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JULY, 1898

CURVATURE OF THE NECK OF THE FEMUR, SOME-TIMES CALLED "COXA VARA."

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# CURVATURE OF THE NECK OF THE FEMUR, SOMETIMES CALLED "COXA VARA."

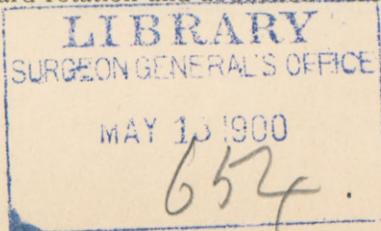
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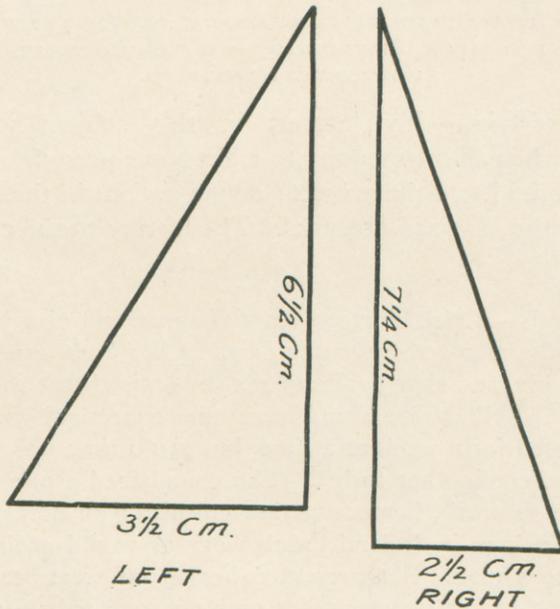
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*Introduction.*—My interest in this subject was first aroused when an opportunity to make some personal observations offered itself, the subject being a patient in the Surgical Clinic of the Howard Hospital. The history of the case is as follows:

CASE I.—A girl, nineteen years of age, about nine years ago began to be annoyed by vague pains in her limb, especially in the right hip, and shortly afterwards she noticed that she limped slightly. At times she would have mild exacerbations of pain, which lasted for a week at a time, but at no time was it severe enough to confine her to bed. She complained especially after a hard day's work, her occupation consisting in doing general work on a farm in Ireland; such work as would ordinarily be allotted to a man. She presented herself for treatment simply on account of her lameness, for now she suffered no pain. If she had been particularly active during the day, the affected limb would be more fatigued than the unaffected one. There was no history of trauma. Examination showed the right trochanter to be elevated  $4\frac{1}{2}$  centimetres above Nélaton's line, which passed over the tip of the left trochanter. The base of Bryant's triangle, on the right side, measured 3 centimetres, on the left 7 centimetres. The trochanter was displaced backward as well as upward. The pelvis slightly inclined to the right. The circumference of the right thigh was  $49\frac{3}{4}$  centimetres, the left  $52\frac{3}{4}$  centimetres. Inward rotation and abduction were restricted

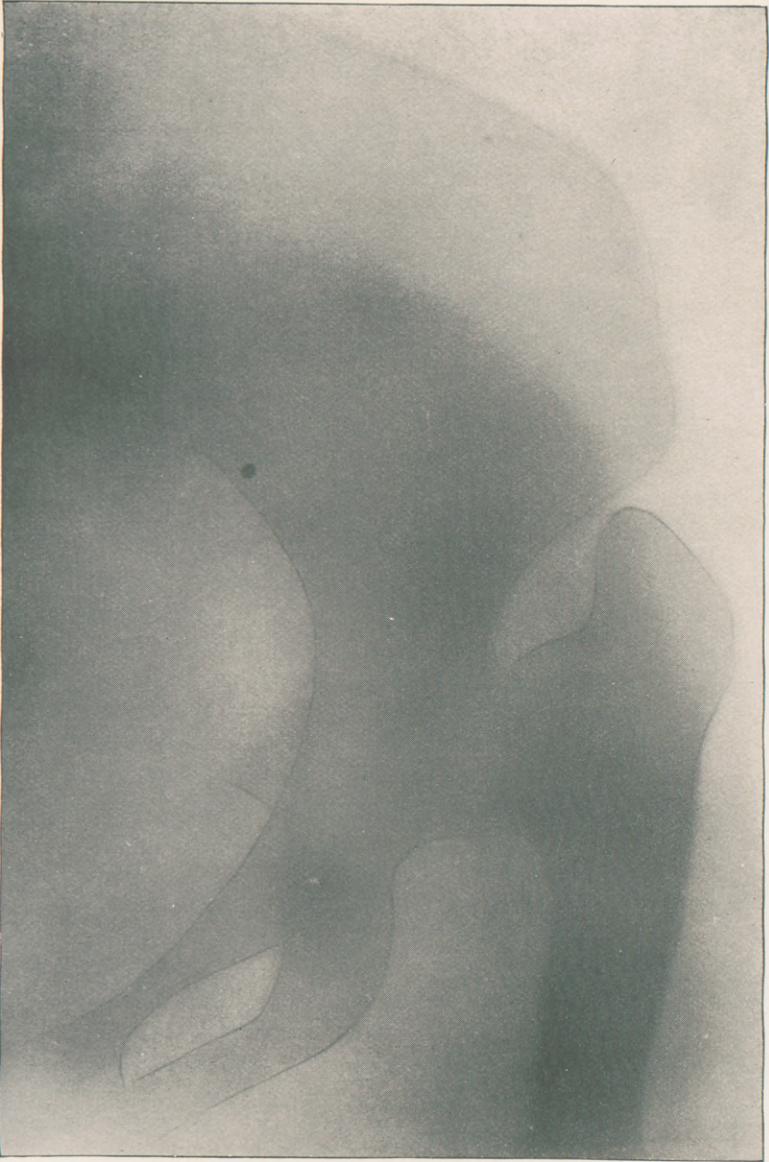


and flexion beyond 90 degrees was impossible, and was accompanied with adduction of the limb. The girl was exceptionally robust, of large bony frame, good muscular development, and presented no evidences of rickets. A diagnosis of curvature of the neck of the femur was made, which was confirmed by a skiagraph of the hip-joint, taken by Dr. Goodspeed, revealing the head of the bone in its normal position, but a marked deformity of the neck. (See skiagraph.) Inasmuch as there was only slight interference with the motion of the joint, and no pain, there was no indication for any course of treatment. The



patient was advised to provide herself with a high sole to be worn on the shoe of the affected side, to make up for the shortening, and thus improve her gait. It is highly probable that at the age now attained by the patient there will be no increase in the deformity, and therefore no necessity for restricting the use of the limb.

CASE II.—A child, eight years old, of German extraction, with a family history free from any hereditary taint that would have any bearing on the disease. About two years ago the child fell, but suffered no immediate inconvenience. Later on the



Skiagraph of the author's case.



mother noticed that the child in romping became more easily fatigued in the right limb than in the left. Such has been the history for the two years intervening between the fall and the present time. The child was admitted to the Surgical Ward of the Home for Crippled Children, and an examination revealed the following condition: The pelvis slightly inclined to the right; the right trochanter was 1 centimetre higher than the left, the base of Bryant's triangle measuring  $3\frac{1}{2}$  centimetres on the left side and  $2\frac{1}{2}$  centimetres on the right. The right trochanter was displaced somewhat backward as well as upward. The distance from the anterior superior spine to the external malleolus on the right side measured  $55\frac{1}{2}$  centimetres, on the left  $56\frac{1}{2}$  centimetres. The circumference of the right thigh was 33 centimetres, of the left 34 centimetres. The sulcus between the trochanter major and the nates was deeper on the right side than on the left. Passive motion was absolutely painless, but very much restricted. Flexion was almost entirely restricted. Inward rotation was not possible beyond a point where the foot pointed directly forward. Any attempt at flexion was accompanied with external rotation. In no way could pain be elicited either by direct or indirect pressure on the joint. In other respects the child was well developed. In walking she limped, favoring the right side.

Dr. Goodspeed kindly took a skiagraph for me, which reveals the following condition: On the affected side the angle of the neck is less obtuse than on the unaffected side. The distance between the tip of the trochanter major and anterior superior iliac spine is greater on the right than on the left, showing a displacement upward of the trochanter on the affected side. These facts correspond with the result of the examination as above described. Under complete anæsthesia the movements of the joint were found to be restricted, but to a less degree than above noted. Flexion was possible to 90 degrees, inward rotation and abduction were limited, and outward rotation abnormally free. This case illustrates well the fact that muscular rigidity is oftentimes responsible in these cases for some of the restricted motion.

*Nomenclature.*—The Germans have variously termed this affection "*Verbiegung*" or "*Verkrümmung des Schenkelhalses*,"

and "*Coxa Vara*," while in English literature we meet with the terms "bending" and "incurvation of the neck of the femur." Of the two latter terms, incurvation or curvature seems to me to be the most descriptive, implying, as it does, that the neck is actually curved, while the term bending might imply simply an alteration in the angle. There has been considerable dispute among the Germans over the adoption of the term "*coxa vara*," a term which, however, is used almost exclusively. Without entering into the details of the discussion, it has been generally acknowledged that the common interpretation of the term "*vara*" applies to only one of three recognized groups of this affection, and that therefore the phrase "*coxa vara*" should not be employed as embracing all the manifestations of this deformity. For this reason, and in order to avoid confusion and simplify matters, I should recommend the adoption of the term "incurvation" or "curvature of the neck of the femur" for all cases.

*History.*—Though the deformity of the upper extremity of the femur, known as incurvation of the neck of the femur, had been recognized and described as early as the middle of this century, it has not been until within the last decade that it has been the object of special study. As early as 1851 Zeis demonstrated a specimen showing distortion of the femoral neck, without any evidence of disease, and two years later Roser described a specimen, obtained at the autopsy of a patient, who died of phthisis, in whom a diagnosis of luxation of the hip-joint had been made ante-mortem; the post-mortem revealed the fact that the head was not displaced from its normal position, the distortion of the neck being accountable for the deformity. Later on, in the year 1857, Dr. Richardson exhibited a specimen, obtained from the dissecting-room of the Medical Department of the Pennsylvania College, showing deformity of the neck and head of the femur, which might have been mistaken for osseous union following intra-capsular fracture. The neck was so deformed as to form with the shaft an angle of 45 degrees, and, in addition, was shortened and increased in its antero-posterior diameter. Rich-

ardson regarded the deformity as a manifestation of rickets, although the remainder of the skeleton gave no further evidence of it. In 1886, Dr. Monks, of Boston, reported a case of "universal deformity of both hip-joints," which undoubtedly belongs to this category, but was considered by the author to be a manifestation of arthritis deformans. The patient was sixteen years of age, of German extraction, with no traces of rheumatic or other articular affections running through the family history. The onset of the disease began two years previously, with pain and stiffness in the right hip, involving in the course of three months the left hip. The thighs are recorded as being rotated outward, the trochanters displaced upward, the heads of the bones being considerably lower than the trochanters; motion in both hip-joints was decidedly limited; and as a consequence the gait was affected, the patient rocking the body from side to side as he walked. Associated with these symptoms were bilateral knock-knee and flat-foot, and poorly developed muscles of both thighs. This case was evidently one of "bilateral curvature of the femoral neck," and is referred to simply as an instance of how recently the disease passed unrecognized. Keetley, of London, had under his care, in 1888, a case exhibiting this deformity. Not until the parts were exposed at the operation, at which he removed a cuneiform section of the femur, was the true nature of the deformity appreciated. On account of the scoliosis, which was also present, the history of slow development, and the presence, in the specimen excised, of such pathological changes as one meets with in rickets, the case was regarded as one of rhachitis adolescentium, in spite of the fact, as Keetley himself admitted, that he had never seen a case of rickets in young adults in which the upper extremity of the femur alone had been attacked. This brief history brings us up to a period when incurvation of the femoral neck first began to be recognized as a deformity with definite clinical signs. To the writings of Hofmeister and Kocher we are indebted for a large portion of all the information which literature furnishes us on this subject. At the present day

the clinical manifestations are clearly understood, and may readily be recognized if one be familiar with them. The modern text-books, however, in many cases do not even mention the subject; while others treat it so superficially that it is my impression that, generally speaking, the medical profession at large are not very, if at all, familiar with even the fundamental facts, and in many cases are not even conscious of the existence of such a deformity. To those who have given it the most careful study the subject still presents many difficulties, and there are many points over which there is still some discussion. As mentioned above, the clinical manifestations are now clearly understood by those who have made it their special study; so, too, are the pathology, the nature, and the mechanism of the deformity, and, perhaps, the treatment. The exact etiology of the disease, however, is still a mooted question. When one considers that but few specimens have been obtained from authentic cases, an explanation at once suggests itself, which will account for the still somewhat indefinite knowledge of certain phases of the subject. Since the valuable and exhaustive papers of Hofmeister and Kocher (in 1894) but little that can claim originality has appeared in literature. Hofmeister in 1894 collected and tabulated some forty cases, all that had up to that time been reported, and from that to the present the writer has been able to gather from literature about forty more. It is not the object of this paper to advance new theories or to furnish original ideas, except in so far as a careful study of the data furnished by those forty additional cases may throw some additional light on one phase or the other of this subject, or may modify somewhat the clinical picture as handed down to us from the earlier writers. The aim of this paper is rather to present the subject in such a way as can be made possible only by a comprehensive study of all the literature pertaining thereto.

