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Some confusion has arisen with reference to the scope and signification of the term Menstruation, in consequence of certain writers having proposed to interpret it in accordance with their own theoretical ideas of the origin or purpose of the menstrual function. In order to avoid all embarrassment from this source, I shall use the word in its primitive and most restricted sense, as implying, simply, a sanguineous defluxion from the genital tract of the human female, the chief characteristics of which are, that it is not symptomatic of disease and has a tendency to recur periodically, most frequently at monthly intervals. This defluxion may be regarded as the final event of a series, and an inquiry into its nature must, necessarily, involve a consideration of all associated phenomena. I will accept as demonstrated facts, that the discharged fluid consists, essentially, of unaltered blood, and that it proceeds from ruptured capillaries on the internal surface of the body of the womb.

The testimony of all observers concurs as to the coincidence

of a general congestion of the generative organs with the menstrual flow; and that these bear to each other the relation of cause and effect I can see no sufficient reason to doubt, notwithstanding the paramount importance which some recent observers attach to the structural changes which take place in the uterine mucosa. The congestion uniformly precedes the flow; when it attains its greatest intensity, the flow ensues, and subsequently it subsides. An invariable antecedent and concomitant is not necessarily the cause of an effect; but when the antecedent is of a nature, according to our conception of the action of forces, to produce the sequence, it is presumable that the one has taken part in the causation of the other; and this presumption is converted into a certainty, when the withdrawal of the first prevents the occurrence or suspends the existence of the second. The engorgement which preludes and accompanies menstruation is of the kind specified; for nothing is more reasonable to suppose than that blood-vessels are liable to be ruptured by distention, and its extinction by means of venesection prevents or arrests the flow. Hence I feel authorized in assuming, that *the congestion of the uterus which obtains at the menstrual period is the principal factor in the production, if not the sole cause, of the hemorrhage.*

It cannot be denied that the mucous membrane of the uterus undergoes notable alterations in connection with menstruation. These have been described as consisting of tumefaction, in consequence of enlargement and proliferation of its component cells (hypertrophy and hyperplasia), and afterwards in fatty degeneration and more or less exfoliation. A difference of opinion exists as to the extent to which the latter process is carried. Engelmann[1] maintains that the fatty degeneration is confined to the superficial layers, and that simply a portion of the epithelial investment is thrown off; whilst Williams[2] contends that the whole thickness of the membrane undergoes disintegration and desquamation. I do not propose, in this connection, to discuss the relative merits of these two opinions, but will simply say that, on account of the histological objections advanced by Engelmann against the latter, together with certain physiological reasons, I am disposed to adopt his views, in

[1] American Journal of Obstetrics, May, 1875.

[2] Obstet. Jour. of Great Britain and Ireland, Feb. and March, 1875.

preference to those of Williams. In either case, the effect would be to weaken, denude, or disorganize the walls of the capillaries, and in this way determine the escape of blood from the free surface of the uterine cavity.[1]

There is not the slightest doubt in my mind, however, that these structural changes are themselves dependent upon the congestion. Growth and nutrition were at one time regarded as purely vegetative functions, over which the nervous and vascular supply exercised no modifying influence. Virchow, in particular, maintained this doctrine; the development which took place under the action of a local stimulus he attributed to what he designated "*nutritive and formative* irritation of the tissues themselves;" but it is a little curious that the very experiment which he cited (section of the cervical sympathetic), as showing that active hyperemia could not engender hypertrophy, has since afforded proof directly to the contrary. Recent authorities admit, not only that active, but that passive congestion also may cause hypertrophy and hyperplasia, examples of which are seen in the various forms of varices from obstruction. In order to have this effect, the congestion must be slowly established and must continue for a good while; when suddenly induced, the tendency is rather to serous effusion. Billroth says on this subject, "Continued stagnation of blood or lymph, as well as their coagulation in the vessels, first induces hyperplasia of the walls of the vessels and the parts immediately around them, distention and tortuosity of the vessels, and thickening of the tissue; the skin of the leg is particularly exposed to this disease, when there is any continued opposition to the escape of venous blood from the extremity." Pathologists do not agree exactly as to the way in which these hyperplasias are produced; according to some, they depend upon proliferation of the original cells, and others attribute them to

