nerves fare rather badly, and must usually be cut; the fat and glands are still attached to the tissues about the subscapular vessels and nerve to the latissimus and must be separated from them carefully. The axillary wound is disinfected, sewn up and drained from the corner by the posterior fold. The breast wound may be drained from either end and the edges should then be brought accurately together.

There is no difficulty in the operation if the glands are movable, but when they are large and adherent to the vessels (which is not always discoverable before operation) the difficulties may be insuperable. They can be shelled off the artery and nerves; but much less easily off the vein: a piece of this may be excised, if necessary, provided the artery is sound. Should an arteriole or venule close to the main trunk be torn, it will necessitate clamping and ligature of the root of the branch, or of the piece of vein whence it sprang, or of the artery on both sides of it. In bad cases, no task is more hopeless than this attempt to clear the axilla of glands: all round, as high as the finger can reach, small, shot-like bodies are felt, which probably could not all be got away even if one or both pectorals were divided. When the growth is adherent to the pectoral, remove a large portion of this muscle; but when it adheres to the ribs, the case is unfit for operation.

The best dressing after a breast amputation is iodoform to diminish discharge, a deep dressing of gauze, and then a large quantity of salicylic or some antiseptic wool, including the shoulder and arm, over this a firm bandage supported by elastic webbing gently coiled round the arm and thorax. If bleeding has been well arrested, this dressing should remain untouched for days.

The mortality after this operation has been about 13 per cent. in Mitchell Banks's practice, septic causes being responsible in the great majority of cases. Of 46 cases, 6 died, in 11 recurrence took place and 10 died within two years, 3 remained free and died from other causes within two years, 10 cases remaining free for two to ten years, 5 cases for one to two years, 9 cases had been operated on within twelve months, and had as yet no recurrence, 1 case was lost sight of and was a palliative operation only. In 3 of the 11 recurrences, glands were found which could not be removed. When the operation fails, it probably lengthens life by a few months; but against this must be placed its mortality.

Recurrences in the scar or axilla should *at once* be removed and freely, so long as this is possible and there is no internal deposit.

Palliative Treatment.—For hopeless cases we may give the following brief hints: For pain, find the mildest narcotics and the smallest doses that will give relief; ring the changes on two or three that their efficacy may be longer maintained. Turn last to opium: morphia hypodermically is the best form. Look carefully to the diet, and choose such as will best support the strength. Turtle-soup, eels, oysters, Edinburgh ale, Constantia wine, Tokay, Champagne; of Greek wines the St. Elie, of Hungarian the dry Ruszter, of Australian wines the Dalwood and Auldana, may give a stimulus to nutrition. As to particular symptoms, *œdema of the arm*, which is often such a distressing complication of the latter stages of this disease, may be somewhat retarded by bandages, and by keeping the limb in an elevated posture. Punctures of the skin may be tried when it becomes excessive.

The extreme *pain* which often accompanies œdema may justify the attempt —dangerous, it is true—to dissect out the cords of the brachial plexus or to divide one or more above the clavicle. *Foul ulceration* must be treated by antiseptics; *fungation* by solid chloride of zinc; but if *stench* or *hemorrhage* be irrepressible, palliative amputation may be proper.

CYSTS.—We have already spoken of galaktocele, of cysto-sarcoma, of soft sarcomata containing degeneration and blood-cysts, and of cystic cancer.

SIMPLE CYSTS full of serous fluid are occasionally met with in otherwise apparently healthy and even virgin breasts, either on the surface or deep in the substance; they are rarely larger than a filbert; are lined with epithelium, and contain a yellow, reddish, or greenish fluid which may escape from the nipple; they are formed of dilated gland-ducts. Their chief importance is the difficulty in diagnosis which a tense swelling often deep in the breast occasions. A puncture will reveal their nature.

HYDATID CYSTS have rarely been met with here. They present the usual signs, and must be incised, the cyst removed, and the cavity drained antiseptically.

Men, as has been incidentally mentioned, also occasionally suffer from cancer and other diseases of the breast, which manifest themselves in the same manner, and require the same treatment, as in the female.

PART IV.

OF THE OPERATIONS OF SURGERY.

CHAPTER XLVIII.

OF OPERATIONS IN GENERAL.

Preparations for Operation.—Frequently there is no time for preparing the *patient*. When there is, we must endeavor to secure the highest possible health before undertaking any serious procedure; but here again we must be careful lest the patient lose ground from anxiety or progress of the disease. In robust patients, accustomed to active, out-of-door lives, a few days of absolute rest upon a spare diet is probably an advantage. When any peculiar position is to be maintained after the operation, it is best to accustom the patient to it beforehand. A good night's rest should, if possible, be insured before the operation. Many surgeons prefer to operate between 8 and 10 A. M., because, should hemorrhage or any complication arise, it is likely that they will have the assistance of daylight in meeting it; but in case of very nervous patients a better night will often be secured by fixing on a later hour. The bowels should be well cleared out by an enema some hours before the operation. For the operation the patient should be warmly clothed and covered, no part being unnecessarily exposed.

A *room* with a good light should be selected and warmed to about 65°. The operating table is best made of two plain deal dressing-tables placed end to end and covered with blankets and a macintosh sheet. Two or three pillows should be at hand. It is a great mistake to do any operation while the patient is in his bed. The position of the patient, surgeon, and assistants in relation to the light should be carefully considered, and the table placed accordingly; much time is wasted in wheeling round the tables or the patient when the anæsthetic has been given. A piece of old carpet or a blanket should be placed on the floor (see p. 599 for other details).

There should be in the room: a fire, with a kettle boiling; cans of hot and cold water, a slop-pail, two or three large basins and towels; a sufficient supply of carbolic lotion (1 in 20) or other antiseptic; brandy, a feeder, and small enema apparatus. The surgeon will bring plenty of carbolized sponges and the dressings; and the anæsthetist will have a hypodermic syringe, ammonia, ether, and any other drugs he may have faith in.

Assistants should be in sufficient number; each should know his duty beforehand and give all his attention to it, anticipating the wishes of the surgeon, so far as possible. A skilled assistant is required to give the anæsthetic, and to help the surgeon by sponging, clamping vessels, compressing arteries to which a tourniquet cannot be applied, etc.; the sponges may be looked after or a part to be amputated held (in most cases) by any intelligent being, and the instruments, covered with carbolic in a white dish, should always be placed behind and to the right of the surgeon, so that he can select for himself.

The *instruments* vary with the case; but, in addition to special instruments, the following should generally be taken: one or two scalpels, a curved probe-pointed bistoury, director, and probe; ordinary tenaculum, clamp, dissecting, sinus, and vulsellum forceps; two blunt hooks; scissors; drainage-tubes of various sizes ready for use (Fig. 4); Esmarch's bandage and tourniquet; fine sulphurous-chromic catgut ligatures, some stout Chinese twist, silver wire of various thicknesses, a pincushion stocked with straight and curved needles threaded with catgut, horsehair, silk and wire; and lastly, a few Lister's buttons. A good lantern should be kept ready for operations at night.

It is well to have delicate instruments made to shut in a handle, like a pocket clasp-knife, to be kept in the pocket till wanted, that the edge or point may not be injured (Fergusson).

The operator should *himself see* that everything is at hand that may be wanted. It is awkward in the middle of an amputation to send out for a saw.

KNIVES, AND HOW TO HOLD THEM.—Knives are of three kinds: scalpels, bistouries, and amputating knives. Scalpels and bistouries should balance on the finger just where the rivets run through; they may be held like a dinner-knife, like a fiddle-stick, or like a pen with the edge up or down. For all free and strong cutting they should be held "like a dinner-knife" (Fig. 279): balance the knife upon the tip of the second finger, opposite this place the thumb, and let the forefinger rest upon the back of the hilt; the third and fourth fingers touch the handle and press it into the palm more or less firmly as occasion may require. A knife is held "like a fiddle-bow," when it is used "on the flat" with forceps, as in opening a peritoneal sac, or, with the edge turned up, in slitting up a sinus on a director. It is held "like a pen" for all fine dissecting work. Amputating knives are held lightly in the hand, between the point of the thumb and the bend of the first and other fingers (Fig. 337) for marking out flaps and dissecting them up; but they are grasped in the clenched fist (Fig. 335) when power is required, *e. g.*, in clearing the bone, or in the sweeps round the limb of a circular amputation.

INCISIONS.—During an incision, the skin must be gently stretched and steadied with the points of the fingers, or it will be dragged along by the knife, and the incision will be ragged and shorter than was intended. In cutting through the skin, pass the knife into the subcutaneous tissue at right angles to the surface; then incline the blade, and make it cut with a sawing motion through the skin to the requisite extent; and, lastly, as the incision is finished, bring the knife up perpendicular to the surface: thus the whole thickness of the skin will be cleanly divided, both at the beginning and end of the incision, without any "*tailing*." Timid operators often make skin-incisions too limited, which embarrasses their subsequent proceedings; others, bolder, make them absurdly "free." Over a hernial sac, or in any place where the skin is loose, it saves time and pain to the patient to pinch up a fold of skin of a size proportionate to the length of the intended incision, to transfix it with the scalpel or bistoury, with its edge directed from the patient, and to cut out straight to the surface. By this means a straight and even incision down to the fascia is made easily and quickly.

When two incisions are to meet, *e. g.*, the semi-elliptical in amputation of the breast—the second should fall into the first *nearly*, but not *quite*, at *its extremity*, so that there may be no little isthmus of the skin left undivided between them; again, in making a V or T-incision, the second cut should be made *toward* the first, *not* from it.

Incisions must be primarily adapted in position and direction to the end in view; they vary in length according to the depth to be reached, and, as this varies with the amount of fat and muscle, the length of the incision necessary to tie (say) the common femoral is not absolute. In deepening the wound, the points noted under "Incision" in "Ligature of Arteries" must be attended to. For most purposes, it is very important that the wound be kept dry in order that the surgeon may see what he is doing.

BLOODLESS METHODS.—A limb may be rendered ex-sanguine, and the blood it contains saved to the patient, by bandaging it from below up with an elastic bandage (Esmarch), or by simply holding it vertical for two or three minutes (Lister) and then applying, in either case, Esmarch's India-rubber cord, so tightly and *rapidly* that arteries and veins are closed simultaneously. A needle may now be searched for with almost as much ease as in the dead body, and in many cases these methods are invaluable. When the main artery cannot be controlled by tourniquet or finger, hemorrhage may sometimes be prevented by the crossing needles and ligature, or by the temporary subcutaneous ligature mentioned at p. 400. It is often forgotten in abdominal sections that hemorrhage can be at once controlled by a finger upon the aorta. When no such control is possible each vessel should be compressed by clamp-forceps as it is cut, *i. e.*, there should never be several bleeding at once; but the fingers and sponges were used for this purpose long before clamp-forceps were thought of, then came the serre-fine (Fig. 288, *a*) and Dieffenbach's bulldog forceps (Fig. 288, *b*), and, lastly, Péan's, Köberle's, and Wells's clamp-forceps.

Lastly, we may operate with Paquelin's cautery knife (p. 869) or with Chassaignac's écraseur (Fig. 289), which tears its way through the tissues and thus prevents bleeding. Instead of the chain shown, stout piano-wire is generally used; some like a fine wire rope, but it is apt to snap. Not uncommonly the main vessels are dragged out, finally cut through and bleed. Neither of these methods is to be recommended when the knife or scissors can be used—and it is very rarely that they cannot, by any one who has learned not to fear bleeding.

FIG. 288.

a, serre-fine; *b*, bulldog forceps.

FIG. 289.

Ecraseur.

For *sutures, drainage*, and *dressings* see pp. 170, 171, 172.

GENERAL REMARKS ON OPERATIONS.—The art of operating has undergone very great changes of late years. Until comparatively recently "brilliancy" in operating was regarded as the test-point of a good surgeon; and, truly, before the introduction of anæsthesia, speed was of primary importance. The rapidity, and at the same time the accuracy, attained by the great surgeons of the later pre-anæsthetic days were indeed marvellous, and one cannot study the writing of the few who then reached eminence, without being impressed by the strength of character—the determination, self-reliance, courage, coolness, and skill—which the successful practice of surgery then demanded. Modern surgery is less exacting, and is in some respects less valuable as a training.

With the introduction of anæsthesia need for haste to shorten the patient's sufferings disappeared; and our means of controlling hemorrhage have become so perfect that there ought rarely to be anxiety upon this score. The consequence is, that, little by little, "brilliant" operating, with all its attractiveness, has been replaced by careful operating. The question is no longer how to effect our object *most quickly*, but how it may *best* be attained; the method which will give the most satisfactory result must be followed, no matter how tedious it may be. It must not, however, be supposed that careful operating is either slow or clumsy: it should be both quick and neat; but the careful cleaning of an artery, the removal of all glands from an axilla, or a subperiosteal amputation can scarcely be brilliant—though the result may be. Perhaps, there is a tendency with some to operate in too leisurely a manner, now that the patient lies as quiet as if dead, and the wound is as dry, and the structures exposed as clear (thanks to Lister's and Esmarch's bloodless methods of operating, or to the clamp-forceps), as in the cadaver; but we should never forget that shock and the depressing effects of anæsthesia vary directly as the length of the operation.

AFTER-TREATMENT.—1. The point of first importance is the maintenance of *asepsis*, or, where this is impossible, of the utmost cleanliness.

2. *Diet:* the best general rule in aseptic cases is to allow the patient boiled fish or under-done mutton chop cut up fine as soon as he wishes for it; when he is febrile or has a foul tongue he will generally be satisfied with slops and farinaceous puddings; but when septic inflammation is to be feared, starvation-diet may be a very important preventive, as it seems to be in compound injuries of the skull.

3. *Stimulants* are given much more frequently and freely than there is any need for; in cases of shock they are most valuable, but after this we think that their only use is to whet a failing appetite and cause food to be taken and digested which would otherwise be left, and for this purpose small quantities of claret or beer with the meals are sufficient. To escape responsibility, the surgeon should not fail to countermand any stimulant which he has ordered so soon as it is no longer necessary.

4. *Anodynes* are frequently necessary; but, like stimulants, they should never be ordered without full reason, for the patient often pays dearly in other ways for the rest procured, or they prove exciting instead of calming, or the patient becomes addicted to their use. Small doses should always be tried at first and repeated if necessary at short intervals till the desired effect is produced; this is especially desirable with morphia. Combinations act better than pure drugs, *e. g.*, morphia and chloral, chloral and bromide are usual combinations. Chlorodyne and Battle's bromidia are other and valuable examples.

5. *Change of air* after an operation is very valuable in completing the cure.

CHAPTER XLIX.

MEANS OF PRODUCING INSENSIBILITY TO PAIN.

History down to the Discovery of Nitrous Oxide.

History.—So terrible is the idea of the surgeon's knife, that it cannot be wondered at that attempts have been made, at various times since surgery was first cultivated, to diminish the tortures both in apprehension and reality which it inflicts. Sir James Y. Simpson (*Edin. Journ. Med. Sci.*, Dec. 1847; *Obstetric Works*, 1856, vol. ii.) brought forward quotations from Dioscorides, Pliny, and Apuleius, authors of the time of the Roman empire, showing that in that age the root of the mandrake (*atropa mandragora*), steeped in wine, was given to cause insensibility (ποιεῖν ἀναισθησίαν) in persons who were to be cut or cauterized; and that whilst the influence of this remedy lasted a limb might be cut off without any pain or sensation. The seeds of the rocket (*eruca*) infused in wine were taken, according to Pliny, by criminals about to undergo the lash, in order to induce a certain recklessness or hardihood of feeling. The "wine mingled with myrrh," mentioned in Mark's Gospel, chap. xv., furnishes an instance familiar to every one. *Bang*, or extract of Indian hemp, is now employed in India for the same purpose, and was used by the Chinese, Egyptians, and Scythians in very early times. The famous confection of Hugo di Lucca, composed of henbane, opium, mandragora, and hemlock, was used as a narcotic vapor to alleviate suffering in the twelfth century. Sir James Simpson showed that the inhalation of narcotic vapors was used preparatory to surgical operations in the thirteenth century. According to Dr. Snow, the vapor of sulphuric ether was probably so used at Naples by Porta in the sixteenth century.

The modern history of anæsthetics may be said to begin at the end of the eighteenth century, when James Moore, house surgeon to St. George's Hospital, introduced a plan for diminishing the sensibility of limbs before amputation, by compressing the principal nerves. This he effected by means of an instrument somewhat resembling Signoroni's tourniquet, consisting of a horseshoe-shaped arch of steel, with a pad at each extremity, and a screw to act upon one of the pads. Moore was permitted by John Hunter, in 1784, to try his plan upon a patient in St. George's Hospital, whose leg, after having been submitted to the process, was cut off with an extremely small amount of pain (*A Method of Preventing or Diminishing Pain in Several Operations of Surgery*, by James Moore, Member of the Surgeons' Company of London, 1784). This plan, however, was soon given up, as not certain, nor without disadvantages; for Malgaigne (*Operative Surgery*, by Brittan, p. 42), who attempted by this means to benumb a patient's leg, found that although some amount of insensibility was produced, yet that considerable pain was caused by the compressing instruments.

The Introduction of Nitrous Oxide Gas.

At the end of the last century, the brilliant discoveries of oxygen and other gases by Priestley, Black, and Cavendish, created a new branch of chemistry called *pneumatic chemistry*, and this in turn gave rise to a new branch of therapeutics called *pneumatic medicine*, whose votaries hoped to cure diseases, and especially consumption, by the inhalation of various kinds of gases. A "Medical Pneumatic Institution" was set up at Clifton by Dr. Beddoes ("A Letter to Erasmus Darwin, M.D., on a New Method of Treating Pulmonary Consumption," by Thomas Beddoes, M.D., Bristol, 1793), with huge reservoirs of gases for the use of patients. Humphry Davy, just out of his apprenticeship, was appointed superintendent in 1799; his experiments on the inhalation of nitrous oxide created great excitement; Coleridge, Southey, Rickman, Roget, Boulton, Watt, Wedgewood, and others, since distinguished as poets, philosophers, and inventors, made proof in their own persons of the effects of the intoxicating gas; the *gaz oxygenium* and *gaz acidum carbonicum* were introduced into the catalogues of medicinal drugs, and it was hoped that we were in possession of remedies, simple and certain, for almost all maladies. Davy, though far from participating in the sanguine dreams of Beddoes, believed it possible that by various combinations of carburetted hydrogen and nitrous oxide, "we should be in possession of a regular series of exciting and depressing powers, applicable to every deviation of the constitution from health." But experience proved the fallacy of these, as of many other plausible speculations. In the course of his experiments Davy found that nitrous oxide relieved him from headache after an intoxication brought on by drinking a bottle of wine in eight minutes, for the purpose of comparing the effects of wine with those of the gas; he also found that it mitigated the pain of cutting a wisdom tooth; and he threw out the hint that as it appeared "capable of destroying physical pain, so it might probably be used with advantage during surgical operations" (*Memoir of Sir H. Davy*, by his brother, John Davy, M.D., London, 1839; and *Researches, Chemical and Philosophical*, by Humphry Davy, Supt. of the Med. Pneumatic Inst., London, 1800, p. 465 *et seq.*).

There was, however, no established or systematic use of this anæsthetic until the year 1844, when Horace Wells, a dentist of Hartford, Conn., U. S., acting upon Davy's suggestion, inhaled the nitrous oxide gas himself before one of his teeth was extracted, with the effect of producing a complete unconsciousness of pain, and also administered it to several patients with the same beneficial results. In December of that year he visited Boston, and made public trial of the administration of the gas, before the Medical College of that city. But this experiment failed from want of proper management; and the failure subjected Wells to so great an amount of ridicule that he fell sick through vexation, retired from practice as a dentist, engaged himself in stuffing and exhibiting birds and in the sale of shower-baths; afterward came to Europe as a picture-dealer, then returned to America, became more and more unsettled in his mind, and died by his own hand in January, 1848. The use of this gas in dentistry was recommended in America in 1863, and is now very general. It is made by heating nitrate of ammonium to 460°–482° F., the gas evolved being purified by passage through three Wolff's bottles containing solution of ferrous sulphate, liq. potassæ, and pure water. Manufacturers sell it in portable, wrought-iron bottles, containing large or small quantities in the liquid state. The gas is obtained by turning a tap into which a pipe, leading to an India-rubber reservoir, has been screwed. From the reservoir another pipe carries the gas to a closely fitting mask, which should have expiratory valves. The reservoir must be kept full by an assistant, unless Clover's apparatus, which the administrator manages with his foot, is used.

Administration.—All air must be excluded, and the patient should not be made to breathe the same gas over and over. In thirty seconds, as a rule, the countenance becomes somewhat livid and the breathing unnaturally deep; in one minute or less the lividity is marked, the eyes prominent, the pupils dilated, the lips blue, lax, and wet with saliva, rendering the aspect very ghastly; the breathing is stertorous and slow; the conjunctiva insensitive, the muscles of the eyes and limbs, especially the long flexors of the fingers, twitch convulsively. If pushed further, the pulse becomes irregular, and respiration ceases, the patient dying of asphyxia. The signs of fitness for operation are: insensitive conjunctiva, the *commencement* of stertorous breathing, and the occurrence of subsultus tendinum of the fingers. This stage is generally reached in one minute, insensibility lasts another minute, and in a third the patient is quite conscious again. A few breaths of air bring back the normal color to the cheek, and, if necessary, the anæsthesia may be prolonged by repeated alternations of gas and air. Insensibility has been kept up for forty minutes in this way, and in New York nitrous oxide is used by some for major operations. Gas probably acts by simple asphyxia. It yields no oxygen to the blood, and animals die in it as soon as in nitrogen; anæsthesia occurs as the blood becomes venous; if twenty to forty per cent. oxygen is given with it, no anæsthesia results; to obtain this, analysis of blood shows that the oxygen in the blood must be reduced to three to four per cent. Hydrogen and nitrogen are said to produce similar effects, but no exhilaration. During anæsthesia, two-thirds the increased amount of carbonic acid is given off, and, if allowed to escape by an expiratory valve, only the nitrous oxide has to be eliminated from the blood to bring back sensibility. When death is produced in animals, respiration stops before the heart, unless the latter is degenerate and its right ventricle early fails to drive the blood through the obstructed pulmonary circulation and becomes over-distended and paralyzed.

Excitement, violent laughing, and struggling may occur in the early stage of the administration or during recovery, but are apparently not due to admixture of the gas with air, as has been supposed. Vomiting after the anæsthesia is rare, headache somewhat more common.

If a gag is to be used, insert it before giving the gas, having a string tied to it and hanging out beneath the mask, for several cases of death are reported from slipping of the gag and its impaction in the glottis; the best gag is a bit of wood of proper length hollowed out a little at each end. Very few deaths have occurred from other causes, and, upon the whole, death has been exceedingly rare. For short cases, it is undoubtedly the safest anæsthetic.

Introduction of Ether.

In 1815 an apparatus for giving ether vapor was figured in *Nysten's Dictionary*; but it was in September, 1846, that ether was first successfully employed as an anæsthetic during surgical operations. The honor of this practical discovery has been disputed between Dr. Charles T. Jackson and Mr. W. G. T. Morton, of Boston. It seems that Morton was a kind of pupil of Jackson. The idea of finding some means of extracting teeth without pain occupied the attention of both. Starting from the fact related in Pereira's *Materia Medica*, that the vapor of ether, pure or medicated with conium, was a well-known remedy[1] in asthma and whooping-cough, and that Jackson himself had inhaled it to relieve the irritation caused by breathing chlorine gas, and that he knew the use of chloric ether for aching teeth, there seems little doubt that the merit of suggesting the ether vapor as an

[1] Short Account of Different Kinds of Airs so far as relates to their Medicinal Use, by Richard Pearson, M.D. Birmingham, 1795.

anæsthetic belongs to Dr. Jackson. The first operation was the extraction of a bicuspid tooth by Morton, at 19 Tremont's Road, Boston, at nine in the evening of September 30, 1846. Thus began a new era in surgery. On October 16th, Morton administered ether in the Massachusetts General Hospital, at Boston, to a patient from whom Dr. Warren removed a tumor in the neck; and on the day following to a patient from whose arm a tumor was extirpated by Dr. G. Hayward. From that time the use of the remedy spread rapidly in all directions.

We may express our regret at some of the proceedings which followed. Morton set up the claim of being not merely the first to administer the ether under Dr. Jackson's orders and directions, as Dr. Jackson affirms, but of being the discoverer of the idea. Then there is no doubt that the discovery was patented, and that the right to use it was the subject of pecuniary bargainings between Jackson and Morton. Dr. Jackson afterwards cancelled the patent and threw the thing open to the world.[1]

From America the news of the discovery was conveyed to England in a communication from Dr. Bigelow, of Boston, to Dr. Francis Boott (*Lancet*, January 2, 1847, and all medical periodicals of that year, *passim*), and it was received most cordially. On December 22, 1846, Liston tried ether in University College Hospital, amputating a thigh and tearing out a toe-nail painlessly. In less than a fortnight it was tried by almost every surgeon in the kingdom: and the medical periodicals for a long time were crowded with instances of its powers in alleviating suffering, and with descriptions of various apparatus for administering the vapor.

ADMINISTRATION.—Ether is best given by means of Clover's apparatus. If the patient is nervous, allow him to breathe a few times through the mask only; then fit on the India-rubber bag moderately full of air, and let him breathe the same air a few times over, with the indicator at "no ether." This may occupy one-half to one minute. In the next minute or two, turn the indicator by successive short moves from "no ether" to "full ether," when the air will pass entirely through the ether-chamber, and keep the mask closely applied. When anæsthesia is attained, the mask may be removed from time to time (must be whenever marked blueness of face is produced) and the indicator turned to midway between "full" and "no ether."

EFFECTS.—Ether produces effects which are very similar to those of chloroform, described in the next section. It is, however, a much less pleasant anæsthetic than chloroform, being pungent and irritating to the air-passages, causing at the outset a sense of choking or suffocation, prolonged holding of the breath, voluntary struggles and endeavors to remove the mask—unless the ether be turned on very gradually.

The stage of excitement and violence is apt to be more marked and more prolonged with ether than with chloroform: the mask should be kept firmly applied unless blueness indicate the need for a breath or two of air. Excitement is most marked in the strong and athletic, and in hard drinkers; in drunkards it may rarely be impossible to overcome it without pushing the anæsthetic dangerously.

Muscular rigidity is more persistent: and if the patient is kept long under, and especially if exposed to cold, troublesome tremors may appear.

[1] Ether and Chloroform, by Henry J. Bigelow, M.D., Boston, 1848. See A Report of the Trustees of the Massachusetts General Hospital, with a History of the Ether Discovery, in Littell's Living Age, Boston, March 18, 1848, which gives Morton's version. The author has received, on the other side, a careful statement of facts and dates from Dr. C. T. Jackson, who claims, with every appearance of justice, the merit of the idea of employing ether.

The *pulse* is quickened and increased in force, and this is maintained for a long time.

After the early sense of suffocation is over the *respirations* are quick and become gradually slower; if the ether is pushed they become stertorous, still slower, more shallow, and finally cease—the pulse continuing perhaps for some minutes after the cessation of breathing. Ether apparently acts first as a stimulant, later as a direct depressant of the respiratory centre; but it is a stimulant to the heart and vasomotor centre, markedly raising the arterial pressure.

Ether produces increased secretion of mucus from the membranes over which it passes; in prolonged operations the filling of the bronchi may cause much lividity, and in patients already subjects of bronchitis and emphysema may ultimately cause death.

The early unpleasantness of ether may be got over by first administering gas fully, and then turning on the ether, as can be done by Clover's apparatus. This seems to be the best and safest mode of anæsthetizing for periods longer than a few minutes. To avoid the expense of gas, sensation may be dulled by chloroform, and ether then used; or the ether may be very gradually turned on.

Being a cardiac stimulant, and killing only through the respiration, it is much safer than chloroform; the signs of approaching death by asphyxia being much more marked than those of death by cardiac syncope.

It must be remembered that ether-vapor is highly inflammable; it should never be used in proximity to the actual cautery; and in operation at night, lights must be kept away from the cone. In bronchitic and emphysematous patients chloroform is preferable, as it is also when light anæsthesia must be maintained for hours, *e. g.*, in renal colic or compression for aneurism. Young children take it well, but up to ten years old chloroform seems equally safe, and is generally given.

Introduction of Chloroform.

Chloroform.—Brilliant as was the early career of ether it was destined soon to be in some measure eclipsed. The late Sir James Y. Simpson, of Edinburgh, made numerous experiments on himself and friends with carbonic chloride (CCl_4), acetone, nitrous ether, and other substances, in the hope of discovering an anæsthetic superior to ether. At last, on November 4, 1847, in company with Drs. Keith and Matthews Duncan, he tried *chloroform* ($CHCl_3$)—an agent which was immeasurably more pleasant to take than ether, which acted more rapidly when each was given upon lint, and, upon the whole, caused less excitement and rigidity. It speedily replaced ether, and is to this day the anæsthetic of Edinburgh; but elsewhere ether has regained the first position, having proved itself decidedly the safer.

Chloroform had been investigated some time before by Flourens and Glover, and it was recommended to Sir James by Mr. Waldie, of Liverpool (*Lancet*, 1847, vol. ii. pp. 631, 687). Moreover, in the *summer* of 1847, Michael C. Furnell—then a student at St. Bartholomew's Hospital, now Principal of the Medical College, Madras—was residing in the house of Bell & Co., of Oxford Street, to perfect himself in practical pharmacy. Excited by the recent discovery of ether, he made many experiments on the different varieties of inhaler. One day, whilst looking for sulphuric ether, he found a dusty bottle labelled "chloric ether." He boldly experimented on himself, and inhaled some of this liquid, which produced a certain amount of insensibility without the suffocating irritation and choking caused by sulphuric ether. He communicated his observation to Holmes Coote, who was looking out for something less irritating than sulphuric ether, and Coote used it during several operations performed by Lawrence in the summer of 1847. But Simpson not only discovered but investigated the properties of chloroform, published his discoveries, and established its use; whilst Furnell, Lawrence, and Coote simply observed the anæsthetic value of chloric ether, and, not knowing that chloric ether was an alcoholic solution of chloroform, allowed the perfect discovery to slip from their grasp (*Med. Times and Gaz.*, 1875, vol. i. p. 586). It is mentioned by Dr. Sansom (*On Chloroform*, 1865, p. 7) that in the neighborhood of the North Cape of Norway, a bag of white ants (which contain formic acid) was in old times boiled in a spirit distilled from parsnips, used by the peasantry as an intoxicating liquid, and produced anæsthesia so complete that operations were performed without pain under its influence. The surgeons who first performed operations with the aid of pure chloroform were Dr. Miller (*Principles of Surgery*, vol. ii. p. 756) and Dr. Duncan, at the Royal Infirmary of Edinburgh, early in November, 1847.

We must refer to works on *materia medica* and chemistry for an account of the composition and manufacture. But, as every one who uses it ought to know good from bad, we may say that pure chloroform is a dense, colorless liquid, having a specific gravity, when quite pure, of from 1.480–1.5. It is exceedingly volatile at all temperatures, and boils at about 140° F. Atmospheric air at the temperature of 40° F. can retain six per cent. of chloroform vapor, and at 60° twelve per cent. It has an agreeable, sweet, fruity smell and taste, and if poured on a piece of blotting-paper and evaporated, ought to leave no oily empyreumatic smell behind. Chloroform is almost incombustible, thus offering an advantageous contrast to ether, from the explosion of which during administration at least one serious accident has happened (*Med. Gaz.*, Sept. 20, 1850).

The impurities to which chloroform is liable are: (1) Alcohol and ether, which are innocuous, but impair its strength. (2) Methyl compounds, if prepared from methylated instead of rectified spirit, from motives of false economy; these produce headache, nausea, and prostration. And (3) chlorine, which, from its irritating and suffocating effects upon the lungs, is highly dangerous. Strong sulphuric acid and dry chloride of zinc produce a black precipitate when mixed with methylated chloroform; and nitrate of silver precipitates the white chloride of silver when added to chloroform containing hydrochloric acid or free chlorine. The latter is detected also by its odor, and its bleaching effects upon litmus-paper.

Effects on the Animal Economy.—The following remarks upon chloroform may, with the exceptions before noted, be taken as applying equally to ether:

The vapor of the anæsthetic is received into the lungs, absorbed into the blood, and conveyed to the nervous centres, upon which it soon produces very marked effects. Three stages of anæsthesia are spoken of: (1) excitement; (2) unconsciousness; (3) profound narcosis or coma; and certain symptoms are described as characteristic of each stage, but many variations occur, and no line can be drawn between the stages.

In the stage of *excitement*, at first, the current of ideas is vivid and not quite under control; there is consciousness of all that is going on, and pain is severely felt. If the vapor is too strong, or pushed too quickly, the patient gasps, and there is cough or spasm of the glottis, with crowing breathing, or, very rarely, cessation of respiration. *Respiration* is rather quicker than normal, but it soon becomes slower. The *pulse* is quickened and perhaps strengthened, but after the first thirty seconds there is a progressive lowering of the arterial pressure (Rep. of Chloroform Com., *Trans.*

Med.-Chir. Soc., vol. xlvii.), due apparently to paresis of the vasomotor centre, and to direct depressing action upon the heart (if sufficiently concentrated, chloroform vapor instantly destroys contractility of the heart-muscle). Soon consciousness becomes imperfect, and the patient becomes more and more drowsy, but all reflex movements persist. All varieties of intoxication may be displayed, according to the patient's mental peculiarities. One man is noisy and struggles violently, another sings or laughs at jokes of his own making, and women frequently weep and appeal to their mothers. But these phenomena are by no means universal, and are generally of short duration. During the struggle the *pupil* is generally large. The occurrence of these movements is a sign that consciousness is close at hand; they often cease quite suddenly, and the first stage passes into the second, inhalation being continued. Vomiting sometimes occurs during this stage; a little careful pushing of the anæsthetic may check it, as it does not happen in the second stage.

In the stage of *unconsciousness* there is profound sleep; all voluntary motion is at a standstill, and the limbs hang limp, and drop like lead when raised. Reflex movements persist longer than the voluntary, but soon they too almost all disappear; the conjunctiva is quite insensitive, and pinching the inner side of the thigh (often a better test than touching the conjunctiva, especially in children) provokes no action. The eye is suffused and turned up, and the *pupil* is *contracted*. The *breathing* is slow and deep, as in natural sleep. The *pulse* should be of about normal frequency, and is more or less weakened. This is the stage in which all ordinary surgical operations are performed.

The stage of *deep narcosis* is entered if the anæsthetic is pushed further. The *pupil* now *dilates*, perhaps suddenly and fully. *Respiration* becomes shallower, irregular, and infrequent, and may finally cease. The pulse becomes rapid, weak, irregular and intermittent. This is a stage of great danger, and should rarely be entered upon.

In the second stage the matrices of the nails, the region of the anus, and the skin of the organs of generation retain their sensitiveness, and reflex movements occur when they are irritated. To prevent them it may be necessary to enter the third stage, and this explains the frequency with which death has occurred during anæsthesia for such trifling operations as those for phimosis, evulsion of toe-nails, piles, etc.

It seems that chloroform, like ether, acts chiefly upon the central nervous system. The brain is distinctly anæmic during anæsthesia. According to Flourens, the nerve-centres are involved in the following order: the cerebrum, the sensory tracts of the cord, the motor tracts of the cord, the sensory tracts of the medulla, the motor tracts of the medulla—when stimuli fail to excite these latter, the animal dies from asphyxia. The peripheral nerves are very slightly affected.

Chloroform, like ether, at first stimulates the respiratory centre, but very soon depresses it. The drug may at first stimulate and then paralyze the depressor centre, thus accounting for variations in pulse-rate; after the first half minute it weakens the vaso-motor centre, and thus lowers the arterial pressure, which effect is much increased by its direct paralyzant action upon the heart. In these actions upon the vascular nervous system it differs from ether, which, for a long time at all events, is a stimulant of all these parts.

ADMINISTRATION.—The most common way of giving chloroform is by means of a bit of lint or a handkerchief; it is by far the simplest method, and probably as safe as any apparatus—for no apparatus can do away with the necessity for care and common sense. But it is somewhat wasteful of the vapor. The corner of a stiffish towel puckered up over the nose while the point lies over the chin makes an excellent close-fitting inhaler. Skinner introduced a pear-shaped wire ring, shaped to fit over the mouth and nose, on to which two bits of wire are hinged; these can be raised and jointed together so as to form a support for a low tent of flannel; a bit of bent wire is soldered to the narrow end of the pear by way of a handle. This can hardly be called an "apparatus;" it is merely a frame to support the lint, which acts very much better than the fingers, and fits well in the breast-pocket. The chief fault in the method of giving chloroform on a bit of lint is that the quantity present in the air inhaled is very variable—reaching its maximum just after, its minimum just before, a fresh addition. This may be remedied by allowing a drop to fall every few seconds on a single layer of lint or other material held over the mouth and nose (Lister). Lister has shown that air passing by lint upon which chloroform has been poured contains much less than the three and a half per cent. of the anæsthetic found to be safe by the Committee of the Royal Med. and Chir. Soc. The chloroform must not touch the lips or skin, or it will blister the face, and in young children and thin-skinned women it is well to put a little vaseline on the cheeks, lips, and nose.

Many inhalers have been invented; *if* the valves work well, they save chloroform and regulate the dose. In time of war the husbanding of chloroform may be very important; otherwise, apparatus is rarely used.

Junker's inhaler is the best. It consists of a bottle of chloroform through which air is driven by a Higginson's syringe; thence it is led by a flexible tube to a closely fitting face-piece. But for this a more or less curved tube may be substituted, which can be passed through either nostril or the mouth into the pharynx, just above the glottis, and it thus forms a very valuable means of maintaining anæsthesia during operations upon the mouth or nose.

The anæsthetist generally stands above the patient's head: it is easy in this position to hold the lint or apparatus in position and to keep a finger upon a temporal artery, whilst at the same time the eye notes the color, etc., of the face and the frequency and depth of the respirations, and the ear listens for the respiratory sounds. This is highly necessary, for the respiratory movements may continue in spasm of the glottis for some time after air has ceased to enter. Noisy, somewhat crowing breathing from slight spasm shows that the vapor is being given too fast; it is relieved by diluting the vapor a little and raising the chin strongly; the effect of the latter movement may be increased by pushing the condyles of the jaw forwards on to the articular eminences by a finger behind each angle, the base of the tongue being thus dragged forwards. Dyspnœa from the accumulation of mucus at the back of the throat may be relieved by opening the mouth wide with tongue forceps and thus exciting swallowing, by sharply compressing the thorax at the end of expiration, or by wiping out the fauces.

It is best to keep the face well turned to one or other side, as the tongue then does not tend to fall back over the glottis, and saliva runs out at the angle of the mouth instead of collecting in the throat and requiring to be swallowed.

The state of the pupil should be examined from time to time: with ether and chloroform it should be kept well contracted, and the conjunctiva should, of course, be insensitive. In children the pupils sometimes do not contract well: too much reliance is never to be placed upon their condition.

No more of the anæsthetic than is absolutely necessary should be given: after the incisions through the skin have been made, a very much smaller quantity suffices to keep the patient insensitive; returning reflexes, signs of pain, etc., will warn the administrator to increase the dose.

Noise and violence in the stage of excitement should cause no alarm, the anæsthetist must push the anæsthetic whilst assistants restrain the movements of the limbs. If the breath is long held the first deep inspiration should be of air only, lest spasm be caused.

If signs of vomiting are noticed, push the anæsthetic a little; it will not occur if the second stage is reached. If it come on, see that the head is turned well to one side and that the vomit escapes freely; solid or semi-solid masses may require removal by the finger. Once the mouth is cleared, go on with the anæsthetic. Sometimes vomiting is most troublesome and persistent, rendering it almost impossible to reach the second stage.

The surgeon should not begin till the patient is fully under; and this is perhaps most important in cases of weak heart, in which sudden, unlooked-for pain may cause cardiac syncope.

There should be no hurry, no undue pushing of the anæsthetic; at the same time, timidity must be avoided. With gas a patient is generally under in one minute; with gas and ether in two to three minutes; with plain ether in Clover's apparatus in four minutes, and with chloroform in three to eight. Some patients take a larger quantity of the anæsthetic than others; rare cases have been reported in which anæsthesia could not be induced. It is impossible, therefore, to speak of a safe or a fatal dose.

General Points in the Administration of Anæsthetics.—The management of an anæsthetic should be committed to one competent person, who should have nothing else to do. If a woman is to be anæsthetized by a man, a third person should always be present. The best time is from 8 to 10 A.M. No meal so heavy as breakfast should be taken within eight hours of the time, but three hours before, the patient may have a cup of soup or beef-tea. It is well always to feel the pulse, listen to the heart-sounds, and ask whether there is or has been any lung-trouble, before commencing: information inciting to extra caution may thus be gained. If the heart-action is very weak, it is well to give a little brandy or ammonia ten minutes or so before the anæsthetic, especially if this must be chloroform. Always ask to *look into* the patient's mouth, and if you see false teeth or any other foreign body, ask for its removal: if nothing is seen, no harm has been done. See that the upper part of the chest may be easily exposed, and that nothing tight remains around the neck, thorax, or abdomen; no garments should remain on which would interfere with artificial respiration, should it be necessary. During the administration watch that no one leaning over presses on the abdomen or thorax. The recumbent position is the safest, and it is dangerous suddenly to raise the head considerably, especially with chloroform and when the pulse is weak.

Causes of Death and Signs of Danger.—Anæsthetics may be divided into two classes: those which produce death through the respiration only, viz., nitrous oxide and ether; and those which may cause death, by inducing cessation either of respiration or of heart-action, or both, viz., chloroform, bichloride of methylene, and other chlorine and bromine substitution-products.

Death from asphyxia may be produced by an anæsthetic: 1st, by its administration in excessive quantity, oxygen being more or less completely excluded for a considerable time; 2d, by the production of a spasm of the glottis; 3d, by depressing the respiratory centre in the medulla and stopping the reflex act of inspiration.

In the case of spasm of the glottis the symptoms may come on suddenly and be very marked—ineffectual efforts to expand the chest, lividity of the head and neck, turgid veins, prominent eyes, dilated pupils, and convulsive struggles. But, more commonly, increasing lividity and more or less gradual cessation of the respiratory movements, with dilating pupil, are the signs of approaching asphyxia; the movements may go on for some time after air has ceased to enter—whence the necessity for carefully listening to the breath-sounds. Death during anæsthesia may occur from asphyxia produced by closure of the air-passages by some foreign body, *e. g.*, a tooth-plate, a piece of tumor, flesh, etc., detached in operations about mouth or nose, blood entering the trachea, or a clot forming gradually over the glottis. The symptoms of this come on suddenly, and their cause in operations likely to be complicated by them is generally at once suspected. But a clot may fill the pharynx so gradually as to cause death without any symptoms other than that of cessation of breathing. In these cases the pulse continues after cessation of respiration. *Post mortem,* distention of the right heart would be found.

TREATMENT.—In all cases of sudden onset the mouth must be opened widely and the tongue dragged forcibly forward first; and, especially in those in which there is any reason to think that a foreign body may be closing the glottis, pass a finger into the pharynx and endeavor to feel and remove any obstacle. This failing, there may be time to let the head hang down and forcibly to compress the chest, with the idea of displacing the body by gravity and by expiration. But few moments can be given to experiments of this kind; if they do not at once afford relief the larynx or trachea must be opened.

In the cases of gradual onset, having seen that the pharynx is clear of mucus or blood if there is any reason to suspect its presence, draw the patient up till the head hangs down over the end of the table (or drag the shoulders to the side of a bedstead) and perform Silvester's artificial respiration. As adjuncts, open doors and windows, and dash cold water on the face, neck, and upper part of chest; hold a broken nitrite of amyl capsule in front of the nose; and, if a battery be at hand, pass gentle currents along the phrenic from one pole on the neck to the other at the epigastrium.

Death from *cardiac syncope* or *paralysis of the heart.* In this the face suddenly becomes deadly pale, the pulse is missed at the wrist, the heart-impulse cannot be felt nor its sounds heard, breathing continues slowly and gaspingly for half a minute or more, and then all is over. This is the way in which chloroform generally kills in man—suddenly, with little or no warning. The anæsthetic is breathed freely till the pulse stops, even after it; there is no lividity, no struggling.

It has been suggested that in some cases the chloroform was impure, in others that its administration was hurried and careless, which is doubtless true. In animals it is found that when the vapor is very dilute and the inhalation prolonged death occurs from asphyxia; when more concentrated, both respiration and cardiac action are markedly depressed; and if still stronger the heart is arrested in diastole (p. 849). It is "pushing the anæsthetic," or giving a strong vapor rapidly, which is to be avoided. Inspiration of air containing more than three and one-half to four and one-half per cent is dangerous; and to render the percentage constant Lister's drop method should be adopted.