*Clinical Picture.*—The earliest manifestations of this deformity make their appearance rather insidiously, usually at the beginning of adolescence, frequently without any apparent cause, exceptionally following some slight traumatism.

The young patient, it will be found, is usually following an occupation that requires him to be on his feet continuously during working hours; it is often his duty to carry heavy weights. The very first thing he notices, perhaps, will be that he is more easily fatigued now than aforesaid; a task which he could formerly perform without any sense of fatigue now wearies him. This slight inconvenience, however, is overlooked; he continues with the same daily occupation, but soon becomes conscious of vague pains about one or the other hip-joint; he is told they are growing pains and a liniment is prescribed. The pain, however, becomes severer, and soon he begins to limp, as a result of the shortening. Finally he finds that the motion of the joint is more or less restricted, he is unable to stoop over, and cannot assume the sitting posture without difficulty. This is the clinical picture of a moderate case. The time required for these symptoms to become so aggravated that the patient seeks medical advice varies. It may be one year or it may be many more, as in the author's case; as a matter of fact, in thirty-five out of seventy-five cases the patient came under the physician's observation within two years of the onset of the disease. There may be certain variations from the typical case, as above described. In some pain is the predominant symptom, the functional activity of the joint being limited but to a slight degree, and again in others the condition is reversed. The pain, as a rule confined to the region of the hip, but occasionally radiating to the knee, is of rather a dull aching character, quite unlike that accompanying inflammatory diseases of the bones and joints. It is present when the patient is in active motion, walking or running, or simply in changing his position, as, for example, from the standing to the sitting posture. In a certain proportion of the cases, if the limb be allowed to remain in one position for any length of time, there will be some stiffness noted immediately on any attempt at motion. The alteration in gait depends upon several factors. Primarily the patient limps because one limb is shorter than the other, as a consequence of the bending of the femoral neck; later on, however, the restricted

motion in the joint is an additional factor. The greater the shortening and the more restricted the articular motion the more conspicuous the limp. When the affection is bilateral, which was the case in nineteen out of seventy-four cases, the gait is quite characteristic, and has been termed the waddling gait; the patient swings one leg in front of or across the other as he walks, his body swaying from one side to the other. Of course, there is a great variation in the degree of deformity, and consequently in the subjective disturbances. Some cases will be able to go on for years, regarding the deformity as but a slight inconvenience, while others are dependent upon crutches for locomotion or perhaps may be altogether bedridden. Occasionally the course of the disease will be interrupted with periods, when there will be an almost complete subsidence of the symptoms, the latter reappearing on the occasion of some slight trauma.

*Objective Symptoms.*—An examination of the patient will reveal further interesting facts. There is *usually* no relation between the physical development of the patient and the deformity. We find it as well in those who are well nourished, of large bony frame, and good muscular development as in those in which these conditions are reversed. In a certain number of cases the skeleton has not developed commensurately with the muscular tissue, and again in others there seems to be a general loss of muscular tone.

Atrophy of the muscles of the thigh on the affected side will be present in every case to a greater or less extent, according to the amount of functional disturbance of the joint and the duration of the affection. In some cases the difference in circumference between the two thighs will amount to seven centimetres. Hofmeister has called attention to a phenomenon that has not infrequently been noticed (a condition which Mikulicz refers to in his work upon the lateral deformities of the knee),—namely, the bluish red discoloration and chilliness of hands and feet on standing for any length of time with the arms hanging. An examination of the affected hip will recognize a dissimilarity in contour existing between

that and the sound one. This is due to the prominence of the trochanter, one of the most constant and most conspicuous objective signs. The trochanter major is almost without exception displaced upward, in many cases both upward and

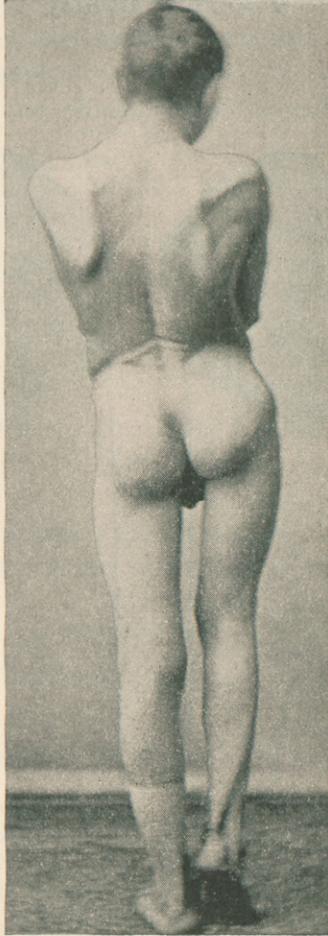


FIG. 1.—Showing prominence of trochanter. (Whitman's case.)

backward, and in not a few cases upward and forward. The displacement upward of the trochanter is accounted for by the bending of the neck on the shaft, so that the obtuse angle normally existing between the two is converted into a right

or more frequently an acute angle. If at the same time the neck is twisted on its long axis, either forward or backward, the displacement upward and forward or upward and backward is thus explained. The prominence of the trochanter is exaggerated by the muscular atrophy, which was referred to above. It is not rare to find between the trochanter and the prominence of the buttock a deep sulcus. (Fig. 1.)

This prominence of the trochanter can also be accounted

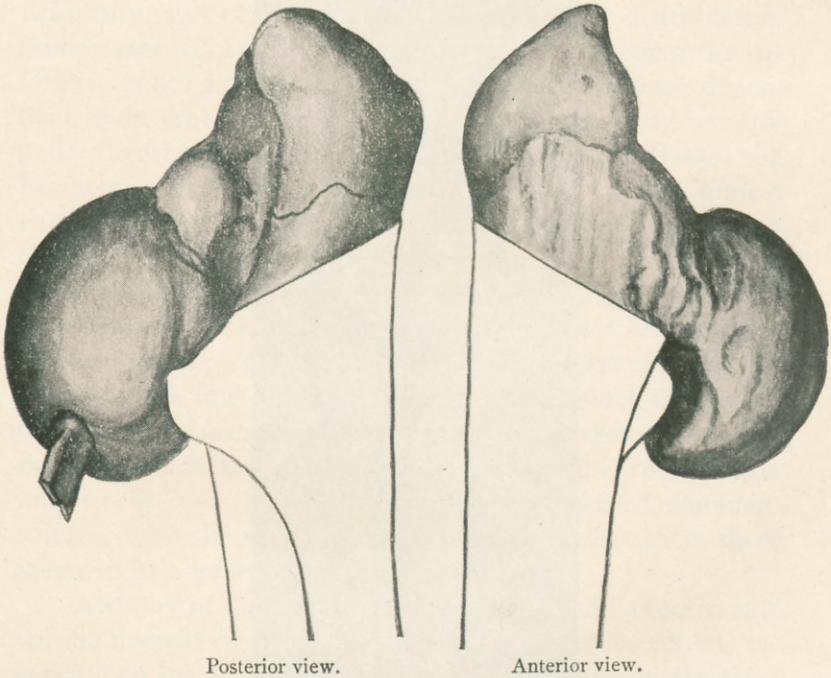


FIG. 2.—Showing deformity of neck. (From the specimen of Schultz.)

for by the elongation of the upper border of the neck of the femur, which takes place as a consequence of the arching of the neck,—a condition easily demonstrated by an examination of a specimen. (Fig. 2.)

The attitude which the affected limb maintains is quite conspicuous and quite characteristic; of sixty-eight cases in which the position of the limb was mentioned, in forty-three the position was that of outward rotation, six outward rota-

tion and adduction, in five outward rotation and flexion, in two inward rotation and adduction, in one adduction, and in one adduction and flexion. In eight the position was normal. Since, therefore, of sixty cases, in which the position of the limb was abnormal, outward rotation was present in fifty-four, we may look upon this unnatural position of the limb as an almost constant feature.

TABLE I.

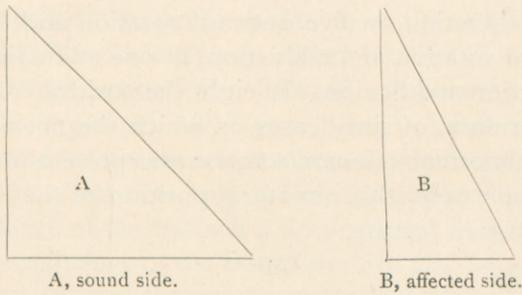
Position of Limb.	Hofmeister.	Frazier.	Total.
Outward rotation . . . . .	27	16	43
Outward rotation and adduction . . . . .	1	5	6
Outward rotation and flexion . . . . .	0	5	5
Inward rotation . . . . .	1	1	2
Inward rotation and adduction . . . . .	1	1	2
Adduction . . . . .	0	1	1
Adduction and flexion . . . . .	1	0	1
Normal . . . . .	5	3	8

The actual displacement of the trochanter major is easily determined by Nélaton's line, which, as is well known, normally passes over the tip of the trochanter; in the deformity with which we are dealing the trochanter occupies a position from one to seven centimetres above this line.

TABLE II.

Centimetres above Nélaton's Line.	Number.
One centimetre above . . . . .	11
Two centimetres and a fraction . . . . .	27
Three centimetres . . . . .	19
Four centimetres . . . . .	11
Five centimetres . . . . .	4
Six centimetres . . . . .	1
Seven centimetres . . . . .	3
Not stated . . . . .	12
Average . . . . .	2.7

Comparing Bryant's triangle in the sound with that in the affected side, in my own case, the dissimilarity is quite remarked.



To continue with the objective manifestations consequent to this bending of the femoral neck, there remains to be discussed the shortening of the limb, tilting of the pelvis, and compensatory scoliosis. Shortening of the limb naturally follows any approach to a right or an acute angle between the neck and shaft, and the degree of shortening is easily estimated by measuring from the anterior superior spine to the tip of the internal or external malleolus. Tilting of the pelvis and the compensatory scoliosis are natural sequelæ of the shortening.

The clinical picture would be incomplete without a reference to the limitation of motion, both active and passive, in describing which I will follow Hofmeister, who divides the cases into three general groups.

GROUP I.—Elevation of the trochanter and limited abduction are the characteristic features. The attitude of the limb is usually normal, flexion and rotation being either normal or limited to a slight degree.

GROUP II.—Elevation of the trochanter and outward rotation. In addition to the limited abduction, associated with cases in Group I, we find in this group that inward rotation is so restricted that it is impossible to rotate the limb farther inward than to a position in which the foot points directly forward. Outward rotation may be possible only to a normal degree, or so far beyond the normal that the patella and foot may point not only directly outward but backward. Abduction and adduction are as described in Group I, the former being markedly restricted or altogether abolished, the

latter entirely free. In the majority of cases flexion is unrestricted, except when attended with outward rotation and adduction of the thigh,—that is to say, if one attempts to flex the limb, he must at the same time adduct it and rotate it outward, or he will soon come to a point where further flexion is restricted. If the affection is bilateral, it is now easily understood why, when both thighs are flexed simultaneously, each leg will cross over its fellow. (Fig. 3.) The appearance of



FIG. 3.—Whitman's case.

such a patient is also quite characteristic, and it is commonly spoken of as the "scissor-legged deformity." The gait is not unlike that seen in cases of bilateral congenital luxation of the hip.

Through the co-operative effect of outward rotation and limited abduction in bilateral cases there exist certain characteristic restrictions in the movements of the legs. For example, such a patient can kneel only with the legs crossed. The explanation of that is apparent: flexion is only possible when the limb is rotated outward, and spreading of the thighs (which would obviate the necessity of crossing the legs) is

quite impossible, since abduction is restricted. For the same reason sitting on a stool with legs close together is impossible, and stooping over to pick an object off the ground is difficult. The *rationale* of this will be appreciated when, by voluntarily limiting abduction and rotating the limb outward, we try in our own persons to touch the floor with our hands. Such an act is only made possible by the preternatural mobility of the vertebral column. Of the three groups the large majority of cases belong to Group II; of fifty-five cases tabulated by Hofmeister, forty-four belong to this group, eight to the first and three to the last, now to be described.