[1] Leopold could not detect any retrograde metamorphosis, and denies their existence (Am. Jour. Obstet., April, 1878). But positive evidence is more valuable than negative, and as I regard Engelmann as a competent observer, I must give my credence in favor of his statements. The truth of the matter I believe to be that these changes are not absolutely necessary to enable the hemorrhage to take place, as is indicated in vicarious menstruation, where the unaltered capillaries of the skin and mucous membrane are ruptured; and in uterine menstruation they probably vary in degree in different individuals, and in the same individual at different times; possibly, in some cases, they may be absent entirely.

an infiltration of the tissues with white blood-corpuscles, *wandering cells*, which escape from the vessels in consequence of intravascular pressure. Making the proper allowance for this difference of opinion, and the consequent difference in phraseology on the part of observers, we will find the descriptions of the changes which occur at the menstrual period in the lining membrane of the uterus correspond very closely with those of hypertrophy and hyperplasia in other parts of the body from various causes, including obstructive venous congestion. In fact, the only essential peculiarity of the former is the low vital activity by which it is characterized, for, notwithstanding the multiplication in the cellular elements, there is no formation of new blood-vessels (Engelmann), the membrane loses its tenacity, becoming sometimes almost diffluent, and finally undergoes fatty degeneration, the most common cause of which is defective nutrition.

The explanation given by Engelmann of the discrepancy between the results of his own investigations and those of Williams, is in unison with this idea of a low organization of the menstrual neoplasm. He claims that his specimens were taken chiefly from the bodies of women who had died of acute diseases or from violence; but those of Williams were of a pathological character, the individuals having been, for the most part, subjects of exhausting diseases, such as typhoid fever, pneumonia, etc. From this it would appear that he believes a vitiated and depraved state of the nutritive functions in general favors and intensifies the molecular changes referred to.

The Ovular Theory of Menstruation teaches that, when a Graäfian vesicle approaches maturity, it creates an irritation which determines an afflux of blood to the pelvic viscera. If this were true, the congestion should be somewhat rapidly established, and should subside precipitately, for the rupture of the follicle would at once remove the source of the irritation. On the contrary, we know that the menstrual perturbation advances slowly to its acme, and recedes in a like manner. Every physician who has used the speculum much is aware, that blood or bloody mucus may be detected issuing from the os uteri twenty-four, sometimes forty-eight hours before and after the discharge is noticed externally. If the initial and concluding stages are thus protracted, it is reasonable to infer that the

preliminary changes which induce the hemorrhage are equally gradual in their progress, and that after its cessation, some time must elapse before the disturbing influences would completely subside.

Engelmann deduced a similar opinion from his anatomical researches, as the following quotations will show. "The facts gathered warrant the conclusion that the mucous membrane of the womb begins to increase in thickness and succulence as the time of menstruation approaches, that the tumefaction is most marked during the period itself, and gradually decreases after the catamenial discharge." "Anatomical experience, as I will show, does not bear out the assumption, which theoretically appears well founded, that the menstrual changes of the mucous membrane just described, come and go as rapidly as the menstrual period itself." "We rarely find a completely normal, inactive uterine mucosa, which seems to indicate that the actual period of rest for that membrane is much shorter than is generally assumed."

Ritchie says, "Menstruation gives rise to a congested state of the uterine vessels, manifested by a redness and increased vascularity of the vagina, and the production on the internal surface of the cavity of the uterus of a meshwork of deciduous, villous vessels, which may remain for two weeks."

It will hence be seen that ample time is allowed for the menstrual development to take place under the influence of congestion.

The most interesting and important of all the problems in this connection is that which relates to the vascular mechanism by which the menstrual congestion is produced. Before we enter upon this inquiry, however, it will be advisable to obtain a correct conception of the general features and extent of the congestion.