TREATMENT.—These cases are very hopeless; indeed, there is probably no chance if the heart has really stopped. Artificial respiration must be begun immediately, free access of air permitted, and nitrite of amyl inhaled; the head should be allowed to hang down, and the legs should be raised, blood to the brain being probably the best cardiac stimulant. Sponges wrung out of hot water should be applied to the præcardia. Puncture of the left ventricle with needles, or the passage of an electric current from an electrode over the cardiac area to a needle in the heart-substance, has not yet saved a life.

There is no peculiar post-mortem appearance to be found in the victims of chloroform; the heart is diastolic and is often fatty, but by no means always. If it be fatty, no doubt less chloroform will be required to stop it than if healthy: but much chloroform will stop the healthiest heart. Chloroform should always be given as if it were certain that the heart is diseased. In some cases where every care has been taken and the heart is found healthy, it is possible that the patient was the victim of idiosyncrasy.

Mixed cases occur in protracted inhalations in which the breathing is slow, or shallow, quick and irregular, the pupil dilating, and the pulse feeble or intermittent. Removal of chloroform, plenty of fresh air, stimulants by mouth, rectum, or subcutaneously, will form the treatment.

After-effects.—The smell and taste of the anæsthetic and eructations flavored by it sometimes persist for many hours, especially after ether. Headache, nausea, and giddiness not uncommonly remain until the patient has had some natural sleep. Hiccough may be very troublesome and is generally relieved by a cup of strong coffee or green tea. Sometimes vomiting and retching continue so long and so severely that life is endangered. Abstinence from food beforehand will diminish, but not always prevent, the vomiting, which is probably the result of brain disturbance. The less the patient is moved about after the operation the better; the eyes should be kept closed, as looking about brings on giddiness. If natural sleep succeed anæsthesia, vomiting is less likely to occur. The treatment of vomiting consists, at first, in giving complete rest to the stomach—stimulants, if required, being administered *per rectum*, or subcutaneously; should this fail after three or four hours' trial, ice may be sucked and small pieces swallowed; small doses of iced soda and brandy or iced champagne may be given; or a small cup of very strong coffee containing pot. brom. grs. xxx. or small doses of dilute hydrocyanic acid. A mustard poultice to the epigastrium is sometimes useful. After many hours of vomiting, all the above fluids being returned, the stomach will sometimes retain a little solid food—chicken or boiled fish—and trouble will be at an end. Meanwhile, if the patient be feeble, nutrient and stimulant enemata must be given regularly.

In old emphysematous subjects, perhaps at the time bronchitic, severe bronchitis may be induced and occasionally it proves fatal. This is generally a result of ether; but exposure to cold and spray are not without their effect.

Uses.—To prevent pain and to relax or prevent muscular contraction. An anæsthetic should be given whenever the pain of an operation or manipulation is likely to be severe, or whenever the resistance, voluntary or involuntary, of the patient prevents the surgeon from carrying out his wishes—especially in the case of children. It is invaluable in the reduction of dislocations, the setting of fractures, the reduction of hernia, the passage of instruments through tight strictures. It lessens the shock of operations; for though the loss of blood and section of nerves produce their effect upon the narcotized subject, the force formerly wasted in efforts at self-control or in agonized cries and struggles is now saved, and the depressing effect of simple suffering is avoided. Occasionally it facilitates the detection of feigned disease.

Applicability.—Patients constantly ask whether they are fit subjects for an anæsthetic, and the answer is "Certainly, if you are fit for an operation" (Bailey). Fat, flabby, pasty-looking people, over thirty-five, and with weak pulses should be looked upon with suspicion. Drunkards and intemperate people bear chloroform badly. Epileptics may have fits induced by the inhalation; and it is said that, in epilepsy and chronic Bright's, convulsions, stertorous breathing, lividity, and coma may be brought on. Heart disease of any kind, but especially degenerative, indicates necessity for unusual caution and the employment of ether—*e. g.*, when faintings or *angina* have been frequent, with dyspnœa, feeble and intermittent pulse, calcified arteries and *arcus senilis*. In bad bronchitis, with or without emphysema, no anæsthetic may be safe, least of all ether; and great caution is necessary in cases of extensive effusion into either pleura or pericardium.

It is very desirable to avoid vomiting in certain operations, *e. g.*, extraction of the lens—lest straining cause escape of the vitreous—and abdominal sections. It is probable that the former operation will now be performed under local anæsthesia from cocaine. In the latter but a very small quantity of the anæsthetic is required after the abdomen is opened. Braine speaks of patients looking about and answering questions, unconscious that the surgeon was breaking down adhesions about an ovarian cyst.

No anæsthetic should ever be administered by any one to himself.

Mesmerism.

"The Introduction of Mesmerism into the Hospitals of India in 1852," by Dr. Esdaile, is an extremely interesting pamphlet, detailing how this surgeon, by means of certain passes, induced a state of insensibility in a large number of natives, and performed upon them some of the most painful operations of surgery. Each patient as he came in was placed under the care of one of the native hospital officials, who made the passes over him several times a day. Sooner or later, at once or after some days, the mesmeric sleep was induced in all cases, and deepened each time that it was induced; then Esdaile operated, the patient slept for several hours, and usually woke free from pain; if not, he was again put to sleep. There was no vomiting, and the patient could be waked for food as often as necessary. The way in which this state is produced is quite unknown: it has obvious advantages over ordinary anæsthetics, but success such as Esdaile's in inducing the mesmeric state has never been met with here, and a person susceptible of it is literally at the mercy of any one who can induce it.

Means of Producing Local Anæsthesia.

An agent which would produce perfect insensibility of a part, whilst leaving the brain in possession of its faculties, would obviously be most valuable. Sir J. Simpson's experiments showed that reputed anodynes, such as opium, belladonna, Indian hemp, and aconite, when applied to unbroken skin, produce so slight an effect that no cutting operation could be painlessly done. Both the above and the vapor of chloroform act more powerfully when applied to ulcers, often allaying the pain these cause.

Our means of producing local anæsthesia are two: cold and hydrochlorate of cocaine—and the cold is produced by ice and salt, or by the evaporation of ether.

Ice and Salt.—Pound sufficient ice quite fine, and *rapidly* mix with it in a non-conducting vessel (wood, gutta-percha) half its weight of finely pounded salt; stir quickly and well with a stick. Remove any lumps, and put the mixture in a thin gauze net, and lay this upon the part held horizontally. Raise it and examine the skin every three or four minutes. Pallor and numbness are immediate, rapidly increasing till the skin is shrunk, and of a peculiar tallowy, corpse-like paleness, perfectly insensitive and hard. A bladder of iced water should be laid over the part to render its thawing slow. If the mixture be too long applied, or heat be incautiously used afterwards, and particularly if the patient be old and feeble, ulceration or sloughing may result. But the judicious use of cold is followed by no ill consequence whatever.

Simple pounded ice in India-rubber bags, or iced water, and through Leiter's tubes is used to control inflammations, and sometimes to assuage pain.

Ether Spray.—Richardson's ether spray affords the readiest and quickest means of freezing the skin. The spray used is exactly similar to the carbolic hand-spray, being worked by a Higginson's ball-syringe which keeps an elastic India-rubber reservoir tightly distended with air; this maintains a constant flow of air through the upper tube of the nozzle, which, passing out over the point of the lower tube, sucks the air out of this, and volatilizes the ether which rises from the bottle to replace the air.

The specific gravity of the ether employed should not be more than 0.723; when poured into the palm, warmed by breathing through the half-closed fist, it should boil briskly (96° F.). The jet should be held about one and a half inches from the surface, and the spray kept constant: the syringe may be worked by the foot. In two or three minutes a white frost appears on the surface, which becomes rapidly blanched, hard, and insensitive. In long incisions the spray must precede the knife—a slow process, and often ineffective; the knife gets coated with ice, and the surgeon's fingers suffer; and, further, ether causes much smarting of a raw surface. In plastic operations there is risk of sloughing of the flaps. It can scarcely freeze the deeper parts; so that neither it nor ice and salt answer for operations other than the shortest and simplest—such as circumcision, removal of piles, warts, wens, and small tumors, opening abscesses, and the application of setons or the cautery; but the Cæsarean section has been done after freezing with ether.

Frequently so much painful tingling of the part is experienced during thawing that it is obviously worse than the smart of the incision.

Hydrochlorate of cocaine was introduced a short time back by Köller, as a local anæsthetic. Solutions, of strength varying from four to twenty per cent., are prepared with boracic lotion, or with sublimate lotion (1 in 5000), for without some antiseptic a fungus grows and destroys the drug. For most purposes a four per cent. solution answers. It is dropped or painted every three or four minutes on to any mucous or raw surface, or injected into any cavity or channel which such surfaces line. Diminution of sensitiveness is manifest in about three minutes, and becomes absolute in ten to twenty, so that all superficial operations can be performed painlessly; in thirty minutes sensation has generally returned. The drug in watery solution does not penetrate the skin, but Murrell has relieved neuralgia by painting the skin of the affected part with a twenty per cent. solution in oil of cloves; the opening of abscesses, removal of cysts and small tumors, even the evulsion of toe-nails, may, however, be painlessly performed by injecting the solution beneath the skin, though this method is not so certain as that by painting. It is obvious that the anæsthetic is most valuable in the surgery of the eye, ear, nose, larynx, trachea, urethra, rectum, and vagina.

With regard to its general effects, cocaine acts like caffein, brightening the intellect, lessening fatigue, and quickening the pulse; in larger doses, it causes delirium, giddiness, and unsteady gait, and ultimately death results from paralysis of respiration. The drug dilates the pupil and antagonizes morphia.

CHAPTER L.

ARTIFICIAL RESPIRATION.

The practice of artificial respiration sprang probably out of the experiments of the illustrious Vesalius, who injected air into the lungs of animals while the still beating heart was exposed to sight, and thereupon saw the venous blood of the right side of the heart pass over as red blood to the left side, as the result of the aëration. The same experiment was afterwards performed before the Royal Society by Hooke, in the seventeenth century; and the wonder with which it was received by the learned of that day shows that the original research of Vesalius had either been lost or forgotten. Since then the experiment has never failed to excite interest; and for a hundred years surgeons have been inventing instruments and plans by which artificial aëration of the blood can be rendered perfect for the restoration of life after accidents which, but for the intervention of art, would be fatal.

Artificial respiration is demanded in every form of sudden death in which respiration is entirely suspended, and may be carried out in conjunction with proper means of restoration. In cases of shock from blows or falls, lightning stroke, sunstroke, or even syncope, artificial respiration may be of extreme value, but it is most commonly required in "asphyxia" from drowning, hanging, or strangling, foreign substances in the air-passages, inhalation of chloroform and other narcotic or poisonous vapors, after tracheotomy for closure of the glottis or larynx, and obstruction of the windpipe. The practice is important also in the treatment of the apnœa of newborn children.

Many METHODS have been suggested, but two are very decidedly superior to the rest, and will alone be described.

1. *Chest Pressure.*—Prof. Howard, of New York, has invented a method, which is adopted by the Board of Health of that city, and is systematically taught to medical men, and to policemen and persons engaged by the waterside. The patient is laid upon his back, with a roll of clothing beneath the loins, so as to make the short ribs bulge prominently forward, and raise them a little higher than the level of the mouth. The arms are then stretched forcibly back over the head, crossed, and held in this position by an assistant, who also holds the tip of the tongue out of one corner of the mouth, grasping it with a dry handkerchief. The operator then kneels astride the patient's hips, and with his thumbs resting on the epigastrium of the patient, spreads out his fingers so as to grasp the waist about the short ribs. He next throws all his weight steadily forward upon his hands, while, at the same time, he squeezes the ribs deeply, "as if he wished to force everything in the chest upwards out of the mouth." This pressure is continued while *one, two, three,* can be slowly counted, when it is suddenly removed with a final push, which springs the body of the operator back to his first kneeling position. After an interval during which *one, two,* can be slowly counted, the pressure is repeated; and the process continued as long as necessary.

2. *Silvester's Method.*—This has been adopted by the Royal Humane Society. The patient is placed on his back on a flat surface, inclined a little from the feet upwards, the shoulders being supported on a small, firm

cushion, or bundle of clothes, and the head allowed to hang back. The arms are then grasped above the elbows, and are drawn strongly and steadily upwards until they meet above the head, and so air is drawn into the lungs. The arms are kept in this position while the operator can deliberately count *one, two,* when they are turned down, and brought gently to the sides, against which, for two seconds, they are firmly pressed. The process is repeated fifteen times in a minute, until there is a spontaneous effort to respire, or until all hope has vanished. It should not be hastily given up in cases of apparent death.

The latter plan can be carried out by one person, but it is more fatiguing than Howard's. In either case the mouth and fauces must be cleared from obstruction before the movements are begun—after immersion, by turning the patient face downwards on the cushion for a few seconds. When natura respiration returns, artificial may be cautiously abandoned.

CHAPTER LI.

SLINGS AND BANDAGES.

Slings.—The importance of a proper application of these supports to the extremities is often overlooked.

For the upper limb the triangular bandage, made by tearing diagonally a piece of stout calico one to one and a half yards square, should be used; it may be covered with black silk. When the forearm is broken it should be supported all along (Fig. 82). Suppose the right arm is to be slung; place the bandage on the patient's chest with one end of the base line on the left shoulder and the apex of the triangle beneath the right elbow; flex the right forearm to 90°, or a little more, laying it on the bandage; raise the other end of the base line, carry it over the right shoulder, and tie the two ends on the left side of the neck; lastly, adjust the base, so as to take the hand or leave it free, as may be required, turn the apex projecting beyond the elbow backwards and pin it tightly to the hinder layer. The elbow should be supported thus in disease of the shoulder. If the clavicle is injured, the pressure upon it of the anterior layer cannot be borne; this must then be passed from front to back through the right axilla, and carried across the back to the left shoulder. But, if the humerus is broken, only the wrist must be supported (Fig. 78) that the weight of the elbow may act as constant extension. The triangular bandage is for this purpose rolled upon itself three or four times. A clove-hitch (Fig. 112) upon a bit of roller bandage does very well in many cases.

The foot may be slung by a long, broad slip of calico round the neck with its ends sewn on each side of a slipper; the patient is thus enabled to move on crutches with little pain or danger to the injured part.

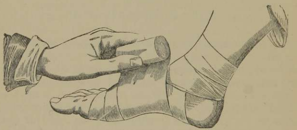
Bandages usually consist of strips of linen, calico, flannel, or stocking-webbing, six yards long and one to three, five, or more inches broad, to allow reversing upon parts of various thickness. They are rolled up for use, and hence have received the name of *rollers*. Besides the simple roller, there are many compound bandages, as the T-bandage and many-tailed bandage. The triangular bandage or handkerchief folded across is capable of a great variety of uses.

Rubber or elastic webbing bandages are used for special purposes.

USES OF BANDAGES.—1. To keep on dressings—linen or stocking-web. 2. To keep on splints and restrain motion—stout, coarse, unbleached calico (the ordinary "roller" and most generally useful bandage). 3. To make pressure upon a part which is the seat of varix, œdema, inflammatory thickening or effusion, or give support when constricting pressure is made higher up—calico, flannel, rubber, or elastic webbing. 4. To give warmth whilst retaining a part in place—*e. g.*, the leg on a Thomas's splint—flannel.

The Roller.—The surgeon should hold it as in Fig. 290, and should pass it from one hand to the other as he encircles the limb with it. He should begin at the extremity of the limb, applying it with uniform pressure—never tightening—as it ascends. He should unfold very little at a time, make each fold overlap half or two-thirds of the previous one, and, as a rule, bring the roller up on the inner side of the limb (Fig. 290). There are three ways of applying the roller, viz., the *simple spiral*, used when the limb varies little in thickness; the *reversed spiral*, changing the surface of the roller which is applied to the skin by an acute angle or *reverse* (Fig. 293) at each turn, necessary when the limb increases rapidly in thickness to bring back the bandage which tends to run up too fast; and the *figure-of-8*, made

FIG. 290.



Bandaging the ankle.

by describing this figure round the limb and used about all joints (Figs. 290, 292, and 296). The last may be applied very quickly over splints also, and holds them firmly in place; but when applied directly to a limb, it exerts pressure unequally—the lower edges in the lower, and upper in the upper, turns being tight, whilst the opposite looser edges, forming thick folds beneath succeeding layers, may hurt; it requires more material than the simple or reversed spiral. In all cases care should be taken that the lower end of the bandage is well covered and tightly held by succeeding turns, that the lower edges of the turns are equidistant, and that reverses and points of crossing in figure-of-8 turns are *in line* along the *outer* side of the limb. To make a reverse requires a little practice: the difficulty is that the beginner will *pull* the bandage into place as in Fig. 293, instead of unrolling a little, *allowing it to lie loose*, turning the roller over and thus making the reverse, passing the bandage beneath the limb and tightening it as the head changes hands; a finger or thumb fixes the upper edge of the bandage, and always in the same line of the limb, as the reverse is made. A bandage, of width proportioned to the thickness of the limb, must be chosen; if it be too wide the reverses will extend right round the limb; if too narrow, gaps of skin will show between them.

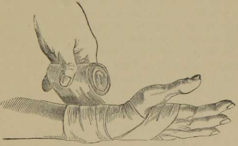
Where sudden hollows occur, as above and below the heel, a pad of wool may be used to fill them; and wool or lint should be used to protect points at all likely to be galled.

FIG. 291.

Finger bandage and mode of ending.

FINGER BANDAGE.—A strip of linen, three-quarters of an inch wide, wound round the finger a few times with the requisite tightness (Fig. 291), split at the end into two tails turned in opposite ways round the finger, and tied in

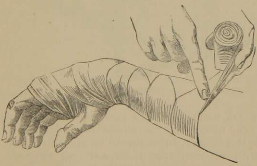
FIG. 292.



Bandage for wrist and hand.

a bow. Whenever firm pressure is made on the arm, each finger must be separately bandaged, to prevent swelling. Then start round the wrist, run

FIG. 293.



Bandage for forearm; a reverse being made with the bandage drawn tight instead of being held slack.

the back of the hand, and with a single turn to the tip of the little finger; come down it with the simple spiral and finish off with a figure-8 turn round the wrist and root of the finger, crossing behind the knuckle. Then go to the ring finger, and so on.

For the Hand (Fig. 292).—A two-inch bandage passed in a figure-of-8 round the hand and wrist, commencing with a turn round the wrist, next passing across the back of the hand and round the metacarpus, excluding the thumb, each turn getting higher up and overlapping the lower, and finishing by one or two turns round the wrist. If for support, fill the palm with wool.

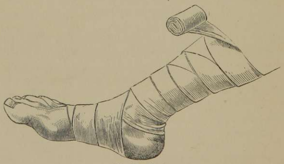
For the Forearm.—After bandaging the fingers, hand, and wrist, as just described, continue up the forearm, and in every turn fold or *reverse* the bandage, seeing that the folds lie *on* the *posterior muscles* and without creases (Fig. 293).

For the arm, a simple spiral suffices; and the *shoulder* is covered in by ascending figure-8 turns which pass from the deltoid across the back to the opposite axilla, back across the front of the chest, round the arm outside the deltoid and from behind forward through the axilla on the injured side. Pad both axillæ and the subclavian region on the injured side to prevent the bandage galling.

For the Foot (Fig. 290).—Place the end of a three-inch bandage on the dorsum of the foot and make a turn round the ankle, bringing up the roller on the *inner* side; next carry it round the instep thus completing a figure-8 turn. By these, with one or two circular turns near the toes, the foot except the heel may be covered. This is the mode of fixing an ordinary leg-bandage below (Fig. 284). But *to take in the heel*, when uniform support is required, make the first turn round the ankle and point of the heel and, having filled the hollows of the sole and over the tendo-Achillis with wool, make figure-8 turns of which the loops get *very gradually* more on to the leg or foot respectively, covering in the foot and ankle as above.

For the Leg (Fig. 294).—The bandage being fixed round the foot, carry it up the leg, with reverses above the commencement of the swell of the calf, that the folds may not be separated. Each turn should overlap the preceding for two-thirds of its breadth, and in thin and old patients much pain may be given if the reverse folds lie on the thinly covered shin. Just below the knee one or two circular turns should be made to finish.

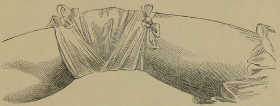
Fig. 294



Bandage for leg.

For the Knee.—If continued up from the leg, ascending figure-8 turns must be used, ending in simple turns above the knee. To compress the knee alone, pad the popliteal hollow, begin with a circular turn round the patella, and then make figure-8 turns with gradually separating loops meeting in the popliteal fold. Simply to keep on dressings, the four-tailed bandage is useful. Split a piece of calico, a yard long and eight inches wide, up the middle from each end to within a few inches of the centre. Place the centre on the patella, cross the four tails under the knee, and tie them two above and two below (Fig. 295). A handkerchief will also do very well.

Fig. 295.

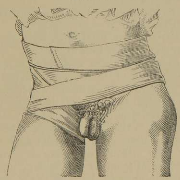


Four-tailed bandage for the knee.

The *thigh* is covered by a reversed spiral.

For the Groin.—The bandage may be continued up from the thigh or may be limited to the groin, being commonly used for retaining dressings and keeping up hernia: it is called the *spica*. Lay the end of the bandage on the pubes and take a turn round the thigh, coming up on the inner side; complete the figure-8 by carrying the roller round the hips, between the trochanters and iliac crests, and bringing it back to the point of crossings in front of the groin; succeeding turns overlap two-thirds of previous ones. Finally, if necessary to cover a dressing, spiral turns may be made round the abdomen. A double spica in which the bandage is carried from the

Fig. 296.

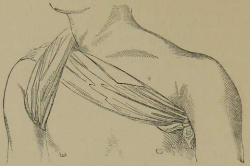


Spica for the groin.

back of either thigh to the front of the other, crossing behind the scrotum so as to press a dressing against the perineum, is the bandage after herniotomy and all aseptic operations about the genitals. A small wooden support (Volkmann's) beneath the sacrum is invaluable in applying this bandage.

For the Axilla.—To keep on dressings or poultices, etc., apply a handkerchief as in Fig. 297, which explains itself.

Fig. 297.



Handkerchief for the axilla (Smith's "Minor Surgery.").

For the trunk simple and reversed spiral turns are used, the several turns being run together along several lines with a needle and thread and kept from slipping *down* by being attached to strips of bandage used like braces over the shoulders, or from *rising* by strips passing beneath the perineum.

For the Head and Neck.—To a man who knows how to bandage each case here suggests the method to be employed; safety-pins are to be liberally employed. There are many methods described. The *knotted bandage* was devised to compress the temporal after arteriotomy. A one and one-half inch double-headed roller (*i. e.*, rolled from both ends to the centre) is used. A graduated compress (p. 363) is placed on the wound, the bandage is laid on the opposite side of the head and the rollers brought round, as low as possible on the head, to the compress where they change hands, are carried through 90 degrees each (to "knot" them) and drawn tight enough to check any bleeding; one is now carried over the vertex, the other under the jaw, and the two ends are pinned to the horizontal turn on the healthy side. More turns than these should not be required. When no compress is needed, the bandage need not be knotted, but may be fixed with a pin or stitch where its direction changes (Fig. 298).

The capelline bandage for retaining dressings is a triumph of art, rarely used. Two 1½-inch 6-yard rollers are fastened together. The surgeon stands behind the patient holding a roller in each hand, lays the united bandages *low down* on the root of the nose, and carries the rollers just above the ears to *below* the occipital protuberance where they change hands, are drawn tight, and are twisted through 180 degrees. One roller henceforth travels round and round the head, as low down as possible; the other passes to and fro from the occiput to the nose, rising very gradually from the horizontal plane to the sagittal line; each layer overlaps two-thirds of the preceding, and the roller goes forward upon one side, returns upon the other, being held down at back and front by the passage over it of the encircling roller. The two ends are pinned to the mass of the bandage behind. If the horizontal turns are low enough and tight enough, it should be impossible to raise the cap from the head; it may be cut out over the eyes, if they are overlapped.

The shawl-cap—a handkerchief folded in the form of a triangle, one angle placed behind, and the two ends crossing the forehead and tied over the occiput—much used by navvies and others laboring in the open air—is sometimes useful.

A FOUR-TAILED BANDAGE may be applied to the frontal region (Fig. 299), and also to the occipital. Fig. 298 shows the direction of the turns of the most useful bandage for keeping dressings on the neck, *e. g.*, after scraping glands. Take a turn or two, as tight as may be, round the neck, then pass

FIG. 298.

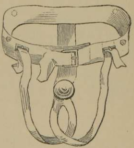
Retaining bandage for the head.

from the occiput low down round the head, then round the neck again, then from beneath the jaw round the vertex, and, lastly, round the neck to the occiput where a pin is inserted, and the bandage cut long enough to pass

FIG. 299.

Four-tailed bandage for the head.

FIG. 300.



Bandage to support perineum, vulva, or anus.

forward in the sagittal line over the transverse vertical turn, under the horizontal head-turn at the forehead and back to the transverse vertical turn.

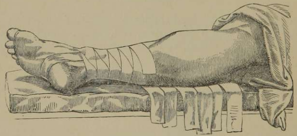
The horizontal turn is drawn well down on each side and pinned to the vertical turn; the end of the bandage is then drawn tight, so as to raise the front of the horizontal turn from the root of the nose and eyes and make all taut, and is pinned to the vertical turn.

The T-BANDAGE FOR THE PERINEUM is made by sewing together in the form of a T two pieces of 3-inch bandage, each a yard long; the horizontal piece fastens round the waist; and the vertical, split up half way from the end into two tails, passes from behind between the legs, retaining dressings or maintaining pressure on the perineum, the ends being carried on either side of the genitals and tied to the waistband. Instrument makers have a more elaborate contrivance (Fig. 300) for cases in which permanent support to the perineum is required; the perineal straps and any pad should be of rubber.

The best SUSPENSORY BANDAGE FOR THE TESTICLES is made with two handkerchiefs, one tied round the waist as a girdle, and the other folded in a triangle, of which the middle of the straight edge is placed under the scrotum behind the testicles, and fixed to the waistband by a tape passing on either side of the anus, whilst the two ends pass through the girdle on each side, and tie to each other and to the middle angle brought up in front of the genitals.

The MANY-TAILED BANDAGE is very useful to keep on splints, fomentations, or dressings when it is important not to move a part. It is made by sewing to a long strip of bandage, other strips long enough to go one and a half times round the part; each of these strips covers two-thirds of the pre-

FIG. 301.



Many-tailed bandage.

ceding, and is put on obliquely to imitate the turns of a roller. The central strip is laid under the part, the cross-strip last attached being below. Fig. 301 shows its application.

CHAPTER LII.

MINOR SURGERY.

VENESECTION AT THE BEND OF THE ARM.—Either the median basilic or median cephalic vein may be opened, but as the median basilic is usually the larger, it is, as a rule, chosen, though requiring more care because it crosses the brachial artery (Fig. 302, *a* and *b*), separated only by the strong bicipital fascia. A piece of broad tape, three-quarters of an inch wide and one and one-half yards long, is first wound round the arm a little above the elbow, tightly enough to check return of blood through the veins but not to stop the pulse. The superficial veins now swell up. The operator takes the forearm in his hand, places his thumb on the vein a little *below* the intended puncture, and then (using the right hand for the right arm, and *vice versâ*) pushes a lancet obliquely into the vein, and makes it cut its way directly out. The lancet is now laid down and a graduated bowl is placed in position to receive the blood; then the thumb is removed. Intermittent contractions of the forearm muscles, as in grasping a pole, cause the blood to run more freely. When sufficient blood has flowed replace the thumb on the vein below the aperture, untie the fillet, put a pad of lint on the wound, and fasten it on with the fillet, thus: place the middle of the tape under the thumb upon the pad, pass it round the elbow in the form of a figure-of-8 (Fig. 290), cross the two ends over the compress, carry them obliquely backward so as not to compress the limb circularly, and tie. A sling should be worn for some days. Fat, concealing the veins, may necessitate a small incision to find one.

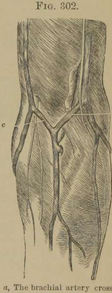
The jugular vein is sometimes opened in cases of apoplexy, and of asphyxia when the right ventricle seems over-distended. The surgeon stands above the patient and puts his left forefinger on the right vein a little above the clavicle and his thumb a little higher up, and opens it between them with a lancet, cutting down and in that the incision may cross the fibres of the platysma. When blood enough has flowed, close the wound with a pad and strapping, and not till this is done should the thumb be removed. In performing this operation, care must be taken that the opening in the skin and *platysma* is *directly over*, and rather larger than that in the vein, otherwise an accumulation of blood takes place under them, causing a tumor (*thrombus*), which by pressure upon the vein may stop the flow of blood.

The veins in the leg, especially the saphena at the inner ankle, and those of the scrotum, or in the neighborhood of the eye or ear, are sometimes opened in the same manner.

Abscess in the areolar tissue, inflammation under the fascia, erysipelas, phlebitis, spreading thrombosis, neuralgia, wound of the brachial, varicose aneurism, and aneurismal varix, are occasional consequences of venesection.

ARTERIOTOMY.—The anterior branch of the temporal artery should be opened above the outer angle of the eyebrow. The surgeon feels for and steadies it with two fingers and opens it between them, cutting it, as in venesection, obliquely across and about half through. When sufficient blood has flowed, cut the vessel completely across, that its ends may retract and contract. Then apply a graduated compress with a "knotted" bandage; and maintain tight pressure for a week. Any subsequent bleeding or spurious aneurism must be treated by completely dividing the artery, if not done already, and by pressure; but if the wound be much inflamed or ulcerated, so as not to admit of pressure, acupress the artery above and below.

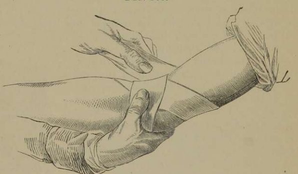
FIG. 302.



a, The brachial artery crossed at the bend of the elbow; *b*, the median-basilic vein, the bicipital ascia intervening; *c*, the median-cephalic vein.

Wet Cupping.—The patient being in a comfortable position, with towels arranged to cover his clothes, and protected from cold, that the flow of blood to the surface may not be checked, and the operator being provided with scarificator, glasses, torch, spirits of wine, lighted candle, hot water, and sponge, conveniently arranged on a table close by—the first thing is to sponge the skin well with hot water, to make it vascular. Dry it with a warm towel, and adapt the glasses to the part. Their number must depend on the quantity of blood to be taken—three to five ounces each is a fair average. Dip the torch in the spirit, set it on fire, introduce it for half a second into a glass, clap it on the skin, and so on with the other glasses in succession. When the skin swells up into the glass, charge the scarificator, and take it between the right forefinger and thumb, at the same time holding the lighted torch between the little and ring fingers of the same hand. Then detach one glass by insinuating the nail of the left forefinger under its edge—instantly discharge the scarificator on the swollen skin, introduce the torch into the glass, and as quickly as possible reapply it. Repeat the process with the other glasses. When they become tolerably full, or the blood begins to coagulate in them, detach them in succession and reapply them if necessary. When the operation is finished, dress the wounds.

Fig. 303.



Binding on the compress after bleeding.

The glasses must not be exhausted too much, or the pressure of their rims will cause severe pain, and prevent the blood from flowing, and the operation will be followed by ecchymosis. The position of the glasses must be slightly varied each time they are applied, that their edges may not again press on the same circle. The expediency of not burning the patient need only be hinted at. In taking off the glasses, the upper part of each should be detached first, that the blood may not run down. The length of the scarificators must be adjusted to the thickness of the skin; for if the incisions are too deep, the fat will protrude through them, and prevent the flow of blood.

For *cupping on the temples* smaller glasses and scarificators are employed. A branch of the temporal artery is often wounded, and the flow of blood may be expedited by slightly lifting the lower rim of the glass. Pressure, by strapping or bandage, should be kept on the wounds for some days afterwards.

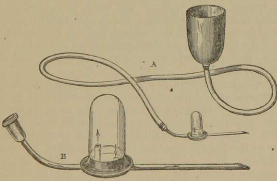
Wet cupping is now never performed. For *dry cupping*, see p. 65.

Leeching.—See p. 65.

Transfusion of blood should be performed when death seems imminent, in spite of the measures given at p. 365, from hemorrhage during labor, from wounds, the bursting of varicose veins, or any other source. It has been recommended in cholera, in which the fluid and saline constituents of the blood are lost by the bowel, and suggested as a means of prolonging life in cases of slow starvation. If it is to be done, it should not be too long postponed. There is a good deal of difficulty in using blood on account of its tendency to coagulate, especially when no apparatus for *direct* transfusion from donor to recipient is at hand; but Panum, of Copenhagen, has shown that defibrinated blood answers as well, so it is now usual to whip the blood with a fork till coagulation ceases, and to strain it through warm, wet, fine linen before injection. The red corpuscles, for respiratory purposes, appear to be most required. Fresh milk, saline solutions (chloride of sodium, grs. 1; chloride of potassium, grs. iij; sulphate and carbonate of soda, āā, grs. xxv; phosphate of soda, grs. ij; water, Oj.—Little), or plain water at 100° F., have also been used. Lastly, it has been sought to avoid dangerous embolism by injecting the blood into the distal part of an artery, like the brachial.

Many instruments have been invented, but it usually happens that none is at hand when wanted; most successful cases have been done with a common syringe. It must have a nozzle that will enter the vein, and should be purified in boiling water or some antiseptic that does not coagulate albumen. The first thing is to find a vein in the patient's arm or leg, through a one and a half inch cut over its situation to pass two ligatures beneath it and tie the lower sufficiently tight to prevent any escape of blood, when a piece of the vein just below the upper thread is seized with forceps and raised as a flap after a snip with scissors. Next the donor of the blood is bled in the ordinary way, in another room, if possible, lest he grow faint from his surroundings, and his blood cease to flow; eight to twelve ounces may be drawn into a clean vessel taken out of water at 105° F., and replaced in it whilst the blood is being whipped.

Fig. 304.



Whitehouse transfusion apparatus.

When free from fibrine, the blood is poured into the syringe whilst the nozzle is closed with a finger, the piston is put in, the syringe turned nozzle upward and all air expelled, and then whilst a little blood is escaping the point is passed upwards into the patient's vein—through the upper ligature which is gently drawn round it—and the blood is forced slowly in. Three or four ounces may be injected twice or thrice at intervals, according to the effect produced. The ligatures may then be removed, the wound sewn up and dressed as after venesection.

Graily Hewitt's glass syringe is graduated, and has a movable curved canula which can be left in the vein whilst the barrel is being refilled; Whitehouse's apparatus (Fig. 304) consists of a funnel, rubber tube (A), and a point (B) with an *air-trap* on it for insertion into the vein. The blood is received into the cup, and allowed to fill the flexible tube and air-trap (which is emptied of air by being turned upside down), then the nozzle can be inserted into the vein. By raising the cup the force of the stream is increased, and it can be stopped in a moment by the finger and thumb of the operator. Direct transfusion also can be performed with this apparatus; but Aveling's tube, with a silver canula at either end, and a three-drachm Higginson's ball syringe in the middle, or even a plain rubber tube with two canulæ, is preferable. They should be filled with water or saline solution to start. Roussel's apparatus is very ingenious, and induces coagulation but slowly; but it is rather complex, and liable to get out of order when laid by.

Acupuncture is performed by running needles two or three inches long right into the painful part. It is very efficacious in some cases of neuralgia, especially sciatica and lumbago; perhaps it allows fluid to escape from the sheath of the nerve. Acupuncture is used also in anasarca, when the skin is much distended; and in hydrocele and ganglion it permits the fluid to exude into the cellular tissue, thence to be absorbed.

Vaccination.—The vaccine should be taken on the seventh or eighth day, before an inflamed areola has spread around the vesicle; and it should be *lymph*, clear and transparent, not purulent nor discolored by blood. To preserve lymph safely, it should be *dried*, or kept in Husband's capillary sealed tubes, not in bottles. The tubes are filled by capillary attraction, and the ends sealed by holding in the flame of a spirit-lamp or candle. Of late years calf lymph has been largely used. The operator with a lancet, or a sharp-pointed knife, makes a number of fine crossing scratches through the cuticle at four spots, arranged to form a diamond over the insertion of the left deltoid. Each spot should be one-fifth of an inch across. Then a drop of clear lymph on the point of the knife is rubbed on each spot, so that the abraded skin may absorb it. The lymph should, when possible, be applied directly from one child to another, and not be carried on points or lancets. But if the lymph for the first patient is on *points*, the surgeon should hold them in the steam of warm water so as to liquefy it, and then wipe one on each abraded spot.

Occasionally vaccination creates a good deal of inflammation and general disturbance; even in adults the arm may be œdematous to below the elbow, and the axillary glands swollen and painful; the most troublesome itching may occur, best treated by carbolic lotion or cyanide of potassium (ʒj ad Oj). In children, the inflammation sometimes ends in sloughing and formation of large ulcers at the sites of the vesicles, and axillary or even subpectoral abscess may follow. It is more than likely that these unusual complications, like erysipelas, which also may occur, are due to inoculation of the sores with some septic poison. Iodoform, boracic fomentations, and incisions are the chief remedies.

Counter-irritation undoubtedly has often an excellent effect in relieving the pain of strumous and other inflammations of joints and bones, of pleuritic stitch, and of many obscure conditions; sometimes, too, it will apparently cause the absorption of inflammatory effusion, though here it is often disappointing. Preparations of iodine and cantharides and the actual cautery are the chief counter-irritants nowadays; setons, issues, and moxæ have little more than an historical interest, having been laid aside on account of their barbarous nature and the frequency with which erysipelas and septic poisoning supervened.

The ACTUAL CAUTERY is a very efficient, and far from being the most painful, manner of effecting counter-irritation. Cautery irons are iron rods set in wooden handles, and bearing heads, which may be round, olive-shaped, disk-like, or hatchet-shaped, according to taste and requirements. The head, heated red-hot, is rubbed on the skin so as to make two or three blackened lines about half an inch wide, and an inch asunder. An antiseptic dressing may be applied till the eschars separate; for it is better to keep the sores open by touching them occasionally with the cautery than by irritating dressing. The cautery is very useful for closing fissures and fistulæ.

Paquelin's cautery-knife or *needle* is by far the handiest. It consists of a wooden handle, upon which a hollow point, disk, or blade of platinum is fixed; this is heated to redness in a spirit-lamp and then benzoline vapor is blown through it with a Higginson's syringe, burns and thus keeps up the heat of the point. It is sometimes used for operations upon vascular parts, but should, if possible, be avoided, as one cannot well see the surfaces cut through, and the eschar left shortly becomes an excellent septic dressing.

Marshall's galvanic cautery has the advantage that the wire can be passed cold along a sinus and then heated.

SETONS are introduced by pinching up a fold of skin, and pushing a broad, flat, double-edged, and large-eyed needle through it, armed with a skein of silk or cotton. As soon as one or two inches of the thread are brought through the needle is cut off. A fresh portion of the thread is pulled through the wound every day, to keep up constant irritation and discharge. If the discharge is insufficient, the thread may be covered with blistering salve before it is drawn under the skin. Instead of threads, a small drainage tube or flat India-rubber band may be used.

ISSUES may be made by caustics, incision, or the actual cautery. 1. A small bit of skin is rubbed with potassa fusa, or with a paste of equal parts of potash and soft soap, till a black slough forms. An attempt to protect the parts immediately around with layers of sticking-plaster is made, a poultice applied till the slough separates and then the sore is kept from healing, either by binding peas firmly on its surface, or by touching it occasionally with the caustic. 2. The skin is pinched up, slit open and peas introduced. Issues are never made over projecting points of bone, nor over the bellies of muscles, where they would be subject to friction and might be troublesome. For diseased vertebræ, issues should be made between the spinous and transverse processes; for diseased hip, *behind* the great trochanter; for diseased knee, just below the inner tuberosity of the tibia. Issues, if indolent or irritable, should be healed; they are of use only when the actions carried on in them are vigorous and healthy.

The MOXA is a method of counter-irritation long practised in the East, and occasionally employed in Europe, for the relief of chronic nervous and rheumatic pains, and for chronic diseases of the joints. One or more small cones, formed of the fine fibres of the *Artemisia chinensis*, or of some other porous vegetable substance—such as German tinder, or linen impregnated with nitre—are placed on the skin over the affected part, set on fire, and allowed to burn away so as to form a superficial eschar. The surrounding skin must be protected by a piece of wet rag, with a hole in it for the moxa.

ELECTRICITY and GALVANISM have many uses in surgery. We have already (p. 416) noted their uses in diagnosis, as demonstrating the presence or absence of the reaction of degeneration, etc., and their use in the treatment of feeble or paralyzed parts. Electrolysis is employed in the treatment of aneurism, of nævi, of hydatid cysts, of superfluous hair on the face, etc.

The galvanic cautery was formerly much used in operations on the tongue, penis, and other vascular parts; but secondary hemorrhage and sepsis were frequent. For details concerning the batteries we must refer to books on the subject.

CHAPTER LIII.

OPERATIONS FOR THE LIGATURE OF ARTERIES.

General Points.

For wound an artery may have to be tied at any point of its course. In these cases the wound forms the guide to the injured vessel; but it is obvious that an accurate knowledge of anatomy is necessary to enable the surgeon so to plan his operation that the artery may be reached with the least possible injury to surrounding parts.

In other cases arteries are tied at "seats of election"—*i. e.*, at spots chosen because of the comparative ease and certainty with which the vessels may be tied at them, and because of the suitability, to the majority of cases requiring them, of the operations at these spots. Only these operations admit of systematic description.

Before commencing an operation of this kind, it is always right to examine the part carefully by eye and touch to acquaint one's self with the superficial vessels, normal or abnormal, lymphatic glands, etc.

All such operations may be divided into four parts: 1. Laying bare the vessel. 2. Opening its sheath. 3. Passing the needle. 4. Tying the ligature. A few words may be said about each stage.

1. Laying Bare the Vessel.—The first point is to find the line of the artery. This cannot be determined too carefully, the ordinary anatomical points being used, and the pulsation of the artery felt wherever possible. In some cases, at all events, it is well to mark the line with an aniline pencil. An incision is then made, either in this line or more or less obliquely to it, so that the centre of the cut shall correspond to the artery at the point at which it is to be tied. Excluding those vessels, as the radial above the wrist, which are subcutaneous, arteries are found by means of certain anatomical relations—muscles, nerves, or bones—more or less easily seen or felt. These "rallying points" divide the operation into so many stages; each point should be made quite clear in its proper order, and no attempt should be made to reach the vessel until this has been done. Thus in the ordinary operation for ligature of the carotid, the first rallying point is the edge of the sterno-mastoid, which should be made plain along the whole length of the wound; the second point is the anterior belly of the omohyoid, the upper border of which must be cleaned from before backward. This of necessity leads to the artery; whereas an attempt to reach the vessel without attention to these guides might fail utterly.

The *incision in the skin* should give plenty of room and be lightly made when the vessel is subcutaneous. It is always made from the surgeon's left to right, and he should stand so that this may most easily be done; his left hand gently stretches and steadies the skin over the deep parts as the cut is made. The length of the incision varies with the depth of the vessel to be tied; and ordinary incisions must be lengthened in fat subjects. The deeper incisions must be of equal length with the superficial, and the bottom of the wound should be kept in one plane—not deeper at one spot than at others. Each anatomical structure should be recognized as it is exposed. According to the importance of their deep relations, parts may be boldly divided, carefully painted through by successive strokes of the knife, slit up upon a carefully introduced director, or picked up in forceps and divided, bit by bit, along any desired line, the knife being held on the flat. Sometimes after the incision of a fascia, or of an intermuscular space, the easiest and best way of proceeding is to introduce two fingers and tear it open to the full length of the wound. After division of the deep fascia the wound should be held open by retractors placed by the surgeon himself. Every bleeding vessel should be secured at once; it is most important that the wound should be dry and the view clear. Some render the limb bloodless before operating. A sharp lookout should be constantly kept, both by the eye and by the left forefinger, for the rallying points, for vessels or nerves in the way of the knife, etc.