GROUP III.—Elevation of the trochanter and inward rotation. The functional disturbances of this group correspond with those of Group II, with this exception, namely, in one we find inward and in the other outward rotation.

Kocher adds to this picture the extended position that the limb frequently occupies in this deformity. He believes too little stress has by others been laid upon this point, for upon its recognition will depend, in a measure, a thorough understanding of the development of the deformity.

*Mechanism.*—With the picture of this restricted functional activity of the joint fresh in our minds, a discussion of the mechanical principles here involved naturally follows.

(1) The limitation of abduction is perhaps the most easily explained. The direction of the neck is so changed in this deformity that the head is already in a position which it normally occupies when the limb is markedly abducted. Thus the excursion of motion in this direction has been entirely completed by the head and neck before an attempt to abduct the limb has been made. Whitman suggests another factor to account for limited abduction. The trochanter major is displaced so far upward that abduction is prevented by the trochanter striking against the ilium. When the inferior border of the neck becomes shortened by this curvature, the head is approximated so closely to the trochanter minor that any attempt at motion in the direction of adduction will force the trochanter minor against the head of the femur, and thus

limit adduction (Schultz's and Müller's specimens show this shortening of the under surface of the neck). The interference with rotation is in a measure due to the increase of the diameter of the neck from before backward, so that the neck impinges upon the acetabular rim when the limb is rotated. To explain the increased range of external rotation and the decreased range of internal rotation, Hofmeister constructed a model by sawing off the neck at right angles to its axis and attaching it again to the shaft in such a way that its relationship to the shaft corresponds to that found in this deformity. If now both femoral shafts are put in such a position that the patellæ are looking directly forward, or, in other words, in a position midway between inward and outward rotation, and the femoral heads are examined, on the normal side will be found as much articular cartilage exposed as is natural with the limb in this position; but on the pathological side but a narrow strip of articular cartilage will be exposed, only so much as would normally be found if the limb were in a position of inward rotation. This may be expressed in another way: While the head maintains its position normally present, when the limb is midway between inward and outward rotation, the shaft, owing to the backward bending of the neck, is at the same time occupying a position of more or less pronounced outward rotation. Consequently, when we attempt to rotate the limb inward, on reaching a point about midway between external and internal rotation the head has already reached the position of internal rotation, consequently further motion in that direction is limited. On the same line of reasoning it can be clearly understood why external rotation is apparently increased. As a matter of fact, the arc of rotation is, as a rule, less on the pathological side than on the sound side. It will be recalled that, in referring to the functional limitations of the joint, mention was made that oftentimes flexion was only possible when accompanied by external rotation. When the limb is moved in the direction of flexion (involving a revolution of the neck on its longitudinal axis) the articular surface of the head will soon

disappear in the acetabular cavity and the neck will impinge on the rim of the acetabulum, thus offering a mechanical obstruction to further flexion; if, now, the limb be rotated outward, the articular surface of the head will reappear from the cavity and further flexion rendered possible.

Before discussing the cause of the curvature and alteration in the angle of the neck of the femur, it will not be out of place to note some of the observations of Humphrey in the normal angle of the neck at different periods of life under various circumstances. (1) The angle varies considerably in different persons at given periods of life. (2) The angle naturally decreases during the period of growth (from foetal to adult life), but that after growth has been completed it does not usually undergo any change, even if life be continued to extreme old age. (3) During the period of growth if the limb be relieved from the weight of the body, as in the bedridden state, in paralysis or in a stump, the angle of the neck with the shaft usually retains the obtuse form of early life or may even become more obtuse.

*Etiology.*—The causation of this affection is a question which has provoked much discussion and speculation, and it has not yet been definitely settled just what the lesion is which, localized in the neck of the femur, permits of its yielding. There exist, no doubt, certain pathological conditions that would account for such an occurrence, as, for example, osteomalacia, chronic osteitis (tubercular, perhaps), arthritis deformans, or rickets. In fact, cases representing each of these have been published; Maydl reports two cases in which the specimens he resected were typical of arthritis deformans; Hofmeister reported a case of bilateral coxa vara, with all the characteristic functional disturbances, in a woman with advanced puerperal osteomalacia; Lauenstein's historic case, reported in 1888, gave evidence of marked rachitic deformities in many of the long bones. Despite these examples, there exists a certain number, constituting no mean proportion of all the cases, in which the exact nature of the deformity has been recognized during life, but in which there were no

demonstrable lesions either of osteomalacia, rickets, or arthritis deformans. It is more with reference to this particular class that the determination of the etiology still remains unsettled. (Before proceeding further, it is better for our purpose to divide the cases into three groups,—the congenital, the infantile, and the adolescent.) This condition of uncertainty is partly to be accounted for by the trifling number of specimens that have been secured for examination, and when this number increases sufficiently to allow of a more thorough study, both macroscopically and microscopically, the final report of the pathologist may suggest the key to the situation. The number of specimens thus far obtained that furnish the material for our speculations is only 16: of these Kocher furnishes 2; Müller, 1; Lauenstein, 1; Richardson, 1; Rotter, 1; Schultz, 1; Kirmisson, 4 (the femoral from two congenital cases); Maydl, 4; and Keetley, 1. (No doubt other specimens exist, but, as far as I know, none have been examined with a view to determining the lesion accountable for the deformity.) Glancing at the pathological reports of these sixteen specimens, it is found that three presented evidences of rhachitic changes; six presented a practically normal structure; two the changes of arthritis deformans; in two there were changes not unlike those of juvenile osteomalacia. Our accurate knowledge of the pathology is confined, then, to examples of rickets, osteomalacia, and arthritis deformans; there still remaining some specimens in which the lesions of none of the aforementioned diseases are demonstrable. The majority of the writers on this subject, not all, agree, in so far as they admit, that some softening process, whatever its nature, must precede the development of the deformity, and most of them believe that in all cases of coxa vara infantum the process is rickets. As for those cases occurring at the time of puberty opinions differ. Müller and Lauenstein speak of the cause as a rhachitis adolescentium or the so-called "late rickets," which differs from the infantile form in that its manifestations are more or less localized and its course limited, claiming that in those specimens in which the structure was

found to be normal the rhachitic process had subsided, leaving no trace behind. Hofmeister is inclined to this view, calling attention to the influence of occupation upon the development of the deformity. Kocher, too, believes occupation to play an all-important part, but states that the presence of rickets in all cases is neither necessary nor possible. He sees in this connection an analogy between coxa vara adolescentium and genu varum adolescentium, as described by Mikulicz. Whitman distinctly states that rickets is not a *sine qua non*, but that the cause of the deformity is to be found among those of genu valgum, pes planus, etc. In the only adult case, which I have had the opportunity of examining personally, there was neither at the time of examination, nor, according to the history, previously any apparent sign of rickets. With a view to throwing some light on the question, I ascertained from the histories in what proportion of the forty tabulated cases there were evidences of rickets, with the following results: In twenty-three cases it was distinctly stated there were no signs of rickets, and in only five was the reverse the case, while in twelve no reference to rickets was made. It is safe to assume, however, that had rickets been present in those twelve cases, the histories would have contained some mention of it, so that we may reasonably state that but 12.5 per cent. of the entire group of cases belong to the rhachitic class. If we exclude from this calculation all those cases that might be strictly termed infantile, a group in the etiology of which rickets is generally recognized, we obtain these figures: of 26 cases there was only 1 in which rickets manifested itself, or 3.8 per cent.; of the 14 remaining cases 4 were congenital; leaving only 10 belonging to the infantile classes, and of these almost 50 per cent. did present evidence of rickets.

In substantiation of the views of Kocher and Whitman I find that in ten of the tabulated cases—*i.e.*, in 25 per cent.—there was associated with the deformity of the hip either genu valgum or pes planus, one or the other or both. In summing up the evidence as presented, the following conclusions may

be drawn. We recognize three classes of curvature of the neck of the femur: (1) Congenital; (2) infantile; (3) adolescent. (Fig. 4.) It is highly probable that in the majority of infantile cases the deformity is due to rickets, the presence of which is demonstrable in deformities of other parts of the bony anatomy; that in the so-called adolescent cases there is no demonstrable rhachitis, the real cause of the deformity being traced to some diminished resistance of the bone, the exact nature of which is still a matter of speculation.

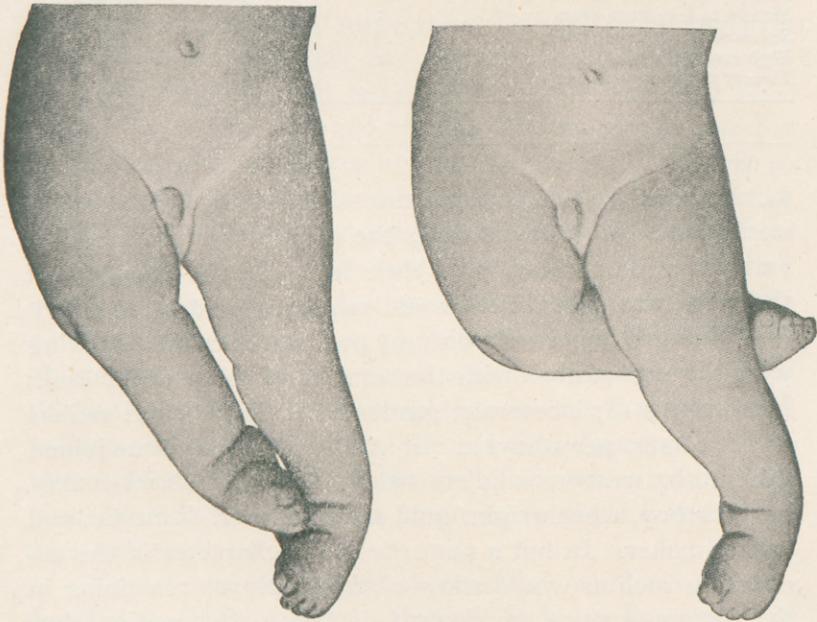


FIG. 4.—Coxa vara congenita. (Kredel.)

*Predisposing Causes.*—In Hofmeister's table of 40 cases, in 32 the onset occurred between the ages of twelve and nineteen. The statistics of Hofmeister coupled with my own give 48 cases between the ages of twelve and nineteen; 18 cases between the ages of six and eleven; 10 under six years and 2 over nineteen years. It is reasonable to assume from the above that the period of adolescence is a predisposing cause. Occupation is believed by many, and rightly too, to be an important

TABLE III.

	Hofmeister.	Frazier.	Total.
Congenital . . . . .	0	4	4
Two to five years . . . . .	1	5	6
Six to seven years . . . . .	2	3	5
Seven to eight years . . . . .	1	1	2
Nine to ten years . . . . .	1	6	7
Ten to eleven years . . . . .	1	0	1
Twelve to thirteen years . . . . .	3	0	3
Thirteen to fourteen years . . . . .	4	0	4
Fourteen to fifteen years . . . . .	3	8	11
Fifteen to sixteen years . . . . .	14	5	19
Sixteen to seventeen years . . . . .	5	6	11
Seventeen to eighteen years . . . . .	3	0	3
Eighteen to nineteen years . . . . .	1	0	1
Twenty to twenty-one years . . . . .	1	0	1
			78

factor, and if we turn to those cases developing at this period, we find that in most instances the occupations required the patients to be constantly on their feet, and the character of the labor was that which would require considerable effort. Combining Hofmeister's with my own statistics the following were the occupations with the number of cases under each: Farm-hands 18; laborers 4; gardeners 2; dairymen 2; millers 2; brewers 2; news-boys 2. In addition there was one joiner, locksmith, weaver, saddler, baker, shop-girl, brick-maker, grocer's boy, wheelwright, gold-smith, furrier, domestic, and basket-maker. In but a minority is the character of the occupation such as would allow of the employee remaining in the sitting posture any length of time. Occupation thus would seem to be a predisposing cause. So too, probably, sex in so far as the male sex are engaged in the more severe occupations. Referring to the statistics, 70 per cent. occurred in males and 30 per cent. in females. The right and left limb seem to be affected with the same frequency, as the following figures show: Right leg 27, left leg 28; bilateral 19.

There remains yet to be considered one more factor,—namely, trauma. In not a few cases traumatism preceded the onset of the deformity; in some cases it seemed only trifling,

TABLE IV.