During menstruation the uterus undergoes a considerable augmentation in bulk, which may be appreciated by a digital examination per vaginam, or by the use of the sound. Its weight is, of course, correspondingly increased, and there is a slight tendency to prolapsus. It has also been noticed, in flexions of the organ, that it becomes straighter, and may even assume a perfectly normal shape. These modifications have been imputed exclusively to the engorgement of the uterine blood-

vessels; but in view of the development which takes place in the mucous membrane, it becomes highly probable that the same influences would engender an analogous development in the parenchyma, and the enlargement may to a certain extent arise from this cause. It must nevertheless be admitted that the force of the congestion is very great, as is evinced by the distention of the womb when the menses are retained within its cavity, by the occasional bursting of the Fallopian tubes, and by the rupture of veins. In accidents of the last kind, it is true, it is surmised that the coats of the vessels have been already weakened by long-continued dilatation, the veins in this locality being exceedingly prone to become varicose, owing to the absence of valves, and this tendency is increased by pregnancy; but instances have been reported of such events occurring in young girls who had never conceived, in which there was no ground to assume the pre-existence of a morbid state. One in point is recorded by Tuckwell, where a fatal catamenial hematocele ensued from the rupture of a vein of the left Fallopian tube, in a girl eighteen years of age. In autopsies of women who have died while menstruating, the uterine and ovarian plexuses have frequently been found much engorged, but that this should not uniformly be the case is very easily accounted for; the cause of the congestion being a vital action, would cease with death, and the blood would seek an equilibrium with that in the rest of the venous system.

The ovaries participate in an equal degree with the uterus in the menstrual congestion; in some cases their firm tissue has been rent asunder and apoplectic clots of considerable size formed within the substance of the organs; and the Fallopian tubes, the vagina, and the external genitalia are more or less affected.

It is really remarkable how little attention this question has received at the hands of gynecologists. Most of them make no allusion to the nature of the menstrual congestion, and those who do are wonderfully brief and unsatisfactory. Meigs, for instance, speaks of it as "A positive affluxion of sanguineous humors . . . to the whole system of the reproductive organs;" Barnes says, "The active physiological process going on in the ovaries naturally determines the blood-current in especial force to the pelvic organs;" and Schroeder simply

denominates it an "arterial congestion." As indicated by these expressions, the prevailing sentiment appears to be, that it is of the character of what is entitled an ACTIVE CONGESTION, one in the genesis of which the arteries are the efficient agents. It has been suggested that the arteries might possess the power, by means of peristaltic action, of exerting a propulsive force upon their contents, and in this way of driving the blood into the structures to which they are distributed; but this idea has been abandoned, and the only form of active congestion now recognized by physiologists is that which accrues from a relaxation of the muscular coats of these vessels, in consequence of which they dilate and permit the tissues to be inundated, so to speak, with blood. I know of no proofs that have ever been advanced to show that this is the form of congestion which takes place in the generative organs during menstruation. It seems to be a mere assumption based upon a supposed analogy with what is witnessed in glandular structures in states of physiological activity, and in parts subjected to local irritation, while very strong evidence may be adduced to the contrary.

The internal organs of generation are supplied with blood by four arteries, the two uterine and the two ovarian, each of which is accompanied by at least one vein, and usually the uterine veins are double. Physiologists tell us that the veins throughout the body are between three and four times more capacious than their associate arteries, and that this disproportion persists down to the capillaries. An inspection of a carefully injected dissection of the pelvic viscera will convince any one that the vessels here do not afford an exception to this rule. Immediately upon emerging from the uterus, the veins anastomose freely with each other and with the extensive venous plexuses in the vicinity, so that the channels for the egress of blood and its onward flow to the vena cava are exceedingly ample.