2. Opening the Sheath.—With the exception of the intracranial, all arteries are surrounded by sheaths of connective tissue, to which they are loosely attached by filaments from their external coats. It is within this sheath that a divided vessel retracts. The vasa vasorum ramify in the sheath before penetrating the artery proper. If, therefore, the sheath be widely separated from an artery, its wall must slough. On the other hand, a needle introduced into the loose tissue between the sheath and the external coat finds its way round the vessel with much greater certainty and ease than in any other path; wounds of veins and inclusion of nerves are thus avoided; and a ligature tied immediately upon the artery divides the internal and middle coats more surely than one tied outside the sheath. Another point of much importance is that the amount of tissue killed by the grasp of the ligature increases with its distance from the vessel; should the wound become septic, this slough forms a septic dressing to the end of the artery, likely to lead to infection and softening of the clot and secondary hemorrhage (page 367). The rule is, therefore, to make a *small* opening in the sheath and carefully to clean the external coat in a narrow ring round which the needle is to pass. The arterial sheath is usually continuous with that of its vein and veins; and sometimes an important nerve lies in the same mass of areolar tissue. It is, therefore, of much importance to open the arterial compartment. How can this be recognized? 1. By anatomical knowledge. 2. By pulsation of the artery: but this may not be at all marked, or may be communicated to a nerve, or a vein may pulsate. 3. By touch: an artery compressed against anything firm forms a flat band with edges which feel decidedly thicker than the central part: a vein can scarcely be felt at all; a nerve is round, solid, and does not flatten out. 4. By sight: an artery, if not blood-stained, is pinkish, a vein dark blue-red, a nerve white. An artery if compressed empties beyond the finger, a vein fills. By these means one must decide exactly where the artery lies, and then proceed to open the sheath over it. To do this pick up a bit of the areolar sheath along the length of the vessel and notch it with a scalpel held on the flat, its edge being turned toward the forceps-points; repeat this until a dense, bluish-white structure is reached from which nothing more can be picked up. This is the external coat of the artery. Now take in the forceps the edge on one side of the aperture in the sheath, raise it from the artery, and separate it from the vessel as far round as possible with the scalpel (held with its back toward the artery), a director, or the unarmed needle. Repeat

the process on the opposite side, until the clear ring round the vessel is complete. The separation of the sheath should not exceed one-quarter inch in the longitudinal direction.

3. Passing the Needle.—In most cases this is best passed unarmed, for a thick thread increases the difficulty. It is a rule to introduce the needle from that side upon which the structure most to be avoided lies: thus, if the vein lie upon one side of the artery, the needle should be passed from that side, or if the vein lie behind and a nerve upon one side, the needle should be passed from the side of the nerve. But if there be sufficient reason this rule may be departed from.

That spot should be chosen for the application of the ligature which is furthest removed from a branch. If the branches arise so close together that the thread must be near one, apply it near the distal and tie this also, because the clot in the distal end is always the feebler. To pass the needle, seize the edge of the hole in the sheath with the forceps, and pass the needle as far as possible round the artery; then seize the opposite edge of the sheath and draw it away from the artery, so as to flatten out the track along which the needle has to pass. A slight side-to-side movement of the point of the needle is all that can be permitted in addition to steady, gentle, onward pressure; the handle must not be too early depressed or the artery may be transfixed.

When the needle has been passed the vessel should be compressed with a finger upon it, whilst an assistant ascertains by cessation of pulsation beyond that the trunk has really been secured. At the same time the surgeon must see that nothing but the artery has been taken up. This having been settled, the needle is threaded and withdrawn, and the ligature tied.

4. Tying the Ligature.—A reef-knot must always be used. The ligature must be applied strongly enough to divide the inner and middle coats, but not so tightly as to divide the external. The vessel must not be dragged from its bed, and all the precautions for tying a vessel in a deep hollow must be observed.

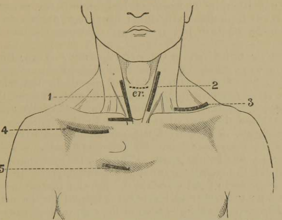
One point remains for consideration before passing on to special ligatures. Secondary hemorrhage has been found to be more common after ligature of arteries in their continuity than on the face of a wound, other conditions being apparently identical. This is regarded by many as due to the elastic tension constantly acting on the injured part of the artery in the former case, and it has been proposed always to divide the vessel between double ligatures. This has not yet been done in a sufficient number of cases to prove that the danger has been overcome. Often tension on a ligatured artery may be reduced to *nil* by position.

Ligature of Special Arteries.

Ligature of the Innominate Artery.—*Line:* From the middle, as nearly as may be, of the manubrium, to the right sterno-clavicular joint. The artery ends usually at the level of the upper edge of the clavicle, but it is sometimes well above this point and more often below it. The patient lies upon his back, with shoulders raised to a convenient height, the head thrown back and the face turned to the left. This position raises the vessel somewhat and draws it nearer the mid-line.

Make an *incision* (Fig. 305, 1) along the lower three inches of the inner edge of the right sterno-mastoid to the level of the top of the sternum; then outward for two inches along the clavicle. Deepen the first cut till the edge of the sterno-mastoid is clear; divide the tendon of the inner head below and carefully raise it with the skin (Fig. 306). In a little loose connective tissue, find the transverse part of the antero-jugular vein (*a. j.*) running outward above the clavicle. Draw it upward, or divide between double liga-

Fig. 305.



Incisions for: 1, innominate, and roots of carotid and subclavian; 2, common carotid; 3, subclavian, third part; 4, axillary, first part; 5, internal mammary in second space; *cr.*, cricoid cartilage.

tures. Divide the sterno-hyoid (*s. h.*) transversely at the lower part of the wound, and then as much of the sterno-thyroid (*s.th.*) as is exposed. Draw the muscles upward with a retractor. The strong third layer of cervical fascia passing down to the pericardium must now be divided with knife and forceps, or on a director, and torn open with fingers. The finger placed in the angle between the trachea and end of the clavicle now feels the pulsations of the vessel which is exposed by careful dissection through some connective tissue, often containing fat. In this lie small veins and sometimes the right inferior thyroid (*i. th.*): all must be carefully dealt with. The point of bifurcation must be made clear. The sheath is then opened and the ligature passed from without or below—*i. e.*, away from the pleura and innominate vein, as far from the bifurcation as possible. The internal jugular may require drawing outward, and occasionally the right innominate vein may be found somewhat overlapping the front of the artery.

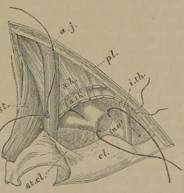
Variations in the length and position of the artery may necessitate enlargement of the wound. More or less of the clavicular head of the sterno-mastoid may have to be divided; but the great difficulty is that the artery even when of normal length can hardly be tied below its bifurcation on account of the prominence of the clavicle or overlapping of the sternum. In this case the clavicle, internal to the rhomboid ligament, may be sawn through and removed; or if this does not expose the artery sufficiently, a piece of the sternum may be removed with a trephine. To allow of this the cut along the sterno-mastoid must be prolonged over the sternum. It is much better to operate thus, than to attempt to pass the needle in the dark.

The operation was first performed by Mott, at the New York Hospital, in 1818; the patient walked out on the twentieth day, bleeding from the wound occurred on the twenty-first, and he died on the twenty-sixth. It has been done 16 times: 15 for subclavian aneurism, 1 for hemorrhage from the axillary after ligature of the subclavian. W. A. Smyth, of New Orleans, on May 15, 1864, operated on the only case that recovered; he tied the root of the carotid as well to prevent, if possible, hemorrhage from the distal end—the usual cause of death. It occurred several times, and forced him, on July 9th, to tie the vertebral. The patient was well on the 19th. The aneurism recurred ten years later, and suppurated; Smyth laid the sac open, but could do nothing but plug, and the patient died in a few days. The latest operation, by Thomson, of Dublin, however, permits us to hope for better results from aseptic ligature: his patient did not die directly from the effects of the ligature, but from perforation at the bifurcation of the artery.

Ligature of the Common Carotid Artery.—*Line:* From the sterno-clavicular joint to a point midway between the mastoid process and angle of jaw (Fig. 305, 2). It lies, with a chain of glands, in the triangular space between the spine (covered by the longus colli and a bit of the rectus cap. ant. maj. above), the larynx and pharynx and the sterno-mastoid, and is covered also, below the level of the cricoid, by the depressors of the hyoid. It lies in a sheath of cervical fascia containing three compartments, the internal for the artery, external for the vein, and a posterior—between the artery and vein—for the vagus. The sup. thyroid vein often crosses the artery high, and the middle thyroid, if present, opposite the cricoid. The descendens noni lies in front of, or in, the sheath; the sympathetic cord behind the sheath; the recurrent laryngeal is behind at the origin and then internal. The sterno-mastoid branch of the sup. thyroid runs down and out over the upper half, the inf. thyroid vessels run in behind the sheath just below the cricoid. There are no branches. The left artery arises in the thorax, where we have nothing to do with it; it is more often overlapped by the jugular vein than the right, and has the œsophagus and the thoracic duct behind it at the root of the neck.

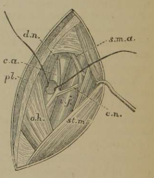
Ligature of the Carotid at its Root (Fig. 306).—The position, incision (Fig. 305, 1), and the operation so far as the reflection of the sternal head (*st.*) of the sterno-mastoid are the same as for ligature of

Fig. 306.



Ligature of the innominate (the vessel was unusually long): *pl.*, platysma; *a.j.*, anterior jugular, the communicating branch with its fellow divided; *st.* and *st.cl.*, sternal and clavicular heads of sterno-mastoid; *s.h.*, sterno-hyoid; *s.th.*, sterno-thyroid; *i.th.*, inferior thyroid vein; *in.a.*, innominate artery; *cl.*, clavicle.

Fig. 307.



Ligature of the left common carotid: *pl.*, platysma resting in the deep fascia; *st. m.*, sterno-mastoid; *o. h.*, omo-hyoid; *s. m. a.*, sterno-mastoid branch; *i.j.*, internal jugular; *d.n.*, descendens noni; *c.n.*, communicare noni; *c.a.*, carotid artery.

the innominate (p. 872), but the incisions need not be quite so long. The anterior jugular (*a.j.*) being kept out of danger, seek the outer edge of the sterno-hyoid (*s. h.*); this must be drawn inwards or notched according to its width and the lowness of the point at which the thread is to be applied; and the sterno-thyroid (*s. th.*) will require similar treatment. The fascia beneath these muscles must be opened and the common sheath of the vessels exposed alongside the trachea, numerous thyroid and other veins being avoided or tied. The sheath must now be opened—*well to the inner side*, so as to enter the compartment of the artery—the vessel cleaned in the usual way, and an armed needle passed from without in. Before tying see that the vagus and recurrent laryngeal are not included; both the vagus and jugular are at some distance from the root of the right carotid, but on the left side the vein often overlaps the artery, and the relation of the vessel to the thoracic duct and œsophagus must be borne in mind. On the right side the vessel should always be tied as far as possible from the innominate bifurcation.

This operation is required for aneurism of the upper part of the carotid.

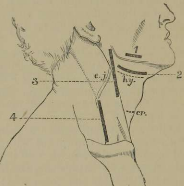
Ligature of the Carotid above or below the Omo-hyoid.—(Fig. 307). *Position* as above. Make a cut (Fig. 305, 2) three inches long, having its centre opposite the cricoid cartilage, through skin, platysma, and fascia upon the edge of the sterno-mastoid; and make this edge quite clear along the whole length of the wound. Now turn the head almost to the mid position and raise it sufficiently to relax the sterno-mastoid, which is to be carefully freed and drawn out with a retractor; in doing this the sterno-mastoid branch of the sup. thyroid may be cut and require ligature. Through the fascia now exposed, on the level of the lower edge of the cricoid cartilage, will be seen the omo-hyoid; make the upper edge of this clear (Fig. 307, *o.h.*). Immediately above it, and close to the cricoid, is the carotid sheath, which must be opened on the inner side, the descendens noni, if seen upon or in the sheath, being spared, and a middle thyroid vein, if present, being drawn aside. More care will be required here than lower to avoid the vagus. The special sheath of the artery must next be opened and the vessel cleaned. The needle is to be passed from without inwards.

The omo-hyoid may be freed from the sheath and drawn down and in, if it is wished to apply a ligature beneath or below the muscle. This operation may be required for wound; for hemorrhage from, or aneurism of, the internal or external carotid or their branches; either alone or with the subclavian for aneurism of the innominate or base of the carotid; for aneurismal varix and aneurism by anastomosis among its terminal branches.

Ligature of the External Carotid.—*Line*: From the back of the thyroid to the back of the neck of the lower jaw. It is at first anterior and mesial to the internal carotid, but winds back and becomes external to it beneath the digastric, the styloid process intervening. As high as a line from the mastoid to the hyoid bone it is covered by the sterno-mastoid; above this by the stylo-hyoid, digastric, and parotid; it lies upon the pharynx, behind the great cornu, and the styloid process and stylo-pharyngeus, which separate it from the internal carotid. No companion vein; the temporo-maxillary trunk is superficial to it in the parotid, and the common facial vein crosses it near the great cornu. The hypo-glossal crosses over it from behind forward, just above the cornu, and the facial higher up in the parotid; the glosso-pharyngeal turns round the stylo-pharyngeus. Branches are numerous: the sup. thyroid at the root, the lingual at the great cornu, the facial at the lower edge of the digastric and the internal maxillary (terminal)—all running forward; the occipital opposite the facial, and the post. auricular beneath the digastric—running backward; the ascending pharyngeal rising from the first inch, and the terminal superficial temporal—ascending.

Position.—On the back, with the shoulder raised, head thrown back, and face turned moderately to the other side. The surgeon stands on the side of the artery to be tied. *Incision* from close behind the angle of the jaw to the edge of the sterno-mastoid behind the thyroid cartilage, of such length that the horn of the hyoid lies at its centre (Fig. 308, 3). It must be deepened through skin, platysma, and fat, the anterior division of the

FIG. 308.



Incisions for: 1, facial; 2, lingual; 3, external carotid; 4, vertebral; *hy.*, hyoid; *cr.*, cricoid; *e.j.*, external jugular.

temporo-maxillary vein being watched for above, issuing from the exposed part of the parotid and running to join the facial (Fig. 309 *c.f.v.*). Open the sheath of the *sterno-mastoid*, and make clear its edge. The wound being now opened with retractors, pick up with forceps the deep layer of the sheath of the muscle at the level of the hyoid, and notch it with a knife held on the flat; divide this fascia carefully upward and downward. A finger touching the tip of the *great cornu* will rest upon the artery at the seat of election. With knife and forceps or two pairs of forceps, work carefully through the connective tissue over the artery at this spot, keeping a sharp lookout for the *hypoglossal nerve* above, and especially for the common facial vein which, when found, must be drawn down and in. If glands are much in the way they may be excised. The sheath of the artery is now opened a little below the great cornu, and the ligature passed from without in. It lies between the origins of the superior thyroid and lingual branches—the situation in which it is most likely to cut off all supply to the tonsil.

The difficulty is to be sure that the artery exposed is the external, and not the internal, carotid. The following points—one or more of them—show this: immediate contact with the hyoid bone, the giving off of branches, the cessation of pulsation in the temporal and facial arteries on compressing the trunk.

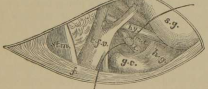
If, to deprive the internal maxillary of blood, it were desired to tie the vessel *below the digastric*, the incision would have to extend from below the ear to the level of the hyoid bone. The parotid would have to be raised and drawn upward, the *digastric* made clear and drawn up, the vessel being found along the lower border of the muscle, giving off just here the facial and occipital, above which the thread should pass.

The *internal carotid* continues the *line* of the common carotid and lies in the triangular interval between the spine and rect. cap. ant. maj. posteriorly, the pharynx internally, and the sterno-mastoid, stylo-hyoid, and digastric, styloid process and stylo-pharyngeus, and the parotid superficially. Its relations to the jugular vein, vagus, int. and ext. laryngeal, and sympathetic nerves, are those of the common trunk, the sheath of which is continued up. The common facial vein crosses near the hyoid. The hypoglossal crosses it below the digastric, and the glosso-pharyngeal with the stylo-pharyngeus. Near the skull the ninth, tenth, eleventh, and twelfth nerves issue between the artery and vein. The occipital and post. auricular arteries pass back over the vessel. It gives no branches in the neck.

This vessel may be wounded by stabs or shots from without, or by puncture from within from a pipe driven forcibly into the mouth or a pin or fishbone thrust into the tonsil or pharynx; ulceration of the tonsil may open the artery. In these cases only is ligature of the internal preferable to that of the common carotid, and it should be done on either side of the wound; but in hemorrhage from the tonsil in scarlet fever the state of the glands renders this impossible (page 551). The internal carotid may be secured as high as the digastric, or even higher, through the incision given for the ext. carotid: the sterno-mastoid must be fully drawn back, and the deep layer of its sheath opened three-quarter inch from the hyoid. To reach it as high as the tonsil, Guthrie proposed the following operation: Make an incision from below the ear downward, one-half inch behind the jaw to the level of its angle, then forward along its edge to the first molar, dividing the facial; draw the second molar, divide the jaw through its socket, cut its fascial connections, and evert its angle to give room; detachment of the internal pterygoid and mylo-hyoid, may be necessary. Feel for the styloid process, define the stylo-hyoid, detach it and draw it, the stylo-pharyngeus and glosso-pharyngeal nerve in, thus exposing the int. carotid outside the tonsil. Herbert Mayo on one occasion divided the styloid process to reach the vessel.

The incision for the ext. carotid (Fig. 308, 3) will serve also for ligature of the roots of the *sup. thyroid, lingual, facial,* and *occipital.* Their points of

FIG. 309.



Ligature of the lingual before it passes beneath digastric: *f*, deep fascia; *st. m.*, sterno-mastoid; *s. g.*, submaxillary gland; *c. f. v.*, common facial vein formed by ant. division of temporo-maxillary and facial and receiving superior thyroid; *g. c.*, great cornu; *hy.*, hypoglossal with digastric above it; *l.*, lingual artery; *m. c.*, middle constrictor.

origin (page 876) are the chief guide, but the vertical part of the hypoglossal, also, will lead to the occipital, and on raising the submaxillary and stretching the ext. carotid, the anterior branches are rendered prominent.

The *lingual* may be tied at two points of its course—before and beyond the post. belly of the digastric. By the first operation the vessel may be secured before the origin of the dorsalis linguæ; but the position of the vessel is more constant at the latter spot.

Position: As for ligature of the carotid, with the head more thrown back and the face more turned to the sound side.

To tie the *lingual before it passes beneath the digastric* (Fig. 309), make an *incision* (Fig. 308, 2), slightly curved up at each end, close above the great cornu of the hyoid bone, starting from its junction with the body of the bone, and running back to the edge of the sterno-mastoid. The curved ends may be lengthened if space is required. Divide the platysma carefully posteriorly, lest the facial or common facial vein (*c.f.v.*) be wounded here; if seen draw it up and back. Raise the upper edge of the wound; the bulging *edge of the submaxillary gland* (*s.g.*) is now seen; divide the fascia along its lower border, free the gland from the hyoid bone, and draw it up. Feel for the *great cornu* (*g.c.*), and have it drawn down and steadied with a hook; make clear the lower border of the posterior belly of the digastric, and find, passing beneath this, the *hypoglossal nerve* (*hy.*) with the small ranine vein below it. Remove any fat and connective tissue concealing the hyoglossus (*h.g.*) between the hypoglossal above and the great cornu below; then, with knife and forceps, cut carefully through the hyoglossus parallel to and midway between these two rallying points. The artery either lies in the wound, or will be exposed by drawing the edges up or down. It has two small venæ comites. It must be cleaned and tied in the usual way. Difficulty is likely to arise in this operation only from the common facial and other veins at the back of the wound.

To tie the *lingual beyond the posterior belly of the digastric.* The position of the patient is the same. The incision starts below and one-half inch external to the symphysis, runs down and back to the junction of the great cornu and body, then turns roundly, and runs up to a little below the angle of the jaw; it may be somewhat shorter in thin people with small submaxillary glands. The fat and platysma are divided with the same care as above, the sheath of the submaxillary opened below, a finger passed beneath the gland to separate and raise it from deeper parts. The tendon of the digastric, with a bit of each belly, is now seen, and superiorly the hypoglossal crosses the field to pass beneath the posterior edge of the mylohyoid, the fibres of which run downward and slightly forward in front. Remove some connective tissue below the nerve to expose the hyoglossus, and divide this midway between the digastric and the hypoglossal. The vessel is now exposed.

The FACIAL ARTERY may be tied by a short transverse cut, through skin, platysma, and fascia, along the lower edge of the jaw, having its centre at the anterior border of the masseter (Fig. 308, 1). The vessel will be felt at the latter spot as a thickish pulsating band; the vein lies behind it.

The TEMPORAL ARTERY may be tied by a short vertical cut immediately in front of the ear, having its centre over the root of the zygoma; it must be separated from a single vein, and from the auriculo-temporal nerve, which lies deep to and behind it.

Both these vessels may be easily controlled by pressure or by acupressure.

LIGATURE OF THE SUBCLAVIAN ARTERY.—Owing to its origin from the aortic arch, the left artery lies at first very deeply upon the longus colli, with the pleura first in front of, then below it; and this, with the fact that the delicate thoracic duct arches out from behind the vessel, above and then in front of it, renders the whole first part on the left side almost inaccessible surgically. Between the second and third parts on the two sides there is no difference of importance.

The right subclavian artery forms a slightly reclined arch lying on the pleura a little below its apex, starting from the sterno-clavicular articulation and ending at the lower edge of the first rib about half an inch internal to the middle of the clavicle. The second part of the vessel is generally one-half to three-quarters of an inch above the clavicle, when the shoulder is fully depressed; but it may be one to one and a half inches above the bone, especially on the right side, or it may be entirely concealed behind it. The latter is likely to be the case when the neck is short, the clavicle strongly curved, and the shoulder thick and high, the former in people of the opposite build.

The first and second parts are covered by the sterno-mastoid; beneath this the sterno-hyoid and -thyroid muscles cover more or less of the first part, and the scalenus ant. descends in front of the second part—all enveloped in layers of the cervical fascia. The third part has only the superficial structures, platysma, and deep fascia, in front of it till it passes beneath the clavicle and subclavian. Below and behind the first and second parts lies the pleura; the third part lies on the first rib, touching the pleura only just external to the scalenus, and behind it is the scalenus med. Above it is the post. belly of the omo-hyoid; this muscle generally forms with the clavicle below and sterno-mastoid internally, a small triangle, in which the vessel is usually tied. The subclavian vein lies in front of, but lower than, the artery behind the clavicle, the ant. scalene passing between the two; it ends at the inner border of the scalenus ant., here joining the ant. jugular to form the innominate, which runs on below and somewhat in front of the first part of the vessel. The int. jugular descends in front of this part close to the inner edge of the ant. scalene, between it and the thyro-hyoid. Behind the jugular, opening into it or the innominate, is the vertebral vein. The deep part of the ant. jugular crosses out over the first part to reach the ext. jugular or subclavian vein, but is superficial to the hyoid muscles. The ext. jugular pierces the deep fascia an inch above the clavicle, generally close to the outer edge of the sterno-mastoid, and descends across the third part to enter the subclavian; it receives the transverse cervical and supra-scapular veins—which may form a plexus over the third part of the artery—and usually the ant. jugular. In the interval between the jugular vein and the origin of the carotid, the vagus descends and gives off its recurrent laryngeal branch, which passes up and in behind the vessel; cardiac and sympathetic branches also lie here. The second part has the phrenic nerve running down and in front of it, but separated by the ant. scalene; on the *left* side the phrenic lies *on* the first part. The third part has the brachial plexus above it, the third cord being low down behind it; the small nerve to the subclavian crosses the vessel to its muscle, and the supra-clavicular nerves cross it superficially in the teguments. The supra-scapular artery crosses the third part, behind the clavicle as a rule; the transversalis colli generally soon passes out of the subclavian triangle, beneath the omo-hyoid. The origin of the first part is more or less behind the root of the carotid.

Branches.—From the first part the vertebral rises from the upper and back aspect, the thyroid axis from the anterior, projecting between the jugular and the ant. scalene; and the internal mammary immediately below the thyroid axis. From the back of the second part springs the common trunk of the sup. intercostal and profunda cervicis. More often than not, the post. scapular rises from the third part, and there may be two or three branches from this part. The branches may, therefore, be scattered over the whole artery. Generally the third part is quite suitable for ligature, so also the second; but the distance between the bifurcation of the innominate and the origin of the vertebral is rarely more than one inch, and may be only a few lines.

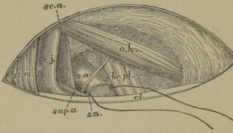
The subclavian artery may perforate the ant. scalene, or, more rarely, lie in front of it with the vein; the vein may be behind the scalene with the artery, and the positions of vein and artery may, very rarely, be reversed. The subclavian may be the fourth vessel to rise from the arch, instead of springing from the innominate; it then passes behind the œsophagus to reach its place on the right side.

Ligature of the first part of the subclavian.—The positions of patient and operator and the early stages of the operation are the same as for ligature of the innominate (Fig. 306). The clavicular head of the sterno-mastoid may require notching. After the sterno-thyroid and sterno-hyoid muscles have been sufficiently divided from their outer toward their inner edges, and the third layer of cervical fascia has been carefully opened, draw the internal jugular vein, and with it the vertebral, outwards. Should the innominate vein bulge upwards, it must be depressed by a retractor. Working now with two pairs of forceps, tear through the connective tissue, so as to see the bifurcation of the innominate and the origin of the vertebral. The vagus nerve must next be found and drawn inwards. The sheath is to be opened midway between the vertebral and innominate, the vessel cleaned with a director, and the needle passed from below, upwards and inwards, every care being taken to avoid injuring the pleura and the vein. If the vertebral rise very close to the origin of the artery, it must be ligatured a little above its root and the artery tied beyond it.

This operation has been performed fourteen times for aneurism of the third part, with a uniformly fatal result, and almost always from hemorrhage. The difficulties are extreme, especially on the left side, where the thoracic duct lies. Whether antiseptics will lead to another trial remains to be seen.

Ligature of the third part of the subclavian (Fig. 310).—*Position:* On the back with the shoulders raised, the head extended moderately, and turned to the other side; the arm is to be drawn forcibly downwards.

FIG. 310.



Ligature of the left subclavian, third part: *cl.*, clavicle; *st.m.*, sterno-mastoid; *e. j.*, external jugular; *sc.a.*, scalenus anticus; *o.h.*, omo-hyoid; *supra.*, supra-scapular artery; *s.n.*, nerve of subclavius; *br.pl.*, brachial plexus; *s.a.*, subclavian artery tied below origin of small branch.

Endeavor to find the line of the ext. jugular. Then draw down the skin over the clavicle, and, cutting directly on to the upper surface of the bone, make an incision three to four inches long from over the outer edge of the sterno-mastoid to the anterior edge of the trapezius (Fig. 305, 4); this divides skin, fascia, platysma, and superficial vessels and nerves; no large vein can be injured unless it cross the clavicle. The skin must be steadied by the thumb and fingers of the left hand below and above the clavicle, and the incision made carefully lest the knife slip into the subclavian triangle. Let the skin spring back: the incision lies close above and parallel to the clavicle. The deep fascia must now be picked up close to the clavicle and notched all along, a sharp lookout being kept for the lower end of the ext. jugular vein : draw it in or out, or double ligature and divide it. Now put the two forefingers through the opening in the fascia, and stretch it gently from side to side. Draw up the upper lip of the wound. The brachial plexus is now well in view, and often the lower edge of the omo-hyoid. The subclavian vein lies as a rule behind the clavicle, out of sight. If the transverse cervical artery should be seen at the upper internal, or the supra-scapular at the lower internal, part of the wound, it must be drawn aside. Tear and cut through the connective tissue just outside the sterno-mastoid until the edge of the ant. scalene (the outer edge of which corresponds to that of the sterno-mastoid) is clear; the finger must be run down along this edge to the scalene tubercle, external to and behind which the artery will be felt on the first rib as a movable flat band with thick edges, with the third cord of the brachial plexus outside it. To expose it, a dense layer of cervical fascia will have to be opened : the nerve to the sub-clavius must be spared if seen. The sheath must be opened where the artery lies on the rib, and the armed needle passed from above downwards and inwards, *i. e.*, away from the last cord of the brachial plexus—the vein being securely placed.

Whenever the above incision does not give sufficient room, a vertical cut upwards must be made from its centre ; this will always be required in fat people with short, thick necks. The sterno-mastoid and trapezius must be divided if they extend over more than the inner and outer thirds, respectively, of the clavicle ; they may meet. Generally, the omo-hyoid is not seen in the above operation, but it may be inserted into, or closely bound to, the clavicle; it must be carefully detached and drawn upwards. When the vertical cut is made, the omo-hyoid is necessarily seen ; its lower edge should be made clear as a landmark. If a plexus of veins cover the artery, they must be hooked aside, or clamped, or tied, before division. If a branch arise, the artery should be tied as far as may be on its distal side; if the ligature must be close to a branch, tie the branch as well as the trunk. It may be extremely difficult to distinguish between the artery and the third cord of the brachial plexus: for pulsation may be very obscure in the artery, or it may be strongly communicated to the nerve. If the signs at p. 871 fail, a thread must be passed round one or other cord, and pressure made upon it with the finger : if pulsation stop in the vessels beyond, the artery has been secured.

The operation is required chiefly for aneurism of the axillary.

If, when the artery is exposed in its third part, it is found impossible or dangerous to apply a thread to it, the *second part* may be tied by cautiously notching the outer margin of the ant. scalene, which, when the head is turned to the opposite side, projects beyond the sterno-mastoid. In doing this care must be taken not to injure the pleura, transverse cervical and supra-scapular arteries, or the phrenic nerve lying near the inner edge of the muscle. The ligature may be passed as is most convenient, as far as possible from the superior intercostal. Twelve cases are recorded with seven deaths.

Ligature of the Vertebral Artery.—*Position:* On the back, with the head moderately extended and turned to the opposite side. Make an *incision* three to four inches long (Fig. 308, 4) upon the posterior edge of the sterno-mastoid from one-inch above the clavicle, the jugular being, if possible, avoided. Make the edge of the muscle clear all along; draw it in with a retractor. The phrenic nerve and transverse cervical artery should now be seen lying on the scalenus ant. Avoiding these, separate the contiguous edges of the scalenus ant. and longus colli, to see the vertebral artery which lies between them generally covered by its vein; this is usually best drawn out. The large seventh transverse process is a good guide to the intermuscular interval. If the artery enter higher than the sixth foramen, it will be *inside* its usual course. The needle is passed from without. Suitable retractors and a good light are essential to success. Smyth first performed the operation (page 874). Alexander, of Liverpool, introduced ligature of both vertebrals as a treatment of epilepsy, but considerable experience has led him to abandon the operation.

The *inferior thyroid* may be tied through a three-inch incision along the inner edge of the sterno-mastoid, having its centre one-half inch below the cricoid cartilage. The carotid sheath and its contents must be drawn bodily outward, and the inf. thyroid will be found running up and in from beneath it about a finger's breadth below the cricoid. The head must be flexed to permit the deeper dissection, and the vessel carefully cleaned to avoid inclusion of the middle cervical ganglion.

The *internal mammary* passes from its origin behind the innominate vein, being here crossed by the phrenic, over the pleura, down and in to the back of the cartilage of the first rib; it then runs down behind the cartilages of the ribs, one-half inch or less from the sternum, to the sixth space, where it divides into sup. epigastric and musculo-phrenic. The triangularis sterni intervenes between it and the pleura below the second space.

It may be tied by an incision starting over the edge of the sternum and running two inches out in any space. Divide the fat, great pectoral, ant. intercostal aponeurosis, and internal muscle—the latter with knife and forceps. Scratching through a little loose areolar tissue shows the artery lying between two veins in the lower spaces, with one in the upper. If the vessel have been wounded and have retracted beneath a cartilage, this may be resected, if necessary to reach the artery.

The *axillary artery* extends from the lower edge of the first rib to the lower edge of the teres major tendon. *Line:* From the middle of the clavicle to the inner edge of the coraco-brachialis, when the arm is abducted to a right angle; otherwise the vessel forms an arch.

Above the pectoralis min. the vessel is covered by the teguments and platysma, pectoralis maj., and costo-coracoid membrane, and is contained in a sheath of cervical fascia. It lies upon the first digitation of the serratus magnus covering the first intercostal space. The vein lies to the inner side: the cephalic and acromio-thoracic veins cross the artery from outside to enter the axillary vein. The brachial nerves lie outside the artery, and the nerve to the serratus mag. descends behind it.

The second part of the artery is covered by both pectorals; no muscle is in immediate contact behind. The vein lies to the inner side; and the three cords of the brachial plexus lie respectively outside, behind, and inside—between the artery and vein.

The third part is covered in its upper half by the pectoralis maj., but below this it is subfascial. It lies upon the tendons of the subscapularis, latissimus, and teres maj.; the coraco-brachialis is to its outer side. The vein lies on its inner side, and generally receives the brachial venæ comites opposite the subscapularis, two or three large veins being internal to the artery below this. The ultimate branches of the brachial plexus lie around the vessel, thus: In front, large internal cutaneous; outside, median, its inner head crossing over the artery below the pectoralis min., and ext. cutaneous; behind, musculo-spiral and circumflex, as far as the lower edge of the subscapularis; inside, the ulnar, between the artery and vein, gradually passing inward behind the vein, and the small internal cutaneous, internal to the vein.

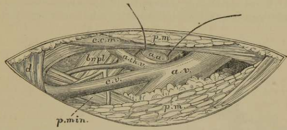
Branches are numerous. The only considerable one above the pectoralis min. is the acromio-thoracic axis, issuing through the costo-coracoid membrane, and at once splitting into branches running to the shoulder, clavicle, and chest-wall. Below the pectoralis the chief branches are the subscapular and post. circumflex, rising opposite the subscapularis.

Irregularities in the relations of the axillary to nerves and veins are frequent; also in the origin and distribution of its branches. About once in every ten cases it gives off a large branch, which may be the radial, ulnar, a vas aberrans or interosseous artery, or which may give origin to some of the chief branches of the axillary and brachial. In the latter case the nerves surround the stem of the branches, and not the main trunk.

The axillary may be tied at any part of its course; but below the clavicle, and where it lies on the latissimus in the third part are the seats of election.

LIGATURE OF THE FIRST PART OF THE AXILLARY ARTERY (Fig. 311).—The difficulties in this operation arise from the depth of the vessel, and the

FIG. 311.



Ligature of the right axillary, first part: *p. m.*, pectoralis maj. cut close to the clavicle; *d.*, deltoid; *c. c. m.*, costo-coracoid membrane; *p. min.*, pectoralis min.; *br. pl.*, brachial plexus; *a. a.* and *a. v.*, axillary artery and vein; *a. th. v.* and *c. v.*, acromio-thoracic and cephalic veins.

numerous branches of the acromio-thoracic artery which ramify superficial to it. They are surmounted by a free incision, by dividing the great pectoral quite close to the clavicle, and by clamping each vessel as it is cut.

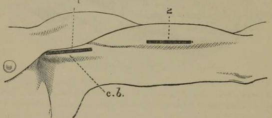
Position: On the back, the shoulder hanging, unsupported, over the edge of a pillow or the table, and the arm lying by the side; the surgeon stands by the side of the patient. The incision (Fig. 305, 4), slightly concave upward, runs one-half inch below and parallel to the clavicle, starting just inside the coracoid process, and ending one inch from the sternal end of the clavicle. The skin, platysma, and fat are divided: the anterior border of the clavicle is plain, on retracting the upper lip of the wound; run the knife along this, divide the fibres of the pectoral (*p. m.*) in several layers, and clamp at once any vessel cut. So soon as the muscle is cut through, retract the lower lip of the wound, and push up the shoulder somewhat, to raise the clavicle. The acromio-thoracic vessel and the ext. ant. thoracic nerves will also probably be seen. Now look for the cephalic vein (*c. v.*), crossing inward over the artery, to enter the axillary vein through the costo-coracoid membrane (*c.c.m.*), which forms the floor of the wound; it may lie quite close to the sheath of the subclavius. Divide or tear through the costo-coracoid membrane above the cephalic vein, making an opening parallel to the clavicle. Hook down the membrane below the opening, and with it the cephalic vein. The axillary sheath is now bare, and the blue vein shows through it, being the innermost of its contents; externally lie the brachial nerves, and between the two the thick, flat band of the artery may be felt on the rib. Whilst a finger draws the vein down and in and protects it from injury, the sheath of the artery is opened high up, and the needle passed from the vein. Care must be taken not to include the third cord of the brachial plexus, and not to mistake it for the artery. The great point is to keep close to the clavicle. The operation is a difficult one, and should never be performed when ligature of the third part of the subclavian would do.

Guthrie proposed to divide the great pectoral in the line of the artery, from the middle of the clavicle to the anterior edge of the axilla. Free access is thus given to any part of the vessel; and by suturing the muscles and careful position it is said that good union may be obtained.

Ligature of the Third Part of the Axillary Artery (Fig. 313).—*Position:* Upon the back; the arms abducted to a right angle, or even more, and so held by an assistant, the forearm being slightly flexed. The surgeon stands below the arm on the left side, either below or above on the right. The axilla must be shaved.

Steady the skin with the left fingers, and make an incision three inches long from the *highest point* of the axilla, immediately behind the anterior axillary fold, downward along the swell of the coraco-brachialis (Fig. 312, *c. b.*). By successive strokes of the knife, divide the fat and deep fascia, and

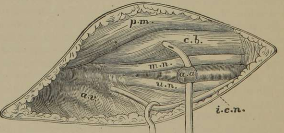
Fig. 312.



Incisions for: 1, axillary artery, third part; 2, brachial artery at middle of arm; *c. b.*, the swell of the coraco-brachialis. The patient is lying, and the arm is seen from below.

make the *coraco-brachialis* evident throughout the wound. If this muscle is drawn forward, a finger passed into the wound feels the cord of nerves and vessels immediately behind it. Nearest the muscle will be felt and seen a thick cord not entering the coraco-brachialis—the *median nerve;* separate

Fig. 313.



Ligature of the left axillary, third part: *p.m.*, pectoralis maj.; *c.b.*, coraco-brachialis; *m.n.*, median; *u.n.*, ulnar, and *i.c.n.*, int. cutaneous, nerves; *a.v.*, axillary vein seen throu h fascia; *a.a.*, axillary artery.

this, and have it held up with the muscle. The artery is now exposed, being in immediate contact with the median. Its sheath must be opened, and the needle passed from the inner side. In this operation the large axillary vein is often not seen at all, or only through the fascia (*a.v.*).

The BRACHIAL ARTERY extends from the lower edge of the teres major to the middle of the front of the elbow, at the level of the neck of the radius (a finger's-breadth below the fold). It lies in the groove between the coraco-brachialis and biceps in front, and the triceps and brachialis anticus behind. It is subfascial till it sinks into the hollow in front of the elbow after passing beneath the semilunar fascia of the biceps; it lies upon the inner heads of the triceps, the insertion of the coraco-brachialis, and the brachialis anticus, and has the coraco-brachialis and biceps to its outer side, perhaps over-lapping it a little. It is accompanied by two venæ comites, and the basilic vein, piercing the fascia at the middle of the arm, runs up internal to the vessel; the median basilic crosses the artery obliquely at the bend of the elbow, being separated from it by the semilunar fascia. The median nerve lies outside at first, but at the middle of the arm crosses inward (generally over); the ext. cutaneous is also outside till it pierces the coraco-brachialis; behind is the musculo-spiral, till it passes back between the heads of the triceps; inside, as far as the middle of the arm, are the internal cutaneous and ulnar.

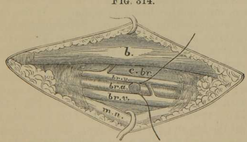
Branches.—The superior profunda rises from the first inch; the inferior profunda and medullary artery near the middle of the arm; and the anas-tomotic about two inches above the elbow.

Irregularities.—The artery, with the median nerve, rarely passes toward the inner condyle, turning forward again beneath a supra-condylar process. It is not very uncommon to find two vessels in place of one in some part of the arm, from high division of the brachial, the origin of a vas aberrans from the axillary, or, very rarely, division and subsequent reunion of the brachial. The two vessels generally lie together in the arm, the abnormal being superficial; at the bend of the elbow the latter is often subfascial, or even subcutaneous. One or other of the vessels may pass through a supra-condylar foramen.

LIGATURE OF THE BRACHIAL ARTERY IN ITS UPPER THIRD.—The limb must be abducted to a right angle: the operator stands below the left limb, above the right. A three-inch incision is made on to the *coraco-brachi-alis*, which is the rallying point. The median nerve and the artery are found and treated as in the last operation.

Ligature at the middle of the arm (Fig. 314).—A three-inch incision (Fig. 312, 2) is made along the edge of the biceps, and deepened through fat and

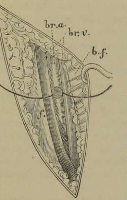
FIG. 314.



Ligature of the brachial at the middle of the arm. *b.*, biceps; *c.br.*, coraco-brachialis; *m n.*, median nerve drawn strongly in; *br.a.*, *br.v.*, brachial.

fascia, till the *edge of the biceps* is clear along the whole wound; draw it out-wards through the fascia. The *median nerve* is now seen, generally where it is crossing inwards over the artery; it must be drawn inwards, the fascia over it having been divided along the whole wound. Between the nerve and the edge of the biceps will now be seen the artery with its two veins; the sheath of the former must be opened, and the needle passed from either side.

FIG. 315.



Ligature of the brachial at the bend of the elbow: *br.a.* and *br.v.*, brachial artery and veins; *b.f.*, bicipital fascia; *f.*, deep fascia.

Ligature at the bend of the elbow (Fig. 315).—Before operating, find, if possible, the line of the median basilic and median cephalic veins; also the curved inner margin of the biceps, and the outer edge of its tendon as low as possible.

With the forearm extended and supinated, make a two-inch incision (Fig. 316, 1) crossing the middle of the fold of the elbow at an angle of forty-five degrees, and having its centre at the fold, midway between the inner condyle and the outer edge of the biceps tendon. The cut should not wound the median cephalic vein, and should lie between the edge of the biceps and the median basilic. As it is deepened the median basilic vein must be freed and drawn in; if this vein cannot be seen before operating, the wound must be cautiously deepened to the fascia, and any veins met with retracted or double-tied and divided.

Branches of the internal cutaneous nerve are necessarily cut in this incision. The fascia being clean, retract the edges of the wound. In the lower half will be seen, running down and in, the thick semilunar fascia of the biceps; this may be divided upon a director. The artery, with its two veins, lies immediately beneath it, rarely covered by sufficient fat to conceal it. The opening in the fascia having been enlarged, the artery is cleaned and the needle passed, as may be most convenient. At the inner part of the wound, which crosses the vessel obliquely, the median nerve may be seen at some distance from the artery; and at the inner end is the biceps tendon.

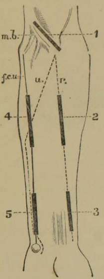
THE RADIAL ARTERY.—*Line:* Almost straight, from middle of bend of elbow to styloid process of radius. It then winds below this process to the back of the wrist, enters the palm between the heads of the first interosseous muscle, and ends as the deep palmar arch by joining the deep branch of the ulnar (Fig. 317).

In the forearm the vessel is covered by the supinator long., generally to about the middle, being subfascial below, between the tendons of the supinator and flex. carp. rad., neither being in contact. It lies upon the biceps tendon, supinator brevis, pronator radii teres, flexor sublimis, flexor pollicis long., pronator quadratus and lower end of radius. Two veins accompany it; and the radial nerve (Fig. 318, *r. n.*) approaches the artery in its middle third, but never touches it. *Branches:* small.

Irregularities.—The artery may be superficial to the supinator long., or even subcutaneous; and at the wrist may pass outside the extensor tendons.

LIGATURE OF THE RADIAL IN ITS UPPER HALF (Fig. 318).—With the arm supinated, make a two-inch incision (Fig. 316, 2) *in the line* (*r*) of the artery; cut through the fat, and expose the deep fascia. Look for the inner edge of the *supinator long.* (*s. l.*), which is probably inside the wound; divide the fascia on it all along the wound. Raise the edge of the muscle and draw it out. The artery (*r.a*)., with two veins, can now be seen and felt through the thin fascia binding it to the pronator teres. Open this fascia, clean the artery, and pass the needle as may be most convenient. The radial nerve is not seen.

FIG. 316.

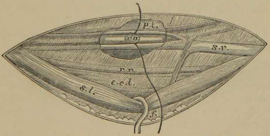


Incisions for: 1, brachial at bend of elbow; 2, and 3, for radial in upper half of forearm and at wrist; 4 and 5, for ulnar at corresponding points; *m.b.*, median basilic and ulnar veins; *u.* and *r.*, lines of ulnar and radial arteries; *f.c.u.*, flexor carpi ulnaris. The tendons of the flexor carpi rad. and palmaris longus are indicated at the wrist.