Sex.	Hofmeister.	Frazier.	Total.	Percentage.
Male . . . . .	31 77.2 per cent.	24 61.5 per cent.	55	69.6
Female . . . . .	9 22.0 per cent.	15 38.5 per cent.	24	30.5

but the resulting disability was so pronounced that the patient became disabled, and a fracture or dislocation of the upper extremity of the femur suspected. Trauma, occurring in a case where the deformity had already developed, often excited exacerbations and temporarily caused increased disability. To occupation and trauma Whitman adds another factor,—namely, predisposition to deformity. It seems to me not at all improbable that a disproportion between the weight of the patient and the size of the bones furnishes in some cases a clue to the situation. As Humphrey pointed out, the angle of the neck is constantly changing during the period of growth, and that this change is due chiefly, if not altogether, to the superimposed weight of the trunk. With this in mind, it is not unreasonable to assume that in a heavy patient, with slender bones, the existing disproportion between the body weight and the size of the bones may predispose towards the formation of an acute angle between the neck and shaft.

Kocher and Hofmeister explain the evolution of the deformity in different ways. Hofmeister holds the weight of the superimposed body accountable for the downward displacement of the head and neck. This may be mathematically explained by the law of the parallelogram of forces, one force acting in the direction of the neck tends to foreshorten it, another, acting at right angles to the first, tends to draw the neck downward. The nearer the neck approaches to a right angle, the greater will be the power of the second component force. (See Fig. 5, C.)

Practically, therefore, the deformity, when once started,

supplies itself with the physical elements sufficient for its further development. The bending downward of the neck is due, therefore, to the weight of the superimposed body, while backward displacement of the neck is caused by the traction of the muscular group attached to it.

Kocher agrees with Hofmeister only in part. He believes the body weight to be a factor in the displacement of the head, but the backward displacement and, in a measure, the downward displacement, he believes to be due to the traction of the Y-ligament. This is brought about by the loss of muscular tone, the muscular relaxation that is associated with this class of patients. The muscles relax and the trunk is

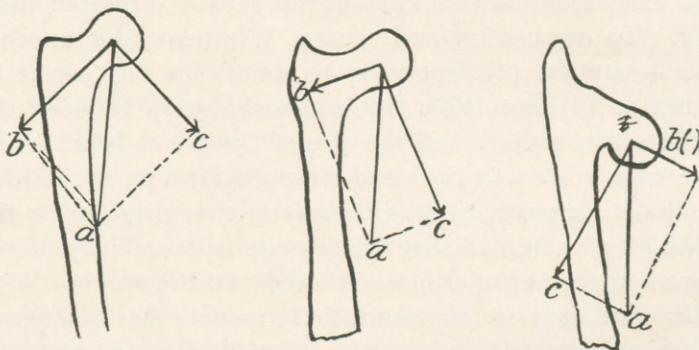


FIG. 5.—Diagram of Hofmeister.

suspended through the medium of the ligament which is thereby put on the stretch and drags the head downward and backward, simultaneously approximating the head to the posterior surface of the neck. This explanation differs from Hofmeister, who claims the backward displacement to be due to muscular traction on the great trochanter.

*Pathology.*—The number of specimens that have from time to time been removed at operations or on the post-mortem table are so few that our knowledge of the pathology is necessarily limited. A brief abstract will be given of reports of all specimens that have up to this time been removed, and from a general review of these we may be able to select the salient points that have hitherto been observed.

Richardson's specimen exhibited a deformity of the neck and head of the femur, which might have been mistaken for osseous union following fracture. The neck of the specimen was so depressed as to form with the shaft an angle of 45 degrees, much shortened and increased in its antero-posterior diameter.

Very little information can be obtained from the description of Monk's specimen. The trochanter is described as occupying a position higher and farther forward than normal, and the heads of the bones are considerably lower than the trochanters.

An examination of the wedge-shaped section of bone removed from the upper epiphyseal region of the femur by Keetley shows such changes as one finds in rickets. Keetley remarked that he himself had never seen a case of rickets in young adults, in which the upper extremity of the femur alone had been attacked.

Müller is, perhaps, the first to have given a detailed description of the gross appearances and altered structure of his specimen. The upper margin of the neck in his specimen is lengthened, and the distance from the tip of the great trochanter to the cartilaginous margin of the head is about  $3\frac{1}{2}$  centimetres less than normal. The upper border of the neck forms a slight convexity, while the lower border is concave. The distance from the lesser trochanter to the margin of the head is  $2\frac{1}{2}$  centimetres less than normal. The epiphyseal line appears as a thin streak; the line of separation between the diaphysis and epiphysis being easily recognized by the arrangement of the trabeculæ.

*The Structure of the Bone.*—There is thickening of the so-called Adam's arch, and the compact structure on the inner side of the neck has attained a thickness of  $1\frac{1}{2}$  centimetres; it changes suddenly to the spongy, unlike the normal condition in which the transition is gradual. There is a deviation from the normal in the arrangement of the trabeculæ. In the normal bone the most dense trabecular reticulum is between Adam's arch and the upper circumference of the articu-

lar surface of the head passing through the *under* and *inner* part of the neck. To the outer side of this the trabeculæ are more loosely arranged. In the pathological specimen the arrangement of the trabeculæ are quite different, here the trabeculæ are most dense on the *upper* and *inner* portion of the neck, while in the under and inner part the trabeculæ are less compact. There is no recognizable variation from normal in the consistence of the bone, nor on the surface of the bone or articular cartilage. The microscopical examination showed no specific changes.

Lauenstein's specimen was removed from a rhachitic subject six years of age. The neck formed a right angle with the shaft on both sides; the trochanteric epiphysis took a horizontal course, while the epiphysis of the head of the bone was directed upward and inward, or, in other words, in a vertical direction. The under border of the neck is very much shortened. On both sides the neck shows an abnormally great thickness, when compared with the thickness of the shaft or the relative thickness of the other bones. Especially characteristic of rickets are the thick lines of ossification, wider medullary spaces, and the presence of islands of cartilage scattered through the medullary tissue. On cross section both bones presented a thickened Adam's arch. The necks form an angle with the shaft of 36 degrees. Lauenstein believed that this specimen undoubtedly showed an underlying rhachitis.

Schultz furnishes us with a rather detailed description of his specimen, in which, however, he found no distinct rhachitic changes; the inferior surface of the neck is very much shortened, and is marked by a slight concavity, measuring only one-half centimetre. On the other hand, the superior surface of the neck is longer than normal, and is represented by a convexity. From the posterior aspect it is seen that the *linea intertrochanterica*, passing obliquely from above outward to below inward, approaches the posterior boundary of the head, so that a continuation of this intertrochanteric line (which ordinarily terminates in the trochanter minor) will ex-

actly intersect the lower half of the line forming the posterior boundary of the head. The neck is unusually broad, and is bent not only downward, but downward and backward. There is a change both in the shape of the head and in its relation to the neck; the normal femoral head represents two-thirds of a sphere, while a cross section of this specimen shows the head to be but one-third its normal size. Normally the spherical surface of the head is directed upward, but in this specimen it is more in the direction inward than upward, so that the view from behind overlooks a larger area of articular surface than can be seen from the anterior aspect. The epiphyseal lines are normal in every respect, with the exception that their direction instead of being horizontal is vertical. The position of the head and neck is that occupied normally by the limb in the position of abduction. Instead of only the articular surface of the head, there is in addition the greater part of the upper surface of the neck in contact with the acetabular rim. This portion of the neck resembles the cartilage-covered head and has moulded itself to the shape of the superior portion of the acetabulum.

*Changes in the Structure.*—Normally the density of the bone in the head and neck varies according to whether or not it occupies a position in the line of direct pressure. In that portion to which the weight is directly transmitted the osseous tissue is dense, while in the remaining portion the structure is more loose. Since the direction of the neck has changed and with it the direction of the line through which the weight is transmitted, that portion occupied by the densely arranged bony tissue occupies an area differing from that found in the normal bone. Apart from these changes in the bony structure, there are no demonstrable pathological lesions either on the surface or interior of the cartilage or bone.

Kocher has contributed to the literature of the pathology of this deformity a description of two preparations. Case I: On cross section the bone showed normal cancellous tissue; the neck of the femur is twisted downward and backward

around its transverse axis, and outward and backward around its vertical axis, thereby appearing from before backward thinner than normal. The neck is from three to four centimetres longer, and presents a marked convexity forward. The articular cartilage is present throughout, but in some places is attenuated, so much so that the cancellous tissue can be seen through it, and is even in some places exposed. Towards the neck the cartilage appears irregular, its irregular edges projecting beyond the head in the shape of an umbrella. The cancellous tissue beneath the cartilage is exceptionally loose, having large medullary spaces. Case II: On cross section the cancellous tissue appeared unchanged, except immediately beneath the areas in which the articular cartilage was attenuated, when the tissue was less compact. The epiphyseal line is in the upper portion plainly not broadened, but somewhat irregular. In the middle of the bone are several areas of cartilage separated from each other by cancellous tissue. There is no granulation tissue present. On cross section the trochanter appears normal, the cancellous tissue a bluish red. On the upper circumference, about three centimetres from the epiphyseal line, is the beginning of the more compact part of the neck. In the acetabulum and in the neck, at the attachment of the capsule, the capsule is somewhat injected and swollen.

Maydl described four cases, two of which presented lesions of arthritis deformans. Case I: The head was exceptionally flat and broadened. The surface and circumference of the head are studded with osteophytes, about the size of beans. The cartilage is present throughout, but attenuated. Case II: The head was not spherical but quite flat. There are no remains of the ligamentum teres. The articular surface is enlarged, measuring 8 centimetres horizontally and 5 centimetres vertically, and its border is covered with stalactitic osteophytes. The cartilaginous layer is thin; on cross section it is seen that at the epiphyses there is a remnant of bony tissue two to four millimetres thick. The areas of absorption project beneath the epiphyseal cartilage to a depth of three-

fourths millimetre into the medullary tissue, in which calcareous and osseous detritus are deposited without any definite arrangement. Case III: The head and neck are bent forward and downward, so that the superior and posterior surface of the neck glides over into the corresponding part of the head, while between the head and the neck there is a furrow three centimetres deep. The anterior and inferior portion of the head articulates no longer with the acetabulum, but is displaced forward beneath the anterior and inferior surface of the neck, and the inner surface of the femur just at the trochanter minor. The neck is flattened antero-posteriorly; on cross section it is scarcely one and a half centimetres thick. Vertically, however, the dimension is increased, measuring five centimetres. There is a double curve of the neck, somewhat concave forward in the inner half, and concave backward in the outer half. On the anterior superior portion of the line separating the neck from the shaft the osseous tissue is unusually compact. The structure of the tissue in the head and neck differs somewhat from the normal; the most dense cancellous tissue is found in the upper and outer portions; while in the remaining portion the trabeculæ have a less compact arrangement. There is no trace of an epiphyseal line. Case IV: The appearance of the head and neck and the location of the furrow correspond with the description of Case III. Through extension of the articulating surface backward its horizontal dimension is increased to 10.5 centimetres, the vertical to 7 centimetres. The superior surface of the head is convex, while the posterior is flat, smooth, and does not project on the neck. The inner half of the superior surface of the neck is convex, the outer half straight, and its diameter throughout shows no variation. In the lower portion of the head and neck the tissue is dense and compact, whereas in the upper portion the structure is the reverse.

Kirmisson examined a specimen which he removed from an infant at the post-mortem table. The femoral head was much enlarged and could hardly be contained within the articular cavity. Between the head and trochanter major, on

the anterior surface, there is a bony prominence separated from the head by a groove. The trochanter minor projects considerably on the posterior surface. The ligamentum teres was hæmorrhagic and the posterior part of the capsule very much attenuated. The histological examination of the bone was entirely negative. The following is a description of specimens removed from another infantile case by Kirrison. The femoral heads are slightly flattened and the posterior superior portion is separated from the anterior inferior by a small ridge. There is no arthritis or increase of synovial fluid. On the anterior surface of the neck, as in the other case, there was a small eminence, which on transverse section proved to be a thickening of the capsule at its attachment. The cartilage is perfectly normal. The trochanter majora are displaced backward. A histological examination of the femora was absolutely negative.