Supposing a progressive dilatation of the arteries to set in; it is clear that they could not conduct enough blood into the parts to tax the capacity of the veins in carrying it off until they had attained three times their original calibre. After this point was passed, and the apertures of influx become greater than those of efflux, an accumulation of blood would

take place in the capillaries and erectile spaces, and a gradually increasing pressure would be exerted on their internal surfaces; but it must be seen by any one acquainted with the most elementary principles of physics that this pressure could never be rendered equal to that with which the blood is propelled in the arteries, as long as there was any leakage. To accomplish this, the venous conduits must be hermetically closed, and the cells filled by the arteries in the same manner that the cistern of a hydrostatic press is filled by its injecting pipe. It is unfortunate that we have no means of gauging the pressure that is sustained by the tissues of the generative organs during menstruation; estimating it by its effects, I believe it to be, in some cases, little short of the full force of the arterial circulation. For a force even approximating this to be brought to bear, without closure of the veins, an enormous enlargement of the arteries would be requisite—one, at all events, sufficient to be detected by the sense of touch. Yet I have made many examinations of the uterine arteries, through the walls of the vagina, without being able to perceive any increase in their size or impulse at the menstrual periods. Fluctuations can be discerned, but they bear no fixed relations to menstruation, and depend, in all probability, upon some reciprocal action between the uterine and ovarian arteries.

Admit, for the sake of argument, that the necessary arterial action might occur without being detected, or that the work of flooding the parts with blood devolves exclusively upon the ovarian arteries which are out of reach, we would thus account for the parenchymatous swelling of the uterus and ovaries; but can we imagine it possible for the blood to pass through these structures with sufficient force and in sufficient quantity, subsequently, to distend the veins, even to rupture them? This query I should most assuredly answer in the negative; for it must be remembered that the resistance offered by the capillaries to the passage of the blood takes off from three-fifths to two-thirds of its force, and that the walls of the veins are elastic and, although thinner than those of the arteries in their normal state, are more capable of resisting pressure.

I at one time hoped that this point might be definitely settled by thermometric observations upon the generative organs, but have found the subject more intricate than I anticipated,

and have not been able to arrive at positive results; yet the burden of the evidence, if I do not misinterpret it, is against the theory of arterial congestion.

It is now an established fact that the temperature of a part depends largely upon its blood supply, and if there is an increased afflux of blood to any organ or tissue in a physiological state, an elevation of temperature invariably follows. In experiments in which paralysis of the vaso-constrictor nerves has been artificially induced, an astonishing increase of heat has been observed. For example, in some instances, where the sympathetic nerve has been divided in the neck, causing a dilatation of the vessels on that side of the head, the temperature has risen as much as 18° Fahr.

Very little seems to be known as to the variations of the temperature of the generative organs in connection with menstruation. Schroeder remarks that, "In opposition to the older statements, Rabuteau declares that the temperature, as measured in the vagina, shows an average depression of about 1° Fahr., and that the frequency of the pulse is also less. The excretion of urea is also diminished. Hennig was able to confirm the fall of the pulse, but not of the temperature." In my own investigations I have encountered very great difficulties, the chief of which has arisen from my inability to procure perfectly healthy individuals as subjects, by whom to establish a physiological standard. I have made over six hundred observations distributed among eighteen women, in every one of whom some trouble of the generative organs was at least suspected. In some the actual disease was slight, and in two, who had applied for relief from sterility, nothing abnormal could be detected. I have found that there is *almost* always an appreciable alteration of the temperature of the uterus and vagina as compared with that of the body, as indicated in the axilla, at the menstrual periods. In the majority there was a relative elevation of the temperature of these organs, in the early stages of menstruation, but in no instance did the maximum during menstruation exceed that of the intermenstrual period more than ½° Fahr. In some the relative temperature would fall at one period and rise at another from causes of which I could take no cognizance; and in others *it would be uniformly depressed at the menstrual periods*, the depression

usually manifesting itself several days beforehand. The following case affords an example of the last kind:

The subject of the observations was a virgin 20 years of age, and of delicate aspect. Her local troubles were anteflexion of the womb and tenderness, with some enlargement, of the right ovary.