FIG. 317.

Dissection of forearm and hand to show radial and ulnar arteries. Supinator longus drawn aside; muscles of superficial layer, except flex. carp. ulnaris, cut; flex. poll. long., flex. profund. dig., and pronator quadratus exposed.

FIG. 318.

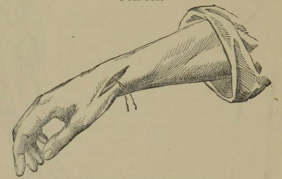


Ligature of the left radial in its upper half. *f*, deep fascia; *s. l.*, supinator long.; *e. c. l.*, ext. carpi rad. long., and *r. n.*, radial nerve, both seen through fascia; *p. t.*, pronator teres; *r. a.*, radial artery with two veins; *s. v.*, a superficial joining a deep vein.

LIGATURE OF THE RADIAL ABOVE THE WRIST.—A one and one-half inch incision (Fig. 316, 3) is made in the line of the artery, midway between the outer edge of the radius and the flex. carp. rad. tendon, and cautiously deepened through the subcutaneous tissue. The deep fascia must be raised and divided over the vessels, the artery cleaned and the needle passed from either side.

LIGATURE OF THE RADIAL OUTSIDE THE WRIST.—With the radial side of the forearm uppermost and the hand adducted over a sandbag, make an *incision* from a point midway between the styloid process of the radius and

FIG. 319.

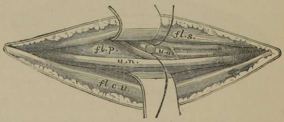


Incision for radial outside the wrist.

the groove for the extensor secundi internodii poll. to the ulnar side of the base of the first metacarpal (Fig. 319). This crosses the radial vein, which must be drawn to the radial side. A branch of the radial nerve to the thumb usually lies in the ulnar half of the wound. Open the deep fascia carefully; the artery, with two veins, will be found crossing the wound at an acute angle, and must be tied as usual. Some use the ext. sec. internod. tendon as a guide, making the incision along it; but such interference with the tendon exposes it to great danger of sloughing or adhesion. It is, however, a dead-house operation.

The *ulnar artery* (Fig. 317) takes a gently curved *line* convex inward, from the middle of the bend of the elbow to the middle of the ulna; from this point it runs straight to the outer side of the pisiform bone and divides into its superficial and deep branches; the former constitutes the superficial palmar arch, the latter passes between the little finger muscles to complete its deep arch.

FIG. 320.



Ligature of the left ulnar artery. *fl.c.u.*, flexor carpi ulnaris; *fl.s.*, flexor sublimis; *fl.p.*, flexor profundus; *u.n.*, ulnar nerve; *u.a.*, ulnar artery.

In the forearm the vessel is at first deep to the pronator teres, flex. carpi radialis, palmaris long., and flex. sublimis; it lies upon the insertion of the brachialis anticus and the flex. profundus. Above the middle of the forearm the vessel issues from beneath the inner edge of the sublimis, and then lies between the flex. carp. ulnaris and the flex. profundus, bound down by fascia to the latter muscle. Just above the wrist it comes forward and winds on to the annular ligament, being then subcutaneous. It has two *veins* with it. The ulnar nerve lies far inside it at first, but comes into contact with the artery where it emerges from beneath the flex. sublimis (Fig. 320) and continues thence internal to and somewhat deeper than the vessel. The palmar cutaneous branch of the ulnar nerve lies on the artery in its lower fourth. The median nerve, internal to the ending of the brachial takes a straight course down the forearm crossing the ulnar one inch below its origin, and separated from it by the ulnar head of the pronator teres, and often, by a slip, from the coronoid process to the flex. poll. long. The interosseous trunk is a large branch rising one inch down. When the ulnar rises high, it is almost always superficial to the muscles, and may be subcutaneous.

Ligature of the Ulnar in its Upper Half (Fig. 320).—Success in this operation depends upon hitting the internal (Fig. 316, *f.c.u.*) between the flex. carp. ulnaris and flex. sublimis. To do this, stretch a bit of string from the inner condyle of the humerus to the inner side of the pisiform bone, and, starting from the middle of the forearm, make an incision, three to four inches long, upward in this line. Deepen it to the fascia, when a white line, formed by the *tendinous edge of the flex. carpi ulnaris* (*fl.c.u.*), will be seen; if two appear, take the innermost. Divide the fascia upon the muscle just external to this throughout the wound. Flex the hand, raise the flex. carpi ulnaris, separating it from the flex. sublimis with the handle of the scalpel, and have it drawn inward with a retractor. Cease the separation so soon as the white *ulnar nerve* is seen lying on the flex. profundus. Anterior and external to this is the edge of the *flex. sublimis* (*fl.s.*); divide the fascia *upon* the edge of this muscle, separate it from the profundus with the handle of the scalpel, and draw it forward and outward with a retractor. The ulnar artery (*u.a.*), with two veins, will be found running down and in to join its nerve, beyond the border of the muscle, at the lower part of the wound; it may be cleaned at any point, and the needle passed as is most convenient.

Ligature of the Ulnar Above the Wrist.—Starting one inch above the pisiform bone, make a two-inch *incision* (Fig. 316, 5) along the radial side of the *flex. carpi ulnaris tendon*, deepen the wound boldly on to this tendon, and make it plain throughout the wound. Now slightly flex the wrist. With the handle of the knife, separate all the tendon from the flex. profundus, which is left covered by a layer of fascia, until the *ulnar nerve* is seen through this fascia; just anterior to it lies the ulnar artery with its veins. Open the fascia over them, clean the artery, and pass the needle from the side of the nerve.

The superficial palmar arch (Fig. 317) is convex downward, and reaches a line drawn across the palm from the cleft between the thumb and forefinger. It lies beneath the palmar aponeurosis, and over all nerves and flexor tendons. It is often joined externally by the superficial volar, and rarely, in its concavity, by an enlarged median artery. It gives off from its convexity four digital arteries, which supply all the digits except the thumb and radial side of the first. These vessels (except the innermost) run between the metacarpals and divide at the clefts of the fingers. Incisions must, therefore, be made into the palm in the lines of the metacarpals. The superficial arch and its branches may be easily tied by enlarging any wound. The superficial volar is sometimes a large artery, and it may pass through the short muscles of the thumb; in enlarging the wound, the knife should be carried parallel to the muscular fibres.

THE AORTA, ILIACS, AND THEIR BRANCHES.—The *abdominal aorta* generally divides into the common iliacs in front of the body of the fourth lumbar vertebra, somewhat to the left of the midline, but often in the midline and sometimes to the right of it. It may divide as low as the fifth or as high as the third vertebra. Ordinarily its point of bifurcation is one-half to three-quarters of an inch below and a little to the left of the navel (Fig. 321, *a*), about on a level with the highest point of the iliac crest. If from the above point lines (Fig. 321, *il.*) be drawn to points midway between the ant. sup. spine on each side of the symphysis, the upper third will correspond to the common iliacs, the lower two-thirds to the external.

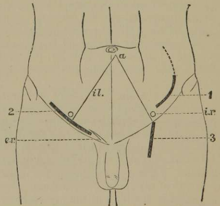
The end of the aorta is covered by peritoneum and lies upon the vertebræ; on its right is the vena cava, on its left the psoas. The nerves of the aortic plexus surround it. The vena cava extends lower than the aorta, beginning in front of the fifth lumbar, behind or just external to the right common iliac.

The *common iliacs* extend from the end of the aorta to the lumbo-sacra articulation, where they divide into external and internal iliacs. They are generally about equal in length (two inches), the right dividing somewhat higher than the left.

Both vessels are covered by peritoneum; they rest upon the fourth and fifth vertebræ. The left artery lies along the inner edge of the psoas, the right touches the right muscle only at its ending; higher up the cava intervenes. The ureter crosses each at its ending, and the sup. hæmorrhoidal vessels descend into the pelvis in front of the left. The vein lies internal to its artery at first; the left continues so and passes behind the upper end of the right artery to join the right vein, which passes behind its artery, and form the cava. Nerves from the aortic to the hypogastric plexus cross the vessels.

The extreme lengths of the artery are less than half an inch and four and a half inches; both rare. The ext. and int. iliacs have been seen rising directly on one side from the aorta. No branches as a rule; but the ilio-lumbar, middle, or lateral sacral, or a renal artery may rise from it.

FIG. 321.



Incisions for: 1, ext. and common iliac (Abernethy); 2, ext. iliac (Cooper); 3, common femoral; *a*, point of splitting of aorta; *i.r.*, int. ring; *i.l.*, line of ext. and common iliac arteries; *e.r.*, ext. ring.

The *external iliac* (Figs. 321 and 322) is covered by peritoneum in front and on its inner side; it lies unsupported over the pelvis along the inner edge of the psoas till close to its ending, when it comes to lie upon the psoas. A chain of glands surrounds both artery and vein. The ureter often crosses them close to their origin; and the sigmoid flexure and ending of the ileum cross the left and right vessels, respectively, high up. The vas or round ligament ascends on the inner side of the vessel near its ending, and when entering the int. ring lies in front of it; so also do the spermatic vessels, but the ovarian vessels cross the artery higher up. The vein lies internal to the artery and becomes also posterior to it a short distance from Poupart's ligament; the circumflex iliac vein crosses inward over it close to Poupart's ligament. The genital branch of the genito-crural lies on it near its ending. Two *branches* of considerable size rise in the last half inch—the deep epigastric and the deep circumflex iliac.

Irregularities.—The external iliac rarely ends in the profunda, the sciatic of the internal iliac giving the chief supply to the lower limb. Branches which should spring from the profunda may rise from the iliac; and its own branches may rise one to two inches from its endings.

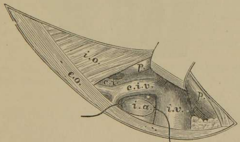
The *internal iliac artery*, one to one and one-half inches long, extends to the edge of the great sciatic notch where it ends in two divisions. It is covered by peritoneum, and lies against the sacrum, the lumbo-sacral cord intervening; the ureter descends on its inner side. Its *vein* lies behind, and the ext. iliac vein crosses outside the first part of the artery to join the internal vein. From the two divisions, anterior and posterior, spring many and important *branches*; the trunk is generally free.

Irregularities.—It may be only one-half inch long, or three inches, often varying inversely as the common iliac. It may divide much higher than the foramen. The ilio-lumbar branch often rises from the common trunk.

The vessels above the ext. iliac are tied by the extension of the incision introduced by Abernethy for ligature of this vessel. The modes of tying this artery will therefore be described first. They are two in number: Cooper's and Abernethy's.

LIGATURE OF THE EXTERNAL ILIAC—*Cooper's method* (Fig. 322).—*Position:* On the back with the hips extended and the shoulders slightly raised. The surgeon stands by the side he is to operate on. Shave the pubes. Feel the external abdominal ring and Poupart's ligament. Quarter of an inch above the latter and half an inch external to the ring begin an *incision* (Fig. 321, 2) which runs out and slightly up to one inch internal to

FIG. 322.



Ligature of the right external iliac (Cooper). *e.o.*, ext. oblique aponeurosis; *i.o.*, int. oblique; *p.*, peritoneum; *i.a.*, and *i.v.*, ext. iliac artery and vein; *c.i* and *c i.v.*, circumflex iliac artery and vein.

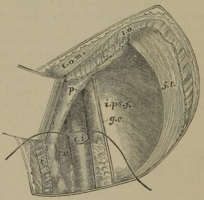
the ant. sup. spine; deepen it through fat to the ext. oblique aponeurosis (*e.o.*) parallel with the fibres of which the cut has been made. Clamp the superficial epigastric vessels if they bleed. Separate the fibres of the oblique aponeurosis throughout the wound, and hold up the upper edge. The cord is now exposed surrounded by the cremaster, and in the outer half of the wound lies the internal oblique (*i.o.*). Have the cord raised and cut through the cremaster below and outside it. The fascia transversalis, which now appears, is to be picked up with forceps below the ring, notched, and torn open with the fingers. Two retractors now draw the cord, with the epigastric artery, up and in, and the internal oblique and transversalis up and out; at the same time they guard and draw up the peritoneum (Fig. 322). The removal of a little connective tissue lays bare the lower end of the artery. If the branches rise normally, the sheath should be opened one inch above Poupart's ligament, and the needle passes from within (vein) out. The circumflex iliac vein crossing lower down must be carefully avoided, and the genital branch of the genito-crural, lying on the vessel, should not be included in the ligature.

The advantages of this operation as compared with Abernethy's are: Its greater ease, the smaller size of the wound, the lesser tendency to hernia, the slighter disturbance of the peritoneum. Its disadvantages are the greater danger of wounding the branches of the artery and the circumflex iliac vein, and the difficulty of extending the incision so as to secure the artery higher than one and one-half to two inches up.

Abernethy's method, modified by Liston (Fig. 323). *Position:* As for Cooper's.

The *incision* (Fig. 321) begins (or ends) one inch above Poupart's ligament and half an inch outside the internal ring and curves up, to a point one inch above and internal to the ant. sup. spine. The wound is carried

FIG. 323.



Ligature of the left ext. iliac (Abernethy). *e.o.m.*, ext. oblique; *i.o*, int. oblique; *t.*, transversalis; *f.t.*, fascia transversalis; *p.*, peritoneum; *i.ps.f.*, ilio-psoas fascia; *g.c.*, genito-crural nerve; *e.i.* and *i.v.*, ext. iliac artery and vein.

through the fat and the ext. oblique aponeurosis laid bare; this is divided along the concave edge of the wound, so far as possible between its fibres. The internal oblique and transversalis are next divided by successive light strokes of the knife, the concave edge being always adhered to. The fascia transversalis is now exposed. It must be opened without injury to the peritoneum. This is best effected by picking up a bit, and notching it, in the neighborhood of the internal ring where subperitoneal fat is most plentiful. A broad director may then be cautiously passed beneath it, or it may be carefully torn open by the fingers to the full length of the wound. The inner lip being retracted, the peritoneum is next stripped from the iliac fossa—directly inward, *not* up and in. The spermatic vessels adhere to it. Turn the patient on to the sound side so that the intestines may fall away, and have the peritoneum protected by the fingers of an assistant. Open the sheath of the artery, clean it as thoroughly as possible, and pass the needle from within outward. Be most careful not to injure the structures in contact with the lower end of the artery, should the thread be placed here; the circumflex iliac vein, especially, bleeds profusely if wounded.

In some cases this artery has been found dipping down, even a finger's length, into the cavity of the pelvis—either naturally (very rare), from advanced atheroma, or pushed down by a mass of enlarged glands which may frustrate the attempt to tie.

Ligature of the Aorta, Common and Internal Iliac.—Should the patient be very fat, the incision given must be extended upward and inward; and this must be done also if, for any reason, it be found necessary to tie the common instead of the external iliac. The incision should be prolonged toward a point midway between the navel and xiphoid cartilage; one ending two inches above the ant. sup. spine generally suffices to tie the *common iliac;* and, through one, on the left side, reaching to the level of the navel, a thread may be placed on the end of the *abdominal aorta.* Except that the incision is longer and the peritoneum more widely stripped up, the operation is the same as that for the external iliac. The ureter adheres to the peritoneum and is raised with it. To decide which vessel is exposed at the bottom of any part of the wound, we depend upon the surface-marks given at page 889, and a careful examination with the finger for the bifurcations of the aorta and com. iliac and of the bones in their vicinity. Elaborate cleaning of the artery is impossible. The needle must be passed from within out round the common iliac; the left artery being the easier to reach and to tie, its venous relations being much less close. Round the aorta the needle should be passed from the cava.

The *internal iliac* can be tied through the incision for the common trunk. The needle has to be passed guided chiefly by sense of touch; the great difficulty is the veins—the internal iliac behind and somewhat internal, the external outside the upper end. These must be carefully separated from the artery with an aneurism needle having a well-rounded point. The vessel cannot be cleaned; it must not be strongly pulled upon in tieing the knot, lest the ilio-lumbar branch be torn through.

The main object of all these operations is to avoid a wound of the peritoneum, though in this the more extensive ones have not uncommonly failed. They were introduced when the treatment of the peritoneum was little understood, and it is probable that most surgeons would nowadays prefer to tie any vessel above the lower end of the external iliac through an incision in the linea alba or linea semilunaris.

The *femoral artery* extends from Poupart's ligament to the upper end of the lower third of the thigh, where it passes through the opening in the adductor mag., becoming popliteal. *Line:* From midway between the symphysis and ant. sup. spine to the inner tuberosity of the femur, the thigh being somewhat flexed, abducted, and rotated out (the position for ligature).

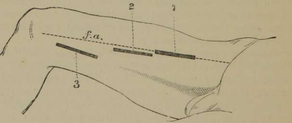
It lies in the hollow, often visible and always to be felt, between the extensors of the knee and the adductors of the hip, covered below its upper four inches by the sartorius. The upper two inches are surrounded by an areolar sheath, containing three compartments—the outer for the artery, middle for the vein, and the internal three-quarter inch long, is the crural canal. Superficial for about four inches, the artery is then covered by the sartorius and a fascia which passes between the vastus int. and the adductors long. and mag., roofs in a triangular interval (Hunter's canal), and becomes increasingly dense as it descends. It lies upon the psoas, pectineus, adductors brev., long. and mag., being separated from the pectineus by its own vein and the profunda vessels. To its outer side, in Hunter's canal, is the vastus int. The femoral vein is in the same plane, and internal to the artery at Poupart's ligament, passes behind it at about the upper edge of the sartorius, and gradually reaches its outer side in Hunter's canal; the profunda vein lies between the artery and the pectineus; and a subcutaneous vein often ascends in the line of the artery, to end in the saphenous vein, which is internal to it. The anterior crural nerve lies one-quarter inch outside the artery, in the depression between the psoas and iliacus; its internal cutaneous branch crosses just above or beneath the edge of the sartorius; and the internal saphenous crosses gradually inward over the artery in Hunter's canal. *Branches:* The external pudics, superficial epigastric, and circumflex iliac—small superficial arteries rise immediately below Poupart's ligament. Somewhere in the second inch the *profunda* rises from the outer side of the femoral, runs out a little on the iliacus, and gives off the two large circumflex branches before turning in beneath the main trunk on to the pectineus. In Hunter's canal muscular branches rise, and, just above the opening, the anastomotic, which divides at once into a superficial twig, accompanying the saphenous nerve, and a deep one running in front of the tendon of the adductor mag. to the knee.

Irregularities.—Rarely the ext. iliac ends in the profunda, the main artery lying at the back of the limb and being a much enlarged sciatic. The artery may divide, and the two branches reunite in some part of its course. The profunda may arise less than one inch below, or even as low as four inches below Poupart's ligament; and it may spring from some aspect of the artery other than the outer. When rising low, one or both circumflex arteries will probably rise from the femoral.

The femoral may be tied above the origin of the profunda, below this branch at the apex of Scarpa's space, and in Hunter's canal. The apex of Scarpa's space is the usual seat of election. For all the operations the patient lies on his back, with the hip slightly flexed, abducted, and rotated out, the knee being bent. The surgeon stands outside the limb, cutting from above down on the right side, from below up on the left.

LIGATURE OF THE COMMON FEMORAL.—A two-inch longitudinal incision (Fig. 321, 3), in the line of the artery, having its centre one-half inch

FIG. 324.

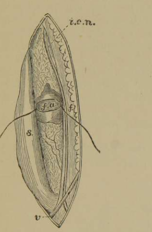


Incisions for: 1, the femora in Scarpa's space; 2, the femoral in Hunter's canal; 3, the popliteal; *f. a.*, the line of the femoral artery.

below Poupart's ligament, may be used. Spare the glands as much as possible; twist any bleeding vessels and make clear Poupart's ligament. The deep fascia and femoral sheath must be carefully opened, the sheath of the artery then notched, the vessel cleaned and the needle passed from within outward. The objection to this operation is the necessary proximity of the ligature to collateral branches. Through a somewhat longer cut, having its centre one and one-half inches below the ligament, it is easy to tie the *profunda* near its origin.

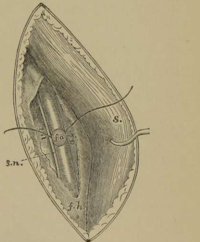
LIGATURE AT THE APEX OF SCARPA'S SPACE (Fig. 325).—A three to four-inch incision (Fig. 324, 1) is made in the line of the artery, having its centre four inches below Poupart's ligament, and deepened through the fat to the fascia lata; lymphatic glands, and the vein before mentioned (p. 894), must be avoided, if possible. Retract the edges. Through the fascia the *edge of the sartorius* (*s.*) will be seen crossing the wound downward and inward; divide the fascia *upon* this edge so far as the muscle is exposed in the wound. A branch of the middle cutaneous nerve may be seen piercing

FIG. 325.



Ligature of the right femoral in Scarpa's space; *f.*, fascia lata; *s.*, sartorius; *i.c.n.*, int. cutaneous nerve; *v.*, a small superficial vein; *f.a.*, femoral artery. The loose connective tissue round the vessels, as distinct from the sheath of the artery, is shown. Reduced one-third. The subject was thin and old.

FIG. 326.



Ligature of right femoral in Hunter's canal. *s.*, sartorius, turned in; *f.h.*, fascia roofing in Hunter's canal; *s.n.*, long saphenous nerve; *v.t.*, vastus int.; *a l*, adductor long.; *f.a.*, femoral artery. Reduced one-third. The subject was very muscular.

the muscle; and the internal cutaneous (*i.c.n.*) crosses inward over the artery at the upper edge of the muscle. Raise the muscle with the outer retractor. Through the fascia beneath it will be seen and felt the femoral artery. Open the fascia over it longitudinally; then its sheath, and pass the needle from within out, as being most easy. Great care must be taken not to wound the vein behind the artery.

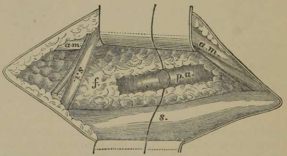
LIGATURE IN HUNTER'S CANAL (Fig. 326).—The line given for the femoral artery is obviously anterior to its lower part, which renders it necessary in this operation to cut one-half inch behind and parallel to the line; otherwise the vastus int., and not the sartorius, is exposed in the wound. The *incision* (Fig. 324) should be three to four inches long, and have its centres at the mid-point of the thigh. Superficial veins must be avoided, and the fat cut through till the fascia lata is exposed. This must be divided upon the sartorius, the fibres of which are almost vertical, inclining slightly inward. Being certain that the sartorius is reached, retract the outer lip of the fascia, and free the *anterior edge* of the muscle; pass a retractor beneath it, and draw it back and in. The fascia roofing in Hunter's canal is exposed, and beneath the lower end the saphenous nerve may be seen escaping; open it and slit it from end to end of the wound, first making sure that nothing but it lies upon the director. Now the artery in its sheath presents, the ext. saphenous lying in front, and the vein behind or outside. Open the sheath, clean the vessels carefully, hold the inner cut edge of the sheath with forceps and make it tense, and pass a blunt needle from behind forward.

The POPLITEAL ARTERY starts from the opening in the adductor mag., and ends beneath the soleus at the lower end of the popliteus. It runs from above, down and out, to the internal between the condyles, then rather less outward to its division opposite the angle between the tibia and head of the fibula. It is covered at first by the semi-membranosus, then it is superficial, and, finally, the heads of the gastrocnemius come together over it. It lies on the popliteal muscle. Its vein lies behind and outside it above, crossing gradually to the inner side; into it opens the short saphenous, which ascends in the midline, and pierces the fascia at the lower part of the space. The internal popliteal nerve, descending in the midline of the limb, lies over the artery, but separated by some distance, where the latter lies in the midline (at back of knee-joint); lower down it crosses to the inner side. A branch of the obturator to the knee lies on the vessel. Several muscular *branches* arise above the joint, and opposite the knee five articular vessels come off.

Irregularity.—The only one of surgical importance is that it may divide as high up as the intercondylar space.

LIGATURE OF THE POPLITEAL above the knee may be done in two ways: (*a*) The patient is placed on his face, the knee extended. A four-inch

FIG. 327.



Ligature of the right popliteal. *a.m.*, adductor mag.; *s.*, sartorius; *s.i.*, internal saphenous nerve with branch of anastomotic branch; *p.a.*, popliteal artery lying in fat, *f.*

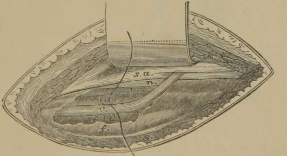
incision is made in the midline, reaching to or from the popliteal fold. Deepen the wound through the fat, looking out for the short saphenous; open the deep fascia all along, and expose the *semi-membranosus* above. Below this, pass the finger into the fat, and feel for the tight tolerably superficial cord of the *int. poptiteal nerve.* Now flex the knee, draw the semi-membranosus in and the int. popliteal out, without exposing it, and deepen the wound carefully in the interval, feeling frequently for the thick cord formed by the artery and the vein lying on the femur. The separation of the artery from the vein must be made *from the inner side* with blunt instruments. When the artery has been cleaned as well as possible, pass an armed needle from without, protecting the vein with a finger.

(*b*) The position is that for tying the femoral. A four to five-inch incision (Fig. 324, 3) is made along the posterior edge of the adductor mag. tendon, the fascia is bared and opened, the adductor mag. is drawn forwards, the sartorius backwards, and the long saphenous nerve, passing down and back beneath it, exposed. The fat of the popliteal space now protrudes. Tear carefully through it, and the finger will soon feel the thick cord of the vessels; the artery presents, and is cleaned and tied without any vein or nerve of importance being seen.

The POSTERIOR TIBIAL artery continues in the line of the popliteal, and ends beneath the int. annular ligament, midway between the int. malleolus and the point of the heel. It is covered by the gastrocnemius and soleus in its upper two-thirds, but is subfascial on the inner side of the tendo Achillis in its lower third. It divides into the two plantars beneath the abductor hallucis. It is bound down to the deep muscles by the layer of fascia over them, and is adherent to the under surface of this fascia. It lies on the tibialis posticus, flexor long. dig., and the back of the tibia and ankle-joint. Behind the malleolus, it has the tibialis post. and flexor long. dig. tendons one-quarter inch inside, and the flexor long. hallucis is one-half inch outside it (Fig. 328). It has the usual two *veins*. The post. tibial nerve lies inside the artery at first, crosses it about one inch down, and remains on the outer side. The peroneal *branch* is the chief. Rising one inch down, it runs outwards between the tibialis post. and soleus, to reach the inner edge of the fibula, along which it lies in a fibrous sheath between the origins of the tibialis post. and flexor long. hallucis, largely overlapped by the latter. At the lower end of the interosseous space, it sends forward the ant. peroneal, and runs down behind the ext. malleolus to the heel and foot. The ant. peroneal runs down in front of the malleolus also to the outer side of the foot.

Irregularities.—The artery may spring from the popliteal as high as the intercondylar notch; may be very small, or absent, being replaced by a large peroneal, crossing the leg where the communicating branch normally lies. The peroneal may rise as low as three inches below the popliteus, or it may come off too high, even from the popliteal. It is very rarely absent, and too large much more commonly than too small. The ant. peroneal may replace the the ant. tibial below.

FIG. 328.



Ligature of the right posterior tibial at the middle of the leg. *s.*, soleus; *s a.*, soleus aponeurosis; *f.*, deep layer of fascia; *f. l. d.*, flexor long. dig.; *a. n.*, and *v.*, posterior tibial artery, nerve, and vein.

LIGATURE OF THE POSTERIOR TIBIAL (Fig. 328) at the middle of the leg. *Position:* On the back with the limb semi-flexed and laid on the outer side. A four-inch incision is to be made one inch behind and parallel to the inner margin of the tibia, its centre corresponding to the middle of the leg. This is carried through skin and fat, the saphenous vein being looked out for and avoided. Then the deep fascia is opened, and, as a rule, the soleus only is exposed, the gastrocnemius falling away to the outer side of the limb. The fibres of the soleus rising from the tibia are now to be divided all along the wound, in an antero-posterior plane, by successive strokes of the knife, until the *tendon forming its deep surface* is everywhere plain. This is to be pinched up, notched, and opened from end to end. Sometimes a few fibres will be found rising from its deep surface; they must be carefully divided. Extend the foot fully, pass a broad retractor beneath the soleus, and open the wound fully; through the thin deep layer of fascia, the nerve and vessels are now seen lying deeply on the tibialis post. The veins adhere closely to the artery and must be carefully separated.

Some operators have proposed to detach the soleus from the bone, instead of cutting through it; but it is difficult to distinguish its fibres of origin from those of the flexor long. dig., and, above all, this proceeding detaches the deep layer of fascia which, when raised with the soleus, carries the vessels along with it.

The above regular operation is very rarely required; in cases of wound one would, as a rule, enlarge the opening up and down, and thus reach the bleeding point.

Ligature of the posterior tibial in its lower third. The vessel is now subfascial, and rests on the flex. long. dig., or on the tibia. It is easily reached by a two to three-inch incision parallel to the inner edge of the tibia, and midway between it and the tendo Achillis. One or two layers of fascia must be slit up to expose the artery.

Fig. 329.

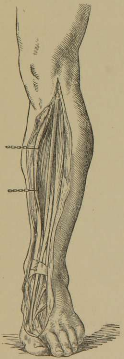
The relations of parts behind the inner ankle.

Ligature of the posterior tibial behind the malleolus. A curved incision two and a half inches long and concave forwards is made, a finger's breadth behind and below the malleolus; the pulsation of the vessel should be used as a guide. The incision is deepened and the int. annular ligament divided along the *concave* edge of the wound. If the incision has been well-placed, the artery is now exposed : clean and tie. Avoid opening the sheaths of the tendons on either side of it (p. 897).

To TIE THE PERONEAL ARTERY at the middle of the leg. The patient lies on the opposite side, and the leg, moderately flexed, rests on the inner side. A four-inch *incision* is made in the middle of the leg, directly over the posterior edge of the fibula. It is deepened between the peronei and soleus until the *bone* is reached. The soleus must be raised and drawn inwards by a retractor; if rising from the fibula above, it must be detached as high as the wound extends. The *flex. long. hallucis* is now exposed beneath the deep layer of fascia. The two must be carefully detached from the bone all along the incision until the *tube of fascia* (p. 897) containing the peroneal is reached. The muscle being held up whilst the ankle is extended, the sheath of the vessels can be opened and the artery cleaned and tied.

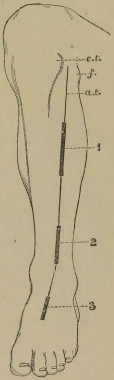
The *anterior tibial artery* extends from the lower edge of the popliteus to the front of the ankle, whence it is continued as the dorsal artery of the foot to the post. end of the first intermetatarsal space.

FIG. 330.



The relations of the anterior tibial and dorsal artery of the foot.

FIG. 331.



Incisions for: 1, ant. tibial above middle of leg; 2, do. above ankle; 3, dorsalis pedis; *e. t.*, ext. tuberosity of tibia; *f.*, head of fibula; *a. t.*, the line of the ant. tibial.

Line: From a point midway between the head of the fibula and ext. tuberosity of the tibia to a point midway between the malleoli, and thence on to the base of the first interosseous space (Fig. 331, *a. t.*).

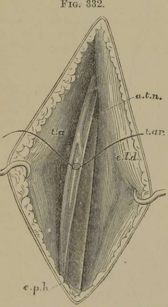
Coming forward at once between the heads of the tibialis post. and through the interosseous membrane, the artery at first lies very deeply on the membrane with the tibialis ant. inside and the extensor com. dig. outside; but the extensor prop. hallucis soon intervenes between it and the latter muscle, and in the lower third of the leg crosses the artery which lies, opposite the ankle, between the ext. prop. hallucis (inside) and the ext. com. dig. (outside). The artery lies in its lower third on the front of the widening tibia and on the ankle-joint; it is much nearer the surface below than above. One of its two veins is placed in front, the other behind it. The ant. tibial *nerve* appears on the outer side of the artery in the upper third, lies in front of it for most of its course, but generally on the outer side at the ankle.

The *dorsal artery* is subfascial except near its ending, where it is crossed by the slip of the extensor brev. dig. to the great toe. It lies on the inner tarsal bones and passes into the foot between the heads of the first dorsal interosseous muscle. It has a *vein* on each side, and the ant. tibial *nerve* outside.

Branches.—All small.

Irregularities.—In high splitting of the popliteal, the ant. tibial may pass in front of the popliteus. It may be small and reinforced by the int. plantar or ant. peroneal; or, rarely, it may be absent. The dorsal artery not uncommonly curves out below the ankle, ultimately returning to the first space.

Fig. 332.



Ligature of left ant. tibial above the middle; *t.a.*, tibialis anticus; *e.p.h.*, ext. prop. hallucis; *e.l.d.*, ext. long. digitorum; *a.t.n.*, and *t.a.r.*, ant. tibial nerve and artery.

To Tie the Anterior Tibial.—*In the upper third. Position:* On the back, with the knee moderately flexed over a firm pillow; the limb must be held with the toes pointing straight forward. The line of the artery should be accurately marked and a four-inch *incision* made in the upper third of the leg (Fig. 331, 1). Retract the edges of the wound, and if the interstice between the tibialis ant. and ext. com. dig. is not at once evident, divide the aponeurosis transversely from near the tibia to a point outside the line of the artery. The cleft will now be evident, and the fascia must be slit up and down throughout the wound. Flex the ankle and separate the muscles; at the lower part of the wound the ext. prop. hallucis may appear and must be drawn out. The artery will thus be exposed and must be cleaned and tied, the nerve in front of it being held aside (Fig. 332).

In the middle of the leg the operation is quite similar to the above, but the ext. prop. hallucis is seen much sooner after opening the fascia.

In the lower third a three-inch *incision* is made in the line of the artery, reaching to one inch from the ankle-joint (Fig. 331, 2). Divide the fascia all along the wound. Farabeuf recommends the insertion now of the left forefinger beneath the inner lip of the aponeurosis to the crest of the tibia, and the drawing outward of everything lying on the bone; then let the innermost cord slip—it consists of the tibialis anticus and ext. hallucis. The space outside them must be opened from below up, and in it will be found the artery when the foot is flexed and the muscles lax. In most people the interval between the ext. hallucis and the ext. com. dig. can be felt opposite the ankle. (Even as low as this, the vessel is often best found internal to the ext. prop. hallucis.)

To TIE THE DORSAL ARTERY OF THE FOOT, make a one and one-half-inch incision in the line of the artery extending from or to the base of the first space (Fig. 331, 3). Deepen the wound, sparing any nerves or vessels seen, and seek in the upper part of the wound the inner slip of the *extensor brevis*. Free its upper border and draw it gently outward: the vessels should lie beneath it. If they do not, let the muscle go and carefully examine the base of the first space.

CHAPTER LIV.

AMPUTATIONS AND EXARTICULATIONS.

DEFINITION.—"Amputation" implies the removal of the whole or a portion of an extremity, or of some part which projects from the surface of the trunk—*e. g.*, breast, penis, tonsil; the present chapter deals with the limbs only. In an "amputation" the bone is divided; in an "exarticulation" the limb is removed at a joint.

INDICATIONS for amputation are numerous:

1. *Injury:* (*a*) Completely smashing the part, (*b*) tearing the main vessels, so that gangrene must ensue; or (*c*) the main nerves, causing irreparable paralysis, together with other serious damage to the limb; (*d*) extensive loss of soft parts, rendering recovery with a useful limb impossible; and (*e*) loss of skin too great to allow of healing even with the help of transplanted bits of skin.

2. *Inflammation:* (*a*) Threatening life by hectic and albuminoid degeneration, or (a much less common indication) by septicæmia, pyæmia, or tetanus—there being reason to hope that removal of the local mischief will be followed by subsidence of the general symptoms; or (*b*) damaging the part so much that recovery with a useful limb is impossible; or (*c*) remaining chronic and incapacitating the patient from earning a living. Under *b* and *c* fall cases of extensive incurable ulceration, especially annular, of the leg; and to this group belong inflammations of joints—the commonest causes of amputation in civil practice.

3. *Gangrene* of a considerable part from any cause—*e. g.*, mechanical injury, burn, or frostbite, ruptured artery or aneurism, spreading gangrene, hospital gangrene, and other acute septic inflammations, or arterial thrombosis ("senile" gangrene).

4. *Malignant growths* of the soft parts or bones not freely removable by milder measures; and disabling *simple growths* or *elephantiasis* similarly qualified.

5. *Deformity* or *paralysis* rendering a limb useless, unsightly, an encumbrance, or the seat of frequent ulceration.

Our PRIMARY OBJECT in amputating is completely to remove an injured or diseased part in such a manner that the patient shall have the best chance of recovery with the most serviceable stump.

The *mortality after amputation*, as after all operations, is influenced by the age and general condition of the patient, and by the hygienic circumstances under which he is placed; but it is influenced far more by the hygiene of the patient's own wound, by the cause for which the amputation is performed, and by the height at which it is done.

The very young and very old do not bear serious operations well; yet surprising recoveries occur, and we must admit that we are frequently much deceived as to the resisting power of a patient. To be placed in a hospital which has long been crowded with septic wounds is undoubtedly one of the greatest misfortunes that can befall a wounded man; but if his own wound be thoroughly guarded against the entry of germs from without, he is practically safe from the diseases which were formerly hospital scourges. Asepsis and drainage of the wound are all-important, both to the patient himself and his wounded neighbors, if he have any; for, putting aside shock and primary hemorrhage as more or less accidental, septicæmia, septic osteomyelitis, pyæmia, *secondary* hemorrhage and gangrene of the stump, are *the* causes of death after amputation. Osteomyelitis occurs more easily when the medullary canal has been opened than when the saw has passed through the cancellous end of a bone. From an etiological point of view (see above) amputations may be classed as (1) amputations for injury, (2) for disease, and (3) of expediency—divisions of practical importance, for the mortality varies much in the different groups, being greatly higher after amputation for *injury* than for *disease:* shock and primary hemorrhage account for much of the difference, but septic disease was formerly so rife among the former cases as to give rise to the saying that a robust countryman who had never had a day's illness was a worse subject for amputation than one worn by chronic joint disease and long confined to bed. Bryant long ago showed that at Guy's the mortality after amputations of *expediency* was exceptionally high (forty per cent.) and chiefly from septic disease, the otherwise healthy subjects seeming to act as virgin soil to their poisons. Antiseptics ought to render such cases the least dangerous, one would think; and they do prevent sepsis in most of the traumatic cases seen early.

A factor of great importance in the result of *amputations for injury* is the *time* at which they are performed. Experience has shown that no time is so favorable as that soon after the infliction of the injury. It is advisable in cases of intense shock to rally the patient before operating; otherwise the sooner the operation is performed the better. Amputations done within the first twenty-four hours of an injury are called *primary*. After this period, *in septic cases*, traumatic fever sets in and continues three to six days, until suppuration is well established. This period is most perilous for any extensive cutting operation; the blood is probably charged with chemical poisons, and perhaps contains organisms absorbed from the wound, death from septic disease is common, and is rendered much more likely by the addition of a large raw surface. Amputations done at this period are termed *intermediary*. When suppuration is well established, amputations (*secondary*) may be performed with a much better chance of success; but if we add to the mortality after secondary amputations the mortality among patients during the period between the first twenty-four hours and the establishment of suppuration, it will be found that the patient's chances are best after primary amputation, always excepting injuries necessitating amputation above the middle of the thigh, in which shock is almost invariably fatal. When a patient comes under notice in the intermediary stage with a limb that should obviously have been removed primarily—as not uncommonly happens, especially in military surgery—it seems to be still a question whether it is better to amputate at once, or wait for the secondary period; probably aseptic amputation at once would give the best results.

Lastly, nothing is more capable of statistical proof than this—that the mortality rises with the height at which we amputate: as Dieffenbach said, "Zollweise steigt die Gefahr." This, however, must not be taken as meaning that we are not to remove another inch of bone in order to give the patient a serviceable stump.

The Principles of Amputation.—The objects which we should have constantly before us in amputating are these: 1. To provide ample (*i. e.*, loose) covering for the end of the bone and divided soft parts, that rapid union may occur. 2. To do this with the least sacrifice of length of limb, not only because of the greater fatality of the higher amputations, but because a long stump gives a patient more power over an artificial limb. 3. So to place the flaps (having due regard to the above major principles) that they shall hang in position almost without assistance from sutures or dressing. 4. To provide a dependent aperture for drainage. And, 5. To insure that the scar shall not be over the end of the bone, or in such position that it will be pressed upon by an artificial limb.

The *amount of covering* required varies somewhat. We must, obviously, have one diameter of covering at right angles to the line of scar; and in addition to this sufficient to make up for shrinking of the elastic skin and its displacement by contraction of long muscles in connection with it; in some cases also we must allow for the shrinking due to inflammatory infiltration of the flaps. Elasticity of the skin is greatest in youth, very slight in old age; muscular contraction is greatest in strong subjects with little fat, and upon the flexor aspects of limbs where most of the long muscles, unattached to the limb-bone, are placed (*e. g.*, back of thigh); cicatricial shrinking occurs when the flaps are already infiltrated; and when, from any cause, union is slow, taking place by granulation, retraction from all causes reaches its maximum, sometimes necessitating resection of the bone after an operation in which ample covering was provided. This may be necessary also if the covering sloughs. Experience has shown that we must never provide less than one and a half diameters of covering, and that it is safer, where possible, to provide two diameters; the latter amount is really necessary in the thigh.

Material for Covering.—The skin on the extensor surfaces of limbs, especially over the knee and heel, is better adapted to pressure than that on the flexor aspects, and should as a rule be used. A patient, after amputation of a lower extremity, is much steadier on an artificial limb when the whole or part of the weight can be borne upon the end of the stump. That this may be done, it is essential that the covering be loose, and the scar non-adherent to the end of the bone. In upper limb stumps the point of pressure against a limb is always greatest on the flexor aspect of the stump; the scar should, therefore, lie towards the extensor side.

Not uncommonly the brawny infiltrated skin about a chronically inflamed joint, perforated, perhaps, by two or three sinuses, is rejected as unsuitable for the formation of flaps, and an amputation of the leg or thigh is done instead of the much superior operations through the ankle or knee. This material, being well vascularized, is, however, excellent for flaps unless it is much undermined, riddled, and blue round the edges of many sinuses.

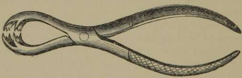
It was formerly thought an advantage to have the bone-end covered by a good pad of muscle, so as to form a "well-cushioned stump." This is a mistake, for all muscle soon atrophies and disappears from a stump, being replaced by scar-tissue. Muscle should, therefore, be present in the covering only when it is required to insure its vitality; otherwise, muscle should be cut so as to retract to about the level of the end of the bone. In any quantity it is a distinct disadvantage, rendering the flaps heavy, and liable to displacement by their own weight and momentum—when the limb is moved—or by muscular contraction.

Lastly, it is well to raise a cylinder or broad anterior flap of periosteum, adherent to the deepest muscle, which may fall over the sawn surface of the bone; for periosteum adheres more quickly than any other tissue to bone, and leads to the earliest closure of the medullary canal—a matter of special importance in septic cases. In exarticulation at the hip the whole of the periosteum corresponding to the length of covering has been raised and preserved, and sufficiently stout new bone has formed in the stump to enable the patient to wear an artificial limb. We are not aware that *subperiosteal amputation* has been practised at the shoulder.

This seems to be the best place to mention that in exarticulations there is no need to remove healthy cartilage from the bones; primary union will take place over it, as we see every day after the removal of fingers, and if this is missed, cartilage granulates readily. But when it is inflamed, or when the synovial membrane or bone is tubercular, all morbid parts should be carefully removed with the saw, gouge, scissors, or knife.

PREPARATIONS FOR AMPUTATION—both as regards the *room*, the *table* and the *patient*, are those given at p. 839. Three *assistants* will be required: 1, to give the anæsthetic; 2, to assist the surgeon in retracting the flaps and tying vessels; 3, to hold the limb. If a tourniquet is not used, a fourth assistant must compress the main artery; No. 2 can, however, perform this duty, when No. 3 must assist in tying the vessels, etc., so soon as the limb is removed; otherwise No. 3 steadies the stump. The patient when anæsthetized is so placed that the limb to be removed projects well beyond the edge of the table. When amputating a leg, it is usually well to tie the sound limb to the corresponding leg of the table. Means are now taken to render the limb to be removed bloodless (p. 841), and Esmarch's rubber band, which has entirely replaced Petit's tourniquet (Fig. 141), is applied.