*Résumé of Pathology.*—An analysis of the description of all the specimens subjected to examination furnishes us with the following data: The gross appearances of the deformity show a marked similarity. The neck of the bone is bent downward and backward, its superior surface elongated and convex, its inferior surface shortened and concave. In the majority of cases the neck was flattened so that its antero-posterior diameter was diminished and its vertical diameter increased. In some instances there was a marked furrow at the junction between the head and neck, supposedly due to the pressure exerted by the rim of the acetabulum. Examination by a cross section of the bone revealed a departure from normal in the structure of the cancellous tissue; in the upper half of the neck the cancellous tissue was much more compact than in the lower half, a condition the reverse of that found in the normal bone. This has been explained by the fact that, when the neck is bent downward, the line, through which the weight of the superimposed body is transmitted, and which normally passes through the lower half of the neck, now passes through its upper half. (See Figs. 6 and 7, a cross section of a normal and abnormal bone.) With these exceptions

there was no change noticed in cancellous tissue except in two cases, when it was described as being unusually spongy beneath the articular cartilage. The tissue situated at the junc-

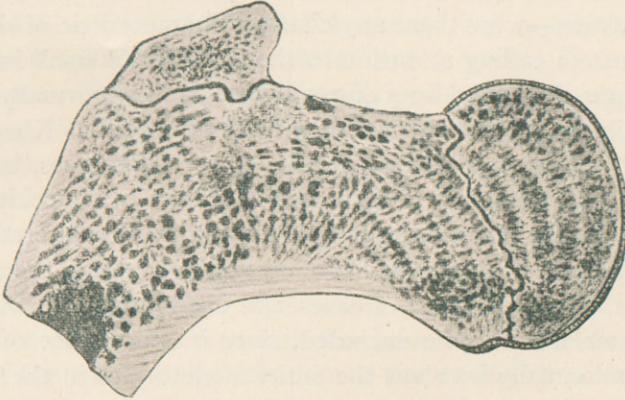


FIG. 6.—Normal bone, showing the structure more compact in lower portion of neck. (Schultz.)

tion of the neck with the shaft, or that portion known as Adam's arch, was in some instances more compact than nor-

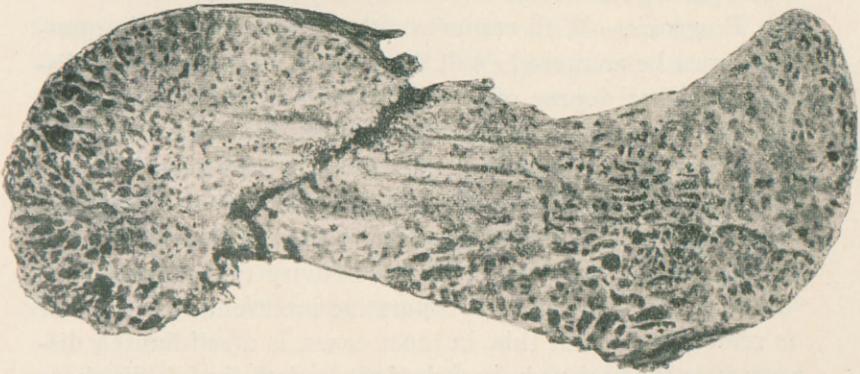


FIG. 7.—Head and neck from a case of coxa vara, showing more compact structure in upper portion of neck. (Schultz.)

mal. The epiphyseal lines, as a natural consequence of the deformity, had changed their direction, the trochanter epiphysis becoming horizontal and the epiphysis at the head ver-

tical. In one instance there was no trace of the epiphysis. There were practically no alterations in the articular structures,—that is to say, in the capsules, ligaments, and articular surfaces. In but two cases—namely, those of Keetley and Lauenstein—were there any changes characteristic of rickets, Lauenstein calling attention to the presence of small islets of cartilage, thickened lines of ossification, and abnormally large medullary spaces. It is a fact worthy of note that Kirmisson found no histological changes in either of his cases, both of which were congenital. In summing up the evidence, it must be concluded that whatever be the nature of the alteration in the structure of the bone that allows of its bending, the alteration is, in the majority of cases, not characteristic of rickets. Osteomalacia may be excluded, since it is a disease of adult life, and usually involves the entire skeleton, as in the single case described by Hofmeister. That there are numerous diseases of the bone that could cause the deformity,—*e.g.*, osteomyelitis, rickets, osteomalacia, chronic osteitis, arthritis deformans, etc.—is undoubted, but, up to the present time, the evidence does not admit of the acceptance of any one of these as the pathogenic factor in the majority of cases.

*Prognosis.*—With respect to the prognosis certain questions must be answered, Will the patient be permanently disabled? What degree of disability must be anticipated? etc. The first question is easily answered in the affirmative, because once the deformity has developed it can never be altogether rectified; there will always be a certain amount of shortening, which will at least make the patient walk lame. As regards the limited functional activity of the joint, this can be partially restored by operative intervention. It must be remembered that this, in most cases, is a self-limited disease; after the patient has reached the period of adult life there will be no increase in the deformity, and if we can rectify what deformity exists at this time, we can rightly expect that the results will be permanent. As regards the degree of permanent disability, this will altogether depend upon the amount of deformity present when the case comes under your observation. If it be slight, there is every reason to believe

the progress of the deformity will be checked, if appropriate treatment be carried out. If, on the other hand, the patient presents himself to you for the first time with a marked deformity, you can promise him improvement only through surgical intervention. Should treatment be neglected, the condition will usually go on from bad to worse, and, if the affection be bilateral, the patient may eventually be compelled to resort to crutches, since the resulting "scissor-legged deformity" makes locomotion difficult or impossible. In a small minority of cases, however, the patient seems able to carry on his or her daily occupation without increasing the deformity beyond a certain point. These remarks apply more especially to those cases of rhachitic and mechanical origin, but when osteomalacia or arthritis deformans are at the bottom of the trouble, the duration of the disease is unlimited, and the prognosis unfavorable.

*Diagnosis.*—It would not seem a very difficult task to make a differential diagnosis between this affection and other abnormal conditions about the hip-joint; nor is it difficult in the average case, if one is familiar with the course of its development and the history of the subjective and objective symptoms. As a matter of fact, however, in not a few of the cases that have been reported errors of diagnosis were made, some cases being mistaken for coxitis, some for congenital luxation, and others for impacted fracture of the neck, epiphyseal separation, and anterior subluxation. In many the diagnosis was not finally established until the exact nature of the deformity was disclosed at the operation. It is best to follow a systematic plan of investigation and examine the patient in regard to the following points:

- (1) Atrophy.
- (2) The position of the trochanter in relation to Nélaton's line.
- (3) The relative length of extremity, measured from anterior superior spine to internal or external malleolus.
- (4) Actual length of extremity, measured from the tip of trochanter to external or internal malleolus.
- (5) Extent of outward rotation.

- (6) Limitation of inward rotation.
- (7) Restriction of abduction or adduction.
- (8) Disturbances of flexion or extension.

When a case presents itself with the usual history,—namely, one of slow development, with perhaps occasional exacerbations following slight trauma, with the characteristic prominence of the trochanter and attitude of the limb, and presents marked interference with the functional activity of the joint, with comparatively little or no pain,—your suspicions should be at once aroused.

(1) *Diagnosis from Coxitis.*—A number of cases of curvature of the neck have been mistaken for incipient coxitis. In coxitis there is also a history of insidious development, but attended with the characteristic and sometimes most pronounced joint-pains. Motion is limited, but equally in every direction; never is motion in any one direction entirely free or abnormally so, as in the abnormally free range of motion in the direction of outward rotation present in coxa vara; while passive and active motion in coxitis elicit pain, in coxa vara they are painless. In the former there are signs of local inflammation, as evidenced by the pain on motion, pressure, etc. In coxa vara there is no local tenderness. One may be attended with elevations of temperature and eventually signs of suppuration, phenomena that are never observed in the other. The shortening in coxitis may be due to flexion of the limb on the pelvis or to absorption of the head and neck; in coxa vara it is due to the bending of the neck. Rest and extension will restore to the joint, in coxitis only, a perfect range of motion.

(2) *Diagnosis from Fracture or Epiphyseal Separation.*—It is well known that in coxa vara the subjective and objective disturbances may be very much aggravated by traumatism. It is in such instances that the necessity of a diagnosis from fractures or epiphyseal separations arises. The presence of crepitus, severe pain on motion, and localized tenderness are points that contrasted with the symptoms of coxa vara should be sufficient to differentiate the two affections.

(3) *Diagnosis from Congenital Dislocation.*—The only

symptom which these two affections have in common is the upward and backward displacement of the trochanter. If, however, in the case of congenital dislocation, traction be made upon the limb, the trochanter can be drawn down to its normal position. Some confusion may arise when the curvature of the neck is bilateral and causes the waddling gait, characteristic of congenital dislocation. In all cases, finally, the diagnosis may be confirmed by the skiagraph. (As far as I have been able to find out the accompanying skiagraph of my own case is the first one published in connection with this deformity.)

*Treatment.*—Of all the phases of this subject, the treatment has been given the least attention. One could sum up in a few words all the ideas of the management of the disease that can be gathered from literature. They include rest, extension, and massage, with attention to hygiene and the internal administration of phosphorus, if there are evidences of rickets.

When the case first comes under observation there is usually a certain amount of pain present, some muscular rigidity (such as we often find in a case of pes planus) which is partially accountable for the limited motion. Absolute rest in bed with extension meet these indications so well that in the course of a few days the pain and muscular rigidity will have disappeared; this will be an opportune time to determine the amount of limited motion due to the deformity itself. Extension has been applied by some, experimentally, of course, with a view towards reducing the deformity by traction, as it were, but, as had been anticipated, the results have been negative. When the pain and muscular rigidity have subsided there are no further indications for confining the patient to bed. If an apparatus can be constructed which will prevent the transmittance of any weight through the neck of the femur the patient should be allowed unlimited freedom. I have thought that an apparatus, such as the so-called Taylor traction splint, would answer this purpose well. It should be worn just as long as there is any danger of the deformity increasing,—that is, until the period of adolescence

is past. If, when the splint is discarded, there is some shortening, the patient should be advised to wear a sufficiently thick cork sole. Massage has been advised almost universally; when there is general relaxation and loss of tone of the muscles, an occasional predisposing cause of coxa vara, massage would seem to be indicated; so, too, should it be of benefit when, as is almost always the case, the affected limb has atrophied, and in this connection passive motion and certain exercises should be of service. The importance of the adoption of antirhachitic *régime* in rhachitic infants and children need only be alluded to. Operative interference is reserved for those cases in which the disability is pronounced, and this is especially true of the bilateral cases; a resection of the head and neck was the first operation performed for the relief of this deformity, at a time when its exact nature was not fully understood. This has been recognized as an unnecessarily severe operation, since there is no change in the formation of the head or articular cavity. More recently Kocher, Hofmeister, and others have advised a subtrochanteric osteotomy, and this was regarded as the proper operation until Kraske pointed out some objections to it. He claimed that if an osteotomy be performed, it should be through the neck of the bone, since a subtrochanteric osteotomy, while it may correct the malposition of the limb, cannot correct the limited functional activity and shortening, since the muscles that move the hip are attached above the point where the bone is divided and the upper section still remains in a faulty position. It has been offered as an objection to Kraske's operation that there is danger of subsequent ankylosis of the joint, if the latter is infected during operation. Kraske meets this objection with the reply that the attachment of the capsule in coxa vara makes it possible to perform his operation extra-articular. On account of lengthening the superior surface of the neck, the line in which the capsule is inserted is drawn inward towards the head, leaving a space between the capsule and trochanter major large enough to allow of the removal of a wedge-shaped section of bone. The following is a brief description of the operation: An incision beginning above and

to the inner side of the tip of the trochanter major and running downward to eight or ten centimetres exposes the linea trochanterica and base of the neck. The periosteum is divided for half the circumference of the neck and pushed upward a distance of two centimetres towards the head. A wedge-shaped section of bone is removed with its base two centimetres broad, directed upward and forward. Budinger has since modified Kraske's operation; he regards it unnecessary to remove a wedge-shaped section of bone, since simple division of the bone will answer the purpose just as well. He has reported a case in which he carried out this idea. After the operation a fixed dressing was applied, retaining the limb in a position of outward rotation and abduction (at an angle of 50 degrees). At the end of three weeks' time this dressing was removed and an extension applied, the limb being gradually returned from the abducted to the straight position. Passive motion was begun six weeks after the operation, the results of which were all that could be desired; the shortening disappeared and abduction and inward rotation were unrestricted. The success of the operation depends upon the position in which the limb is retained during the after-treatment. It should be placed in that position occupied by the head and neck,—namely, that of abduction and outward rotation,—so that when union has occurred the shaft will hold its proper relation to the head and neck.

BRIEF HISTORIES OF CASES THAT HAVE BEEN REPORTED SINCE HOFMEISTER'S ARTICLE IN 1894.