Date.	Temperature of Vagina.	Temperature of Uterus.	Temperature in Axillary space.	Excess of Vag. Temp. over Uterine.	Excess of Vag. Temp. over Axillary.	Excess of Uterine Temp. over Axillary.	Pulse.	Day of Menstruation.	The pulsations of the uterine arteries could not be felt through the vaginal walls at any time.
Oct. 3.	99¼°	..	98¼°	..	1°	..	..		
Oct. 9.	99½	99¼°	98½	¼°	1	¼°	80		
Oct. 12.	99¾	99¼	98¾	½	1	½	84		
Oct. 13.	99½	99¼	98½	¼	1	¼	82		
Oct. 14.	99½	99¼	98½	¼	1	¼	76		
Oct. 15.	99½	99¼	98½	¼	1	¼	..		
Oct. 16.	99¼	98¾	98½	½	¾	¼	82		
Oct. 17.	99¼	99	98¾	¼	½	¼	78	1st day	Menstruation free and painful.
Oct. 18.	99½	99¼	98¾	¼	¾	½	70	2d day	
Oct. 20.	99½	99¼	98¾	¼	¾	½	73	Last d.	
Oct. 23.	99½	99	98½	½	1	½	88		
Oct. 30.	99½	98¾	98¼	¾	1¼	½	86		
Nov. 6.	99¼	99¼	98½	0	¾	¾	81		
Nov. 12.	99¼	99½	98½	0	¾	¾	84		
Nov. 14.	99½	99½	99	0	½	½	86		
Nov. 16.	99½	99½	99¼	0	¼	¼	84	1st day	Suffering from severe cold. Menstruation free and slightly painful.
Nov. 27.	99½	99½	99	0	½	½	80		
Dec. 7.	99½	..	98½	..	1	..	84		
Dec. 11.	99½	99¼	98¾	..	¾	..	92		
Dec. 20.	99½	..	99¼	..	¼	..	80	2d day	Menstruation free. No pain.

In order to produce the mechanical effects heretofore alluded to, the arterial congestion must be quite intense, and, I should think, would necessarily lead to a greater elevation of temperature than was witnessed in any of my cases; and while I can readily conceive that a rise in temperature might accompany a venous congestion of the parts, I cannot see how a fall in temperature could be compatible with an active hyperemia.

[1] "It is certain that whatever determines an increased supply of blood to any part, raises the temperature; and, whenever the quantity of blood in any organ or part is considerably diminished, its temperature is reduced." Flint's Text-Book of Phys., page 514.

The only form of congestion to which all the phenomena of menstruation can be satisfactorily ascribed, is one due to an impediment in the course of the venous circulation. From this we would expect a low grade of hypertrophic and hyperplastic development; it would account for the distention of the veins, as well as of the parenchyma of the generative organs; for the force with which the blood is effused in the uterine cavity in cases of cervical occlusion; for ruptures of the tubes and ovaries, and would not necessitate an enlargement of the arteries, nor lead, uniformly, to an elevation of the temperature.

The question next obtrudes itself upon us as to the nature of this impediment, Can we assign any reasonable cause for the venous obstruction?

A mechanical venous congestion is thought by some to exist in the process of erection of both the male and female organs, but is denied by others, chiefly in consequence of the difficulty anatomists have had in pointing out the manner in which it could be produced, and because erection does not follow the ligation of the principal veins of the penis. Muller long ago demonstrated that it required the full force of the arterial blood pressure to accomplish perfect erection, and, as we have already explained, this cannot be brought into action without venous obstruction. Accordingly, in order to give the proper rigidity to the corpora cavernosa by artificial injection, he found it indispensable to prevent the return of blood through the veins by pressure *within the pelvis.* Thus the necessity for the existence of some means of arresting the venous current is proven mathematically and experimentally.