FIG. 333.



Fergusson's lion-forceps.

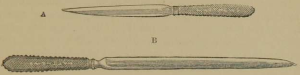
There is, however, occasionally (chiefly in thigh above lower third) an objection to the use of a tourniquet in amputations, viz., that it prevents retraction of the divided muscles when it is applied at all close to the plane of section of the bone. In addition to the *instruments*, etc., mentioned at p. 840, an amputating knife of suitable length will be required; also a saw, a pair of strong bone-forceps, lion-forceps (Fig. 333), and one or two elevators.

The *knife* should have the shape shown in Fig. 334, A and B. It must be strong, straight-backed, and sharp-pointed, the point being formed chiefly by the sloping back of the edge. Its length varies with the size of the part to be removed and with the method employed; for transfixion it should be about half as long again as the diameter of the limb; but for circular amputations and flap operations by dissection a shorter knife is preferable, its point being more under control and its movements more swift and accurate.

For modes of holding these large knives see page 846. The *saw* preferred by most surgeons is short, broad-bladed, with a stiffened back and small,

Fig. 334.

A



B

Amputating knives.

well-set teeth; but many use a narrow Butcher's saw (Fig. 361) with which they render the sawn surface slightly convex from front to back.

Performance of an Amputation.—The *position of the surgeon* is governed by a simple rule: he should always stand so as to be able to raise the covering with his left hand. The *mode of raising a flap* is as follows: After marking it out by a cut which goes down to the deep fascia, the left fingers seize the edge of the covering and raise it more and more whilst the knife plays on the deeper parts dividing its attachments to them. In this process of raising the covering there is a great temptation, in order to get on quickly, to insert the point of the knife *between* the skin and the deeper parts and in so doing to turn its edge toward the skin; this must never be done, for it endangers the bloodvessels of the flap and often leads to sloughing: the knife-edge must be kept vertical, or almost vertical, to the deep parts, whilst its "flat" presses against the raised part of the flap. The detachment of the covering should be kept as far as possible in one transverse plane, the knife being drawn again and again toward the operator, superficial to the fascia, or sinking more and more deeply into the muscle, as may be required. The heel of the *saw* is applied as high as possible to the bone previously cleared by a sweep of the knife round it, or by elevation of the periosteum; it is steadied against the left thumb-nail, which also rests on the bone, and drawn firmly back from heel to point so as to make a groove, in which it is afterward worked lightly to and fro, along its whole length. The last few strokes, especially, should be lightly made lest the bone be splintered. This is still more likely to happen if the assistant, holding the limb, allow it to bend down; whilst if he raise it too much the saw will become locked. The left hand of the surgeon on the stump must make up for shortcomings on the part of the assistant. When there are two bones in the part, sawing should be commenced on the stouter and more fixed (tibia or ulna), then the other should be attacked and both should be divided at the same time, the more fixed being the later if anything. During the sawing, assistant No. 2 aids the surgeon in steadying the limb and keeping the flaps out of the way; if there is difficulty in doing this a "retractor" made of linen split from one end to the middle into two or three tails, according as the part has one or two bones, and carbolized—should be applied. Care must be taken in retracting the flaps, not to tear back the periosteum above the saw-cut; in the neighborhood of chronically inflamed joints it is easily stripped off for an inch or two. The *bone-forceps* are used to remove small spicules and projecting corners; the *lion forceps* to hold the end of the bone should an extra bit require removal—this should be done at once if the flaps seem short.

When the limb has been removed, the main and all visible vessels are tied with catgut; then the tourniquet or digital compression is relaxed and the rest are secured. General oozing (common above inflamed joints) must be checked by heat, pressure, and elevation. The wound is next brought together with stay-sutures (Fig. 144) of stout wire, or, if for any reason the covering is short, with button suture; and between these the edges are accurately brought together with a continuous horse-hair suture, apertures being left only for tubes. These should be of large size and are usually best arranged in the form of an inverted T. One goes from corner to corner of the incision, the other passes upward across the face of the bone, protruding through the centre of the incision in amputations by a long anterior flap, but through a dependent buttonhole in circular or long posterior flap operations.

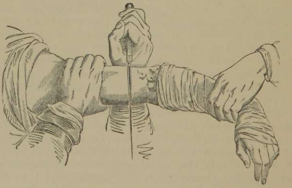
If septic sinuses are present every effort must be made, by removing their edges, scraping their surfaces, and free application of strong antiseptics, to render the wound aseptic.

The dressing may consist of the antiseptic materials preferred by the surgeon. He will obtain excellent results from iodoform, a deep dressing of gauze, applied in broad straps round and over the stump, covered by a large mass of wool firmly compressed by an ordinary bandage, over which one of elastic webbing is lightly rolled; this should not be changed unless discharge comes through and remains moist, or unless the temperature rises and remains up. Some surgeons apply a posterior splint of Gooch's material, but the above dressing acts as splint also. The stump may be laid at a convenient angle upon a pillow, to which it is well to secure it by a few turns of bandage.

There are two METHODS OF PROVIDING A COVERING for a stump: the *circular* and the *flap*; modifications and combinations of these are also practised. We shall shortly describe each method, and see how it accords with the principles above stated. It will be remembered that one and a half to two diameters of covering are required (p. 903); we can take the diameter at right angles to the proposed scar with a finger and thumb used as callipers.

THE CIRCULAR METHOD.—The skin must be stretched as tight as possible by assistants two and three to insure a clean-cut wound. The surgeon grasping the knife firmly like a sword, with the point upward and the edge toward the arm, stoops down and passes his arm well under the limb, lays the heel of the knife on it, as near to his own side as possible (Fig. 335), and

FIG. 335.



Circular amputation in middle third of arm: commencement of first incision.

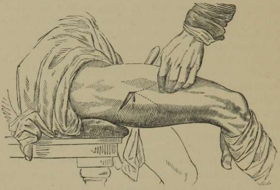
then, withdrawing his hand and rising, he makes an incision through skin, fat, and deep fascia [this usually permits easier retraction, and insures the nutrition of the flap] completely round the limb at one sweep. Assistant No. 2 now retracts the teguments, whilst the knife divides their connections with the muscles; or, if this does not answer, the surgeon, aided by the assistant, folds back the skin like a coat-cuff, until covering equal to *at least* a diameter of the limb is gained; then the knife, being put close to the edge of the folded-back skin, is made to divide the superficial muscles, which promptly retract, and then everything down to the bone by a third clean circular sweep a little higher (Amputation by a "*Triple Incision*," Hey, *Surg. Obs.*, 1814, p. 527). The next thing is to separate from the bone the periosteum and deep muscles for another inch or more by means of an elevator, and then, the soft parts being well retracted, the saw is applied and the bone divided. The second and third incisions should provide another diameter of covering. The edges are brought together in a horizontal line, or in one which slopes slightly down and out (to assist drainage); the corners stick out sharply and look ugly at first, but, as the scar contracts, they sink in, and the appearance of the stump is all that can be desired.

The circular amputation provides ample covering with the least possible shortening, supposing the skin to be sound; there is apt to be some bagging in the posterior pouch, if the wound is septic, unless a special drainage hole is made, for no dependent aperture is provided; if the second and third cuts are properly placed, the light skin-flaps are pressed by the dressing against a tolerably flat surface of muscle, just above which lies the end of the bone: the drag of the posterior upon the anterior portion of the skin is very slight, and it is not liable to displacement by muscle; and the scar, though on the face of the stump, is behind the bone, which, in almost all situations, lies toward the anterior surface of the limb. This method of amputation was found to give very good results by the German surgeons in the Franco-Prussian War, the patients being able to bear transport well and early; it is best adapted to the arm and thigh. *Disadvantages*, in addition to those just mentioned, are: that it is very wasteful when the skin is damaged upon one side of the limb only; that it requires some practice and skill to leave a smooth deep surface; that it is often impossible to retract the skin, or even to turn it back and dissect it up, in amputations for disease, and it is equally so when the size of the part increases rapidly, as between the lower and middle thirds of muscular legs, thighs, and forearms. The latter difficulties may be got over by using the combination method known as the "modified circular;" by the addition of a single lateral incision, allowing a flap like a cuff to be raised (*à la manchette*); or by the addition of two lateral incisions, thus transforming the amputation into one with equal square skin-flaps.

The FLAP METHOD may be practised in two ways: by transfixion (cutting from within out), and by dissection (cutting from without in).

The *operation by transfixion* with antero-posterior flaps is thus performed: The surgeon, standing outside a right, inside a left, limb, grasps the flesh on the anterior surface of the limb with his left hand, and lifts it as much as possible from the bone; then passes his knife horizontally through it till its point touches the bone, over which he carries the point, with a steady, uninterrupted thrust, pushes it through on the other side as far back as possible, so that its base may equal half the circumference of the limb (Fig. 336). He then carries the knife downward, close to the bone, for a certain distance, and, finally, cuts out with a rather sharp turn forward, so as to make the anterior flap squarish or spade-like, but without corners. The knife is again entered in the wound a little below the top of the first incision, passed behind the bone, brought out in the wound on the other side, and similarly cuts the posterior flap in the direction of the lower dotted line in the figure. Both flaps are now drawn back, the knife swept round the bone to divide any remaining muscular fibres, and the bone sawn through. The flaps together must make up one and a half to two diameters of covering; they vary inversely in length, and sometimes one, again the other, has to be made the longer; but, almost everywhere, the anterior should be the longer, for the

Fig. 336.



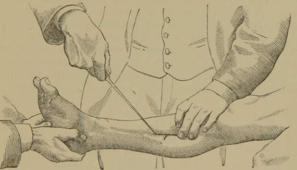
Amputation of thigh by antero-posterior flaps; the limb transfixed, the lines of flaps dotted out. It is better for the surgeon to stand outside the right limb, as he can then pinch up the anterior muscle and use his left hand generally with much greater effect.

higher the posterior flap is raised upon the surface of the stump, the greater will be its tendency to displacement, and the worse will be the natural drainage. In some situations—*e. g.*, lower third of thigh where the femur widens out, and arm—lateral flaps by transfixion are used; one might fear that the femur would project between them in front, but they rotate so here that the external becomes more or less anterior, and the internal posterior.

The sole advantage of the flap-method by transfixion is the speed with which it can be performed; but this, at the present day, is scarcely anything to its credit. It is a method which cannot be applied in some places, and is very difficult to follow in others; the bases of the flaps sometimes prove very unequal, when it is difficult to circle round the bone; vessels, especially large ones, are apt to be split longitudinally, sliced obliquely, or opened more than once; the flaps frequently turn out pointed, they are very heavy, and liable to displacement from the mass of muscle they contain (especially at back of thigh and leg), which, in muscular subjects, usually protrudes so that the skin edges can scarcely be got together over it. Owing to the large quantity of flesh on the back of the lower limb and front of the forearm, transfixion greatly tempts the surgeon to provide his principal flap from this aspect of the limb, where it will require artificial support to keep it in position, and necessitate artificial drainage. There can be no doubt that the circular method yields a much better result than the flap by transfixion.

The *flap method by dissection*, however, does away with all those objections. It is thus performed, supposing the flaps to be antero-posterior, and the anterior twice as long as the posterior. The surgeon places his left thumb and second finger on the ends of the transverse diameter of the limb at the level at which the bone is to be sawn, inserts the point of the knife through the skin just below the tip of the second finger, and carries it down in the mid lateral line for almost half the length of the anterior flap; here he makes a short notch backwards and downwards, to represent the commencement of the posterior flap; without removing its point from the wound, the knife is brought back into the original line, and carried on almost to the full length of the anterior flap; but one inch to one and a half inches above this a well-rounded corner begins (Fig. 337), and the knife is carried across the limb, at the proper level, to the mid-lateral line on the other side, a symmetrical corner being formed here; the knife now cuts up in the mid-lateral line to the thumb, and is then drawn back in the wound to near the middle of this border of the anterior flap, and rotated so as to cut another notch, corresponding to that on the other side, again to mark the posterior flap; lastly, the knife is passed beneath the limb, and, bending over to see, the surgeon places its heel in the farther of those two notches (Fig. 338), and brings the blade round under the limb into the near notch, defining a slightly convex flap. The limb should now be held up, so that the posterior flap can be raised—of skin and fat only to about one inch below its base—

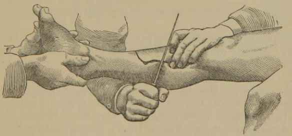
FIG. 337.



Marking out the flaps—rounding the corner: position of left hand and mode of holding knife.

then the superficial muscles should be divided by a sweep of the knife, that they may retract to the level of the saw-cut. The limb being lowered, the anterior flap is raised with light drawing cuts, the knife-edge working always towards the bone. Usually half or more of this flap may consist of skin,

FIG. 338.



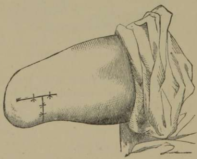
Completing the posterior flap.

fat, and fascia, but in thin, old, and feeble subjects it may be advisable earlier to cause the knife to sink into the muscle more and more deeply with successive side-to-side sweeps, and to reach the bone at a point one inch below that at which it should be sawn; then both flaps are held up, and a circular sweep is made round and down to the bone at this spot, the periosteum and deep muscles are elevated from it, and the saw is applied.

This method is slower than that by transfixion, and requires more pains and skill; in return for which the flaps are accurately shaped to meet the surgeon's views, and contain just so much muscle as he considers necessary for their support, and the skin and vessels are cut at right angles. The recent stump may be compared as to the materials of which it consists and their arrangement with that given by the circular method; but flaps by dissection have the advantages of being universally applicable, of utilizing any undamaged skin upon one side of the limb, and, when the surgeon is untrammelled, of perfect natural drainage, of flaps hanging in position almost without support, fitting well together both along the edges and deeply, and of a scar usually on the posterior aspect of the stump, the face of which is made of the skin from the extensor surface; but the surface to heal, the tendency to sloughing, and the possibility of displacement of the flaps, are somewhat greater, owing to the lateral incisions, than in the circular operation. Accordingly combinations of the flap and circular methods, securing the advantages of both, are generally practised.

Flaps may vary both in length and position, either to meet the views of the surgeon or the requirements of the case. The latter being a variable quantity cannot be dealt with exactly, but we may say that, low down in a limb, a surgeon will generally feel justified in amputating a little higher than may be absolutely necessary to get a better stump; but as the trunk is approached, especially in the thigh, he would endeavor to use one long

Fig. 339.



Teale's method applied to the lower third of the thigh.

flap, or awkwardly placed flaps, rather than amputate higher up in a more regular way; and he would not readily sacrifice a short stump of forearm which would enable the patient to execute the elbow movements in an artificial limb.

A stump may be covered by a single long flap, as in Syme's and Pirogoff's amputations at the ankle, Carden's at the knee. The originators of the flap-operation, Lowdham, of Exeter (flap by dissection, before 1678), and Vermale, of Amsterdam (by transfixion, 1696), amputated by a single posterior flap in the leg. But, as a rule, this would require amputation much higher than is really necessary. The longest stump above any given point results from amputation by the circular method, or by equal flaps; but after these, as a rule, drainage is imperfect, and the scar is usually near the bone. These defects can be remedied by making the anterior and posterior flaps stand to each other as two to one. In the lower part of the thigh, however, contraction of the long hamstrings is so great that it displaces even a skin flap; and if the proportions of the flaps are those just given, the posterior leaves the anterior, and the stump assumes somewhat the appearance of a pair of hawk's-bill forceps. In this situation, therefore, the flaps should be equal, or the posterior may be a little longer.

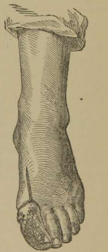
The transverse diameters of the lower limb and arm being less than the antero-posterior, lateral flaps may be shorter than antero-posterior, and may enable an amputation to be performed slightly lower; but the scar is almost necessarily over the bone. A long posterior flap is the worst that can be chosen, both as regards drainage, difficulty in keeping it in position, and suitability for pressure; but, when it is necessary to use it, the first two defects may be remedied by a drainage-hole in the flap and supporting dressing, or by turning the patient on his face. The advantages of an anterior flap—which hangs naturally in position, and which is long enough to give a dependent aperture for drainage, subsequently becoming a scar well behind the bone—have been recognized since the introduction of the amputations which bear the names of Teale and Carden. The latter concerns the knee-joint only, but the former may be applied to any part.

Rules for Teale's Operation (Figs. 339 and 356).—Begin by marking out the flaps with iodine. Take half the circumference of the limb where the bone is to be sawn; this (one and a half diameters) is the length and breadth of the anterior flap, which should be quite square. The posterior flap is exactly one-fourth the length of the anterior; the lateral lines should be so placed that the larger vessels and nerves may be contained in the posterior flap out of the way of pressure. The two lateral incisions are first made, through skin and fat; then the

Fig. 340.

Oval amputation of leg before the stump is sewn up. Sketched from one of a series of operations performed by Haynes Walton to illustrate this work.

Fig. 341.



Racquet-incision for removal of great toe and metatarsal bone.

transverse cut is made right down to the bone, and *all* soft parts are raised to the base of the flap; the posterior flap is similarly made. After a transverse cut down to the bone has divided all soft parts, the bone is sawn in the angle of the flaps. The stumps thus made (Fig. 339) were excellently adapted to bear pressure, but to this end it is necessary only to carry the scar to the posterior margin of the stump, which may be done by a much shorter anterior flap. The lower third of the leg and the region of the wrist are the seats where this method may best be practised; injury of the skin up to the patella would force a surgeon following Teale's instruction to amputate through the middle of the thigh or higher.

The OVAL METHOD (Fig. 340) is really a circular amputation, the circle being placed obliquely to the limb, so that its lower part lies over the muscles which retract most strongly. When divided in the plane of the oval down to the bones they draw up to some distance above it, leaving a posterior flap, chiefly of skin; this is retracted, the remaining soft parts round and between the bones are divided, and the bones sawn. The resulting stump is almost as bad as that by the long posterior flap by transfixion.

The *racquet-incision*, which is really an oval joined at its apex by a long cut like the handle of a racquet, is frequently applied to exarticulation at ball-and-socket or condyloid joints, and yields excellent results (Figs. 341, 343, and 348).

The *modified circular method* was invented by Syme. It enables the circular amputation to be practised where the limb is increasing rapidly in size, and does away with the projecting corners which at first spoil the appearance of the circular stump. The surgeon begins by dissecting back two short, semilunar flaps, anterior and posterior, of skin and fascia only (Fig. 356, *d*); each embraces half the circumference of the limb. These being drawn back, a circle of skin is raised till a diameter of covering or rather more is obtained, when the amputation is completed after the circular method.

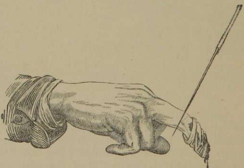
The *combined flap and circular method*. The modified circular amputation answers admirably in the thigh and arm, but is too like the circular to be free from the general objections to the latter (p. 907); these can be got rid of by making anterior and posterior skin-flaps equal to one diameter and then finishing as in the circular operation. The flaps must have the relative lengths indicated at p. 910 as necessary to insure in the different parts the full advantage of the flap method. This is the best all-round amputation.

AMPUTATIONS AND EXARTICULATIONS OF THE UPPER LIMB.

We shall now indicate the methods of operating which seem to yield the best results at different points.

For methods temporarily of controlling hemorrhage at various heights in the upper limb, see p. 355.

FIG. 342.



Amputation of the second phalanx. It should be bent to 90 degrees with the first phalanx, and the blade should be at right angles with its dorsal surface.

EXARTICULATION OF THE SECOND AND THIRD PHALANGES.—An assistant holds the hand of the patient, dorsum up, with the fingers towards the surgeon, and keeps the sound fingers out of the way. The surgeon takes the phalanx to be removed firmly between his finger and thumb and bends it to 90 degree with the phalanx next above. He then makes, with a narrow bistoury, a straight cut from side to side of the joint directly on to the head of the proximal phalanx, divides the lateral ligaments, carries the blade through the joint, close round the base of the phalanx to be removed, and makes an ample flap of the tissues on its palmar aspect.

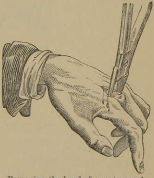
A long anterior and short posterior flap may be raised by dissection anywhere in the finger and the bone nipped through in the angle.

Exarticulation of the third phalanx is rarely required; injury either does not justify it, or requires removal higher; a necrosed phalanx after whitlow may be removed through the sinuses, after which the nail falls forward more or less on to the end of the finger. It has been objected to exarticulation of the second phalanx that the first phalanx would remain permanently extended; it does not do so, for the interossei are its flexors. Its presence adds strength to the grasp, and in the forefinger is otherwise useful; but it is not pretty.

Exarticulation at a Metacarpo-phalangeal Joint.—The hand is held as above, the sound fingers being drawn well aside and somewhat flexed. The surgeon takes the finger to be removed in his left hand, inserts the point of a bistoury in the dorsal aspect about three-quarters of an inch above the prominence of the knuckle, and makes a racquet-incision by cutting through the skin in the mid-line of the digit almost to the level of the web; a little above this an oval cut round the finger commences and occupies the lowest flexor fold in front of the joint; it is best made by carrying the knife for a short distance toward the web on the surgeon's left, then returning to the end of the straight incision to cut round the side of the finger on the surgeon's right, and as far across the palmar surface as possible, and, lastly, carrying the knife under the finger from the left side and connecting the ends of the last and first incisions. The finger is now forcibly extended, the flexor tendons cut as high as possible, the joint opened *from the front*, and the finger removed by a combination of extension, twisting, and cutting. The digital arteries are tied, a horsehair drain inserted, and the wound closed.

When it is desirable to diminish deformity, even at the expense of some utility, the head of the metacarpal bone should be cut off with bone forceps, placed—not vertical, as in Fig. 343—but sloping downward and forward, to prevent a prominence on the dorsum, and to allow the other fingers to be brought closer together, so that the loss of the digit is less noticeable. This should not be done on the hand of a laboring man, as some strength is thereby sacrificed. Care should be taken, during the after-treatment, to keep the fingers parallel, that they may not cross at the tips.

Fig. 343.

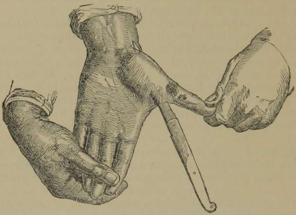


Removing the head of a metacarpal bone.

In removing the heads of the second and fifth metacarpals, the bone forceps should slope downward from the free side.

Exarticulation of the thumb with its metacarpal bone is best effected by means of a *racquet-incision*, beginning a little above the tubercle on the outer side of the base of the first metacarpal and made as above described. The anterior flap is first dissected up; then, carefully avoiding opening the metacarpo-phalangeal joint, the knife is carried down in front of and on the inner side of the bone, *cutting upon it* all the time, whilst the thumb is strongly abducted. The joint is opened from within, care being taken not to wound the radial artery, which lies close to the base of the bone.

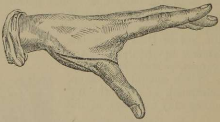
Fig. 344.



Anterior flap by transfixion.

An *anterior flap by transfixion* gives a very similar result, the chief difference being that a small strip of skin, which can be well spared, is sacrificed. The thumb being abducted, a bistoury is inserted near the metacarpo-phalangeal joint, its point is thrust between the bone and the muscles of the ball of the thumb, as close to the bone as possible, and brought out just above the articulation with the trapezium (Fig. 344). The bistoury is then made to cut its way outward, and the point of the knife is carried from its point of emergence, round the metacarpo-phalangeal joint, down the inner edge of the bone, to the point of entry of the bistoury (Fig. 345); the knife

Fig. 345.



Oval incision or result of transfixion.

now runs down the inner side of the bone and exarticulation is effected as above directed.

Exarticulation of the fifth finger with its metacarpal bone is performed by a racquet-incision starting just above the carpo-metacarpal joint, running down the ulnar edge of the dorsum of the metacarpal, and encircling the root of the finger. Everything is raised from the bone, the knife is passed down its outer side, and whilst the finger is strongly abducted the metacarpal is disarticulated from the unciform.

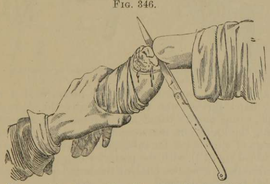
When a metacarpal bone is alone diseased it should usually be extirpated subperiosteally, through an incision from joint to joint on to its subcutaneous border, the corresponding phalanges being left. Should the phalanges prove useless, they may be removed subsequently.

It is a standard rule never to remove any more of the hand than is absolutely necessary. In cases of crush, powder explosions, and similar injuries, if enough of one digit to form a hook can be saved, it will be better than any artificial hand. With regard to the thumb and the first of the fingers, these remarks have special force. Every one-quarter inch of either is of value. In crushes and laceration from explosions no set operation is usually possible; so soon as it is evident what parts are dead they should be removed, flaps fashioned, and bones cut through with forceps as low down as possible.

Exarticulation at the Wrist.—1. The *circular*—or, preferably, *modified circular*—method gives a very good result in this situation; the length of the covering on either aspect should equal, or nearly equal, the antero-posterior diameter of the wrist, measured at a line joining the styloid processes. The tendons are cut by a circular sweep just below the styloid processes; the joint is opened by a cut across the back of the fully flexed wrist, the convexity upward of the carpus being remembered; a lateral ligament is then cut through, the knife carried across the joint, and the remaining attachments of the hand divided. Finally the styloid processes of the radius and ulna are removed with forceps, any hanging tendons cut short, and the integuments are brought together.

2. *Flaps.*—A skin flap may be raised by dissection from either the dorsal or palmar aspect of the limb: in the latter case everything down to the

Fig. 346.



Flap amputation at the wrist; cutting palmar flap from within out.

long tendons should be included that the superficial palmar arch may continue to supply the teguments, and some care is required about the pisiform bone, lest the ulnar be wounded; a short flap should, if possible, be raised on the opposite side, but is not absolutely necessary. The long tendons and joint are dealt with as above. A posterior long flap lies best in position; a *Teale's amputation* is sometimes done here. The method shown in Fig. 346 of raising a short posterior flap, opening the joint, and cutting a long anterior flap from within out, is very unsatisfactory, on account of the shape of the joint surfaces, and difficulty in avoiding the unciform process and pisiform.

The *radial* artery and, usually, its *superficial volar* branch; the continuations of the *ulnar* to the hand; and sometimes an abnormal *median* artery going with the nerve of the same name, will require ligature after this operation.

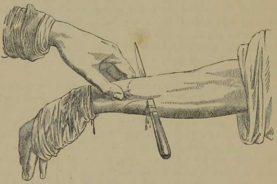
Amputation of the forearm should be performed as low as possible: it is surprisingly easy to creep up higher than was intended.

1. A *circular* amputation can be done near the wrist, but where the limb is increasing rapidly in size, a *modified circular* only is possible. More than a diameter of skin-covering should be provided and folded back, then the superficial muscles are divided and allowed to retract, and lastly, the interosseous membrane and deep muscle are divided, the knife being thrust from above and from below between the bones, and used to clean them as in Fig. 357. The soft parts may be stripped up for a little from the bones and interosseous membrane before applying the saw, but the interosseous arteries should not be cut a second time.

The *radial, ulnar*, and one or two *interosseous* arteries require tying.

2. *Flaps* should always be made by dissection; for transfixion—though it looks nice in a picture (Fig. 347)—is difficult or impossible on the back of

Fig. 347.



Amputation of forearm; formation of posterior flap by transfixion.

the forearm, and, on the front, leads to the pressure of a large mass of muscle in the flap; further, the flaps, especially the posterior, are often faulty in shape, being narrow-based and pointed, and sometimes it is impossible to bring the knife out the second time at the puncture on the far side; so a bridge of skin is left for subsequent division. The *combined flap and circular method* (p. 912), with the posterior flap the longer, is very good; but sometimes the flaps must be equal, or the anterior the longer. The deep parts are treated as above directed.

Exarticulation at the elbow is best performed by the *modified circular method*, the third incision (through the deepest muscles) being made on the level of the head of the radius; the flaps being held up and the elbow forcibly extended, the joint is opened by division of the external lateral and anterior ligaments (the obliquity, down and in, of the lower end of the humerus being remembered). Then the forearm bones are wrenched backward, the internal lateral ligament divided, the olecranon dissected out, and the forearm removed.

Some make a short posterior flap, open the joint round the olecranon, pass the knife through the articulation, and cut a long anterior flap from within out; but this is more difficult, and gives no better result than making the anterior flap by transfixion.

Amputation of the Arm.—1. The *circular* (Fig. 335) and *modified circular* methods are here seen at their best. Nothing need be added to the general description of the operation (p. 906).

2. *Antero-posterior flaps* by dissection, the anterior being the longer, or the *combined flap and circular* method (p. 912), will give a good result. In case of need the flaps (or one long flap) may be placed in any position. Antero-posterior or lateral flaps, by transfixion, are easily made, but are objectionable; the vessels should lie in the posterior or inner flap respectively.

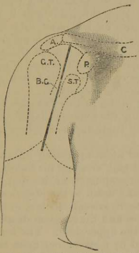
Besides the *brachial* artery, which is found in close relation to the median nerve in front and to the inner side of the bone, the *superior profunda*, found behind and to the outer side with the musculo-spiral nerve, and the *inferior profunda*, found to the inner side with the ulnar nerve, usually require ligatures.

Exarticulation at the shoulder may be performed in many ways:

1. *By the Oval or Racquet Incision.*—The patient, for all shoulder-amputations, lies, semi-recumbent, upon a low table, with the damaged shoulder projecting beyond the edge.

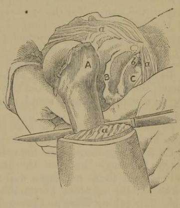
If an excision is contemplated, a straight cut, down to bone and four inches or more long, is made in the line of the limb (which is lying naturally

Fig. 348.



Excision of the shoulder by anterior incision (black line). The dotted lines below show how the excision may be converted into an amputation (Spence). A, acromion; C, clavicle; P, coracoid process; G.T. and S.T., great and small tuberosities; B.G., bicipital groove.

Fig. 349.



Exarticulation at the shoulder, showing how the vessels should be taken: A, great tuberosity; B, capsule; C, glenoid fossa; a, deltoid; b, biceps tendon. (Agatz, slightly modified.)

by the side), starting close below the clavicle, and a little outside the coracoid process; the capsule of the joint should be opened by the cut; a finger introduced should feel the bicipital groove, and, unless it is destroyed, the biceps tendon may, in some cases of injury, be drawn aside and saved. Now, rendering first one, then the other, edge of the cut in the capsule as tight as possible by hooking the left thumb beneath it, and having the humerus rotated strongly in the opposite direction, pass in a scalpel beneath the thumb and, cutting on to the bone, detach from it the capsule and the pericapsular tendons (sub-, infra-, and supra-scapularis and teres min.). The head of the bone can now be protruded and examined by carrying the elbow back, and pushing it upward. If excision is decided upon, the neck is cleared, and the head of the bone sawn off, whilst it is steadied with lion-forceps; then the capsule is sharp-spooned or dissected out with scissors when it is granulating, and the wound closed and drained—best through a posterior button-hole. But if amputation is necessary, extend the incision to six inches or more, and from its lower end carry an oblique oval skin-deep cut round the limb, thus completing a racquet incision; dissect up the skin and fat for an inch along the vertical, and for more than an inch along the oval margin; then the deltoid also is raised in the outer flap until the humerus is bared, as in Fig. 349, and is attached only by the great vessels and nerves and tissues around them. The surgeon now passes his knife through the joint, and cuts down close to the humerus till the line up to which the skin has been raised is reached; and he cuts directly inward here so soon as the assistant, whose thumbs have followed the knife, says that he has the axillary artery securely in his grasp. The vessels are now tied, the edges brought together, and a large tube introduced posteriorly.

The *advantages* of the method are that it gives ample covering and an excellent stump; the surgeon has the choice between excision and amputation, the first incision being the best known for excision; should amputation be decided upon it can be rapidly carried out, the head being already disarticulated; there is practically no bleeding up to this point, and, if without skilled assistance, the surgeon himself can, with his left hand, take the axillary in the flap. But the operation cannot be done when the head and neck of the humerus are so smashed that even with lion-forceps the rotatory movements cannot be performed, nor is it possible when the head is enlarged by new growth. In such cases we must have recourse to the following:

2. *Intero-external flaps*—formed by dissection or transfixion.

In operating by dissection some surgeons prefer in this situation to stand facing the patient and to take the arm, leaving the external flap to be raised by an assistant; others stand outside either limb and themselves take the flap.

Supposing the surgeon to take the arm and to be operating on the right side, he carries the limb inward and forward and, crossing his hands, marks out a flap beginning below the spine and the scapula near its root, passing above the angle between the arm and trunk down to the insertion of the deltoid, and there making a well-rounded turn, ascends to just outside the coracoid; the assistant everts the skin below and the surgeon dissects up a light flap, taking more and more deltoid in the upper half. The arm being now strongly adducted, the capsule is opened by a strong cut upon the head of the bone, the knife is passed between the scapula and humerus and down along the inner side of the latter for a sufficient distance; then directly inward so soon as the assistant holds the vessels securely. On the left side the outer flap is begun in front. When the surgeon takes the flap—which is, on the whole, best—he starts in front to mark out either flap, crossing his hands a little in dissecting up on the left side. This method also gives very good results; it can be applied in all cases; the wound is rather larger than after the oval method. The weight of the inner flap does not act deleteriously.

The operation by transfixion is not to be recommended, on account of the difficulty in carrying the knife sufficiently far round the prominence of the head of the humerus to get a wide-based, well-rounded, external flap, which necessarily contains all the deltoid. The completion of the operation is the same as in the last case.

Amputations and Exarticulations of the Lower Limb.

Exarticulation of the second and third phalanges is performed exactly as in the hand, but is more rarely required.

For methods of temporarily controlling hemorrhage at various heights in the lower limb, see page 355.

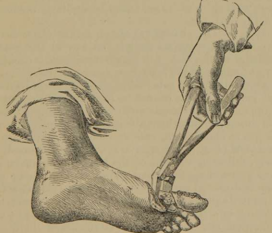
Exarticulation at a metatarso-phalangeal joint is performed by a racquet-incision as in the hand; but these joints in the foot lie much further above the web than do the corresponding joints in the hand. The rule is that the metatarso-phalangeal joint lies as much above the web as the point of the toe projects beyond it. The straight part of the incision should, therefore, begin on the dorsum, one to one and one-half inches above the web. Disarticulation is effected from below, the toe being wrenched strongly upward. The head of the metatarsal bone should not be removed if it can be avoided, width of tread being essential to stability.

In the case of the great toe, special care must be taken to provide loose covering for the large head of its metatarsal. If possible, the oval incision should not begin until the level of the web is reached. A tight scar here is a source of great trouble, and short flaps are likely to lead to very slow healing. Loss of the great toe destroys all springiness in stepping forward; loss of the head of the metatarsal causes marked lameness.

Exarticulation of several or all the toes may be required in cases of crush or of frost-bite. A transverse incision is made upon the dorsal aspect and as long a flap as possible raised here ; the tendons are divided over the joints upon which they act. Then a corresponding palmar flap is raised, the toes successively wrenched up, the joints open from below, and the toes removed one after another. The flaps are then brought together over the heads of the metatarsal bones.

Exarticulation of the great toe with its metatarsal bone may be performed through a simple racquet-incision (Fig. 341), starting a little above the

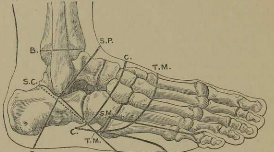
Fig. 350.



Removal of head of first metatarsal with bone-forceps. See text.

tarso-metatarsal joint on its dorsal aspect; but it is much facilitated by adding upon the inner side of the foot a vertical cut, not invading the sole, which lies over the joint between the first metatarsal and the internal cuneiform, and joins the commencement of the racquet-incision. An internal flap is thrown down, the knife being kept close to the bone; then, the toe being drawn strongly up and in, the knife is passed up along its outer side of the base, the tendon of the *peroneus longus* is divided, the joint opened, all ligaments cut, and the toe removed. The dorsal artery should not be wounded as it turns down through the first space into the sole.

FIG. 351.



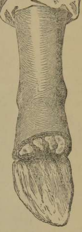
Bones and outline of a foot, showing the lines of incision for various amputations. S.M., fifth toe and metatarsal bone; T.M. and C., outlines of short dorsal flaps in the tarso-metatarsal and Chopart's amputations, each meeting T.M.C., the sole flap; S.P., the dorsal cut in Syme's and Pirogoff's amputations, of which S. and P. mark the sole flaps; B., saw-cut through the tibia and fibula in either of these amputations; and S.C., the cut through the os calcis in Pirogoff.

If possible, the base of the bone, and the attachment of the long peroneal tendon, should be preserved, the tendon being an important support of the arch of the foot. When exarticulation is not required a simple racquet-incision suffices. In dividing a metatarsal bone, the forceps or saw should be applied obliquely—not vertically as in Fig. 350—that no prominent angle shall remain upon the dorsum.

The FIFTH TOE AND ITS METATARSAL may be similarly removed: the incision is shown in Fig. 351, S.M.

EXARTICULATION OF ALL THE METATARSAL BONES (*tarso-metatarsal exarticulation*) is a dissecting-room operation, the key to the performance of which is a knowledge of the line of the tarso-metatarsal articulations. The foot is held at right angles to the leg by an assistant; the surgeon sits down facing the sole and feels for the tubercle of the fifth metatarsal and the first tarso-metatarsal joint. [If this cannot be felt it may be taken as lying one inch in front of the tubercle of the navicular bone.] Marking these two points with a finger and thumb, he sinks his knife into the margin of the foot opposite that spot which lies to his own left, cuts up along the margin to opposite the head of the metatarsal (Fig. 351, T.M., T.M.C.), then turns roundly and crosses the foot obliquely, following the line of the heads of the metatarsals; turns roundly again and cuts along the other margin of the foot up to the second point. This flap is dissected up to its base by strong side-to-side cuts which sink more and more deeply into the arch of the foot, ultimately reaching the bones. The surgeon now stands, and seizing the metatarsus in his left hand, depresses it somewhat and connects the extremities of the plantar incision by a cut across the dorsum, slightly convex toward the toes (Fig. 351, T.M., T.M.); a short flap is raised here and held out of the way, the metatarsus is strongly depressed, the tendons are divided, and the tarso-metatarsal joints are opened by a few well-directed sweeps of the knife across the dorsum—first, those of the fifth, fourth, and third toes, lying almost in line, and led to by the tubercle of the fifth metatarsal, then that of the second, one-eighth inch higher up, and, lastly, that of the first, one-quarter inch lower down (Fig. 352). But although all these joints may be gaping on the dorsum, even strong pressure may fail to separate the metatarsus from the tarsus, so stout is the interosseous ligament binding the second metatarsal to the internal cuneiform; the point of the knife must be sunk in between these bones—care being taken not to transfix the plantar flap—and as the ligament is divided, the metatarsus yields to the pressure made upon it with a loud crack. The few remaining bands are divided, the vessels secured, and the plantar flap turned up and attached to the dorsal. It will be noticed that by following the line of the heads of the metatarsals, a plantar flap has been cut which is longest on the inner side where the foot is deepest. This shape is not nearly so well obtained when the sole flap is cut from within out after disarticulation, as in Fig. 353.

Fig. 352.



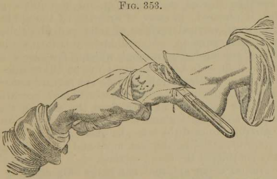
Plantar flap after Hey's or Lisfranc's operation—too pointed.

This operation is sometimes spoken of as Hey's, whilst that of sawing across the metatarsus, above the disease, which is employed in practical surgery, is called Lisfranc's: as a matter of fact, Hey performed both these operations (*Observations*, third edition, p. 552).

In cases of injury, both this and the next operation may be performed by means of a longer dorsal and shorter plantar flap.

Chopart's, or the transverse tarsal, exarticulation is performed through the transverse tarsal articulation, *i. e.*, the astragalo-navicular of the calcaneo-cuboid joints. The details of the opera-

Fig. 353.



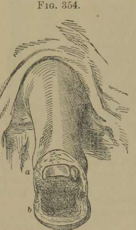
Chopart's amputation: formation of the plantar flap from within out.

tion are very like those of the last. The surgeon first marks with his finger and thumb the tubercle of the navicular and the calcaneo-cuboid point, which lies one-half inch behind the tubercle of the fifth metatarsal, and cuts a plantar flap (Fig. 351, c., t.m.c.) extending forward from rather above these points to the heads of the metatarsals; then raises a short dorsal flap (c., c.), divides the extensor tendons and ext. brev. dig., opens the astragalo-navicular and calcaneo-cuboid joints and disarticulates from above. Care must be taken not to open by mistake the ankle-joint, the synovial membrane of which extends to the neck of the astragalus. Fig. 353 represents the formation of the plantar flap from within out, which is more difficult and less satisfactory than dissection. If the heel be drawn up after this operation, as it not uncommonly is, division of the tendo Achillis may be required.

In these amputations the *dorsal artery* of the foot, and the external and internal *plantar* or *digital* branches usually require ligature.

SYME'S AMPUTATION THROUGH THE ANKLE-JOINT consists in the removal of the entire foot, the skin of the heel being preserved as the most natural covering for the stump. The surgeon first finds the tip of the external malleolus, and then marks a point exactly opposite to it, about one-half inch behind and below the inner malleolus. These points are joined by two incisions, one passing down and slightly *back* (Fig. 351, S.), and the other straight across the dorsum so as to cross the sole over the front of the posterior tubercles of the os calcis (Fig. 351, S.P.). If the first incision be placed as directed, there will be little difficulty in the next step, which is to dissect the lower flap from the os calcis. In doing this the foot is strongly flexed by the assistant, and the surgeon's left thumb-nail drags back the flap; the edge of the knife must cut always upon the bone, the point never being inserted beneath the flap to detach it quickly; this error is often responsible for sloughing of the flap, which is nourished chiefly by the calcaneal branches of the external plantar and by the posterior peroneal. The foot is then forcibly extended, the anterior incision deepened boldly into the ankle-joint, the lateral ligaments are divided, and the foot removed. The malleoli are then cleared, sawn off (Fig. 351, B.), and a piece must be cut off the tibia, if diseased; in cases of arthritis of the ankle it is well to remove also the small vertical surfaces of tibia and fibula, between which the synovial membrane runs up. A small incision is then made in the most dependent part of the heel flap, through which a few pieces of carbolized catgut are passed, their ends being brought out on either side between the flaps. These act as an efficient drain, and do not require removal.

FIG. 354.



The slightly cup-shaped heel-flap in Syme's operation.

At Guy's Hospital and many other schools Syme's operation has been modified thus: After marking out both flaps, the surgeon stands, extends the ankle strongly and disarticulates at once, then, keeping the edge of his knife turned carefully toward the bone, he dissects the os calcis out of the heel flap from above, extending the foot more and more with his left hand. This is by many considered the easier method.

Rarely an internal or an external flap is the only covering that can be obtained without going higher than the ankle.

PIROGOFF'S AMPUTATION THROUGH THE ANKLE (*modified*).—Take the same points as for Syme's operation and make a similar dorsal incision (Fig. 351, S.P.); but the plantar incision crosses the sole at the level of the tubercle of the fifth metatarsal (P.), the blade of the knife being kept during the cross-cut in the plane of the incision so as to leave a bevelled edge. The ankle-joint is now fully opened and a Butcher's saw, or one with a narrow blade and movable back, is placed behind the astragalus and made to cut its way through the os calcis in the line of the plantar incision (S.C.); the foot is thus set free. The malleoli are cleared and sawn off together with a thin slice of the tibia (B.), the heel flap is brought up and wired to the tibia—the tendo Achillis being divided if there is much tension—and the edges are united by sutures. As a rule, no drains are inserted.

A very handy method of doing this operation is described by Pirrie, of Aberdeen. After the cut across the sole, the saw is at once applied, and the os calcis divided from below in the line of this incision. The anterior cross-cut is then made a little above the ankle-joint, and the malleoli sawn off without opening it. The two wounds are then connected at their posterior corner by dividing the tendinous and ligamentous structures behind the joint. A very neat stump may be thus made very expeditiously, and with little disturbance of the parts.

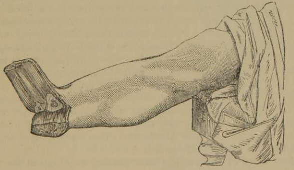
The great object in this modified Pirogoff's amputation is to make a very oblique section of the os calcis, that its sawn surface may be large, and that little twisting of the bone may be required to apply it to the tibia; the cut across the sole must, therefore, be carried at least as far forward as indicated.