CASE I (Kocher).—The patient, a laborer, aged eighteen years, had never been sick till the past year, when he complained, for the first time, of darting pains in the left hip on walking. These pains were not very severe, still the patient began to limp. Following a period of rest or after fatigue the pains were more severe than after moderate exercise, and soon extended to the body and knees. The limping grew worse, but the patient did not take to bed. In two weeks the same train of symptoms appeared on the right side. Matters grew worse, and in August, 1882, the limping was very pronounced and the pain more serious. The patient went to bed for four or five weeks, but afterwards his condition was so much aggravated that he could only walk the length of the room. Since August he was only able to go about with the aid of two canes; the pain was not present if the patient kept quiet, but was

elicited by every movement or attempt at walking. The patient's condition on May 11, 1883, was as follows: He is a lean, slender, well-built young man. The legs are parallel; the right somewhat flexed and rotated outward. No inequality in length or tilting of the pelvis. Only with the greatest effort is the patient able to raise the legs extended while in the dorsal decubitus. Abduction and adduction are both limited; on the left side there is slight external rotation. In all attempts at passive motion on the right side the body moves with the thigh. There is no apparent abnormality in the conformation of the joint, and there is no pain on pressure. He can only flex the knees by moving the entire body, and one knee cannot be flexed without the other. The patient is able to walk only with some support, and makes great efforts with the body in order to raise the legs from the ground. The diagnosis of arthritis adhesiva was made.

Treatment consisted in an excision of the right hip-joint and breaking up of adhesions in the left under ether. The improvements in the motion of the right thigh were so marked that the patient requested an excision of the left hip-joint, and his request was granted.

CASE II (Kocher).—The patient, an eighteen-year-old boy, worked up to one year ago in the country and then went into a cheese manufactory, where he was required to stand the entire day, and was exposed to the cold. In February, 1893, he first experienced pain in the hip-joint, which was increased on motion and worse in bad weather. Three weeks afterwards he noticed that the right foot was turned outward, and within fourteen days the right foot assumed the present position. Abduction was complete, but flexion only possible to the angle of 40 degrees. To the end of May his condition remained unchanged. After a course of treatment in Baden he complained bitterly of pain on standing and felt weak. Pain in the right hip was greater than that of the left, and was felt especially after standing for a long period of time. The family history was negative, and the patient himself had never suffered from rheumatism.

His condition on the 31st of October, 1893, was as follows: The patient stood with his legs rotated outward, the left leg being in front of the right and in marked adduction. There was also a high grade of flat foot and a slight genu valgum. The right somewhat more pronounced than the left. The iliac spines were on the same level. The great trochanter was prominent on both sides, especially on the right, and both seemed displaced forward. There were no changes in the soft structures covering the joints and pressure on the bones and joints elicits no pain. The following measurements were taken: From the anterior superior spine to the external malleolus, left 96 centimetres; right 95 centimetres; from the anterior superior spine to the internal malleolus, left 94½ centimetres; right 94 centimetres; from tip of great trochanter to the articular line of knee, left 51½ centimetres; right 50 centimetres. The right leg is two centimetres shorter than the left. Flexion in the left hip-joint is possible only to 6 degrees; passive motion to 35 degrees; inward rotation is very much limited. The foot is markedly rotated outward. In the right hip-joint active flexion is possible to 15 degrees,

always associated with adduction, and passive flexion to 35 degrees; the right foot is also rotated outward. The thighs are not as strong as they should be, but neither are atrophic. The gait of the patient is very peculiar, and while at rest the patient stands with one knee in front of the other, as in genu valgum. The treatment consisted in resection of the hip on one side.

CASE III (Borchard).—A boy, aged fifteen years, was admitted to the hospital November 17, 1896, with the history of having been struck on the right hip by the pole of a wagon eleven weeks before. Immediately after the accident he could not stand erect and fell over backward on his right side. Several attempts were made at reduction, believing it to be a luxation, but naturally without success. On further questioning it was ascertained that he had experienced weakness in the left leg, especially after severe work and after long periods of standing during the past summer. In the dorsal position both spinous processes were on the same plane. The left trochanter being displaced both upward and backward, being two centimetres above the Roser-Nélaton line. The leg lay in a position of moderate adduction and slight outward rotation. Abduction is possible to 30 degrees, rotation inward is limited, outward rotation and adduction being normal. On flexion the left leg crosses the right and the foot is rotated outward. Pressure and passive motion are not painful, but active movements, standing and walking for any length of time, excite some pain. Diagnosis: "Coxa vara." Treatment: Extension, with the leg in the position of abduction for fourteen days. The patient was then allowed to go around with a high sole on the sound foot; massage was employed daily; extension applied at night. At the end of December the condition was much improved, and the patient able to go about without support and scarcely any limp. Examination on discharge: Position of trochanter unchanged. Inward rotation and abduction improved. On flexion the left leg no longer crosses over on the right.

CASE IV (Leusser).—The patient, aged eighteen years, complained for several months of moderate pain, aggravated by walking, and limped slightly. The occurrence of a slight accident—namely, stubbing her toe against a small stone—brought on severe pains in the joints. Family history was distinctly rhachitic. The patient herself had sustained previously a fracture of the right thigh, humerus, clavicle, and scapula. Examination: The affected limb was rotated outward; active motion excited the greatest pain, passive motion only moderate pain. Diagnosis: Impacted fracture of the neck of the femur. At the end of two weeks, and rest in bed, the error of diagnosis was discovered; further examination found the pelvis inclined towards the left, slight scoliosis in dorsal vertebræ, outward rotation of the left foot. Abduction is diminished; the other movements of the joint are normal. The left thigh is  $2\frac{1}{2}$  centimetres shorter than the right, and the trochanter is elevated three centimetres above the Roser-Nélaton line. Relative length of extremity on the left side  $88\frac{1}{2}$  centimetres, on the right side  $91\frac{1}{2}$  centimetres; absolute length on left side 85 centimetres; on the right 85 centimetres. Genu valgum especially marked on the left side.

CASE V (Schnitzler).—An eighteen-year-old girl, who has worked for the past four years in a shop where she was continually on her feet, experienced pain in the left hip and knee for the last four months. Soon she began to limp, and finally noticed some shortening. Lately the pain is present both on motion and at rest. Examination: Circumference, left thigh, 3 centimetres, and left calf 2 centimetres less than the right. Distance from spine and trochanter is  $2\frac{1}{2}$  centimetres shorter on left side. Flexion and extension are free; abduction abolished, and adduction very much diminished. Rotation inward is limited. Trochanter prominent.

CASE VI (Whitman).—Well-nourished boy, fifteen years old, appeared with limp on right side and shortening of leg, for which a high shoe was worn. Limping began about one year ago. Examination: Trochanter prominent, elevated upward and backward above Nélaton's line. Actual shortening  $\frac{3}{4}$  of an inch; apparent shortening  $3\frac{1}{2}$  inches. No limitation of flexion, extension, or rotation. Abduction was absolutely restricted. Two years later shortening increased to  $1\frac{1}{2}$  inches, trochanter became more prominent, pelvis tilted upward, and lateral curvature of the spine developed. In this case there was no evidence of rickets.

CASE VII (Whitman).—Well-nourished boy, aged sixteen years, has had flat-foot for indefinite period, and has worked for two years in a grocery-store, where he was required to lift heavy weights. The symptoms appeared the previous spring, a peculiar soreness and stiffness being felt in the right hip. These disappeared after a period of rest, but returned with increased severity when work was resumed. Soon the opposite hip became involved. Examination: Flat foot, slight knock-knee, and hyperextension at the knee were all present. Trochanters slightly elevated above Nélaton's line. Flexion and extension were complete, but abduction and inward rotation limited. The gait was rolling. After a treatment of rest and gymnastics he returned to work, but three months later reappeared, and at this time was able to walk with much effort, the body swaying from side to side. Trochanters markedly elevated and nearer the median line. Extension free but flexion and abduction limited. Examination four months later: Adduction so marked that on flexion one leg crossed the other. The trochanter is progressing upward and backward instead of forward. Lumbar lordosis well marked.

CASE VIII (Whitman).—An overgrown boy, aged seventeen years, has been employed for the past year as a baker, his occupation requiring him to stand for many hours each day. During the past year noticed bending of right knee and peculiar stiffness of left hip and thigh, most marked on changing from position of rest to one of activity. Examination: Well-marked knock-knee on the right side; trochanter slightly elevated, there being no actual shortening. Abduction and inward rotation restricted.

CASE IX (Whitman).—The patient, aged eleven years, news-boy by occupation, began to limp one year ago; complained of stiffness and discomfort in hip. Examination: Compensatory tilting of pelvis, ele-

vation of trochanter to an inch above Nélaton's line. Shortening one inch. Inward rotation and abduction are limited.

CASE X (Ogston).—Girl, aged fourteen and a half years, has been ailing for the past four years; she experiences difficulty and pain in both active and passive motion of the hip-joint. The arc of rotation outward and inward was less than the normal.

CASE XI (Ogston).—Patient, aged nineteen years, gives an indefinite history of pain in the hip for some years. Eversion is marked.

CASE XII (Ogston).—A boy, aged sixteen years, occupation brick-worker, has complained of pain in his hip for the past year. Moderate adduction and outward rotation. No measurable shortening of the neck of femur. On flexing the thigh the latter was rotated outward so that the foot passed across the sound leg, assuming a tailor's attitude.

CASE XIII (Kredel).—Coxa vara congenita. Little girl, aged three years, with marked genu valgum and muscular atrophy of both legs; is able to flex knee-joints only to a right angle. There is also clubbed feet on both sides. The femoral shafts are unaltered. On right side trochanter elevated  $3\frac{1}{2}$  centimetres; on left side  $4\frac{1}{2}$  centimetres. Flexion is normal, abduction and inward rotation are limited. Outward rotation is increased. When the child kneels both legs cross each other.

CASE XIV (Kredel).—A well-nourished, five-months old boy. Right leg  $1\frac{1}{2}$  centimetres shorter than left; outward rotation marked. On flexion the knee-joint to a right angle; the right leg crosses its fellow. Trochanter elevated 1 centimetre above the normal. Flexion normal, abduction and inward rotation absolutely restricted. There is marked pes equino varus. The left hip-joint is normal, but the knee-joint is quite stiff and the patella is absent. The same deformity of foot as on right side.

CASE XV (Zehnder).—Farmer, aged forty-two years, gives a history of rheumatism in infancy, following which he had an ankylosed elbow-joint. Up till his sixteenth year his gait was normal, but from that time pain began in the right hip, especially during the winter. One year later he began to limp. In the last seven years at times the pain has been severe, more especially in the last three winters. During the past year shortening has greatly increased. Examination: Trochanter raised 9 centimetres on right side; 6 centimetres on left above the Nélaton line. From trochanter to external malleolus, right  $89\frac{1}{2}$  centimetres, left  $91\frac{1}{2}$  centimetres. From anterior superior spine to external malleolus 82 centimetres on both sides. On the right side flexion is possible to 130 degrees. Right side abduction impossible. Adduction possible till leg crosses its mate in upper one-third of leg. Left side abduction only slightly possible. The left foot can be rotated outward to an angle of 50 degrees. On kneeling, the patient crosses one knee over the other.

CASE XVI (Zehnder).—The patient, a boy eleven years old, has had more and more difficulty since the time he first learned to walk. During the past year it was noticed that the right leg was always turned inward. Flexion on both sides is normal. Rotation outward is completely restricted; on right side abduction is impossible; on left side possible to a slight degree. Adduction possible on both sides. Length of limbs from

trochanter to the external malleolus is equal. Distance from anterior superior spine to external malleolus on right side, 1 centimetre shorter than on left. The right trochanter stands 5 centimetres, the left 4 centimetres, above Nélaton's line. Slight lordosis.

CASE XVII (Zehnder).—The patient, a letter-carrier, aged twelve years, has limped ever since he has been able to walk. Examination: The cartilages of the ribs are somewhat thicker than normal; although there are no other evidences of rhachitis. Distance from spine to external malleolus, right 59 centimetres; left 61 centimetres. Distance from right trochanter to external malleolus, on both sides,  $56\frac{1}{2}$  centimetres. Actual shortening 2 centimetres. The right trochanter is 2 centimetres higher than the left. Flexion and adduction are unrestricted. Inward rotation about the same on both sides, external rotation freer on left side than on right.