The mechanism by which this arrest is effected has, I think, been sufficiently indicated by modern anatomists. Savage states that, as the pudic vessels pass backward between the aponeuroses of the perineal septum, "the veins, unlike the arteries, are subject to compression by some of the muscular fibres of the septum which separate the two vessels by passing between them." Frey, in speaking of erection of the penis, says, "no doubt hindrance to the exit of the blood from the organ increases the erection," which hindrance he believes to depend on the action of "smooth muscles." The uterus and ovaries are as eminently erectile in structure as the external

organs, and since the rationale of erection must be the same in both cases, it is a valid inference that a similar collocotion of muscular fibres must exist in connection with the uterine and ovarian veins or their branches. If, through the intervention of such an agency, the veins could be hermetically closed, complete erection would follow; but this is impossible in consequence of the free venous anastomoses in these parts, and a supplementary action on the part of the arteries becomes necessary, in order to give perfection and promptness to the process. For the execution of this function the arteries are peculiarly adapted in structure. Every investigator who has had occasion to refer to the subject at all, has noted the unusual thickness of the walls of the blood-vessels of the organs of generation, especially of the internal ones. This is owing to an excessive development of their muscular tunics. According to Frey, the arteries of the ovaries possess wonderfully thick muscular coats; and Chroback says with reference to the vessels of the cervical portion of the uterus (which is believed by some to be endowed with special erectile properties), "The thickness of their walls is so disproportionate that the calibre of each vessel is only about a third of its gross diameter." Through this endowment, they are capable of undergoing either contraction or dilatation in an extreme degree.

In the act of erection, as thus explained, we have a precedent for asserting the participation of an obstructive congestion in determining the functions of the generative apparatus.

The influences which preside over the menstrual congestion are generally believed to be circumscribed in character and limited to that portion of the organism in immediate relation with the generative organs. Savage mentions cases as having been recorded of double uterus, in which menstruation took place from the two horns at different epochs. If this were true, it would certainly tend to sustain the above idea; but I have not seen the original reports, and do not know by whom or with what accuracy the observations were made, and, consequently, do not attach any importance to them; especially as Klob states to the contrary, on the authority of Kussmaul, that "in all these malformations of the uterus, menstruation occurs in the same manner as in the normal organ, and the menstrual flow proceeds from both or only one uterine half."

During menstruation disturbed innervation and disordered vascular action are witnessed throughout the entire economy. In vicarious menstruation we have the specific phenomena of menstruation, periodic physiological hemorrhage, manifesting itself in different parts of the body, and this, notwithstanding the normal discharge from the uterus may continue, showing that there is not simply a diversion of the menstrual force from its usual channels, but that distant parts are affected simultaneously in the same way.

Scanzoni is undoubtedly correct in attributing vicarious menstruation, not to a concentration of nervous energy upon the affected part, but, as a general rule, to an abnormality of the implicated tissues. Thus, some years ago, a young woman was under the joint care of Dr. E. R. Palmer and myself; upon one cheek there was a large *nevus maternus*, and the same condition of the blood-vessels existed in the buccal mucous membrane, extending as far as could be seen down the throat. At her menstrual periods she frequently suffered from hemoptysis, the blood coming from the pharynx and upper part of the esophagus. Recently, a still more striking case has occurred in my own practice. A girl, now sixteen years of age, has been my patient since infancy. When quite young, she complained of symptoms which led to an examination of the throat, and it was discovered that one tonsil and the corresponding half of the pharynx presented the appearance of a capillary nevus. Inflammation from cold would cause these structures to become very much swollen and sometimes to bleed. Bearing in mind the previous case, I predicted that she would menstruate vicariously from this locality when she arrived at puberty. The first menstrual period occurred in August last (1877), and, as is frequently the case on such occasions, the molimen was intense and the hemorrhage very free. On the second day she began to spit blood, and in the course of a few hours, the hemorrhage from the throat became alarming. Under the exhaustion thus produced, the discharge from the uterus ceased, the vicarious menstruation continuing for three days. Upon each subsequent epoch the flow has been moderate, and accompanied by an expectoration of bloody mucous. Cases of a similar nature have been met with, in

which the diseased surfaces were situated on various parts of the mucous membranes and the skin.