Syme's and Pirogoff's (modified) amputations give the best two stumps in the body, the whole weight being often borne upon the tough skin of the heel. Pirogoff's leaves a stump little shorter than the natural limb, but a simple round boot makes Syme's stump its equal in this respect. Syme's amputation is much more frequently applicable than Pirogoff's, which is of use mainly in cases of injury of the foot; in cases of tubercular disease not affecting the astragalus an amputation through the tarsus will suffice, but when the astragalus is diseased, the probability is that the os calcis also is affected, or that it will become so if left in the flap. When the saw-cut through the os calcis is made vertically instead of obliquely, there is much tension on the tendo Achillis and consequent tendency to displacement of the os calcis when it is brought into place, and the weight is borne on the tender skin at the back of the heel instead of on the plantar surface of the heel. The greater length of Pirogoff's stump makes it the more difficult to fit an artificial foot.

Amputation of the Leg.—Almost every method of amputation has been practised in the leg.

Teale's Amputation (Fig. 355).—The lower third of the leg is the seat of election for this method; higher up it becomes too wasteful to be practised except in very unusual cases of destruction of soft parts on the posterior

Fig. 355.

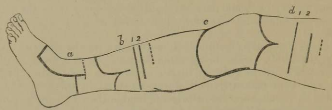


Teale's amputation (after Teale).

aspect of the limb, and the tendency of so long a flap to slough must always be considerable. The inclusion of all the soft parts in the flap reduces this danger to a minimum, but has obvious disadvantages connected with it.

The *combined flap and circular amputation* (Fig. 356, *b*) gives an equally good result as regards ability to bear weight, and is more generally applicable. Anterior and posterior skin-flaps, of length equal respectively to two-thirds and one-third of the diameter of the limb, are raised and separated from the deep parts for one-half of an inch or so above their angles of union; here the calf muscles are divided by a single sweep (1), and a little higher (2) the muscles attached to the bones and the large vessels are divided thus: the knife is thrust through from the front between the bones, close to that one which is farthest from the surgeon, and made to divide the anterior muscles by cutting against the bone nearest to the surgeon, round which it

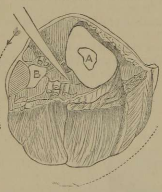
FIG. 356.



a, Teale's amputation above ankle. *b*, combined flap and circular method at middle of leg: 1, circular cut through superficial muscles; 2, through deep muscles. *c*, amputation by lateral hooded flaps through knee. *d*, modified circular amputation through lower third of thigh; 1 and 2 as in *b*. Dotted lines are saw-cuts.

circles. It is next thrust through close to this bone from behind, and made to complete the division of the posterior muscles by cutting against the bone farthest from the surgeon; as it is withdrawn it is inclined so as to divide soft parts on the posterior aspect of this bone. Lastly, the heel of the knife is placed on the far side of the most distant bone, and a circular sweep is made which divides any remaining soft parts. With an elevator the periosteum may now be raised from the bones up to the point of sawing: to facilitate this on the fibular side it is usually necessary to prolong the skin incision up to the line of amputation (Lister), the muscles and septa are here so closely adherent. The thumb-nail easily separates the muscles and vessels from the interosseous membrane (Teale), and they are quickly stripped from the tibia when the periosteum is not raised. Care must be taken not to wound again the vessels. The bones are now sawn across (p. 905). Syme usually commenced by making a short cut obliquely downward to remove the projecting corner of the tibia, and then reapplied the saw vertically over the end of the oblique cut.

FIG. 357.



Clearing the bones: the arrows show the movements of the handle of the knife when passed between the bones from the front and from behind (after Agatz).

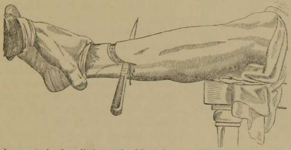
In the lower third of the leg the anterior flap must equal the diameter in length to throw the scar behind the bones.

LATERAL HOODED FLAPS were introduced by Stephen Smith, of New York, and are largely employed in America. It appears that they have also long been used at Guy's (Bryant, *Med. Chir. Trans.*, 1886, p. 163). Two short lateral skin-flaps are marked out, and, from their angle of union behind, an incision is carried up in the midline to the point at which it is intended to saw the bones. The flaps and manchett of skin are now raised until more than a diameter of covering is provided, when the amputation is finished by the circular method as above. It is said that the scar lies altogether behind the bone, that drainage is excellent, and union rapid.

Flaps may be raised by dissection from other aspects of the limb, when it is very desirable to have the stump as long as possible.

The *long posterior flap by transfixion* exhibits fully the faults of this method. It is thus performed: A very short skin flap is raised from the front of the limb, the ends of the incision lying just behind the tibia and fibula; the knife is then placed in the end of the incision near to the surgeon and thrust across behind the bones to the opposite end—care being

Fig. 358.



Amputation by a long posterior flap; limb transfixed from the outer side, the knife points inward and forward.

taken that it does not pass between the bones, which it easily may do as the fibula lies posterior to the tibia—and a flap, containing most of the muscle of the calf and long enough to cover the stump, is cut; the bones are then cleared and sawn in the angle of the flaps. The flap is often very pointed. To diminish its weight, many surgeons remove much or all of the calf muscles with scissors; this is certainly wise, but the method should never be employed except as a necessity.

The *modified circular* method may be employed when the skin is healthy all round above a certain level. The free edges of the flaps should be rather more than one diameter below where the bone is to be sawn. The later proceedings are the same as in the combined flap and circular method. The result is least satisfactory where the bones are widest from before back —viz., in the lower third of the limb.

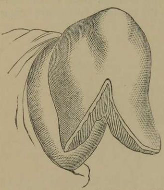
The *oval method* (Fig. 340) is even more faulty than the long posterior flap by transfixion, for the posterior flap is usually short.

In amputations one inch below the head of the fibula the *popliteal artery* only is divided; two inches below, the *ant.* and *post. tibial;* and three inches below, the *tibials* and the *peroneal*: a short distance above the ankle the peroneal divides into anterior and posterior branches.

Exarticulation at the Knee-joint.—In cases of injury requiring amputation so high, this is an excellent amputation; but for diseases of the knee it is necessary to remove the diseased cartilage as well as the inflamed synovial membrane, *i. e.*, to perform a supracondyloid amputation.

The operation is best performed by *lateral hooded flaps* (Fig. 356, *c*, S. Smith). The incision commences one inch below the tubercle of the tibia, and runs back to the mid-line behind, forming a short convex flap, and then straight up to the flexure of the knee; a similar flap is marked out on the other side, the flap over the inner condyle being somewhat fuller than that over the outer. The skin is raised, the lig. patellæ divided, and the tibia removed by cutting the capsule below the attachment to it of the semilunar cartilages. These are left on the condyles of the femur, and are of much service in preventing retraction of the flaps and keeping all the parts close together (Brinton, Bryant). The patella is left. The same advantages are claimed for this method here as in the leg; also that septic osteomyelitis is less likely, as the bone is not opened, and that the movements of the stump are very strong owing to the very slight interference with the insertion of muscles. Many surgeons experienced in the operation have seen no inconvenience arise from leaving the patella, and doing so certainly saves dissection, diminishes the wound, and preserves the attachment of the extensor; occasionally the bone is drawn up on the front of the thigh, but it is not evident that this would do any harm.

FIG. 359.



Result of amputation by lateral hooded flaps through the knee (Stephen Smith).

Pollock recommended amputation here by anterior and posterior flaps, by dissection; the former starts from the level of the tibial articular surface and reaches five inches below the patella; the latter is about half as long; both are squarish, with rounded angles. When the flaps are raised the ligamentum patellæ is divided, the joint opened, and a knife passed through it from before back, dividing the ligaments and tendons, and freeing the tibia. The patella, if healthy, is left.

A long *posterior flap* (Syme) may be made by cutting through the joint from the front, and then out some distance down the leg: the results are very bad.

Amputation through the condyles is a favorite operation, and is performed in many ways—a long anterior or long posterior flap, antero-posterior flaps, and Lister's modified circular method.

The *long anterior flap* was introduced by Carden, of Worcester, and, like Teale's amputation, is historically important as marking the recognition of the value of this covering. Carden cut straight out behind, and obtained some excellent results; but a considerable posterior flap is required in this situation, because of the tendency of a single anterior flap to slough, of the frequent impossibility of obtaining so long a flap, and of the very great tendency of the skin on the posterior aspect of the thigh to retract. Amputation by suitable *antero-posterior* flaps gives good results, and may occasionally be practised when Lister's still better method cannot. In these operations some surgeons remove the patella, others preserve it either intact or deprived of its cartilage, according to the recommendation of Gritti; in the latter case it is hoped that the bone will unite with the cut surface of the femur, to which it might nowadays be wired or pinned.

Lister's *modified circular* amputation is thus performed: A cut is made straight across the front of the limb at the level of the tubercle of the tibia, and the ends of this incision are joined by sweeping the knife, inclined at an angle of forty-five degrees to the axis of the leg, across the back of the limb, and thus forming a very short posterior skin-flap. The limb is now held up, this flap is dissected up, and then the whole circle of skin and subcutaneous tissue is raised as in a circular amputation. The hamstring tendons are cut so soon as they are seen, for they retract greatly, and, if divided later, would shrink up far above the level of the same surface of bone, behind which there would then be an empty space. Next, by half bending the knee, the upper border of the patella is brought down below the fold of skin. A cut is made into the joint above it, the lower end of the femur cleared at the level of the upper margin of the patellar articular surface, the saw applied vertical to the shaft and parallel to the lower articular surface of the femur, and the condyles removed. When the joint is much swollen from arthritis, the circular covering cannot be stripped up, and one or two lateral incisions must be made; and in these cases the leg may be removed so soon as a knife can pass above the tibia, the patella being dissected out later, and the end of the femur and the synovial membrane removed. The advantages of this operation are: ample covering with the least sacrifice of length of limb, little tendency to slough owing to the form of the flap, and a stump capable of bearing a good deal of weight, the skin over the knee being accustomed to pressure.

In all amputations through the knee or condyles, a large tube should be placed in the suprapatellar pouch and brought out in the wound; suppuration may necessitate a counter-opening into the pouch.

AMPUTATIONS OF THE THIGH.—Here, again, most methods may be employed. Formerly, *flaps by transfixion* (Fig. 336) were usually made—lateral in the lower third, where they always rotate considerably, and antero-posterior higher up, the posterior being the longer, to allow of the excessive retraction in this aspect, which was, of course, much exaggerated by cutting the muscles long in the flap. Teale's amputation (Fig. 339) is much too wasteful to be practised here. Much better results are given by the *combined flap and circular* method, or by the *modified circular* (Fig. 356, *d*), which, owing to the position of the femur in the limb, leaves a scar well behind the bone; in no situation is the latter operation practised with better results. It is well to remember as a rule here, that the posterior flap should, if possible, be as long as, or even slightly in excess of, the anterior, and should contain no muscle below the first sweep through the superficial muscles.

EXARTICULATION AT THE HIP has been performed for laceration of the soft parts of the thigh and compound fractures of the shaft and neck of the femur when no lower amputation is possible; extensive necrosis of the upper part of the shaft of the femur, or for disease of the hip-joint when excision has failed to relieve and the patient is sinking; for sarcoma extending so high that recurrence after lower amputation is likely, or for recurrent sarcoma of a stump; rarely, for painful or diseased stump, after amputation high up.

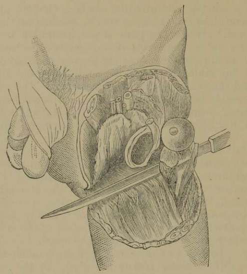
Though still high, the mortality after this operation has been sinking decidedly of late years, chiefly on account of the better arrest of bleeding, the saving of the blood in the limb, and the employment of better methods of amputation by which prevention of sepsis and diminution of shock are possible. As a primary or intermediate procedure it is very fatal—90–95 per cent. of the cases dying; after secondary operations, about 70 per cent. die; whilst after operations for disease, only 42 per cent. die.

Hemorrhage may be controlled by any of the methods given at p. 357, by a finger on the external iliac above Poupart's ligament, or by simply taking the femoral in the flap before it is cut through and quickly clamping smaller vessels.

(1) ANTERO-POSTERIOR FLAP BY TRANSFIXION.—This was the operation usually performed up to a few years ago, when Furneaux Jordon advocated the use of a racquet-incision (*see* below).

The patient's hips are brought to the edge of the table, the sound limb fastened to a leg, the trunk held on the table, and the scrotum raised out of the way of the knife. The thigh having been slightly bent and abducted, to amputate the left limb the knife is entered between the upper and middle

FIG. 360.



Exarticulation at hip by transfixion; anterior flap cut and raised, head disarticulated, knife passed behind bone to cut posterior flap.

thirds of a line drawn from the anterior superior spine of the ileum to the great trochanter, and pushed obliquely inward and downward across the capsule of the joint to a point about two inches below the tuberosity of the ischium; on the right side the knife is entered below the ischium and brought out below the iliac spine. A large anterior flap is made, about six or seven inches long, in which the femoral is firmly grasped by an assistant before the cut outward is made; when completed, the flap is drawn well up. The anterior part of the capsular ligament, already laid bare, is then divided by a strong cut on to the head of the bone rendered prominent by forcible extension and rotation out of the limb; the head is forced out, the *ligamentum teres* cut through, and the disarticulation completed. The knife is then carried through the joint over the trochanter (Fig. 360), the muscles attached to which have been divided, and, the hip being somewhat flexed once the knife is behind the bone, the posterior flap is made somewhat small and thin, by cutting from within out.

(2) The *racquet-incision* was adapted to this operation by Furneaux Jordan (*Lancet*, 1879, vol. i. p. 405), who points out that the cut surface is less extensive than after amputation by transfixion, and the nerves are cut further from the trunk; therefore union should be more rapid and shock less. But this method has the advantages also that the wound can without difficulty be kept aseptic and that the operation can be done subperiosteally; moreover, there is not the slightest use for hurry on the score of hemorrhage, for the only difficulty in the operation—getting the head out of the socket—is surmounted before any vessel of importance is cut, and the femoral vessels can be taken in the flap by an assistant, or even by the surgeon, before they are cut.

Marcus Beck, after much experience in this class of operative surgery at

University College, teaches as follows: The patient is placed upon his sound side with his hips at the edge of the table; the sound hip is fully flexed and kept so by a bandage passing from above the knee round the neck; another bandage from the knee to an upper leg of the table keeps the patient from slipping down. The limb to be removed is grasped above the knee by an assistant and held slightly adducted. Starting about one and a half inch above the trochanter, the surgeon sinks a six-inch knife into the bone and cuts downward on to the trochanter and shaft of the femur to a point six or seven inches below the trochanter; then a rather sharp turn is made, and an oval incision sloping slightly down and in it is begun—first away from the surgeon, then towards him—and completed by a sweep under the limb. The skin, fat, and fascia should now be dissected up for three inches or so. Next, the surgeon pushes his thumb into the cleft in the muscles above the trochanter, and putting them on the stretch, he cuts them away from the bone—first on one side, and then on the other, the separation on the posterior aspect being very free and carried low down on the shaft. The limb is now strongly adducted and the surgeon makes a strong cut in the line of the original incision into the joint, opens it and divides the capsule posteriorly, when further adduction and an upward push by the assistant, who places one hand high up inside the thigh, dislocates the head; the round ligament and anterior portion of the capsule are then divided. The surgeon now passes his knife over the head of the bone, which the assistant drags out of the way, cuts down close to the bone to a little above the line up to which the skin has been reflected, and the femoral vessels having been compressed in the flap by an assistant, the soft parts on the inner side are divided from within out, whilst the thigh is brought to the straight position from one of extreme adduction. The vessels are then secured, the lower end of the stump sewn up *quite close*, and all drainage arranged for from the outer side.

When this operation is done for disease, it is often wise to raise the periosteum from the bone through the first straight incision; by so doing a rod of bone may form in the stump sufficient to afford insertion to the muscles, and to enable the patient to use an artificial limb.

The duties of the assistant holding the limb in both the above operations are very important, and, unless he understands and discharges them intelligently, the difficulties are much increased, as is the case also when the bone is broken and the leverage of the femur lost; the head and fragments must then be separately seized with lion- (Fig. 333) or sequestrum- (Fig. 366) forceps and dissected out.

Affections of Stumps.

Retraction of the flaps and protrusion of the bone may occur from the flaps having been cut too short and brought together with extensive tension or from any cause which long prevents deep union and permits the elasticity and contractility of the tissues to act unopposed. Original shortness, evident at the operation, should usually be remedied at once by removal of a bit more bone; but when it is intentional, to get as far away as possible from a morbid growth, button-sutures should be inserted in sufficient number to render the edges free from tension. With antiseptics and uniform support rapid healing may thus be obtained. If not, the tendency to retract must be met by weight-extension applied to a loop of strapping fixed to the flaps or by the re-insertion of button-sutures; which failing, removal of more bone is necessary.

Necrosis.—Delay in healing is due usually to some necrosis of the end of the bone. Death of a mere scale will keep open a sinus for weeks or months; in the case of the shaft of the femur, a complete ring not uncommonly separates containing the whole thickness of the bone below but consisting above of longer or shorter spicules derived chiefly from the inner layers. Perhaps some small sequestra are due to the mechanical injury done to the bone; they are said to be more common after use of the saw than of the bone forceps. But the great majority are caused by a local septic traumatic osteomyelitis.

Diffuse septic traumatic osteomyelitis is a very fatal affection, leading frequently to pyæmia (*see* p. 281).

Conical Stump.—Most stumps become more or less conical in shape from wasting of their muscles; but a "conical stump" is one in which, owing to original shortness or retraction of the flaps, union has only just managed to occur—the stump is conical from the first, the apex being formed by the bone covered by a thin red adherent cicatrix, constantly liable to ulcerate and unable to bear the least pressure or friction.

The remedy is simple; the bone must be shortened either by a longitudinal incision over it on the side opposite the vessels, and sawing off a sufficient piece, removing also any ulcerated portion of the cicatrix; or if the projection be considerable, and the integuments generally very thin, by amputation higher, removing the entire end of the stump.

Neuralgia of a stump sometimes arises because the truncated extremities of the nerves (which after amputation always become more or less bulbous) are too long and adhere to the cicatrix, so as to be subject to constant compression and extension. Sometimes it is independent of any morbid state of the extremities of the nerves, but arises from some ascending neuritis (*q. v.*). In many such cases, however, no local cause is detectable, and the pain is evidently connected with an hysterical condition. The symptoms are extreme irritability and tenderness, paroxysms of violent neuralgic pain, and spasms and twitchings of the muscles. If there be pain excited only by pressure upon one tender spot, where perhaps a bulbous nerve-end may be felt, excision of this part of the scar will probably cure. If the stump be conical treat as above directed. But when the pain and tenderness are diffuse, largely cutaneous, and characterized by the peculiarities of neuralgia or hysteria, the treatment must be general; painting with lin. aconiti, Scott's ointment worn as a plaster, emplast. plumbi, or belladonnæ may relieve. Re-amputation or nerve-stretching is useless in these cases.

CHAPTER LV.

EXCISION OF BONES AND JOINTS.

I. Excision of bones may be required for injury, necrosis, caries, or tumor. There is probably no bone in the body of which *portions* have not been removed for the above reasons, but complete removal is much less common. When small bones are shattered by injury their fragments may be picked out, any periosteum recognized being spared. Acute necrosis occasionally leads to death of the whole shaft of the long limb-bones, which will require early or late removal (*sequestrotomy*, p. 285), when the joints at either end are unaffected; but secondary suppuration of a large joint necessitates amputation. Caries of bones of the carpus and tarsus sometimes justifies their sub-periosteal excision, but the tendency to recurrence of the disease is so great that the operation is not very often practised; some excellent results have, however, been obtained by excising even large portions of the tarsus. Malignant tumors have rendered necessary the removal of the clavicle and scapula, also partial removal of cranial bones, ribs, and pelvic bones; but malignant growths of the limb bones are best treated by amputation at the joint above; or, in the case of the femur, sufficiently high to be well beyond the disease. Removal of tarsal bones—*e. g.*, astragalus or cuboid—is sometimes undertaken to relieve deformity (p. 494).

REMOVAL OF THE CLAVICLE for tumor has rarely been performed, and has given rise to the greatest difficulty on account of hemorrhage, and the importance of its posterior relations. A free incision along and extending beyond the end of the bone, and another at right angles to this will be required; the skin-flaps must be raised, and if a bit of the bone near either end is free from growth, saw through it, and start thence to separate the growth from the great vessels and nerves; otherwise disarticulation at the outer end must be effected. Clamp-forceps would be constantly required, and the operation would probably afford an opportunity of carrying out Treves's excellent suggestion for the treatment of air entering veins—*i. e.*, immediately the noise characteristic of this is heard, to fill the wound with boracic lotion from a sponge kept ready in case of need. This saves all delay in seeking for the veins at fault, and the vessel will soon be revealed by the escape of bubbles from it, which could not happen if the vein were compressed.

The SCAPULA may be excised through a ⊢-shaped incision along its spine and vertebral border, extending somewhat beyond these points; the flaps being raised, the acromion is sawn through and left (if it is not dangerous to leave it) that the prominence of the shoulder may be preserved, or disarticulated, or the outer end of the clavicle also is removed; then the trapezius, deltoid, omohyoid, levator anguli, and rhomboids are divided near their attachments—together with the suprascapular vessels and nerve, and the posterior scapular vessels—the vertebral border is dragged from the thorax, and the serratus divided close to the posterior margin, a hand passed between it and the sub-scapularis, and the bone drawn so far out that the coracoid process may be sawn through, or the muscles detached from it; the knife now divides the supra- and infra-spinatus and teres minor muscles, either clearing the neck of the bone (if the glenoid cavity can be safely left), or opening the shoulder-joint. The upper edge can now be drawn strongly from the body, when the knife must be made rapidly to divide the subscapularis and teres major, probably the upper edge of the latissimus, and numerous branches of the subscapular vessels. The nearer the knife can be kept to the bone the less chance of wounding the main trunk of the subscapular. Bleeding may be checked by digital pressure on the subclavian from the upper end of the wound.

Sometimes the extent of the tumor necessitates removal of the arm with the scapula; or, when a tumor of the scapula is fungating largely, the only way to obtain covering after its removal may be to amputate the arm, using its soft parts to lay on the thorax. The mortality after these serious operations has been unexpectedly slight. When the arm is preserved, especially if the neck of the scapula is cut through, it is usually a useful member.

The COCCYX has been excised through a longitudinal incision when subcutaneous division of all the structures round it has failed to relieve the pain of *coccydynia*.

II. Excision of Joints. Indications.—(1) Wound with splintering of the bones, the damage not being so extensive but that the limb, after removal of the fragments, will be useful (pp. 191, 292, and 294). (2) Septic suppurative arthritis following on wound, uncontrolled by free drainage, fixation, and antiseptic treatment. In these cases, when possible, the intermediary period should be tided over, if it has been thoroughly established before the patient is seen—secondary resections yielding a better result. (3) Tubercular arthritis not improving under treatment, or suppurating: there is still much difference of opinion on this subject (*see* p. 325). (4) Faulty ankylosis and old dislocations greatly impairing the use of the limb; the propriety of excision in these cases varies with the need of the patient for improved movement, his general health and age, the mortality and results as regards movement of the excision in question.

Excision or Amputation?—In deciding between these we must consider:

(1) The *state of the joint:* If the disease or injury be so extensive that union is unlikely, or removal of the damaged parts would leave the limb useless, amputation must be done. With regard to length and strength these are of most importance in the lower limb—firmness as a prop being indeed essential here; in the upper limb the preservation of the hand and its movements is all important.

(2) The *general state:* Patients of highly tubercular nature, and especially such as are actually suffering from phthisis, are very bad subjects for excision.

(3) *Age:* The removal of epiphyses in young children necessarily leads to extreme dwarfing of the limb, whilst after middle age repair after excisions for joint-disease is very imperfect. Most surgeons hold that excisions in the lower limb—except the hip—should not be done after thirty (though Gant and others have had successes even as late as fifty), but in the upper limb they may be practised later, other things being favorable.

(4) The relative mortality and results as regards usefulness of excision and the alternative amputation must be borne in mind.

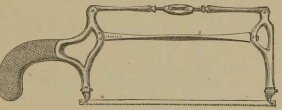
(5) The possibility of keeping the joint aseptic is very important.

General Points.—(*a*) The *incisions* should be so planned as to give free access to the joint without injuring important ligaments, muscles, etc.; when in aseptic cases this cannot be avoided, tendons, bones, and nerves cut across must be carefully sutured. (*b*) In cases of tubercular disease great care should be taken to remove with knife, forceps, and scissors, sharp spoon or gouge as much as possible of the granulating synovial membrane and all foci from the bone-end. As a rule, partial excisions are to be avoided: the surgeon must exercise his discretion whether or not to remove a whole articulation for very limited disease, but recurrence is frequent after partial operations. (*c*) In cases of injury all periosteum should be carefully preserved, as also the capsule the connection of which with the periosteum should not be destroyed; but in cases of disease, at least in the upper limb, where movement is more important than strength, many surgeons regard the subperiosteal method as giving a poor result—the bone formed from the raised periosteum being sometimes so massive, rough, and mis-shapen, as actually to limit the movement of the joint about which it is thrown out, whilst removal of the periosteum usually gives a satisfactory result. (*d*) Every effort should be made to render the part aseptic and to obtain early healing of the skin-wound. (*e*) In the lower limb the most perfect fixation is desirable, but in the upper all the movements of the joint should be practised from an early date—passively at first, then actively also—and regular massage of the muscles should be performed that atrophy may be combated. Both must be continued for weeks. Faradization also may be used.

Results.—The excision may effect all that could be expected, or it may be only partially successful owing to deformity in cases where bony union should have, and has, been effected, or to stiffness owing to extensive adhesions where motion is desired. Failure may be due to continuance of the disease; or, in traumatic cases, to spread of septic inflammation, extensive suppuration of the soft parts, caries of the bone-ends, non-union and hectic. In these cases the choice between reëxcision and amputation must be made, and depends chiefly on the lengths of bone removed at the first operation, and the extent of the recurrent disease. Again, the wound may heal and a "flail-joint" result: this is especially common in excisions for injury, and is usually a consequence of too free removal of bone, destruction of the bone-forming power of the periosteum by free suppuration, imperfect fixation in the lower limb, excessive use of passive movement in the upper, or extreme atrophy of the patient's muscles. In some of these cases preservation of the periosteum would probably have led to a different result, but we have no means of selecting the cases of disease in which it is necessary; the periosteum should be preserved in all traumatic cases. Lastly, bony ankylosis may ensue, when a movable joint is desired: forcible movement under chloroform should then be tried, but should it fail the joint must be fixed in that position in which it will be most useful.

Instruments for Excisions.—In addition to those mentioned at p. 840, a specially stout and large scalpel in a strong handle, elevators, lion-forceps (Fig. 333), cutting bone-forceps—straight, elbowed, and curved—gouges, and a resection saw: either Butcher's (Fig. 361), of which the blade can be

Fig. 361.

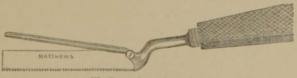


Butcher's saw for excision.

set at any angle, and is narrow enough to cut in a curve, and which consequently must be handled with some skill to make it cut in one plane; or a short, broad, stiff-backed amputation saw which is used especially for the knee. In many cases a narrow saw with a movable back (Fig. 362) is useful. Two copper retractors and blunt hooks should be ready.

It is always well to render the limb bloodless; and in cases of excision for

Fig. 362.



Wood's crank-saw for excision.

disease it is very important to remove all tubercular and septic granulation-tissue, afterward applying 1 in 20 carbolic, or 1 in 500 sublimate, lotion.

To avoid removing long pieces of bone the solid shell beneath the periosteum may sometimes be completely scooped out.

Excisions for injury consist usually in picking and dragging out, through an enlarged wound, splinters of bone, and in protruding and rounding-off the ends of the bones; they admit of no formal description. The following operations serve as guides in the treatment of injuries but have been planned for cases of disease.

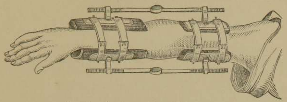
Excision of Special Joints.

Excision of the Shoulder.—The *straight anterior incision* described and figured at p. 917, and about four inches long, is by far the best. This is in the line of the long head of the biceps, which should be preserved if it be not destroyed by disease. The whole of the diseased head should be removed with a small saw; but no more should be taken away than is necessary, as such important muscles are attached close to the head. If the tuberosities must be removed, preserve the capsule and periosteum. The glenoid fossa rarely requires the application of the gouge; when it does the prognosis is usually bad. The synovial membrane should be removed with a sharp-spoon, sublimate lotion 1 in 500 applied, and then iodoform rubbed freely; a large tube is brought out through an opening in the skin and deltoid behind (*above* the circumflex vessels and nerves), and the anterior wound is closed carefully. No splint is required: a good pad of antiseptic wool in the axilla as part of the dressing, and a bandage fixing the arm until healing is fairly established, are all that is necessary. Then passive movement and massage must be regularly practised. As a rule, the arm, after excision of the head of the humerus, cannot be raised above a horizontal line, but all other movements should be present and strong.

Excision of the Elbow.—The patient lies on his back, and the arm is held—with the elbow somewhat bent and the olecranon pointing as nearly upward as possible—by two assistants, one of whom grasps the upper, the other the forearm. A straight longitudinal incision, five or six inches long, is made a little inside the centre of the back of the joint, starting three inches above the olecranon and sinking at once into the bone, then running down over the olecranon and along the subcutaneous border of the ulnar.

If it is intended to preserve the periosteum, this membrane is now elevated together with the tendinous insertion of the triceps and muscular fibres arising from the process; but if the periosteum is not to be saved these parts are shaved off as close as possible to the bone. By traction with the left thumb placed in the cut above the olecranon, by keeping the edge of the scalpel constantly turned toward bone, and by varying the amount of flexion of the joint, it is easy to raise all the soft parts first on one side and then on the other as far as the epicondyles; on the inner side the ulnar nerve will be raised with all care from its groove behind the inner condyle, and on the outer equal care must be taken not to injure the prolongation from the tendon of the triceps to the fascia over the anconeus, which is the chief connection left between the extensor muscle and the forearm bones. The joint is now flexed and the base of the olecranon, having been deeply notched with a saw, is cut through with bone-forceps and the process is removed. Forced flexion till arm and forearm are parallel and a touch or two of the knife on the lateral ligaments cause the joint to gape and permits examination of the bone-ends. Now cause the humerus to protrude by drawing the forearm down, seize it with the lion-forceps, clear it for the saw by a sweep or two of the knife, and remove as much as is necessary. The two epicondyles should be left if possible; the portion between them may be cut out into the shape of a horse-shoe. Then the coronoid process and head of the radius are similarly removed, one after the other: the orbicular ligament being spared if possible. The wound is drained and accurately brought together, and the joint, in a position of moderate flexion, is wrapped in a large wool dressing, round which an elastic bandage is lightly coiled. The

FIG. 363.

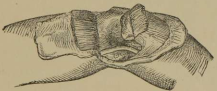


Heath's splint for excision of the elbow.

limb may be simply laid on a pillow: no splint is required unless the dressing just described is insufficient to prevent lateral displacement of the bones; this is most likely to occur after excision for injury. When required, a simple angular splint often, jointed at the elbow, is as good as any. C. Heath's splint (Fig. 363) acts well, but the clamps beneath the dressing open an easy way for sepsis. Very gentle passive movement and shampooing should be begun at the end of the first week when all goes well, and the patient must be encouraged to use his muscles as early as possible; but when a flail-joint is likely, absolute fixation at a right angle must be maintained until tolerably firm union is established.

Many other incisions have been employed, especially ⊢ and H cuts: they are now rarely used in much swollen joints to give room. But cross cuts should never extend deeper than the skin; the elbow opened by the old H

FIG. 364.



Excision of elbow by H-cut; all soft parts divided.

incision is shown in Fig. 364, and, the *triceps* being cut across, complete loss of extension-power should not cause surprise.

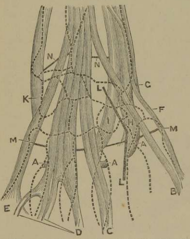
Hüter, from an experience of about forty cases, strongly recommends the following operation: A longitudinal cut two centimetres long is made on to the inner epicondyle rather toward its flexor aspect, and through it the common tendon and int. lat. ligament are divided close to the bone or elevated with the periosteum. Next an incision, eight to ten centimetres long, is made on to the external epicondyle and most superficial part of the head of the radius. The ext. lat. ligament is divided, the soft parts separated from the front and back of the head of the radius, which is at once removed with a fine saw or bone-forceps. There is now room to introduce the forefinger into the joint, to stretch the capsule and strip it from the front and back of the humerus with an elevator or probe-pointed knife. If the forearm is drawn over to the ulnar side the humerus protrudes easily through the long radial wound, leaving the ulnar nerve, which has not been touched, upon the ulnar side; the end of the bone is to be sawn off. The olecranon can then be shelled out of its coverings with perfect ease and removed. In this way the triceps and its attachments to the forearm are less interfered with than by the longitudinal incision, the ulnar nerve can scarcely be injured, and Hüter says the restoration of function is more complete; he had met with no failure in civil practice. He gives no caution about the posterior interosseous nerve, which is obviously endangered, as it winds back through the supinator brevis below the head of the radius, by his long radial incision.

The long wound is closed accurately, whilst the inner affords perfect down-drainage.

Excision of the Wrist.—This was the latest of the resection operations to yield a good result. The operation now almost invariably performed is that introduced by Sir J. Lister (*Lancet*, April 1, 1845), which was planned in accordance with the view that the *whole* synovial membrane must be removed, whilst the numerous tendons must be interfered with as little as possible.

The first step is to break down any existing adhesions in the wrist or finger tendons. An incision (Fig. 365, LL) is made down to bone from about the middle of the dorsal aspect of the radius, on a level with the styloid process, down and out to the radial side of the base of the second metacarpal, and thence along the radial border of this bone for half its length. The first part of this cut should lie parallel and a little internal to the ext. sec. inter. nod. poll. (B) and necessarily divides the tendon of the ext. carp. rad. brev. (I). With an elevator the soft parts on the radial side of the incision are now raised, the ext. carp. rad. long. (H) being first detached from its insertion. The radial artery and the thumb tendons being drawn out by a small retractor, the trapezium is separated from the rest of the carpus with bone-forceps placed in the lower part of the wound; then the wrist is extended, and the tendons on the dorsal surface of the hand are separated from the carpus—but not from the radius and ulna—as far toward the ulnar side as possibly. Now, supinating the hand, make an incision on the palmar side of the posterior edge of the ulnar, starting two inches above the joint and running half-way down the fifth metacarpal, keeping toward the palmar aspect. First complete the raising of the dorsal tendons, detaching the ext. carp. uln. (K) from the base of the fifth metacarpal. The soft parts on the front of the wrist are now to be raised, an elevator being used and kept close to the bones; the pisiform bone and unciform process must be separated with bone-forceps from the rest of the carpus, and then, the wrist being flexed, the mass of tendons can be raised. The carpus (except the trapezium and pisiform) can now be separated with

Fig. 365.



The radial cut and parts concerned in Lister's excision of the wrist: A, radial artery and deep arch; B, ext. sec. internod. poll.; C, ext. indicis; D, dig. ext. comm.; E, ext. min. dig; F, ext. prim. internod. poll; G. ext. oss. met poll; H and I, ext. carp. rad. long. and brev.; K, ext. carp. ulnaris; LL, line of radial cut; MM shows amount of metacarpus to be removed; and NN the amount of radius and ulna. (Lister, slightly modified.)

bone-forceps from the radius and metacarpus and extracted with sequestrum-forceps (Fig. 366). The radius and ulna can now be protruded from the ulnar incision and their diseased surfaces removed; it is a great advantage when the styloid process can be preserved by the oblique cut shown (N), for

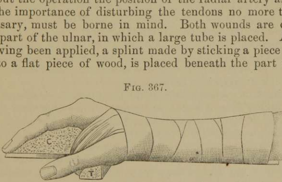
FIG. 366.

Sequestrum-forceps.

when it is removed the hand tends to fall to the ulnar side; all synovial membrane and cartilage from between the ulna and radius must be removed with a chisel and spoon. The bases of the four inner metacarpals are similarly protruded from the ulnar and radial wounds and removed—the position of the deep arch being remembered. There being now plenty of room, the trapezium is seized and dissected out, care being taken not to cut either the radial artery or the flex. carp. rad. tendon in the groove on its anterior surface; then the base of the first metacarpal is protruded and its cartilage removed. Lastly, the unciform process may be dissected out, and the pisiform bone cleared of cartilage or removed according to its state.

Throughout the operation the position of the radial artery and deep arch (AA), and the importance of disturbing the tendons no more than is absolutely necessary, must be borne in mind. Both wounds are closed except the central part of the ulnar, in which a large tube is placed. An antiseptic dressing having been applied, a splint made by sticking a piece of cork (Fig. 367, C) on to a flat piece of wood, is placed beneath the part so as to keep

FIG. 367.



Hand fixed upon Lister's splint for excision of wrist. (Lister.)

the fingers semi-fixed, and thus enable the surgeon to break down adhesions forming in the flexor sheaths—which he could not do were the fingers kept extended. The thumb tends to drop into the palm and is supported by a bar of cork (T), whilst a pad of gauze keeps it out from the forefinger.

The *after-treatment* is most important. The object is to get full movement of the fingers and firm fibrous union between the metacarpals and forearm bones. The wrist is, therefore, kept as fixed as possible until distinct union is established; then all the movements of the wrist are regularly gone through. But from the second day the fingers and thumb are to be fully flexed and extended at every joint. Passive movement must be continued until the patient's muscles can prevent the formation of adhesions. A splint must be worn so long as the wrist is weak, and often a hollow one supporting the ulnar border of the hand is best, as the hand tends to fall that way.

Excision of the hip may be performed through variously placed incisions. Langenbeck's posterior and Hüter's anterior incisions are usually employed.

For the *posterior incision* the patient is turned on to the sound side; the surgeon stands behind, and an assistant in front holds the slightly flexed diseased limb above the knee with one hand and the flexed leg with the other, using the latter as a lever in rotatory movements. The incision begins at right angles to the surface midway between the crest of the ileum and the top of the great trochanter, sinks in at once to bone (which should be the head of the femur) and runs downward—curving round parallel to, and keeping its distance from, the trochanter—until it is four or five inches long. The hip is now flexed, strongly rotated in and pushed up, and with the help of a stroke or two of the knife upon the capsule at the bottom of the wound, the head is dislocated, makes its appearance in the wound, and can be sawn off. Some surgeons, believing that the trochanter obstructs drainage, always cut the muscles from it, and saw through the bone above the trochanter minor; but perfect drainage can be obtained without this, and the major process (if healthy) should be left. Sayre is one of those who always remove it. After the above incision, he pulls outward the flap exposing the trochanter, divides the periosteum horizontally below it as far round as possible, and elevates it and the muscles from the process; he then opens the joint freely, tilts out the head, which completes the stripping-off of the periosteum, and saws through below the trochanter major. He says that he thus gets a longer limb, and showed a specimen at the Congress of 1881 in which a distinct neck had been reproduced. After the ordinary excision the femur usually rises until the trochanter minor rests like the head in the acetabulum; so preservation of the trochanter major does not increase the length (but it does the strength) of the limb. Through the above incision sequestra can be easily removed from the acetabulum, and extensive resections of the hip-bone have occasionally been performed through it.

When the head of the femur is dislocated and lies on the dorsum ilii, an incision parallel to the fibres of the gluteus max. may be made directly upon it. In these and other cases Gowan's osteotome enables the head to be removed through a very short incision.

For the ANTERIOR INCISION the patient lies upon his back and an incision three to five inches long is begun at a point midway between the ant. sup. spine and the tip of the trochanter maj., and carried downward and a little forward parallel, and somewhat external, to the sartorius. The cut falls between the edges of this muscle and the tensor vag. fem. and gluteus medius; these are separated, and the bone reached just where the fibres of the vastus ext. are rising from the root of the trochanter and anterior trochanteric line. An incision parallel to the neck of the femur is made through the capsule and these fibres, and an elevator levers the soft parts from the bone above and below the cut. A finger can now be introduced; it guides a narrow saw to the neck of the femur, and this is divided at right angles to its long axis, seized with bone-forceps, and twisted out. The trochanter can be removed easily from this incision if necessary. Perfect drainage may be established through a puncture made upon bow-forceps pushed from the back of the joint through the tissues of the buttock. It is said to be difficult to reach the acetabulum through this incision, and it is not suitable for cases of dorsal dislocation.

As hip-abscesses most frequently point in front of the tensor vag. fem. (p. 343), the incision necessary to open them leads directly to the junction of the neck and shaft.

After excision of the hip simple weight-extension, with sand-bags on either side of the limb, usually acts well. Long splints, and Hamilton's splints, simple and bracketed, are used; but if one is required, the best is the modification of Thomas's double hip-splint for cases complicated with sinuses (p. 345). Both limbs may be fixed to it with plaster of Paris.

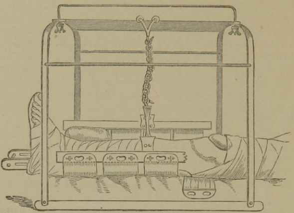
For the *results* of excision of the hip for disease, see p. 348.

EXCISION OF THE KNEE.—The incision ordinarily used starts far back over the condyle of the femur farthest from the surgeon, behind the lateral ligament, runs downward and forward to the tubercle, just above which it passes, and then turns up to a point on the other condyle symmetrical to the starting-point. This short flap is raised containing the patella and its ligament; the joint is then flexed, the lateral and crucial ligaments fully divided, the thigh and leg brought into contact all along and held vertical. By traction on the leg and a few sweeps of the knife the lower end of the femur is protruded and cleared for the saw; in adults the whole epiphysis is usually removed, but in children the epiphyseal line should be spared, if this can be safely done. [*A cut passing above the patellar surface removes the whole epiphysis.*] The sawn surface of the femur should be parallel to the surface of the normal condyles; when the plane of these is unrecognizable, flex the thigh to ninety degrees and hold it so that its inner border corresponds to the mid-line of the body; the saw must now be held horizontal—both from teeth to back and from point to heel. The tibia is next protruded and cleared and a thin layer cut from its surface, the leg being vertical and the saw horizontal. Every attention must be paid to the direction of these cuts and to leaving perfectly plane surfaces. The saw may be used from or toward the popliteal as may be most convenient; with the most ordinary care, wound of the popliteal is impossible. The patella may be dissected out or cleared of cartilage and left. After this operation a short tube should be brought out through an opening made upon forceps pushed from the joint out beneath the skin just external to the biceps tendon; and a large tube may run from the suprapatellar pouch to the outer side of the wound, the rest of which is accurately closed, the ends of the lig. patellæ having been carefully united.

Jones, of Jersey, uses the same incision, but raised a skin flap only, opened the joint on either side of the patella and its ligament, and pushed them aside whilst he removed the bone-ends. This preserves the extension apparatus intact, but is a difficult method to practise and does not permit free access to the synovial membrane. With the same object of preserving the extensor intact, to prevent dropping back of the tibia, Volkmann makes a transverse incision across the lateral ligaments and centre of the patella, saws through the latter, and thus opens the joint. After excision, the cartilage is removed from the patella and the fragments are wired (p. 271). This is an excellent operation.

Whatever method is adopted, it is essential in tubercular cases that the whole synovial membrane be dissected out, that at the back of the joint being removed after the ends of the bones have been resected; the femur and tibia should be made to fit accurately and without strain, and it is well to fix them together by a couple of stout wire sutures taking a deep hold of each; all bleeding should be checked before closing the wound; and the selected fixation apparatus should be firmly applied whilst the patient is still anæsthetized. There are plenty to choose from, but the great majority are applied close to the limb, and the fixation which they afford is gained at great risk of sepsis; this is true of MacIntyre's splint (Fig. 368) cut narrow behind the knee, and of the formerly popular combination of a modified MacIntyre and a bracketed long splint (Fig. 369) introduced by Parkinson. From an antiseptic point of view Butcher's box-splint, lined with horsehair and shown in Fig. 370, is much superior; but it possesses no advantage over a piece of Gooch's splint, cut as in 373, to fit the patient. A large gauze dressing, reaching far up and down, is applied, and then the limb is laid in the splint, well padded with some antiseptic wool, and a bandage is *firmly* applied round all. The splint should reach a little more than half-way round the thigh,

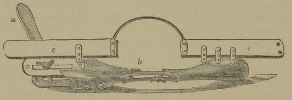
FIG. 368.