CASE XVIII (Zehnder).—A boy, four and a half years old, has since his second year complained of pain in the right hip. For the past year and a half the child has limped. Examination: No evidence of rhachitis beyond thickening of the costal cartilages. Right trochanter 2 centimetres above Nélaton's line. Distance from anterior superior spine to external malleolus, right 51 centimetres; left 53 centimetres. Distance from trochanter to external malleolus alike on both sides. Actual shortening 2 centimetres. Flexion is not diminished; abduction possible beyond the normal; rotation and adduction unrestricted.

CASE XIX (Zehnder).—The patient, a girl, aged nine years, has had a disturbance in her gait for the past six years. Slight thickening of costal cartilages gives evidence of rhachitis; family history negative. Examination: Distance from trochanter to external malleolus, left 64 centimetres; right 61 centimetres. Distance from anterior superior spine to external malleolus, 59 centimetres, on both sides. The right trochanter is 3 centimetres above Nélaton's line. Left trochanter exactly on Nélaton's line. Flexion and inward rotation undisturbed.

CASE XX (Zehnder).—The patient, a young girl, began to limp ten years ago. She was treated for coxitis and was bedridden for more than a year. For a while she walked with two crutches, but lately only uses one stick. No tubercular history. Examination: No evidence of rhachitis. Distance from spine to external malleolus, right 81 centimetres; left 75 centimetres. Distance from trochanter 79 centimetres, on both sides. Left trochanter 6 centimetres above Nélaton's line. Left leg is atrophied, adducted, and slightly rotated inward. Flexion is limited, as is outward rotation. Adduction is unrestricted and abduction possible to a slight degree.

CASE XXI (Frazier).—The patient, a girl, aged nineteen years, presented herself with the following history: The father and one sister died of consumption, two brothers died in infancy, one sister and her mother are living and well. Present history: About nine years ago she began to be troubled with vague pains in her bones, especially in the right hip-joint. Shortly afterwards she noticed a slight lameness affecting the right leg, the pain increasing when the lameness developed. At times she would have exacerbations of this pain, lasting sometimes as long as

a week; but at no time being severe enough to make her bedridden. The pain and lameness were especially severe after a hard day's work. Her occupation consisted in doing general work on the farm in Ireland, such work as would ordinarily be allotted to a man. Examination: Abduction of right leg possible to 35 degrees, left leg to 45 degrees; inward rotation very slightly restricted and painful in the right leg, and normal in the left. External rotation normal on both sides. The base of Bryant's triangle measured, on right side, 3 centimetres, on the left side 7 centimetres. Nélaton's line passes over the tip of the left trochanter. The right trochanter is  $4\frac{1}{2}$  centimetres above it, and is displaced upward and backward. The pelvis is tilted at an angle of about 5 degrees. The circumference of the right thigh  $49\frac{3}{4}$  centimetres; left thigh  $52\frac{3}{4}$  centimetres. Anterior superior spine to tip of internal malleolus, right,  $80\frac{1}{4}$  centimetres; left,  $80\frac{1}{4}$  centimetres. Umbilicus to tip of internal malleolus, right,  $84\frac{1}{2}$  centimetres; left,  $87\frac{3}{4}$  centimetres. Anterior superior spine to upper border of patella, right,  $40\frac{3}{4}$  centimetres; left,  $40\frac{3}{4}$  centimetres. Treatment: Rest in bed. Buck's extension to right leg. During the week the patient was in the hospital the temperature record was irregular, showing an evening rise varying from  $100.5^{\circ}$  to  $99^{\circ}$  F. At the end of two weeks' treatment the patient was again examined, with results corresponding exactly to those recorded on her admission, with one or two exceptions. Where abduction was only possible to 35 degrees, on admission, it was now possible to 55 degrees; flexion to 90 degrees; is free from pain. Further flexion elicits pain and arches the lumbar spine. It is also noticed that on flexion the affected limb crosses over its fellow. The trochanter is displaced upward, but not backward, as was recorded in the first examination.

CASE XXII (Bauer).—In November, 1894, a seventeen-year-old servant-boy was admitted with the following history: There was no tubercular taint in the family. When five or six years of age he had experienced pain in the left leg, followed by shortening and limping. After a while these symptoms disappeared. When fifteen years of age, while employed in digging ditches, the pains in the left leg returned, and he again began to limp. Though the pain was never severe, he soon had to give up his occupation. Genu valgum developed on the left side. Examination: The left leg is shortened, adducted, and rotated outward; the pelvis somewhat oblique, but no lordosis; the left trochanter somewhat elevated; muscles somewhat atrophied. Forced movements were painful. The patient was treated for three weeks with rest in bed, extension, and massage; after which, being considerably better, he was discharged, wearing a high sole on the injured side.

CASE XXIII (Bauer).—The patient, aged seventeen years, was a milk-carrier, beginning to work at the age of eleven, and when thirteen was forced to carry large milk-cans. About eight months ago he fell and hurt his knee, the injury was followed by some trouble in the left hip, which was aided by warm baths. Mother died of heart- and lung-disease, nine brothers and sisters of some acute disease. Examination: No abnormality in head, spine, or upper extremities. Internal organs perfectly healthy; the head of the left trochanter was  $3\frac{1}{2}$  centimetres;

that of the right 2 centimetres above Nélaton's line. The leg was rotated outward and the movements at the hip-joint were restricted. Treatment: Rest in bed, extension, and massage. Result: Improvement.

CASE XXIV (Bauer).—In February, 1895, the patient, aged sixteen years, a farm laborer, presented himself with the history that for the last two years he had pain on exertion on the right side of thorax. In the summer of 1894, after a fall, the patient began to limp. Later on in the year, while working at ditching, the pains returned with greater severity than in the summer. Examination: No signs of rhachitis. Right trochanter  $2\frac{3}{4}$  centimetres above Nélaton's line, left barely up to it. The leg is rotated outward, rotation is limited, and the muscles of the right thigh measure 4 centimetres less than the left. Under chloroform narcosis the movements were found to be almost normal; abduction was somewhat limited and to a less degree inward rotation. Treatment: Rest in bed, extension, massage, and bath. Patient was discharged, wearing a high sole on the injured side, very much improved.

CASE XXV (Ciuti).—Several years previous to 1897 the author met with a case which he at first confounded with incipient coxitis. The patient was treated by a resectio subtrochanterica. The operation was followed by complete cure.

CASE XXVI (Renssen).—In January, 1894, the patient, aged fifteen years, complained of pain in his right leg and hip. There was slight limp. Inclination of pelvis to the right, slight scoliosis; both trochanters on the same horizontal plane, but the right more prominent. The articular movements were normal; no pain on pressure over the hip-joint. Treatment: Rest in bed for two weeks, oleum hyoscyami being applied locally. The pain disappeared but the limping remained. The patient was discharged with instructions not to undertake hard and difficult labor.

CASE XXVII (Budinger).—In November, 1895, the patient, a girl, aged fifteen years, complained for some time of limping and sharp pain in the left hip. The patient herself was poorly developed, and from a distinctly rhachitic neighborhood. In April, 1896, her condition was much worse, the pain was more severe, the leg shorter, and the movements more limited. For the past few weeks she has been bedridden, and relies entirely upon crutches to get about. Examination: There was marked genu valgum and flat foot on both sides, exaggerated on the left. The patient herself was poorly nourished. Internal organs normal. Both femora are very much rotated outward, the left being 3 centimetres shorter than the right. The tip of right trochanter is 1 centimetre, the left 4 centimetres, above Nélaton's line. Abduction and outward rotation are limited on the right side, while on the left they are exaggerated. Inward rotation is very much restricted, while flexion is entirely free. The treatment consisted in an excision of a wedge-shaped section of bone from the neck of the femur. This operation can be carried out without opening the capsule. The result was satisfactory, the articular movements of the joint were restored.

CASE XXVIII (Fabricant).—The patient, a girl, eight years of age,

presented herself for treatment September 16, 1895, complaining of pain in the left groin and limping. Her family history was negative. The pain first appeared in February of this year, originating in the hip and extending to the knee. Soon afterwards she began to limp. Examination: The patient is of rather tall stature for a girl of her years, with rather poor muscular development. The pelvis is tilted, the left side being lower than the right. Compensatory scoliosis. The left leg is shorter than the right, rotated outward, with some muscular atrophy. Left trochanter  $2\frac{1}{2}$  centimetres above the Roser-Nélaton line. Active and passive motions of the hip-joint were painless but limited. Abduction was especially restricted. Treatment: Rest in bed with extension followed by massage. The course of treatment lasted two and a half months, at the end of which time the patient could walk without limping or without discomfort.

CASE XXIX (Fabricant).—The patient, a girl, aged seven years, was first seen November 2, 1895. Previous history: She was the last of eleven children; developed slowly; was not able to walk till the third year, after which time she began to limp. The limping soon became worse, and some pain was experienced if the child was on her feet for any length of time. No distinct rhachitic history. Examination: Development commensurate with her age. Prominence of right trochanter, which was  $3\frac{1}{2}$  centimetres above the Roser-Nélaton line. Compensatory scoliosis. Flexion limited to 90 degrees and outward rotation. Treatment: Rest, extension, and massage. Result unknown.

CASE XXX (Fabricant).—The patient, a girl, aged eight years, was first seen September 20, 1895. She had suffered from the usual diseases of childhood and had experienced pains in the epiphyses of the long bones. No distinct rhachitic history. For the past two years her parents noticed that her gait was unnatural. Examination: The right leg flexed and rotated outward. Trochanter prominent and 2 centimetres above the Roser-Nélaton line. The pelvis tilted, but no scoliosis. Active and passive motions were painless. Treatment: Rest, extension, and massage. At the end of six months' time the extremities were of equal length and the patient walked without limping. The trochanter was on a level with the Roser-Nélaton line.

CASE XXXI (Fabricant).—The patient, a girl, aged seven years, was first seen November 2, 1895. Her father was scrofulous and her mother had suffered from scoliosis. The patient herself, an ill-developed child, was subject to attacks of diarrhoea and diaphoresis; a year and a half ago had a suppurating lymphadenitis of the cervical glands. She began to limp about seven months ago and complains now of pain in her right hip. Examination: Right leg shorter than left and rotated outward. Trochanter prominent and  $1\frac{1}{2}$  centimetres above Roser-Nélaton line. Active and passive motions painless and unrestricted. Treatment: Rest, extension, and massage. In the course of a month the pain had disappeared and the patient walked without fatigue and limped but little. Five months later the extremities were of equal length and the limping had disappeared.

CASE XXXII (Ghillini).—Patient, a girl, aged sixteen years, gave

no distinct rhachitic history. Her mother noticed that she limped when a small girl, but that she was free from pain. When ten years of age the pain first appeared, and was so severe at times as to impede walking. A diagnosis of coxitis was made and twenty-five injections of an iodine preparation were employed without success. Re-examination: The left leg was shorter by 2 centimetres than the right. The great trochanter was 2 centimetres above the Roser-Nélaton line. Abduction, flexion, and internal rotation were limited. Treatment: Massage and gymnastics. The pains disappeared, but owing to the unequal length of the limbs the limping continued.

CASE XXXIII (Ghillini).—The patient, a boy, aged fourteen years, was born of healthy parents. At the age of two years he developed rickets and genua vara. When six years of age he first complained of pain and limping on walking. Examination: Right leg 3 centimetres shorter than left; right trochanter 2 centimetres above the Roser-Nélaton line; left thigh somewhat atrophied. Extension and abduction are limited. The limb is rotated outward.

CASE XXXIV (Schneider).—The patient, a boy, aged eighteen years, was perfectly well up to two years ago. His father and mother are living and well; his three sisters have died of causes unknown to him. The pains in the hip began about two years ago, persisting when the patient was at work, acquiescing after a good night's rest. He was employed since his fourteenth year as a field hand. During the past year, walking became more and more difficult, the pains became more aggravated, and the patient began to limp and experience difficulty in stooping. Examination: The patient is fairly well nourished and of moderate muscular development; no evidences of rickets. Genu valgum present on both sides; the feet are rotated outward. Flexion is possible only to a right angle and somewhat painful; abduction is limited to 17 centimetres; inward and outward rotation are also somewhat restricted. Both trochanters are higher than the Roser-Nélaton line. In walking, the patient swings the body to and fro and crosses one leg over the other. A radiograph was taken, but the result was unsatisfactory. Treatment: Rest, extension, and nutritious diet were followed by amelioration of the subjective symptoms. Any attempt, however, to walk for any length of time brings on fatigue.

CASE XXXV (Kirmisson).—A boy, aged nine years, admitted to the hospital May 8, 1896, presented numerous rhachitic deformities, among which were a pronounced dorso-lumbar scoliosis, curvatures of the tibial and femoral shafts. The foot was directed to the front. The great trochanter on the right side was  $2\frac{1}{2}$  centimetres higher than on the left (above Nélaton's line). The trochanter was not only displaced upward but forward. The radiograph revealed a similar picture on both sides,—namely, curvature of the femoral diaphysis near the neck, perhaps more pronounced on the left side. The case was looked upon as a rhachitic curvature of the femoral neck, probably of congenital origin.

CASE XXXVI (Kirmisson).—Male, aged two and a half months, was admitted to the hospital November 28, 1896. Nothing is known of the child's antecedents. It was small, cachectic, and quite emaciated.

Examination: Both limbs were rotated outward, flexion was incomplete. Two swellings, symmetrically located, were present in the groin between the head of the femur and the great trochanter, offering obstacles to the natural motion of the limb. Result: The child died December 13, 1896. At the autopsy it was found that the femora were in forced external rotation, and that the great trochanters were displaced upward and backward.

CASE XXXVII (Kirmisson).—Patient was admitted to the hospital when sixteen days old. The child was extremely emaciated, but presented no traces of syphilis. Examination: The lower extremities were habitually flexed. There was double club-foot. Both femora were rotated outward. The trochanters on both sides were on a level with Nélaton's line, 2 centimetres behind the superior anterior iliac spine.

CASE XXXVIII (Maydl).—The patient, fifteen years of age, came of apparently healthy parents. Up to one year ago she was perfectly well. At this time she slipped in going down-stairs, striking forcibly her right hip. Fourteen days after the accident she complained of pain localized in the hip and knee, coming on after walking. Examination: The right leg is in the position of moderate abduction, flexion, and outward rotation. Active motions are possible only when accompanied with movements of the pelvis. The right trochanter was displaced 4 centimetres above Nélaton's line. At present she limps, but has no pain. Treatment: Resection of the hip-joint. The patient was discharged cured several months afterwards.

CASE XXXIX (Maydl).—A laborer, aged eighteen years, was admitted to the hospital July 12, 1895. There was no rhachitic family history. The patient himself had always enjoyed perfect health until the onset of the present disease, which was caused by the patient stumbling over a piece of coal, two days after which he felt pain in the affected limb. Subsequently the limb became emaciated and the motions became more restricted. Examination: The patient was of large stature, with a strong bone frame-work, good muscular development, and remarkably well nourished. The left leg is rotated outward, and both active and passive motion in the joint absolutely restricted. The length of the extremities is equal. Treatment: Hip-joint resection. The head was found to be both widened and flattened.

CASE XL (Maydl).—A laborer, aged eighteen years, was admitted to the hospital February 25, 1896, with a good family history. During the summer of 1895, after jumping over a hedge, he experienced pain from his hip to his knee on the left side. Since that time he has limped and has been unable to bend the leg. Examination: The patient is developed proportionately to his age. The left leg is rotated outward, slightly abducted, and shortened. The motions of the left hip-joint are entirely restricted. Trochanter prominent. Treatment: Hip-joint resection. It was found at the operation that the neck was so bent that the head touched the small trochanter.

CASE XLI (Maydl).—The patient, a seventeen-year-old boy, was admitted November 23, 1896, with the following family history: The

mother was an epileptic, of nine brothers and sisters five died early, the remaining four are living and well. In October, 1895, the patient first experienced pain on walking, beginning in the buttock and extending to the popliteal space. The pains almost vanished in April, and did not return until October, 1896. Examination: Rather tall in stature, with good bony frame-work, and well nourished. The left leg is moderately rotated outward, slightly flexed, but with no noticeable shortening. With the pelvis fixed active and passive motion is limited. The trochanter on the left side is prominent. Treatment: Hip-joint resection. The head and neck presented the deformity of coxa vara.

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TABLE OF OBSERVATIONS (FRAZIER), INCLUDING THOSE CASES REPORTED SINCE THE PUBLICATION OF HOFMEISTER IN 1894.

Number.	Sex and Occupation.	Age at Time of Onset.	Age at Time of Present Note.	Right or Left Leg.	Elevation of Trochanter. Cm.	Customary Position of Limb.	Rhachitic Diathesis or Signs.	Limitation of Motion, etc.	Subjective Disturbances.	Other associated Deformities.
1	Female.	Con- genital	3 years.	R. L.	3½ 4.2	Outward rotation.		Abduction and inward rotation limited; outward rotation increased; flexion possible to a right angle.	As the child kneels, the legs cross one over the other.	Bilateral club foot and genu valgum.
2	Male.	Con- genital	5 mos.	R.	1.0	Outward rotation.	Not stated.	Abduction and inward rotation absolutely restricted; flexion possible with adduction.		Bilateral pes-equino-varus, congenital absence of patella.
3	Male.	Con- genital	2½ mos.	R.		Outward rotation.	Unknown.	Flexion incomplete; trochanter displaced upward and backward.		
4	Female.	Con- genital	16 days.	R. L.		Outward rotation and flexion.	Unknown.	Trochanter displaced forward.		Bilateral club foot.
5	Male, post-boy.	2 years.	12 years.	L. R.	2.0		None.	Flexion and adduction unrestricted; external rotation freer on right side than on left.	Has limped ever since he was able to walk.	
6	Male.	2 years.	4½ years.	R.	2.0		None.	Rotation, flexion, and adduction unrestricted; abduction possible beyond the normal.	Complained of pain for 2½ years, and has limped for past year and a half.	
7	Female.	3 years.	9 years.	R.	3.0		Slight.	Flexion and inward rotation un- restricted.	Has limped for the past 6 years.	
8	Female.	3 years.	7 years.	R.	3.5	Outward rotation.	None.	Flexion limited to 90 degrees.	Was unable to walk till third year, after which she began to limp.	Scoliosis (compensatory).
9	Female.	5 years.	15 years.	L.	6.0	Inward rotation and adduction.	None.	Flexion and outward rotation limited; abduction very much restricted.	Was bedridden for more than a year, treated for coxitis; walks with the aid of a cane.	

10	Female.	6 years.	8 years.	R. 2.0	Outward rotation and flexion.	None.	Active and passive motion painless; trochanter prominent.	Limped for past two years.	
11	Male.	6 years.	14 years.	R. 2.0	Outward rotation.	Yes.	Extension and abduction limited.	Complained of pain on walking and limped when 6 years old.	Genua vara.
12	Female.	6 years.	7 years.	R. 1.5	Outward rotation.	Yes.	Active and passive motion unrestricted.	Passive motion is painless.	
13	Female.	8 years.	8½ years.	L. 2.5	Outward rotation.	None.	Active and passive motion, especially abduction, were limited.	Pain on walking; limps; passive motion painless.	Compensatory scoliosis.
14	Male.	9 years.	9 years.	R. 2.5	Inward rotation.	Yes.	Inward rotation was limited; trochanter displaced both upward and forward.		Curvature of tibiae and femora; scoliosis.
15	Male, newsboy.	10 years.	11 years.	R. 2½		Not stated.	Inward rotation and abduction limited.	Stiffness and discomfort in hip.	
16	Female.	10 yrs.	14 yrs.	R. 5.0		Not stated.	Outward rotation completely restricted; on right side abduction is entirely arrested; flexion and adduction unimpaired.	Difficulty in walking since first attempt at same.	Lordosis.
17	Male.	10 years.	11 years.	L. 4.0		Not stated.	Inward rotation restricted; flexion possible with adduction; abduction slightly restricted.	For past 9 years has been limping. Previously had pain in hip; at present is free from pain.	
18	Female, farm-hand.	10 years.	19 years.	R. 4.5	Normal.	None.	Abduction, inward rotation, and flexion are limited.	As a small girl limped, but was free from pain. Since then pain so severe as to impede walking.	
19	Female.	10 years.	16 years.	L. 2.0		None.	Trochanter displaced upward.	When 5 or 6 years old first complained of pain and limped. The symptoms disappeared and returned when he was 15 years old.	Genu valgum.
20	Male, laborer.	5 years.	17 years.	L. ?	Outward rotation and adduction.	None.		For the past year has limped.	Scoliosis.
21	Male.	14 years.	15 years.	R. 3.0	Adduction.	None.	Trochanter displaced upward and backward; abduction entirely restricted.		
22	Female.	14 years.	15 years.	L. 4.0 R. 1.0	Outward rotation.	Not stated.	Abduction and outward rotation are limited on right side and exaggerated on left; inward rotation, both sides restricted.	Pain and limping for some time. Recently bedridden or relies upon crutches to go about.	

Number.	Sex and Occupation.	Age at Time of Onset.	Age at Time of Present Note.	Right or Left Leg.	Elevation of Trochanter. Cm.	Customary Position of Limb.	Rhachitic Diathesis or Signs.	Limitation of Motion, etc.	Subjective Disturbances.	Other associated Deformities.
23	Female.	14 years.	15 years.	R.	4.0	Outward rotation and flexion.	Not stated.	Motions of joint very much restricted.	Symptoms attributed to a fall. At first pain and limping, at present free from pain.	
24	Male.	14 years.	15 years.	L.	2.0	Outward rotation and adduction.	Not stated.	Flexion possible only with adduction; trochanter displaced upward and backward.	At first complained of weakness in limb on walking or standing for any length of time. Has pain. Symptoms aggravated by a fall.	
25	Male, grocer-boy.	15 years.	16 years.	R. L.	3.0	Outward rotation.	None.	Abduction and inward rotation very much restricted; flexion possible only with adduction; trochanter displaced upward and backward.	Began with soreness and growing pains. Now has "scissor legged" deformity and waddling gait.	Pes planus, genu valgum, lordosis.
26	Male, brick-worker.	15 years.	16 years.	.	.	Outward rotation and adduction.	None.	Flexion is possible only with adduction and eversion.	Began with pain about 1 year ago.	
27	Male, farm-hand.	15 years.	16 years.	R.	2.7	Outward rotation.	None.	Abduction and inward rotation slightly restricted.	At first vague pains in hip; after a fall these became aggravated and patient began to limp.	
28	Male.	15 years.	15 years.	R.	.0	Normal.	Not stated.	Articular movements normal; right trochanter prominent.	Began with pain. This has disappeared and only a limp remains	Scoliosis.
29	Male, baker.	16 years.	17 years.	L.	.0	Normal.	Not stated.	Abduction and inward rotation slightly limited; trochanter displaced upward.	Complains chiefly of stiffness in hip and knee.	Genu valgum.
30	Male, farmer.	16 years.	42 years.	R. L.	9.0	Outward rotation.	None.	Right abduction impossible, flexion limited; left abduction very limited, adduction possible much beyond normal.	Began with pain in hip, followed 1 year later by limping.	

31	Male, milk-man.	16 years.	17 years.	L. 3.5	Outward rotation.	None.	Articular movements restricted.	Forced to carry heavy cans for past 8 years. Onset followed a fall 8 months ago.	Bilateral genu valgum.
32	Male, farm-hand.	16 years.	18 years.	R. L.	Outward rotation.	None.	Flexion possible to a right angle; abduction inward and outward; rotation limited.	Began with pain 2 years ago. During past year walks with difficulty, waddling gait.	
33	Male.	16 years.	17 years.	L.	Outward rotation and flexion.	None.	With the pelvis flexed active and passive motion are restricted; trochanter prominent.	At first noticed pain on walking 1 year ago.	
34	Male, laborer.	17 years.	18 years.	R. L.	Outward rotation and flexion.	None.	Abduction and adduction are limited; flexion limited.	Began with pain in left hip followed by limping; later right hip involved.	
35	Male, worked in a cheese manufactory.	17 years.	18 years.	R. L.	Outward rotation.	None.	Right flexion limited and only with adduction; left flexion and inward rotation limited; trochanters displaced upward and forward.	Began with pain. Soon noticed eversion. Patient stands with one leg in front of the other. Peculiar gait.	Genu valgum and flat-foot.
36	Female.	17 years.	18 years.	L. 3.0	Outward rotation.	Yes.	Abduction limited; other movements normal.	At first moderate pain aggravated by walking. Slight accident aggravated symptoms.	Bilateral genu valgum; scolio sis.
37	Female, shop-girl.	17 years.	18 years.	L. .0	. . . . .	None.	Abduction absolutely restricted; adduction and inward rotation limited; trochanter prominent.	At first moderate pain; soon afterwards limping.	
38	Male, laborer.	17 years.	18 years.	L.	Outward rotation.	None.	All articular movements restricted.	Following slight trauma; pain experienced on walking.	
39	Male, laborer.	17 years.	18 years.	L.	Outward rotation and abduction.	None.	Articular movements restricted; trochanter prominent.	Pain and limping.	