Knee after excision upon a MacIntyre swing from a Salter's cradle.

and it is used for the first two or three dressings—so long as the discharge continues free; but as soon as the first rush is over, the splints shown in

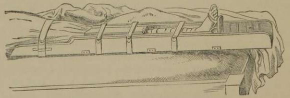
FIG. 369.



Parkinson's splint for excision of the knee.

Fig. 373, made of hoop-iron, may be applied as follows: The patient being anæsthetized, the Gooch splint it opened and a small dressing applied round

FIG. 370.



Butcher's box-splint with falling sides.

the knee; the front of the foot, leg, and thigh are then covered with a layer of boracic lint and an anterior splint containing the iron rod intended for this aspect of the limb is made of flannel soaked in thick plaster cream; the limb is now raised in contact with the anterior splint and a posterior one containing the other iron is applied, the two being held together by a plaster bandage. When the plaster is set, the limb can be swung by the hook on the anterior iron opposite the bend of the ankle.

But the best of all splints after excision of the knee is Thomas's knee-splint, applied with a few turns of plaster bandage round the thigh and leg above and below the dressing, whilst the handkerchief thrown in figure-8 round the ankle, or a short extension strap, fixes the foot to the end of the splint. A large quantity of antiseptic wool is massed about the joint and compressed by elastic webbing wound lightly round it and the splint, so that it not only checks oozing, but gives efficient support to the limb between the plaster bandages. This dressing should not be changed unless discharge comes through and remains moist, or unless some unfavorable symptom arises.

Results.—The limb, when firm union in the straight position occurs, is thoroughly serviceable, enabling the patient to walk as strongly as ever, and we read of a case of Park's performing the duties of a sailor. But in a considerable number of cases the disease continues, little or no union occurs, and sinuses multiply—a result shown in Fig. 372, necessitating either re-

FIG. 371.

Result of excision of left knee, by Mr. Price, Oct. 1856. The patient was a woman, aged 26; the patella was retained, but was cut out after a year because abscesses continued to form round it. The limb was finally most serviceable.

FIG. 372.

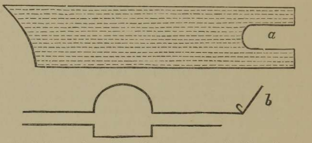
Knee of a boy, aged 9, 2 years and 3 months after excision by Mr. Price: amputation, recovery. *Lancet*, Nov. 27, 1858.

excision or amputation to prevent death from hectic, etc.; a second or even a third resection may be successful. Even those who recover will have frequently a deformed limb, either because early displacement back and out is not prevented, or because bending out occurs when the patient begins to walk; and this may happen even after apparently firm union for some months. The mortality and the necessity for amputation have both been considerable reduced by modern surgery, but the necessity for long wearing of a splint, to prevent bending and disappointment, remains.

Excision of the knee, though it has been successfully undertaken by Gant and others as late as 53, should rarely be performed after 35. Under this age, with a sound constitution and disease which can be removed with tolerable completeness, the patient had a good chance of recovery with a valuable limb.

Excision of the Ankle-joint.—Formal excision is now rarely undertaken, Syme's amputation being performed instead. Sinuses are opened up, the whole astragalus perhaps removed, and gouges are applied freely to other bones; such operations may lead to very good results, the deformity and impairment of the limb being surprisingly slight.

Fig. 373.



a. A piece of Gooch's splint for use after excision of the knee, osteotomy for deformed femora, or leg-bones, etc.; b, pieces of hoop-iron bent into anterior and posterior splints for excision of the knee.

The joint may be excised through incisions over each malleolus. The first cut is made along the posterior edge of the external malleolus just in front of the peronei down to the point of the process, and is about two inches long; it then turns up along the anterior edge for one inch; the skin and peritoneum are elevated together, the flap raised, the fibula sawn through above, the upper end of the fragment drawn out with forceps, the periosteum separated from its inner surface, the ligaments attached to the malleolus divided from within, and the process removed. The peronei are usually exposed, but must not be injured. Next, a vertical incision one and a half inches long is made over the inner malleolus reaching to its tip, and a curved incision, rather longer, is made round the border of the process—the two cuts forming an anchor. Periosteum and skin are now raised from the longitudinal wound, and then the periosteum and tendons are elevated first from the anterior then from the posterior surface of the tibia; the tibia can now be sawn through with a narrow saw. When the section is complete, the int. lat. ligament is cut from the malleolus, and the loose piece of bone seized with forceps and twisted out. The tendons behind the malleolus may be exposed, but must not be injured. Lastly, a fine saw is passed in at the posterior end of the anchor-cut, and made to remove the whole joint surface of the astragalus, cutting in a line which is concave upwards; or this may be made the second step of the operation, being effected after removal of the outer malleolus.

Dissatisfied with the results of this method in tubercular arthritis, and attributing the failures to imperfect exposure and removal of the diseased parts, Hüter introduced, for these cases, an operation by an anterior transverse incision, dividing all tendons, nerves, and vessels in front of the joint, together with the lateral and anterior ligaments. The joint is then opened widely, all diseased parts carefully removed, bones subperiosteally when possible, a transverse drain is inserted, and then all the tendons and nerves are sutured. Before their division, catgut threads are passed through each, above and below the points at which they are to be cut. In the few cases upon which he had thus operated, Hüter had obtained primary union of the skin-wound, and complete restoration of the functions of the tendons and nerves.

The foot may be steadied by an anterior and posterior plaster splint outside the antiseptic dressing, or it may be fixed upon a Thomas's knee-splint with a foot-piece moving on the vertical bars, or it may be bandaged to an anterior splint of hoop-iron or stout wire. It should be swung. The prognosis varies just as for the knee; the operation is not usually successful after mid-life. Hüter is strongly in favor of early resection.

Excision of tarsal bones is usually an informal operation when undertaken either for disease or injury, being performed through enlarged sinuses or wounds, or, when dislocated, through an incision directly on to the displaced bone. As a rule, it should be attempted in cases of disease only when this is limited to one or two bones, as often happens when the os calcis or cuboid is its seat; but very extensive disease has thus been successfully dealt with in children and young adults.

The performance of such operations as these upon normal subjects is much more difficult than upon those actually suffering from caries of the bones, in whom the part to be removed is usually soft and reduced in size, whilst its ligaments tear or strip off more or less readily on account of inflammatory infiltration and softening. The extent of the incisions necessarily varies with the amount of dissection that has to be done.

The *posterior part of the astragalus* can be excised in cases of astragalo-calcaneal disease only after resection of the ankle by Langenbeck's method: the saw is pushed across the joint from the anterior end of the anchor-incision, and made to cut its way downward and a little backwards through the neck into the groove beneath the bone in which the interosseous astragalo-calcaneal ligament is attached. The hinder part of the bone is then seized and twisted out

When the whole astragalus requires excision by a formal operation, the anterior limb of Langenbeck's anchor-incision should be prolonged forwards to the tubercle of the navicular bone. After removal of the malleolar arch, the dorsal astragalo-navicular ligament is elevated from the astragalus, and the whole bone wrenched out, either at once or after division of the interosseous astragalo-calcaneal ligament with a bistoury thrust into the sinus pedis. After removal of the bone the os calcis and navicular must be examined, and morbid parts gouged away.

The danger in this case is recurrence, which is frequent—so frequent that many surgeons rarely or never perform such excisions; if the disease is checked by the operation, the foot on recovery is usually strong, useful, and movable at the false joint. The elevated periosteum of the malleoli in young people usually forms sufficient bone to make the joint laterally secure.

When the malleoli are sound, they have sometimes been saved, either without or with division and displacement, to permit extraction of the astragalus; when they are replaced the ankle may be drained by a tube brought out external to the tendo Achillis.

The *os calcis* may be subperiosteally excised through a horse-shoe incision running from a point one-half inch posterior to the tubercle of the fifth metatarsal round the heel and along the inner side to a point below the astragalo-navicular joint, keeping all the while above the sole; the flap is raised from the sole, and an elevator is employed to raise with it all the periosteum from the plantar surface; next the periosteum and all soft parts are elevated from the sides and upper surface, the tendo Achillis being cut away from the bone; the astragalo-calcaneal joint is now opened, the interosseous ligament divided, after which the bone can be removed. The usefulness of the foot after this operation and the small amount of deformity are surprising.

Ollier employs a single incision starting outside the tendo Achillis running down to the heel and then turning toward the tubercle of the fifth metatarsal.

The *cuboid* or other small bone must be exposed in the way least likely to injure tendons or vessels and carefully removed, together with any disease of contiguous bones. Excision of the *navicular* or *cuneiform bones* is almost useless, as the complex synovial membrane which runs between these bones is usually widely affected.

APPENDIX OF FORMULÆ.[1]

Section I.—Tonics.

ACID TONICS.

The four mineral acids are good tonics. Sulphuric is considered the most tonic and astringent, nitric and nitrohydrochloric the most alterative and cholagogue, phosphoric the mildest and most nourishing; but many such views are imaginary. For economy's sake, these acids may be prescribed in bulk, thus:

F. 1. *Dilute Sulphuric Acid.*—℞ Acidi sulphurici diluti unciam dimidiam. *Dose,* ♏v–x *for a child,* x–xxv for an adult, in three ounces of water, or of water sugared, or sweetened with syrup of ginger or orange-peel.

All four dilute acids of the P.B. have the same dose, and may be prescribed in the same way. The most effective tonic of all is:

2. *Aromatic Sulphuric Acid,* best with water only; *in debility with thirst, profuse perspiration, atonic diarrhœa, etc.*

3. *Sulphuric Acid and Æther, or Sutton's Punch.*—℞ Acidi sulphurici diluti ♏xl; spiritus ætheris sulphurici compositi fʒij; sacchari albi ℥ss; aquæ menthæ viridis f℥vj. Misce. Sumatur pars quarta quater die. *An admirable restorative after illness; for delirium tremens, etc.*

4. *Dilute Nitromuriatic Acid.* (See also F. 168.)—℞ Acidi nitromuriatici diluti fʒij; spiritûs ætheris nitrosi fʒij; syrupi f℥jss; aquæ f℥viijss. Misce. Sumatur pars sexta ter die. *In dyspepsia, with nasty tongue and inactive liver.*

With a dose of this it is often useful to give a pill of sulphate of zinc (gr. j) *with a little bitter extract, or, in other cases, liquor taraxaci* ʒj.

℞ Acidi nitromuriatici diluti fʒij; infusi chirettæ f℥vijss. Misce. f℥jss ter die. (*Dr. Prout.*)

℞ Acidi nitrici diluti, acidi muriatici diluti, āā fʒjss; syrupi aurantii f℥j; aquæ florum aurantii f℥j; aquæ destillatæ f℥xiijss. Misce. Sumatur cyathus vinarius ter vel quater die. (*Brodie.*)

5. *Nitric Acid Mixture to Relieve Thirst.*—℞ Potassæ nitratis ʒj; acidi nitrici diluti fʒij; syrupi f℥ij; aquæ puræ Oij. Misce. Dosis f℥iv pro re nata.

6. *Nitrous Acid Mixture for Dysentery and Diarrhœa.*—℞ Aquæ camphoræ f℥iv; acidi nitrosi ♏xxx; tincturæ opii ♏xx. Misce. A tablespoonful every two hours. *Said by Parrish to have a wide reputation in the United States.*

7. *Phosphoric Acid for Hectic.*—℞ Acidi phosphorici diluti fluidunciam dimidiam; infusi quassiæ fluiduncias octo. One tablespoonful in a wineglass of water. *This acid is next to the vegetable acids in mildness, and is suitable, when combined with anodynes and demulcents, for coughs and irritable throats; with tonics and pepsin for dyspepsia and debility; for thirst, etc.*

LIGHT BITTER TONICS.[2]

Use a light bitter infusion instead of the sugared water mentioned above, thus:

8. *Cinchona or Cascarilla with Acid.*—℞ Acidi sulphurici diluti ♏v–xv; syrupi aurantii fʒss; infusi cascarillæ (*vel* decocti cinchonæ) fʒx. Ter die sumendus.

9. *For Children.*—℞ Decocti cinchonæ f℥j; syrupi zingiberis fʒj; acidi sulphurici diluti ♏viij. Ter die.

[1] The word *Squire* appended to a formula indicates a quotation from Squire's "Companion to the British Pharmacopœia," 10th edition. The word *Parrish*, indicates quotation from Parrish's "Treatise on Pharmacy" (Philadelphia, 1864).

[2] Many bitter medicines are made less nauseous by the addition of a few drops of the *spirit of chloroform*.

10. *Quinine as a Stomachic and Tonic.*—℞ Quiniæ sulphatis gr. ij; acid sulphurici diluti ♏v–xv; tincturæ aurantii, syrupi ejusdem, āā f℥ss; aquæ f℥ss. Ter die sumendus.

11. *Quinine with infusion of Roses.*—℞ Rosæ gallicæ petalorum drachmas duas; acidi nitrici diluti fluidrachmam dimidiam, aquæ destillatæ frigidæ fluiduncias quinque. Let them stand two hours, stir frequently, then strain, and add one drachm of powdered sugar. Dissolve twelve grains of sulphate of quinia in the above, and fill with water to six ounces. Dose, one ounce, twice or thrice daily.
To make a *clear* quinine mixture with infusion of roses, the infusion must be made with *dilute nitric acid*, not *sulphuric*, nor any sulphate. (*Squire.*)

12. *Quinine with Ammonia.*—Prescribe *Tinct. Quiniæ Ammon*, ʒj, P. B., in cold water, ℥ij, twice or thrice daily. *An agreeable stimulating tonic.*

13. *Quinine as a Febrifuge and Antiperiodic.*—Quinine may be given as a simple tonic, as above; it may be tried in all cases characterized by periodicity, and thus resembling malarious disease, for which, in all its forms, quinine is a standard remedy; and, lastly, it may be used as an antipyretic. In the last case it may be given in two ways: either in doses of 5–10 grs. every two or three hours, or in one knock-down dose of 30 or 40 grs.—the patient in both cases being reduced to a state of stupor with severe headache and loud subjective noises. Antipyretics thus used seem so to poison the protoplasm of the body that its metabolism is checked and the temperature consequently falls; they should be used only when the patient seems to be in danger from the fever, and are not commonly employed in the secondary fevers of surgery. It is exceedingly doubtful whether quinine has any influence over the rigors of pyæmia or of urethral origin. Many like the quinine bitter; large doses are best given stirred up with milk, made into a bolus in moistened wafer paper (to be had at any pastrycook's), or into pills (gr. v) with a paste of flour and boiling water.

14. *Liquor Cinchonæ.*—℞ Liquoris cinchonæ flavæ (*Battley*) ♏xx; aquæ pimentæ f℥j. Quater die sumendus. *In profuse suppuration and spreading inflammations*; it may be given in water simply, or combined with the aromatic sulphuric acid. The extr. cinch. liq., P.B, is said to be half the strength of Battley's.

15. *Bark with Ammonia.*—℞ Decocti cinchonæ flavæ f℥jss; ammoniæ carbonatis gr. v. Bis vel ter die.

16. *Bark with Liquor Potassæ.*—℞ Decocti cinchonæ flavæ f℥jss; liquoris potassæ ♏xx; tincturæ cinchonæ compositæ ♏xxx. Bis vel ter die.

17. *Bark with Guaiacum.*—℞ Tincturæ guaiaci ammoniatæ, tincturæ cinchonæ compositæ, singularum f℥j Misce. Dosis fʒij, bis die e cyatho lactis. *In chronic rheumatism and constipation with debility.*

18. *Sulphate of Zinc.*—℞ Zinci sulphatis gr. j; extracti anthemidis gr. iij. Fiat pilula, ter die sumenda. The dose may be increased to five grains; to be taken at meal times. *A good tonic in oxaluria, especially with nitromuriatic acid*, F. 4.

19. *Valerianate of Zinc.*—℞ Zinci valerianatis grana ij–x; mucilaginis tragacanthæ q s. ut fiat pilula, ter die sumenda. *In nervous exhaustion.*

20. *Oxide of Zinc Pills.*—℞ Zinci oxidi grana quatuor; extracti gentianæ granum. Fiat pilula, ter die. *Of great service in the profuse perspiration of phthisis.*

PREPARATIONS OF IRON.

21. *Iron Filings.*—℞ Ferri limaturæ puræ granum; mannæ, saponis, theriacæ, vel extracti glycyrrhizæ quantum satis sit ut fiat pilula, ter die sumenda.
When iron is administered slowly and gently to produce a gradual improvement of health, the metallic iron, in the form of filings or of Quevenne's "reduced iron," answers perfectly well. Be it observed that these solid preparations are apt to irritate the rectum. The old sweet black steel wine from Apothecaries' Hall, *the carbonate and oxide, citrate, tartrate, and phosphate, are also slow and unirritating. So is the "Mistura Aromatica," P. B., commonly called Heberden's Ink. The practitioner must decide whether to give a rapidly acting and powerful styptic preparation, such as the chloride, or a mild one. A pale, broad, flabby, teeth-indented tongue almost always requires a strong preparation. The tongue should be cleaned by a little rhubarb and soda or other means before iron is given. Combine it with ginger or capsicum when it is "heavy" for the stomach. Dark bilious persons who find difficulty in taking iron should take with it plenty of fruit or lemon-juice.*
"*Fer Réduit.*"—May be taken in the form of the *Trochisci ferri redacti*, P. B.

22. *Citrate of Iron with Ammonia.*—℞ Ferri et ammoniæ citratis (*Bullock*) ʒss; ammoniæ sesquicarbonatis ʒss; tincturæ cardamomi compositæ, syrupi, singulorum fʒiij. Aquæ f℥vj. Misce. Dosis pars sexta ter die. *In debility with acidity and flatulence.*

Citrate of Iron for Children.—℞ Ferri citratis gr. xij (*Bullock*); syrupi aurantii fluidrachmas duas; aquæ destillatæ f℥iij. Misce. Dosis f℥ss ter die.

23. *Iron in an Effervescing Draught.*—℞ Ferri et ammoniæ citratis gr. v; ammoniæ carbonatis gr. v; potassæ bicarbonatis gr. xv; syrupi zingiberis ʒss; aquæ f℥iss. Twice or thrice daily, in effervescence with one tablespoonful of lemon-juice, or 15 grains of citric acid dissolved in a tablespoonful of water.

24. *Acetate of Iron.*—℞ Tincturæ ferri acetatis (P. B.) fluidrachmam; aquæ pimentæ fluiduncias sex. Sumat æger partem sextam ter die. *A mild and effective salt of iron, as also is the tartrate.*

25. *Phosphate of Iron* (P. B.)—℞ Syrupi ferri phosphatis, P. B. f℥ij. Sumatur cochleare parvum ter vel quater die.

The syrup of *pyrophosphate of iron*, made by Cooper, of Oxford Street; *Parrish's compound syrup of phosphates* of iron and lime, sometimes called *chemical food*—an acid solution containing in one fluidrachm 2½ gr. phosphate of lime, 1 gr. of phosphate of iron, with traces of phosphates of soda and potassa, and free hydrochloric and phosphoric acids—are very useful. The *lactate of iron* has little solubility and little taste, and is often mixed with chocolate, etc.

26. *Chloride of Iron.*—℞ Tincturæ ferri perchloridi fʒij; syrupi zingiberis ℥j; spiritus ætheris nitrici fʒij; aquæ f℥vij. Misce. Sumantur cochlearia duo magna bis die.

In erysipelas and pyæmia, in which the perchloride is given in large doses, as in fʒj *every three or four hours, it passes through the alimentary canal and completely deodorizes its contents.*

27. *Iron with Quinine.*—℞ Quiniæ disulphatis ℈j; tincturæ ferri perchloridi fʒjss; syrupi aurantii fʒiv; aquæ fʒxiv. Dose ʒj, or more, in water. (*Parrish.*)

28. *Ammonio-chloride of Iron.*—℞ Ferri ammonio-chloridi gr. xx; tincturæ zingiberis fʒij; ammoniæ sesquicarbonatis ℈j; syrupi f℥ss; aquæ destillatæ f℥vss. Misce. Dosis f℥j ter die. *In debility, with acidity and flatulence.*

The writer finds this the best preparation to allay the craving of drunkards. The ammonio-chloride is not in the P. B.

29. *Steel and Acid Mixture.*—℞ Ferri sulphatis gr. xij; acidi sulphurici diluti fʒj; tincturæ cardamomi compositæ f℥ss; infusi rosæ compositi f℥vss. Misce, sumantur cochlearia duo magna bis vel ter die. (*Brodie.*)

30. *Steel, Ammonia, and Quassia.*—℞ Infusi quassiæ f℥ss; tincturæ ferri ammoniati fʒss; ammoniæ sesquicarbonatis gr. vj; syrupi aurantii fʒj; aquæ destillatæ fʒvij. Misce, fiat haustus, bis vel ter quotidie sumendus. *For hysterical women.* (*Brodie.*)

31. *Iodide of Iron.*—The syrup (P. B.), ʒjss in water or ginger tea, may be given thrice, or one of *Blancard's pills of iodide of iron* twice, daily.

32. *Griffith's Mixture.*—℞ Myrrhæ contritæ ʒj; potassæ carbonatis ʒss; ferri sulphatis gr. xij; spiritus myristicæ f℥ss; sacchari ʒiv; aquæ f℥vss. Dissolve the sulphate in two ounces of water; then rub the other ingredients smoothly together, and add them. Dose f℥j to f℥jss thrice daily.

NUX VOMICA AND STRYCHNIA.

33. ℞ Liquoris strychniæ, P. B. ♏iij; tincturæ zingiberis ♏x; aquæ fluidunciam. Bis vel ter die. The strychnia may be gradually increased to 10 minims (=$\frac{1}{12}$ grain). This valuable medicine may be added to any *acid* tonic. Curtis's syrup of iron, quinine, and strychnia is of great service, or the following:

℞ Liquoris strychniæ fluidrachmas duas; tincturæ ferri chloridi fluidrachmas quatuor; quiniæ sulphatis grana viginti quatuor; syrupi zingiberis ad fluiduncias tres. ʒj bis vel ter die.

℞ Tincturæ nucis vomicæ (P. B.) fʒj; acidi nitromuriatici diluti fʒij; tincturæ zingiberis fʒij; syrupi fʒiij; aquæ fʒvss. Misce. Dosis pars sexta ter die. *In atonic dyspepsia this is most valuable; also in any form of functional paralysis after all known causes are remedied.*

Nux vomica is the pleasantest bitter possible, and may be given alone or combined with phosphoric or other acids or purgatives.

Section II.—Stimulants and Nutritives.

41. *Ammonia.*—℞ Liquoris ammoniæ, P. B., semidrachmam; mucilaginis acaciæ drachmas sex, aquæ fluiduncias sex. Misce. Dose, a sixth part occasionally, with an equal quantity of water.

℞ Ammoniæ sesquicarbonatis gr. xx; spiritus ætheris sulphurici f℈j; syrupi zingiberis f℥iij; aquæ anethi f℥vjss. Misce. Dosis pars quarta subinde. *In syncope, hysteria, tympanites, etc.*

Ammonia Pills.—℞ Ammoniæ carbonatis gr. v; extract. gentianæ q. s. ut fiat pilula. *To be kept in a corked bottle. One or two relieve dyspeptic flatulence, palpitation, etc.*

42. *Chloroform Mixture.*—℞ Spiritus chloroformi f℈j; pulveris acaciæ ℈j; aquæ f℥vj. Misce. Dosis pars quarta subinde.

Chloroform Mixture with Camphor.—℞ Chloroformi f℈j; camphoræ gr. xxx; ovi vitellum; aquæ f℥vj. Tere simul, ut flat mistura. Dosis f℥j.—(*United States Pharm.*)

43. *Strong Camphor Mixture.*—℞ Camphoræ gr. xxv; amygdalas dulces decorticatas sex; sacchari purificati ℥iij; optime contere, dein adde gradatim aquæ menthæ viridis f℥vijss, ut fiat mistura, cujus sumantur cochlearia tria magna quarta quaque hora. (*Hooper.*) *In hysteric and various nervous and spasmodic affections.*

The soluble *essence of camphor* (*not* spirit of camphor), freely miscible with water, may be given in doses of 10–30 drops.

44. *Negus.*—Cinnamon, ginger, nutmeg, and cloves, of each, bruised, one scruple, white sugar, one ounce, claret six fluid ounces (or port or sherry, and hot water, of each, three fluid ounces). Heat together until boiling begins, then strain. Dose, two fluid ounces. *In collapse, syncope, rigors, etc.*

White Wine Whey.—Sherry or madeira a wineglassful, hot milk half a pint; boil together till the milk curdles, then strain through muslin.

Egg Wine.—Beat up well with a spoonful of cold water the yelk of a new-laid egg. Add to these by degrees a glass of sherry, mixed and boiled with an equal part of water. Add a little nutmeg and sugar.

A Nightcap.—Dissolve a quarter of an ounce of isinglass and two lumps of sugar in a small tumbler of boiling water. Add half a glass of brandy, a glass of sherry, or two glasses of claret, and a bit of nutmeg or cinnamon. *A capital thing for a patient who is afraid of cholera.*

PREPARATIONS OF FLESH MEAT.

45. *Essence of Beef.*—Take a pound of lean beef, free from skin, bone, and fat; chop it up; put it into a large earthen jar with cover; cement the edges with flour paste; tie it up tightly in a cloth; plunge it into a saucepan, and let boil for two hours; pour off the liquid essence from the coagulated muscle: let it stand till cold; skim off the fat.

See communications by the author to the *Obst. Soc. Trans.*, vol. iii. p. 143, and *Med. Times and Gaz.*, 1861, vol. i. pp. 536, 587, advocating the use of this essence as a substitute for brandy in cases of *debility and nervous exhaustion.* The essence of beef originally prepared for the writer from the above formula by Brand is excellent; also Gillon's "Essence of Beef," etc. Brand's "Concentrated Beef Tea" is good where a mild gelatinous broth is desired. Liebig's "Extract of Meat," especially the South American, is not nice by itself, but good to flavor poor broth. These preparations contain little albumen, but the extractives seem to act as a stimulant.

Purée of Meat.—Take any raw or underdone meat, chicken or mutton by preference; cut off skin and fat, pound it in a mortar until it is a paste, if raw, or a powder, if cooked. Diffuse a tablespoonful of this through half a pint of good beef soup, and let it just boil.

Meat Custard.—Take any cooked meat, or poultry, pound it to a powder, separate sinew, fibre, etc.; mix it with yelk of egg and milk, to make a custard; flavor with salt and a little marjoram; gently cook it till it sets. *These are modes of administering meats to patients too feeble to masticate.*

Raw meat is both food and medicine in cases of obstinate diarrhœa, especially of infants, vomiting of pregnancy, and ulceration of intestines from fever, dysentery, or tubercle. The meat may be beef or mutton, which may be scraped so as to get the red pulp free from sinew, or may be pounded into a paste. This may be given to infants with a little sugar; to adults it may be given with pepper and salt in a sandwich, or mixed raw with beef-tea, or with warm gelatinous broth and allowed to set to a jelly, so that it may be eaten cold. See article by the author, *Med. Times and Gaz.*, 1870, vol. ii. p. 4. A nourishing juice may be obtained by just covering scraped beef with water, allowing it to stand for an hour and then squeezing through muslin; flavor with sugar or salt.

Pancreatized food is very valuable for patients of feeble digestive power, and for others able to take but little food. Sir William Roberts's brochure should be consulted for full details. He recommends the *Liq. pancreaticus* (Benger).

Pancreatized Milk.—To milk, Oj, add water, ℥v, to prevent curdling; heat to about 140° F.; add *about* ʒij of liq. pancreat. (it is not of constant strength) and sod. bicarb. gr. x; cover and put under a cosey in a warm place for 1–1½ hours; so soon as a slight *bitter flavor* is perceived, boil for two or three minutes to stop all fermentation. The flavor is improved if the milk is skimmed and the cream added after digestion.

Pancreatized Milk-gruel.—Make a thick gruel of wheat flour, oatmeal, arrowroot, sago, pearl-barley, pea, or lentil flour; whilst boiling hot add an equal quantity of milk; the temperature will be about 125° F. To each pint add liq. pancreat. ʒij–iij, and sod. bicarb. gr. x. Treat as above. This, Roberts says, is the most nutritive preparation; it may be used as the basis of jelly, blancmange, etc., suitably flavored.

Pancreatized Beef-tea.—Minced lean beef 1 lb., water Oj., sod. bicarb. gr. x; let simmer for 1½ hours; decant; beat up the residue to a pulp and add to the bouillon; at 140° F. add liq. pancreat. ℥j and stir; digest under cosey for two hours; boil, strain, and season with salt. Very like ordinary beef-tea, and containing nearly as much peptone as milk.

46. *Phosphorus* is best given as phosphorized olive or cod-liver oil. In rickets, and after operations for ununited fracture, it well deserves a trial in doses of $\frac{1}{100}$th gr. twice daily, or oftener in smaller quantities. Its subtle, poisonous nature must not be forgotten. As an aphrodisiac, and in neuralgia, doses of even gr. $\frac{1}{10}$th have been given.

47. *Phosphate of lime* is best given in the B. P. syrup, ʒss–ij, in water, thrice daily.

SECTION III.—ASTRINGENTS.

61. *For Colliquative Diarrhœa, Ulceration of the Bowels, in Fever, Pyæmia, Phthisis, etc.*—℞ Cupri sulphatis gr. iij; pulveris opii gr. jss; extracti glycyrrhizæ q. s. ut fiat massa in pilulas vj dividenda. Sumat unam quartis horis.

62. *Gallic Acid Mixture.*—℞ Acidi gallici gr. xl; syrupi fʒij; aquæ destillatæ f℥viij. Misce. Dosis pars sexta, tertia vel quarta quaque hora. *In passive hemorrhage.*

63. *Alum Mixture and Whey.*—℞ Aluminis ʒj; acidi sulphurici diluti fʒjss; syrupi f℥ss; infusi rosæ f℥vijss. Misce. Dosis, pars sexta quarta quaque hora. *In the same.*

℞ Aluminis ʒj; lactis Oj; corticis limonis ℈j. Coque per quartam partem horæ, et cola. *To be drunk cold, ad libitum.*

64. *Pill of Creasote for Diarrhœa and Vomiting.*—℞ Creasoti guttam; saponis grana quatuor. Fiat pilula post singulas liquidas sedes sumenda. A small quantity of opium may be added at discretion.

65. *Turpentine as Astringent and Alterative.*—℞ Oleo terebinthiniæ fʒj; sodæ bicarbonatis ʒj; misturæ amygdalæ f℥viij. Misce. A sixth part every four hours. *In hæmaturia and other passive hemorrhage also, in rheumatic iritis.*

The *Confectio Terebinthinicæ*, P. B., is a good form, or the oil may be given in doses of ten drops in a wineglass of cold water. Much used by Dr. Begbie.

66. *Bismuth for Diarrhœa.*—This is best given in the dose of sixty grains of the subnitrate stirred in a wineglassful of milk, or water, every three or four hours.

67. *Ergot as a Styptic.*—Liquid extract ♏xv, in a little water, every three or four hours; or ergotine gr. v, dissolved in water, ♏x, subcutaneously.

68. *Lead Draught.*—℞ Plumbi acetatis gr. iij; aceti destillati fʒij; liquoris opii ♏j–x; syrupi fʒj; aquæ destillatæ fʒviij. Misce; fiat haustus quarta quaque hora sumendus ad sex vices. *In active hemorrhage.*

Lead Pill with Opium.—℞ Plumbi acetatis granum; pulveris opii gr. ¼. *In hemorrhage and in colliquative diarrhœa.*

SECTION IV.—ANODYNES AND NARCOTICS.

Medicines of this class are given to allay pain, and may be employed either locally or generally. Among local anodynes we may mention: carbolic acid, hydrocyanic acid, vapor of chloroform, poppy-head or belladonna fomentations, belladonna and glycerine, opium and morphia, acetate of lead ointment and lotions.

The principle of combining several soothing medicines in one prescription is a good one, as our own formulæ, published for many years, amply testify; and any practitioner who desires to economize *opium*, should combine a lesser dose of it with conium, henbane, camphor, Indian hemp, or some of them. The popular narcotic, *chlorodyne*, which is said to combine chloroform, morphia, peppermint, Indian hemp, and prussic acid, shows the success of this principle.

The liquor opii (Battley), the solution of bimeconate of morphia (Squire), the Jeremie's solution (Savory and Moore), or the purified extract of the P. B., are preferable to crude opium or its tincture, because they are deprived of the rank odoriferous principle, and are less likely to nauseate. The deodorized opium of the U. S. Pharm. is a good form.

Conium and other mild narcotics have long had a repute in scrofulous and cancerous ulcers, and Mr. Skey showed the good effect of opium in ulcers of the legs, and in promoting warmth of surface, and keeping up the cutaneous circulation. But the author has seen this mode of treatment greatly abused in cases of disease of the blood-vessels, with ulceration and sloughing. The following was a common remedy at the Winchester Hospital forty-five years ago, in the hands of Mr. Charles Mayo, for painful ulcers on the legs of the poor, chronic rheumatism, etc.

81. *Compound Soothing Pills.*—℞ Pulveris ipecacuanhæ compositi, extracti conii, singulorum ʒj. Misce, et divide in pilulas xxiv; quarum sumantur una vel duæ subinde.

83. *Pulvis Sudorificus Salinus.*—℞ Pulveris ipecacuanhæ compositi grana quindecim; potassæ nitratis grana quindecim; potassæ carbonatis grana quinque. Misce, fiat pulvis, hora somni sumendus e cyatho ptisanæ. *For a bad cold. A substitute for the original pulvis Doveri.*

84. *Compound Opiate Mixtures.*—℞ Liquoris opii sedativi ♏xx; spiritus ammoniæ aromatici, spiritus ætheris nitrici, singulorum fʒjss; syrupi fʒij; misturæ camphoræ f℥vss. Misce. Dosis, pars quarta, quartis horis.

85. ℞ Syrupi papaveris fʒiv; magnesiæ carbonatis ʒss; spiritus ætheris nitrici, tincturæ hyoscyami, singulorum fʒij; misturæ camphoræ f℥vij. Misce. Dosis, pars sexta subinde. *To tranquillize the system after injuries, operations, accouchements, hemorrhage, violent mental excitement, etc.* (*Dr. Gooch.*)

86. *Stimulating Narcotic Draught for Delirium Tremens.*—℞ Extracti opii (Hill) gr. ij, vel iij: aquæ ferventis f℥iv; tere in mortario et adde *brandy* f℥iss; sacchari q. s. Misce. *The patient should be allowed to sip this out of the tumbler like a glass of grog.*

87. *Remedies which persuade Sleep.*—Orange-flower water is decidedly ranked by the French among the *calmants*, and half a wineglassful, slowly sipped, will often coax a patient to sleep; so will valerian, musk, castor, extract of lettuce, cherry-laurel water; the tincture of sumbul in doses of two drachms, given in a little orange-flower water; amongst wines the Champagne and Burgundy, or good red Ofner or Carlowitz (some fine *white* wines are exciting and prevent sleep); amongst beers, Guinness's Dublin stout; lastly, the bromide of potassium, or chloral, in doses of 10 to 20 grs. at bedtime.

88. *Chloral Hydrate.*—May be given in doses of from 5 to 30 grs., but it is best combined with morphia or bromide of potassium; thus

℞ Chloral hydratis grana decem; solutionis morphiæ bimeconatis (*Squire*) ♏v; aquæ anethi fluiduncias duas. Fiat haustus, hora somni sumendus.

℞ Chloral hydratis, potassii bromidi, singulorum gr. x–xx; syrupi aurantii ʒiij; aquæ anethi ℥ij. Misce. Or morphia may be given hypodermically, to be followed in an hour, if sleep is not induced, by a dose of chloral.

89. *Ether and Camphor for Inhalation.*—℞ Camphoræ ʒj; ætheris ℥ss. Misce. *A few drops to be inhaled from a handkerchief in violent nervous headache, neuralgia, colic, uterine spasms during pregnancy, dysmenorrhœa, etc.*

90. *Indian Hemp.*—℞ Extracti cannabis indicæ (*Squire*) gr. iij; mannæ grana duo-

decim. Misce, et divide in pilulas duodecim. Dose, one, two, or more. *An uncertain, but very often efficacious, narcotic in sleeplessness, neuralgia, and other painful maladies.*
℞ Tincturæ cannabis indicæ ♏x; mucilaginis f℥j; aquæ f℥vij. Misce, fiat haustus.

Section V.—Aperients.

101. *Calomel.*—℞ Calomelanos grana quatuor; extracti colocynthidis compositi grana sex. Fiant pilulæ duæ.
℞ Calomelanos grana quinque; antimonii tartarizati grani $\frac{1}{12}$. Fiat pilula. *In acute inflammation with engorged liver.*

102. *The Dose for Bilious Sick Headache.*—℞ Calomelanos granum unum. Fiat pilula. To be followed after an hour by the juice of a lemon in a tumbler of hot water, with a little sugar.

103. *Black Draught.*—℞ Sennæ foliorum ℥vj; zingiberis concisi ℥ss; extracti glycyrrhizæ ℥ij; potassæ carbonatis ℥ss; aquæ ferventis f℥ix. Post horas tres cola, et adde spiritus ammoniæ aromatici f℥ij; magnesiæ sulphatis ℥j (*vel* potassæ tartratis ℥j); tincturæ sennæ, tincturæ cardamomi compositæ, āā f℥ss. Dosis, f℥ss.
This draught is greatly improved, both in flavor and efficacy, by the addition of a few caraway-seeds and cloves, one ounce of buckthorn juice, one of tincture of jalap, and six of moist sugar. It is imitated by the *Mist. Sennæ Co.*, P. B., and is best prepared on the large scale.

104. *Red Draught.*—℞ Magnesiæ sulphatis ℥ij–iv; syrupi zingiberis, tincturæ cardamomi compositæ, singulorum f℥j; infusi rosæ compositi f℥x. Misce.

105. *Haustus Magnesiæ Sulphatis Acidus.*—℞ Magnesiæ Sulphatis ℥j–℥iv; syrupi aurantii f℥ij; acidi sulphurici diluti ♏x–xx; aquæ f℥ss. Misce, fiat haustus.

106. *Haustus Magnesiæ Albus.*—℞ Magnesiæ sulphatis ℥ij; magnesia carbonatis ℈j; syrupi zingiberis f℥j; aquæ menthæ viridis f℥xj. Misce, fiat haustus. *This draught will often be retained by the stomach when almost every other is rejected.*

107. *Rhubarb Draughts and Powders.*—℞ Pulveris rhei gr. x; sodæ bicarbonatis gr. xx; olei lavandulæ ♏ quinque. Misce, fiat pulvis, e cochlearibus duobus aquæ sumendus. *This is the most perfect combination of rhubarb. The lavender hides its flavor completely.*

108. *Pills of Rhubarb and Essence of Ginger.*—℞ Rhei gr. ivss; essentiæ zingiberis fortissimæ q. s. ut fiat pilula. *A very convenient and active pill.* (*Dr. Ferguson.*)

109. *Rhubarb and Polychrest Salt.*—℞ Pulveris Rhei, potassæ sulphatis, āā ℥j; pulveris zingiberis ʒj. Misce. Dosis, gr. x–xl. *A capital aperient for children.* (*Dr. Wm. Fordyce.*)
℞ Rhei, potassæ sulphatis, āā ℈j; spiritus lavandulæ compositi fʒj; aquæ f℥j. Misce, fiat haustus. *A warm efficient purgative.*

110. *Saline Aperient Draught.*—℞ Sodæ potassio-tartratis ʒij; sodæ bicarbonatis ℈j; sacchari albi ʒj. Fiat pulvis, è cyatho aquæ sumendus, cum cochleari magno succi limonis, vel cum acidi citrici granis quindecim.

111. *Epsom Salts and Tartar Emetic.*—℞ Magnesiæ sulphatis ℥j; antimonii tartarizati gr. j; aquæ menthæ f℥x. Misce; sumantur cochlearia magna tria quarta quaque hora. *An active nauseating aperient, fit for robust persons threatened with orchitis or other acute inflammation.* (*Sir A. Cooper.*)

112. *Saline Aperients with Tonics.*—℞ Magnesiæ sulphatis ℥j; acidi sulphurici diluti fʒj; ferri sulphatis gr. xv; infusi gentianæ compositi f℥iij; tincturæ aurantii fʒiv; infusi rosæ f℥vj. Misce. Dosis pars sexta bis quotidie.
Combinations of saline purgatives with tonics, so as to answer the double purpose of draining congested abdominal veins and bracing the system, are of great efficacy in most chronic complaints.
Sulphate of iron gr. j, or quinine gr. ij, or tincture of nux-vomica ♏xv, added to F 105, answers the same purpose.

113. *Pulvis e quatuor Salibus*, or "*German Powder.*"—℞ Sodii chloridi, sodæ sulphatis, magnesiæ sulphatis, potassæ sulphatis, singulorum partes æquales. Optime misceantur, et desiccentur ante ignem. Dosis ʒj–ij, ex cyatho aquæ calidæ. *An agreeable saline aperient. A grain of sulphate of iron or quinine may be added to each dose, with sugar or ginger, if agreeable.*

114. *Carlsbad Powder.*—May be imitated by substituting two drachms of sulphate of soda for the potassio tartrate in F. 110.

115. *Castor Oil Mixture.*—There is nothing offensive in the taste of castor oil, but it is indigestible, and creates unpleasant eructations. People of sense take it floated in a little brandy, or in an acid effervescing draught. They who want it disguised may adopt the following draught (*Parrish*):

℞ Pulveris gummi acaciæ, sacchari albi, singulorum ʒiij; olei menthæ piperitæ guttas quatuor; olei ricini f℥j. Rub the gum, sugar, and mint into a powder; add about ʒvj of water, then the castor oil by degrees, with a little more gum or a little water, as may be necessary to make a perfect emulsion. Then add water slowly to bring the quantity to ℥iv. Dose ℥ss–℥j.

116. *Castor Oil and Turpentine Mixture.*—Substitute half an ounce of oil of turpentine for half of the castor oil in the above.

117. *Aperient Electuary.*—℞ Pulveris potassæ supertartratis ℥ss; sulphuris præcipitati ʒiv; confectionis sennæ ℥j; syrupi zingiberis quantam satis sit.

118. *Pilulæ Catharticæ.*—℞ Aloes ℥ss; pulveris colocynthidis, cambogiæ, āā ʒj; jalapæ ʒij; saponis ʒj; antimonii tartarizati ℈ss; olei caryophyllorum ♏xx. Contunde simul, et divide in pilulas pondere granorum quinque. *A thorough but easy purge.*

119. *Pilulæ Catharticæ cum Calomelane.*—℞ Pilulæ præcedentis ʒiv; calomelanos ʒj. Misce, et divide in pilulas lx.

120. *Podophyllin.*—℞ Resinæ podophylli gr. $\frac{1}{4}$–$\frac{1}{2}$; sacchari albi q. s. ut fiat pulvis. ℞ Resinæ podophylli gr. $\frac{1}{6}$–$\frac{1}{4}$; extracti colocynthidis compositi gr. ij; extracti hyoscyami gr. iv. Fiant pilulæ duæ. *A most efficient purge, but very griping to some persons.*

It is difficult to detect any superiority in podophyllin over good scammony, save that the dose is smaller.

121. *Blue Pill and Colocynth.*—℞ Pilulæ hydrargyri ℈ss; extracti colocynthidis compositi ℈ijss. Misce, fiant pilulæ duodecim.

122. *Sulphate of Iron with Aloes.*—℞ Ferri sulph. exsic. gr. j vel ij; ext. aloes aq. gr. j. Fiat pilula. *In habitual constipation, give one, thrice daily, after food; often no action results for two or three days; so soon as a loose motion results, one pill is left off, or if only one is being taken, it is required less often.* (*J. Kent Spender.*) *This is the best treatment of constipation.*

123. *Pilulæ Aloes Dilutæ.*—℞ Extracti aquosi aloes Barbadensis, saponis, theriacæ, extracti glycyrrhizæ, āā ʒj. Solve leni calore in balneo; dein divide in pilulas xlviij. Dosis, una hora somni. *A capital eccoprotic aperient, unloading the colon of scybala.*

124. *Ipecacuanha and Rhubarb Pills.*—℞ Pulveris ipecacuanhæ gr. xxiv; pulveris rhei ℈iv; saponis ℈ss. Misce, et divide in pilulas xxiv; quarum sumatur una ter die. *A gentle aperient for piles and other congested conditions of the intestines.*

125. *Pills of Colocynth and Pitch.*—℞ Pilulæ colocynthidis compositæ gr. ij; picis nigræ gr. iij. Fiat pilula. *For persons affected with piles.*

126. *Pills of Aloes and Sulphuric Acid.*—℞ Aloes Barbadensis gr. xxiv; acidi sulphurici fortissimi guttas vj. Misce, et divide in pilulas vj; quarum sumantur duo quarta quaque hora. *A very powerful aperient, that often succeeds when almost everything else fails.* (*Dr. Dickson.*)

127. *Guaiacum and Jalap Pills.*—℞ Guaiaci pulveris extracti jalapæ, extracti hyoscyami, āā ℈j; cambogiæ gr. iij. Misce, et divide in pilulas duodecim; quarum sumantur una vel duæ hora somni. *An active purge, not irritating to the rectum.*

128. *Gingerbread Electuary.*—℞ Guaiaci pulveris ʒij; sulphuris, rhei āā ʒj; zingiberis ʒj. *Treacle* quantum satis sit ut fiat electuarium. Dosis, pars sexta. (*Sir C. Locock?*)

129. *Guaiacum Electuary.*—℞ Pulveris guaiaci ʒij; pulveris rhei ʒss; sulphuris ʒj; pulveris myristicæ ʒss; theriacæ quantum satis sit ut fiat electuarium. Dosis, pars sexta omni nocte. *In chronic rheumatic diseases. This is commonly called the "Chelsea Pensioner."*

130. *Colocynth with Henbane and Belladonna Pills.*—℞ Pilulæ colocynthidis compositæ grana tria; extracti hyoscyami grana duo. Misce, fiat pilula.

℞ Pilulæ colocynthidis compositæ grana xviij; extracti belladonnæ granum unum. Misce, et divide in pilulas sex. Dosis, una hora somni. *In piles. Belladonna is too powerful a medicine to be used lightly.*

Section VI.—Alterative, Saline, Febrifuge, and Specific Remedies.

141. *Saline Draught.*—℞ Potassæ nitratis ℈ij; sodæ sesquicarbonatis ℈j; syrupi, spiritus ætheris nitrici, āā fʒj; aquæ f℥v. Misce. Dosis, f℥jss quarta quaque hora.

Effervescing with Potash.—℞ Potassæ bicarbonatis ℈iv; syrupi zingiberis fʒij; aquæ f℥vss. Dosis, f℥jss quarta quaque hora, cum f℥ss succi limonum recentis.

Effervescing with Ammonia.—℞ Ammoniæ sesquicarbonatis ℈ijss; tincturæ cardamomi compositæ f℥ss; aquæ f℥vss. Misce. Dosis, f℥jss quarta quaque hora, cum cochleari magno succi limonum, vel gr. xv acidi citrici. *In the early stage of erysipelas and low fevers.*

Mindererus Draught.—℞ Liquoris ammoniæ acetatis f℥ij; spiritus ætheris nitrici f℥ss; misturæ camphoræ fluiduncias quinque cum semisse. Misce. Dosis, pars quarta quaque hora.

Carbonate of Ammonia.—℞ Ammoniæ carbonatis ʒss; spiritus ætheris nitrici fʒiij; misturæ acaciæ fʒiij; misturæ camphoræ f℥vij. Misce. Dosis, f℥iss tertia vel quarta quaque hora.

Borax.—℞ Sodæ biboratis ʒj; sodæ carbonatis ʒss; potassæ nitratis ʒss. Misce, et divide in pulveres sex; quorum sumatur unus ter die e cyatho aquæ. *In lithic deposits.*

142. *Phosphate of Soda.*—℞ Sodæ phosphatis ʒiij. Fiat pulvis, mane sumendus e cyatho aquæ. *As an aperient when the urine is red.*

143. *Lithia Draught.*—℞ Lithiæ citratis grana quinque; aquæ destillatæ fluiduncias duas. Misce. Ter die sumendus. A bottle daily of Blake's Lithia water is probably the best form of this anti-lithic and anti-podagric remedy.

144. *Calomel and Opium Pill.*—℞ Calomelanos gr. j–ij; pulveris opii gr. ¼–½; extracti glycyrrhizæ quantum sufficiat ut fiat pilula, quartis—sextis horis sumenda. *To mercurialize the system in acute peritonitis.*

145. *Calomel and Opium with Antimony.*—℞ Calomelanos gr. j–ij; pulveris opii gr. ¼–½; antimonii tartarizati gr. $\frac{1}{12}$–⅙; extracti glycyrrhizæ quantum satis sit ut fiat pilula. This formula may be used when there is a considerable amount of sthenic inflammation.

146. *Alterative Pill and Powder.*—℞ Pilulæ hydrargyri granum dimidium; extracti hyoscyami gr. ij. Misce, fiat pilula, bis vel ter die sumenda.

Alterative Powder.—℞ Hydrargyri cum creta gr. ij; pulveris rhei gr. v; sacchari ℈ss; pulveris cinnamomi gr. v. Misce, fiat pulvis, omni nocte sumendus. As a gentle alterative in chronic diseases, when the secretion of bile and urine is scanty.

147. *Plummer's Pill.*—℞ Sulphureti aurati antimonii, calomelanos, āā ʒij; tere simul donec bene misceantur, dein adde pulveris resinæ guaiaci ʒiv; balsami copaibæ q. s. ut fiat massa pilularis ex cujus singulis drachmis formentur pilulæ xij.

148. *Tartar Emetic.*—℞ Antimonii tartarizati granum; aquæ destillatæ fluidunciam. Sumatur cochleare parvum quarta quaque hora.

149. *Colchicum and Magnesia.*—℞ Vini colchici fʒij; liquoris magnesiæ carbonatis f℥jss; misturæ camphoræ f℥ivss. Misce; sumantur cochlearia duo quarta quaque hora.

150. *White Purgative Draught with Colchicum.*—℞ Aceti colchici fʒj; magnesiæ sulphatis ʒij; magnesiæ carbonatis ℈j; syrupi zingiberis fʒj; aquæ anethi fʒx. Misce. (*Sir C. Scudamore.*)

151. *Antilithic Pill.*—℞ Extracti colchici acetici, hydrargyri cum creta āā gr. j; extracti colocynthidis compositi gr. ij. Misce, fiat pilula, omni nocte sumenda. (*Brodie.*)

152. *Sir A. Cooper's Prescription for Chronic Gout and Rheumatism.*—℞ Potassæ bicarbonatis ʒss; tincturæ aurantii fʒij; decocti aloes compositi f℥vij. Misce; sumatur cyathus vinarius omni mani.

153. *Sir A. Cooper's Prescription for Cancer.*—℞ Ammoniæ carbonatis gr. v; sodæ carbonatis ʒss; tincturæ calumbæ fʒj; infusi gentianæ compositi f℥jss. Misce, fiat haustus, bis die sumendus.

154. *Antacid and Carminative Mixture.*—℞ Ammoniæ carbonatis ℥ss; potassæ bicarbonatis ℥jss; aquæ destillatæ f℥vijss. Dosis, f℥iss bis die. For adults laboring under rheumatism, dyspepsia, acidity, and turbid urine. To be taken after breakfast and at bedtime.

155. *Liquor Potassæ Mixtures.*—℞ Liquoris potassæ f℥iij; aquæ destillatæ f℥x. Misce; sumatur pars sexta ter die post cibum.
℞ Liquoris potassæ, tincturæ gentianæ, syrupi zingiberis, spiritus ætheris nitrici, āā f℥iij; aquæ destillatæ f℥vjss. Misce; sumatur pars sexta bis vel ter die post cibum.

156. *Bismuth* (*see* F. 66)—℞ Bismuthi nitratis, sodæ bicarbonatis, singulorum ℈j; pulveris tragacanthæ compositi gr. v; pulveris zingiberis gr. v. Misce, fiat pulvis, hora post cibum sumendus ter die. In all cases of acidity, flatulence, and irritable stomach, combinations of bismuth and alkali are most valuable; but in less doses than twenty grains of bismuth is worthless. Five minims of prussic acid, P. B., may be added to each dose if there is much pain.

157. *Prussic Acid Mixture.*—℞ Acidi hydrocyanici diluti ♏iv; potassæ bicarbonatis gr. x; aquæ f℥ss. Misce, fiat haustus, bis die sumendus. *In cases of irritable acid stomach.*

158. *Antilithic Powder.*—℞ Magnesiæ gr. vj; potassæ bicarbonatis gr. xij; potassæ tartratis gr. xv. Misce; fiat pulvis, omni vespere sumendus e cyatho parvo aquæ. (*Brodie.*)

159. *Sarsaparilla and Nitric Acid.*—℞ Decocti sarsæ compositi f℥iv; acidi nitrici diluti ♏x–xx; tincturæ hyoscyami f℥ss. Misce; fiat haustus, ter die sumendus.
The old-fashioned decoction of sarsaparilla, freshly made, and taken in doses of at least a pint daily, is far better than the concentrated extracts. It is an excellent sedative, nutritive, and diaphoretic; patients should stay indoors and keep warm whilst taking it.

160. *Alkaline Infusion of Sarsaparilla.*—℞ Sarsaparillæ radicis concisæ et contusæ ℥ij; radicis glycyrrhizæ concisæ ℥ij; liquoris potassæ ♏xl–lx; aquæ destillatæ ferventis f℥x; tincturæ cardamomi compositæ f℥iij. Macera per horas viginti quatuor, et cola. Sumatur totum quotidie. (*Brodie.*)

162. *Corrosive Sublimate Pills.*—℞ Hydrargyri sublimati corrosivi, ammoniæ hydrochloratis, āā gr. j; aquæ destillatæ guttam; micæ panis quantum satis sit ut fiant pilulæ xij, quarum sumatur una ter die. (*Sir B. Brodie.*)
Mr. Liebreich gives corrosive sublimate in chronic disease of the eye, in one daily dose of gr. ⅟₂₄ after dinner.

163. *Corrosive Sublimate and Bark for Children.*—℞ Hydrargyri sublimati corrosivi gr. j; tincturæ cinchonæ (*vel* tincturæ rhei) ℥ij. Solve. Dosis, f℥j ter die ex aqua. *To be taken after meals.* (*Sir A. Cooper.*)

164. *Corrosive Sublimate and Steel.*—℞ Hydrargyri sublimati corrosivi grana duo; tincturæ ferri sesquichloridi fluidunciam. Solve. Dosis, minima quindecim ter die, e cyatho aquæ vel decocti hordei, vel sarsæ, vel cerevisiæ, vel *sweetwort.*

165. *Iodides of Potassium and Mercury.*—℞ Potassii iodidi grana quadraginta; hydrargyri corrosivi sublimati granum unum; syrupi aurantii fluidrachmas sex; aquæ ad fluiduncias octo. Dosis, semiuncia ter die, e cyatho aquæ. Half a drachm of the syrup of iodide of iron, or fifteen minims of the liquid extract of bark, may be added to each dose.

166. *Combinations of Mercury with Tonics.*—℞ Pilulæ hydrargyri ℈ij; ferri sulphatis exsiccati ℈j; extracti opii gr. v. Misce, et divide in pilulas xx; quarum sumantur duæ hora somni et una mane. (*Bumstead.*)
℞. Hydrargyri cum creta ℈ij; quiniæ disulphatis ℈j; mannæ quantum satis sit ut fiat massa in pilulas xx dividenda. (*Ibid.*).

167. *Other Antisyphilitic, Antistrumous, and Absorbefacient Remedies.*—Certain remedies which seem to have the power of causing atrophy of morbid cell-growth are of use alike in chronic inflammation, thickening, chronic rheumatism, some ulcers, scrofula, and some tumors, especially of bone and fibrous tissue. They are, 1, *mercury*, F. 162, 165, etc.; 2, liquor potassæ, F. 16 and 155; 3, certain salts of *potash* and *soda*, as the chlorate; 4, certain salts of *ammonia*, as the carbonate, chloride, and nitrate, F. 141, 178; 5, compounds of *iodine*, F. 169 *et seq.*; 6, the analogous compounds of *bromine*; 7, certain other metals, as *gold* and *platinum*. The writer advises that in obsti-

stinate syphilis, in nervous diseases, epilepsy, tumors, etc., these remedies be given perseveringly in alternation or conjunction with some nutrient or tonic. Thus $\frac{1}{24}$ of a grain of the *chloride of gold and sodium*, in a pill (with a glass of sarsaparilla) thrice daily; or a drachm of iodide of potassium, a drachm of bromide, and a drachm of chloride of ammonium, to a winebottle of distilled water, which the patient should take in a week in divided doses.

168. *Chlorate of Potash* may be used as a lotion in the proportion of gr. 80 to an ounce of glycerine and three ounces of water. It may also be made into lozenges (P. B.). As an internal remedy the dose is 10 to 30 grains in solution. Or a mixture may be made of two drachms chlorate of potash, half a drachm dilute hydrochloric acid, three of syrup, and six ounces of water. Dose, a sixth part every four hours. *In ulcerative stomatitis and all foul ulcerations of the mouth; also in sore throat.*

169. *Iodine Mixture.*—℞ Liq. iodinii ♏ v–xv, syr. aurant. ʒj–iij, aq. anethi ℥j–iij, ter die.

170. *Iodine Ointment* (see B. P.).

171. *Iodine Paint.*—It is composed of iodine with half its weight of iodide of potassium, rubbed together with enough spirits of wine to make it of the consistence of paint. *Used as a strong discutient for bubo, diseased joints, etc.*

172. *Iodine Lotion.*—℞ Tincturæ iodinii, P. B., ʒj; aquæ destillatæ Oj. Misce. *For scrofulous ulcers, fistulæ, and washing out cavities.*

173. *Rubefacient Solution of Iodine.*—℞ Iodinii ʒiv; potassii iodidi ℥j; aquæ destillatæ f℥vij. Misce. *To touch very indolent sores.*

174. *Caustic Solution of Iodine.*—℞ Iodinii, potassii iodidi, āā ℥j; aquæ destillatæ f℥ij. Misce. *To destroy weak granulations, ragged edges of sores, etc.*

175. *Iodine Bath.*—Should contain, for children, half a grain of iodine to each quart of warm water; and, for adults, one drachm to twenty-five gallons. The body may be immersed ten minutes. (The Effects of Iodine in Scrofulous Diseases, by Lugol, translated by O'Shaughnessy. London, 1831.)

176. *Iodide of Potassium with Bitters.*—℞ Potassii iodidi ℈j; infusi gentianæ compositi (*vel* decocti cinchonæ) f℥vss; tincturæ aurantii fʒij. Misce. Dosis, pars sexta ter die.

177. *Iodide of Potassium with Alkali.*—℞ Potassii iodidi gr. xij; potassæ bicarbonatis ʒj; (*vel* liquoris potassæ fʒij); syrupi f℥ss; aquæ f℥vss. Misce. Dosis, f℥j bis die.

178. *Nitrate and Muriate of Ammonia.*—℞ Ammoniæ muriatis ʒij; aquæ destillatæ f℥viij. Misce. Sumat partem quartam ter die. (*Sir J. Watson.*)
℞ Ammoniæ nitratis ʒss; aquæ f℥vss; syrupi aurantii fʒiv. Misce. Sumat cochlearia duo ampla ter die. (*Dr. Egan.*) *In rheumatism and secondary syphilis.*

179. *De Valangin's Solution of Arsenic.*—℞ Liquoris arsenici hydrochlorici, P. B., ♏xl; aquæ destillatæ f℥xxiv. *This quantity will fill a winebottle, and the dose is a wineglass three times a day at meal-times.*

180. *Fowler's Solution.*—℞ Liquoris arsenicalis (Fowleri P. B.) ♏xl; aquæ destillatæ fluiduncias xxiv. *Dose as the last.*[1]

181. *Donovan's Solution.*—A compound of arsenic, mercury, and iodine.—Dose, ♏x–xxx.

Section VII.—Emetics.

191. *Relaxing Emetics.*—℞ Antimonii tartarizati gr. iij; aquæ destillatæ f℥iij. Misce.
℞ Antimonii tartarizati gr. j; ipecacuanhæ ℈j. Misce, fiat pulvis. To cut short croup and acute bronchitis of children, the emetic should be given in small doses, and repeated frequently till it takes effect. To be mixed in a wineglass of water.

[1] Arsenic "should never be given when there is any feverishness; never on an empty stomach . . . The first effect to be looked for is an itching or smarting of the conjunctiva, and swelling and puffiness of the lower eyelid; upon which the dose should be reduced . . . If the conjunctiva continue much inflamed, the dose should be again reduced . . . The arsenical course should be continued for as many months after the disappearance of the skin disease as it had existed years before." (Hunt, "Diseases of the Skin." London, 1847.)

192. *Warm Emetic.*—℞ Pulveris ipecacuanhæ, ammoniæ carbonatis, āā ℈j; spiritus lavandulæ compositi ♏x; aquæ fʒj. Misce, fiat haustus. Bibat æger postea infusi anthemidis tepidi octarium. *In the incipient stage of erysipelas, fever, etc.*

193. *Mustard Emetic.*—℞ Farinæ sinapis vulgaris cochleare magnum; aquæ tepidæ octarium. Misce.

194. *Zinc Emetic.*—℞ Zinci sulphatis ℈ij; aquæ f℥ij. Misce, fiat haustus.

Section VIII.—Gargles.

201. *Cooling and Sialagogue Gargles for Acute Inflammation.*—℞ Oxymellis unciam; acidi hydrochlorici diluti ♏xxx; aquæ rosæ f℥j; aquæ puræ f℥vj. Misce.
℞ Potassæ chloratis ʒj; decocti hordei uncias decem. Misce.
℞ Boracis ʒj; mellis ℥j; aquæ rosæ f℥j; aquæ f℥vj. Misce.

202. *Soothing Gargle.*—℞ Extracti papaveris drachmam; boracis drachmam; aquæ ferventis fluiduncias octo. Misce.
Glycerine is a capital soothing application, in diphtheria, etc., either painted on with a camel's-hair pencil, or in combination with either of the above gargles. (See F. 272.)

203. *Vegetable Astringent Gargles.*—Tinct. gallæ, or tinct catechu, f℥ss, aq. ad Oss. *Tannin Gargle.*—℞ *Tannin* ℈j; spiritus ætheris sulphurici fʒiij; misturæ camphoræ f℥vss. Misce. *For salivation, spongy gums, relaxed throat, etc.*

204. *Mineral Astringent Gargles.*—℞ Aluminis ʒj; acidi sulphurici diluti ♏xx vel mel. pur. ʒiij; decocti cinchonæ vel aquæ f℥iij.
℞ Zinci chloridi gr. x; aquæ fʒviij. Misce. It is convenient to give the patient packets of 20 grains of *sulphate of zinc*, and let him dissolve one in a tumbler of water to make a gargle when required.

205. *Creasote Gargle.*—℞ Creasoti guttas xx; aquæ fʒviij. Agita simul donec solutum fuerit creosoton.
Carbolic Acid Gargle.—℞ Acidi carbolici gr. xvj; aquæ fluiduncias octo. Misce.
Antiseptic Gargle.—℞ Liquoris sodæ chlorinatæ fʒiv (*vel* liquoris potassæ permanganatis f℥ss); aquæ destillatæ f℥iij. Misce. A tablespoonful to be mixed with a glass of warm brandy and water, *to be used as a gargle.*

206. *Stimulating Gargles.*—℞ Tincturæ capsici fʒij; oxymellis f℥ss; aquæ f℥vijss. Misce.
℞ Tincturæ pyrethri fʒiij; aquæ ℥viij. Misce.

207. *Corrosive Sublimate Gargle.*—℞ Hydrargyri sublimati corrosivi gr. ij; acidi hydrochlorici diluti fʒj; mellis ℥j; aquæ destillatæ f℥viij. Misce.

Section IX.—Enemata and Suppositories.

211. *Nutrient Enemata* are usually made of beef-tea and the yolk of an egg, often with a little brandy; but pancreatized milk-gruel (p. vi) is probably the best material. Sansom (*Lancet*, 1881) recommended the employment of defibrinated blood, either fresh, or dried and dissolved.
The rectum must be first cleared of feces by an enema. The nutrient enemata should not exceed three or four ounces, given every three or four hours. The rectum should be gently washed out with a small cold water enema twice or thrice daily to prevent decomposition of retained injection. This washing out with water relieves the thirst of which patients thus fed complain so much. Irritation of the rectum often soon supervenes, so that injections are not retained; for a time it may be combated by the addition of a few drops of liq. opii sed. to each injection. Warmth and absolute rest are important adjuncts in rectal feeding.
Suppositories of digested meat have been suggested by Spencer, of York.
Opiate Enema.—℞ Unboiled starch ℥j; laudanum fʒss. Misce. (P. B.)
Opiate Suppository.—℞ Pulveris opii gr. j–ij; sevi—*i. e., tallow*, gr. xx. Misce.

213. *Turpentine Enema.*—℞ Olei terebinthinæ f℥j; vitelli ovi (*vel* mucilaginis acaciæ) quantum satis sit. Tere simul, et adde decocti hordei, *vel* decocti avenæ, f℥xix

214. *Castor Oil Enema.*—℞ Olei ricini f℥iij; potassæ carbonatis gr. xv; saponis ʒj; aquæ ferventis octarium. Tere simul donec bene misceantur.

216. *Purgative Enemata.*—℞ Magnesiæ sulphatis ℥ij; decocti avenæ octarium. Misce.

℞ Fellis bovini inspissati ℥ss; saponis ℥j; aquæ ferventis octarium. *Good for dissolving scybala.*

Half an ounce of senna leaves infused in a pint of boiling water, till cool enough, forms a most effective clyster.

217. *Enemata for destroying Ascarides.*—℞ Aloes, saponis, āā ℈j; aquæ octarium, *vel* infusi quassiæ octarium. One part of dilute citrine ointment with twelve of cocoa butter, placed within the sphincter, is a capital remedy. Suppositories of tannic acid (P. B.) are good.

Section X.—Lotions.

231. *Spirit Lotion.*—℞ Spiritus vini rectificati f℥j; aquæ f℥xv. Misce.

232. *Goulard's Lotion. The liquor plumbi subacetatis dilutus, P. B.*, is a modern form of this, and contains a quarter of an ounce each of "Goulard's extract" (*Liq. plumb. diacet.*) and of rectified spirit to the pint.

233. *Nitrate of Lead.*—℞ Plumbi nitratis drachmam; aquæ destillatæ octarium. Fiat lotio. *A capital deodorizing lotion for ulcers, cancers, etc.* (Dr. Ogier Ward.)

234. *Zinc Lotion.*—℞ Zinci sulphatis grana xx; aquæ octarium. Misce.

235. *Acetate of Zinc Lotion.*—℞ Liquoris plumbi diacetatis f℥ss; zinci sulphatis ℥ss; aquæ destillatæ octarium dimidium.

Acetate of Zinc with Creasote Lotion.—℞ Plumbi acetatis, zinci sulphatis, āā ℈ss; creasoti guttam unam. Tere simul ut fiat pulvis, in aquæ octario dimidio solvendus ut fiat lotio. *A convenient and excellent astringent, corrective of fetor in otorrhœa and other fetid discharges.*

236. *Lotion of Chloride of Ammonium.*—℞ Ammoniæ hydrochloratis ℥j; acidi acetici diluti, spiritus camphoræ, āā f℥ss; misturæ camphoræ f℥xv. Misce. *A discutient; much like the excellent lotion of Raspail.*

237. *Nitric Acid Lotion.*—℞ Rosæ petalorum ℈j; aquæ ferventis f℥viij; acidi nitrici diluti f℥ijss. Misce, et cola post horam. *To clean foul ulcers.*

238. *Opiate Lotion.*—℞ Pulveris opii ℥ss; aquæ destillatæ ferventis f℥viij; macera per horas duas, et cola. *For irritable sores, phagedæna, etc.*

239. *Poppy Lotion.*—℞ Extracti papaveris ℥ij; aquæ ferventis f℥iv. Misce. *The addition of a drachm of borax forms a capital lotion for itching eruptions.*

240. *Conium Lotion.*—℞ Extracti conii ℥j; aquæ destillatæ f℥iij; tere simul, et macera per horas duas; dein cola. *For painful sores.*

241. *Belladonna Lotion.*—℞ Extracti belladonnæ ℈j; aquæ f℥iv. Misce, et cola.

242. *Arsenical Lotion.*—℞ Liquoris arsenicalis f℥j; aquæ destillatæ f℥j. Misce. *In onychia.*

243. *Black Wash.*—℞ Calomelanos ℥j; mucilaginis acaciæ f℥ss; liquoris calcis f℥vss. Misce.

244. *Yellow Wash.*—℞ Hydrargyri sublimati corrosivi gr. vj–xij; liquoris calcis f℥vj. Misce.

245. *Chloride of Zinc Lotion.*—℞ Zinci chloridi grana octo; aquæ destillatæ f℥viij. Misce. *The best lotion for cancer of the womb.*

Mem.—The "liquor zinci chloridi P. B." is strongly impregnated with chlorine.

246. *Iron Lotion.*—℞ Ferri sulphatis gr. viij; aquæ destillatæ f℥viij. Misce. See *Mr. Vincent's* "Observations" *for the use of this lotion in piles.*

Lotions of the *chloride* of iron may be made by adding two fluid drachms of tincture of steel to four ounces of water. A concentrated solution of *sulphate* of iron was much recommended by Velpeau in erysipelas. The *citrate* of iron, in the proportion of five grains to the ounce, is a favorite lotion of Ricord's in phagedænic sores.

247. *Alum Lotion and Bath.*—℞ Aluminis ℥j; aquæ destillatæ octarium. Misce. For an *alum bath*, for leucorrhœa, prolapsus uteri, etc., add a tablespoonful of powdered alum to enough cold or tepid water to make a hip-bath; it should be injected by means of an India-rubber syringe (*Higginson's*).

248. *Blue Lotion.*—℞ Cupri sulphatis gr. viij; aquæ f℥viij. Misce. *Often used with an equal part of opiate lotion, for phagedænic sores, etc.*

249. *Tannin Lotion.*—℞ Acidi tannici ℥ss; spiritus rectificati f℥j; aquæ destillatæ f℥iv. Misce.

Catechu and Oakbark Lotions.—℞ Catechu ℥j; aquæ ferventis f℥viij. Macera per horam, et cola.

℞ Corticis quercus ℥ij; aquæ ferventis octarium; coque ad consumptionem dimidii, et cola.

250. *Borax Lotion.*—℞ Boracis ℥j; aquæ destillatæ f℥viij. Misce.

251. *Lotion of Friar's Balsam.*—℞ Tinct. benzoini co. ℥j; aquæ ℥ij. Misce. *For chronic eczema.*

252. *Benzoin Lotion.*—℞ Benzoini ℥j; spiritus rectificati ℥x. *Add of this tincture* ℥j *to distilled water* ℥vj. *For eczema, chafing, heat, etc.* (*Squire.*)

253. *Solution of Nitrate of Silver with Ether*, for swabbing the throat, is made by dissolving 20 grains of crystallized nitrate in one drachm of water, and adding one ounce of spirit of nitric or sulphuric ether.

URETHRAL INJECTIONS.

254. *Nitrate of Silver.*—℞ Argenti nitratis (*cryst.*) gr. ij; aquæ destillatæ f℥viij. Misce. (*Ricord.*)

N.B. Nitrate of silver for solutions ought to be crystallized, and of a pure white color, not darkened by exposure to light or contact with organic matter.

255. *Sulphate of Zinc.*—℞ Zinci sulphatis gr. viij; aquæ destillatæ f℥viij. Misce.

256. *Acetate of Zinc.*—℞ Zinci sulphatis gr. v; liquoris plumbi diacetatis f℥ss; aquæ rosæ f℥iv. Misce, fiat injectio.

257. *Acetate of Copper.*—℞ Cupri sulphatis gr. v; liq. plumb. diacet. f℥ss; aq. rosæ f℥iv. Misce, fiat injectio.

258. *Ammonio-sulphate of Copper.*—℞ Liq. cupri ammonio-sulphatis ♏xx; tinct. opii f℥ss; aq. rosæ f℥iv. Misce, fiat lotio.

259. *Sulphate of Zinc with Opium.*—℞ Pulveris opii ℈ss; aquæ ferventis octarium dimidium; macera per horas duas, dein cola et adde zinci sulphatis ℈ss.

250. *Sulpho-carbolate of Zinc.*—℞ Zinci sulpho-carbolatis gr. j–ij; aquæ destillatæ unciam. Misce.

261. *Carbolic Acid.*—℞ Acidi carbolici granum; aquæ fluiduncias ij–iv. Misce.

262. *Collyria or Eye Lotions.*—℞ Zinci sulphatis gr. j; *vel* aluminis gr. j; *vel* cupri sulphatis gr. ½; *vel* argenti nitratis gr. j; *vel* zinci acetatis gr. j; *vel* liq. plumbi diacetatis ♏v; aquæ destillatæ f℥j. Misce.

One part of good brandy to six of water makes an admirable collyrium for most cases.

263. *Corrosive Sublimate Collyrium.*—℞ Hydrargyri sublimati corrosivi gr. j; aquæ destillatæ f℥viij. Misce. (*Mackenzie.*)

264. *Opiate Collyrium.*—℞ Zinci sulphatis gr. xij (*vel* liquoris plumbi diacetatis f℥ss); liquoris opii sedativi f℥ij; aquæ destillatæ f℥xij. Misce.

265. *Stimulating Liniments.*—℞ Liquoris ammoniæ f℥j; linimenti camphoræ (*vel* linimenti camphoræ compositi) f℥j. Misce, fiat linimentum.

℞ Tincturæ capsici f℥ss; linimenti saponis f℥ss. Misce.

266. *Chilblain Liniment.*—℞ Tincturæ cantharidis f℥ij; linimentis saponis f℥ix. Misce, fiat linimentum. (*Wardrop.*)

267. *Opiate Liniment.*—℞ Tincturæ opii f℥ss; linimenti saponis f℥j. Misce.

268. *Belladonna and Glycerine.*—℞ Extracti belladonnæ, glycerini, āā Misce.

269. *Anodyne and Camphor Liniment.*—℞ Camphoræ ℥ij; spiritus rectificati ℥ij; glycerini ℥j. *A capital soothing rubefacient for chronic rheumatism and neuralgia.*

270. *Mercurial Liniment.*—℞ Unguenti hydrargyri fortioris, adipis, āā ℥iv; camphoræ ℥j; spiritus rectificati f℥j; liquoris ammoniæ f℥iv. Misce.

271. *Croton Oil Embrocation.*—℞ Olei tiglii guttas xxx; linimenti saponis f℥ss. Misce.

272. *Bismuth and Glycerine Liniment.*—℞ Bismuthi trisnitratis in pulverem subtilissimum redacti semiunciam; *glycerine* quantum satis sit ut fiat linimentum.

273. *Tannin with Glycerine.*—℞ *Glycerine* ℥xv; tannin ℥iij. Misce. *In vaginitis. If diluted with twice the quantity of glycerine, it may be used as an injection in gleet, and as an application in suppurative conjunctivitis.*

Glycerine may be combined with tincture of iodine, creasote, borax, and almost any other liquid. The solid *glycerate of starch* is a capital basis for ointments, and may be substituted for lard or other fat. It is more penetrating and dries less; and is a convenient medium for calomel, red precipitate, and other mercurial salts.

274. *Glycerate of Starch.*—Heat together 6 parts by weight of starch and 30 of glycerine, in a porcelain vessel, over a water bath, stirring till the starch is completely gelatinized. Another formula is 85 parts of glycerine, 5 of starch, and 10 of water. The result ought to be transparent, gelatinous, and soft.

275. *Carbolic Oil.*—℞ Acidi carbolici gr. xlviij; olei olivæ ℥iv. Misce.

277. *Antiseptic materials.*—We must carefully distinguish between truly antiseptic substances which prevent fermentative processes by destroying germs or by inhibiting their development, and deodorizing substances which absorb fresh gases or substitute one smell for another. The latter are useful when foul smells are present, but their presence is rarely excusable.

Carbolic acid is best kept as a syrupy fluid, formed by adding one-twentieth of its weight of water to the crystallized acid, or the crystals may be melted by heat and the fluid acid measured. *Lotions* are used of 1 part in 20 and 1 in 40; they should be perfectly clear; turbidity or undissolved drops mean impurity or excess of the acid, in either case a very irritant application. *Carbolic oil* is used 1 part in 5 for foul ulcers, 1 in 10 for dressing about the anus, penis, etc., and 1 in 20 for catheters. These solutions may be made with glycerine. The lotions are much more effective. *Carbolic gauze* is too well known to need description.

Perchloride of mercury is the most powerful antiseptic at our disposal. Solutions of strength 1 in 500, and 1 in 2000 are commonly employed; instruments must not be placed in them. Sublimated wool (½ per cent., glycerine 5 per cent.) has been used by V. Bruns; gauze also was tried, but proved very irritant; Lister suggested combining the perchloride with the albumen of horse's blood serum as less irritant, but the serum sublimate gauze has given way to alembroth wool and gauze, also introduced by Lister. *Sal alembroth* is the Arabic name of a double chloride of ammonium and mercury.

Salicylic Acid lotion is a saturated solution: an *ointment* is made with paraffin (2 parts) and vaseline (1 part) as a basis of strength varying from 1 in 30 to 1 in 8: a *cream* made by adding salicylic acid to glycerine till the consistence of cream is reached is very useful in preventing carbolic eczema. Salicylic wool is made 3–10 per cent.

Boracic lotion is a saturated solution; *boracic lint* is steeped in a saturated boiling solution of the acid and then dried; the *ointment* is made like the salicylic of strength 1 in 5: in dusting powders, boracic acid ʒj ad ℥j is very useful.

Chloride of zinc lotion contains 20–40 grains to the ounce, and is used for sponging septic wounds—*e. g.*, sinuses after they have been sharpspooned. Even the stronger solution does not prevent primary union, and it certainly delays putrefaction.

Eucalyptus gauze is used in place of carbolic diluted with ol. olivæ; it has been tried as a dressing.

Thymol lotion, a saturated solution.

Acetate of Alumina lotion 2½ per cent.

Sulphurous Acid lotion varies from equal parts of the acid (B. P.) and water downward.

Permanganate of potash to be efficient should be of the strength 5 per cent. (gr. j. ad ʒj).

Iodoform is used chiefly in crystals or powder; the former always when any large surface is to be dusted. Iodoform wool is not commonly used in England.

Section XI.—Poultices.

N.B. Before applying any poultice, it is well to smear the skin with glycerine in order to prevent particles from sticking.

The impermeable spongio-piline is a good and clean substitute for poultices; and like them may be made the means of applying carbolic acid, creasote, opium, etc.

Fomentations may be made by steeping flannel (3 or 4 layers thick) or spongio-piline in boiling opiate or belladonna lotion, F. 238, etc., and wringing it as dry as possible in a coarse towel or special wringer; they should be applied as hot as can be borne and covered with oiled silk, cotton-wool, and a silk handkerchief. They are much cleaner than poultices and are always to be preferred in cases of wounds. Fomentations of boracic lint are a valuable antiseptic dressing.

281. *Bran Poultice.*—Make a linen or flannel bag of the size requisite to cover the part affected, and fill it loosely with bran. Pour boiling water on this till it is thoroughly moistened, and wring it dry in a coarse towel; apply as soon as it is cool enough.

282. *Bread Poultice* consists of bread crumb, without lumps, steeped in boiling water and spread thickly on linen. It does not retain heat well, and should not be applied to raw surfaces.

285. *Mustard Poultice.*—Is best made by mixing flour of mustard with warm (not boiling) water. Rigollot's *mustard leaves*, or *charta sinapis*, P. B., are very convenient.

286. *Opiate Poultice.*—Poultices medicated with conium, or belladonna, or poppy, may be easily made by adding some of the extract to the bread poultice.

Scald a basin; pour into it sufficient boiling water for the poultice, and scatter the meal into this with the left hand whilst whipping the water briskly with a spatula in the right; continue until the mass is smooth, coherent, and no longer sticky. Then spread it (about a quarter of an inch thick) on soft linen of sufficient size.

288. *Charcoal Poultice* is made by stirring an ounce or more of powdered wood charcoal into a linseed meal poultice. Sometimes placed on a colotomy wound, but an oakum fomentation is better.

Section XII.—Ointments.

N.B. The glycerate of starch, F. 274, or glycerine pure, or the benzoated lard, or a compound of wax and olive oil, P. B., or vaseline may be substituted for *adeps* in most of the following ointments with benefit.

301. *Scott's Ointment.*—℞ Unguenti hydrargyri fortioris, cerati saponis, āā ℥j; camphoræ pulverizatæ ʒj. Misce.

302. *Tartar Emetic Ointment.*—℞ Antimonii potassio-tartratis ʒj; adipis ℥j. Misce.

303. *Ointment for Piles.*—℞ Pulveris gallæ ʒj; liquoris plumbi diacetatis ♏xv; adipis ℥j. Misce.

℞ Pulveris opii ℈ss; liquoris plumbi diacetatis guttas x; adipis ℥ss. Misce. The *suppositorium plumbi compositum*, P.B., is a useful form.

304. *Creasote Ointment.*—℞ Creasoti guttas quadraginta; unguenti resinæ, adipis, singulorum unciam. Misce.

305. *Carbolic Acid Ointment.*—℞ Acidi carbolici gr. x–xxx; adipis benzoati unciam. Misce. See *Carbolic Oil*, F. 275.

306. *Carbolic Acid Putty* is made with liquefied carbolic acid 2 drachms; linseed oil 1 oz.; prepared chalk 4 oz. well mixed.

307. *Peruvian Balsam Ointment.*—℞ Balsami Peruviani ℥j; unguenti cetacei ℥j. Misce.

This and the two foregoing, like the old elemi ointment, are good stimulating applications to indolent and sloughing ulcers; but the creasote ointment is the best. It is good also for piles.

308. *Chalk Ointment.*—℞ Cretæ preparatæ ℥j; olei olivæ ʒiij; adipis ℥ss. Misce. *For burns, excoriations with acrid discharge, etc.*

309. *Bismuth Ointment.*—℞ Bismuthi nitratis ʒij; adipis ℥vj. Misce. *A capital ointment for excoriations and irritable sores.*

310. *Magnesia Ointment.*—℞ Magnesiæ carbonatis ʒj; adipis ℥j. Misce. (*Mr. Partridge.*)

311. *Ointments for the Eyelids.*—℞ Unguenti citrini (*hydrargyri nitratis*) ʒss; adipis f℥ss. Solve leni calore.

℞ Liquoris plumbi diacetatis guttas x; morphiæ acetatis gr. iv; calomelanos gr. x; adipis ℥ss. Misce.

312. *Ointment of Nitrate of Silver*.—℞ Argenti nitratis gr. iv; adipis bene loti ℥ss. Misce.

313. *Calomel Ointment*.—℞ Calomelanos ʒij; adipis ʒvij. Misce. *In chancre, condylomata, etc.*

314. *Ointment of Mercury with Opium*.—℞ Unguenti hydrargyri fortioris unciam; extracti opii grana quadraginta. Misce. *For painful nodes.*
N.B. Extract of belladonna may be substituted for or combined with the above.

315. *Green, or Verdigris Ointment (Pharm. Ed.)*.—℞ Cupri acetatis ʒj; cerati resinæ ℥j. Misce. *For flabby ulcers, warts, indolent eruptions, etc.*

316. *Goulard's or Compound Lead Cerate*.—℞ Liquoris plumbi diacetatis fʒiij; ceræ ℥iv; olei olivæ octarium dimidium; camphoræ ʒss. Melt the wax, and add gradually to it the oil, in which the camphor has been previously dissolved; as they cool, add the liquor plumbi, stirring continually till well mixed.

317. *Red Precipitate Ointment*.—℞ Hydrargyri nitrico-oxidi optime pulverizati, ʒj; adipis ℥j. Misce.

318. *Chloroform Ointment*.—℞ Chloroform 1 part; lard 2; blend quickly by trituration. (*Squire.*) *In itching, as pruritus ani, etc.*

Section XIII.—Miscellaneous Prescriptions for Various Surgical Diseases.

331. *Remedies for Vomiting*.—In case of obstinate vomiting, the stomach should receive for a few hours nothing but water by teaspoonfuls, or small lumps of ice, and the patient should be fed by enema. The remedies known by experience to have most effect in checking vomiting are: Hydrocyanic acid, a drop of creasote in a pill, one-tenth of a grain of strychnine in a pill, bismuth in a large dose, and the white draught of carbonate and sulphate of magnesia. The food most easily kept down is cold chicken broth by spoonfuls, or iced soda and milk.

332. *Arnica*.—℞ Tincturæ arnicæ ℥j. Dose, ♏xv-xxx. *In nervous headache, tinnitus aurium, and as a local application for muscular stiffness after bruises. Dr. Garrod thinks that the effect of arnica in causing absorption of a bruise is precisely that of the spirit contained in it, and no more.*

334. *Remedies for Toothache*.—℞ Mastiches ʒj; spiritus rectificati (vel *Eau de Cologne*) ℥jss. Solve. *Cotton imbued with this forms a good temporary plug for a carious tooth. The same purpose is answered by a solution of gum copal in ether, or by collodion, or by a solution of gutta-percha in chloroform.* See Tomes's Lectures.
Æthereal Tincture of Tannin.—℞ Acidi tannici ʒj; mastiches ʒj; ætheris sulphurici ℥j. Misce.
Camphor with Chloroform.—℞ Camphoræ ʒj; chloroform ℥ss.
Pure carbolic acid, liquefied by warmth or the addition of a little warm water, carefully applied on a morsel of wool.
Cocaine, 4 per cent., introduced into the cavity.
These are excellent applications for the cavity of a tooth or an exposed nerve.
To make a Metallic Amalgam or Cement to fill Decayed Teeth.—Rub together in a mortar some silver, reduced to a fine powder by filing or by precipitation, with a few globules of mercury. When well mixed into a paste, knead it well with the fingers, and squeeze out any superfluous mercury. Then, the cavity of the tooth having been properly scraped and dried, fill it with the amalgam, making the surface of the metal smooth and even with that of the tooth. The patient must be desired not to use the teeth for some hours, till the amalgam has become hard.
Stopping of Oxide and Chloride of Zinc.—"For temporary fillings, the various preparations of zinc oxychloride are exceedingly useful. Zinc oxide is mixed with a strong solution of zinc chloride into a thick paste, which after the lapse of a short time becomes perfectly hard."[1]—*Tomes.*
Gutta-Percha Filling.—"Gutta-percha, with which some mineral substance, such as powdered silver or glass, has been incorporated, makes a good temporary filling, capable of lasting for some months. A piece of suitable size must be taken and warmed over a spirit-lamp till the mass is softened. The cavity having been dried, the heated gutta-percha is introduced. It must not be too hot, but it must be sufficiently warm for the

[1] A System of Dental Surgery, by John and Charles S. Tomes (Churchill: London, 1873).

surface to be a little sticky, so that it may adhere to the surface of the cavity. To secure its adhesion, a good plan is to mop out the cavity with chloroform after drying it."

"Of all temporary fillings," says Mr. Tomes, "the preparations of gutta-percha are the most reliable, and where it is protected from the wear of mastication it is exceedingly durable."

325. *Demulcents for Gonorrhœa.*—The best of these is weak mutton broth, taken in great abundance. Besides these, the Liq. Potassæ mixture F. 155, and F. 156 without the bismuth.

336. *Copaiba.*—The best way of taking this is to swallow two or three gelatine capsules before a meal or at bedtime. Or twenty drops of copaiba may be made into an emulsion with half a drachm of Liq. Potassæ and an ounce and a half of water.

Cubebs should be taken in a large dose, one to two drachms, for two or three days only. F. 110 should be taken every morning during its administration.

Copaiba ♏x, pulv. cubebis gr. xx. Make into a bolus and swallow in wafer paper.

337. *Steel Mixture for Gleet.*—Take of tincture of perchloride of iron three drachms, spirit of nitrous ether six drachms, tincture of cantharides half a drachm, water to eight ounces. A sixth part to be taken twice a day.

338 and 339. *Uva Ursi and Buchu* are best administered as infusions, to be taken *ad libitum.* Both are of use in chronic catarrh of the bladder.

340. *Collodion, P. B.*, is made by dissolving 1 part of gun-cotton in 3 of rectified ether and 1 of alcohol. To make it flexible, add to an ounce of collodion 20 minims of Canada balsam, and three of castor oil.—*Squire*

Richardson's Styptic Colloid is made by saturating alcohol with tannin, then adding ether and gun-cotton.

341. *Mustard Bath.*—Put ¼ pound of mustard into a leg-bath; ½ pound into a hip-bath; and 1 pound into an entire bath. The water at 98°. *This is an admirable diffusive stimulant and remedy for internal congestion.*

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