What explanation can be given of such cases? Why do the walls of capillaries, which happen to be abnormally attenuated, rupture and pour forth their contents coincidently with the menstrual epochs? It can only be in consequence of increased pressure from within, and this increased blood-pressure must depend upon a contraction of the muscular elements of the arteries and veins.

Other proofs may be advanced, not only confirmatory of the existence of augmented vascular tension, but showing that it antedates the menstrual flow. Women who are affected with varicose veins experience a fullness in them several days before menstruation. One of my patients has a knot of varicose veins in the bend of the knee; about three days before menstruation these become so swollen and tender as to interfere with locomotion; the pain is somewhat mitigated when the flow is established, and ceases entirely upon its subsidence. The thyroid gland, the spleen, and hemorrhoidal tumors are known to enlarge before and during menstruation; the capillaries of the mucous membranes have been noticed to become injected at this time, and the bluish hue and puffiness of the skin below the eyes, so commonly observed, can only be attributed to an engorgement of the smaller vessels in these loose tissues.[1]

The tendency of this increased contractility of the vasomotor muscular fibres, at large, would be to expel the blood to a certain extent from the arteries and larger veins, and to cause it to accumulate in those vessels which are unprovided with muscular coats, especially the capillaries and smaller veins; while the venous system, as a whole, possessing less tonicity than the arterial, would be the receptacle of a relatively larger quantity of blood than usual. As the vena cava communicates with the internal organs of generation, by means of the ovarian veins and the uterine branches of the internal iliacs, and since these, as well as the veins in the substance of the organs, are devoid of valves, the full force of the

[1] See Tilt on Uterine and Ovarian Inflammation, Third Edition, page 159, *et seq.* Jones and Sieveking's Pathological Anatomy, First Am. Ed., page 539. Whitehead on the Causes and Treatment of Abortion and Sterility, Second Am. Ed., page 36.

retrograde venous pressure would be exerted upon the tissues of the uterus and ovaries, creating there a state, to all intents and purposes, analogous to obstructive venous congestion. The structures on the inner aspect of the uterus not only participate in the general condition, but their blood-vessels having to traverse the central or medullary portion, where they are subjected to pressure in consequence of the turgescence of the erectile spaces, the circulation is still further affected; in this way the mucous membrane of the uterus becomes the seat of a gradually increasing congestion, in which the quantity of blood in the part is augmented, but the amount passing through it in a given time is progressively diminished. Such a congestion would occasion the hypertrophy and hyperplasia of the connective tissue already mentioned; and when the blood-supply becomes insufficient for the proper nutrition of the tissues, fatty degeneration and a breaking down of the superficial layers would ensue. The relative time, with reference to the progress of these changes, at which the hemorrhage occurs, I believe varies in different individuals. The strength of the walls of the capillaries cannot be the same in all cases; in some they probably yield at an early period, while in others they are capable of resisting until the disintegrating process sets in.

It might appear, in view of the fluctuations in the actual amount of the contents of the blood-vessels, arising from the irregularity in the absorption of ingesta, and the variations in the force and frequency of the heart's action, that the blood pressure could not be maintained with sufficient uniformity to accomplish so definite a result. Some very interesting experiments, by Worm-Muller and L. Lesser, are referred to in an article by Lesser, in the Transactions of the New Sydenham Society, vol. lxxi., which throw light upon this point. By these it is shown that, if the quantity of blood in a healthy animal be increased by transfusion, there is at first a slight elevation of the blood-pressure which soon subsides; if the operation be renewed, the pressure cannot be made to rise again above the normal, though the original amount of blood in the body of the animal be doubled or tripled: If an animal which has previously been bled be transfused, the blood-pressure may be restored to the normal, but cannot be made to go

beyond. A slight bleeding has no perceptible effect upon the blood-pressure, but free venesection causes it to fall regularly until it reaches zero. The researches demonstrate that, when the blood-vessels are not suddenly and abnormally depleted, the blood-pressure is regulated by the vaso-motor muscles.

Although I regard this general action on the part of the circulatory system as in itself a sufficient cause for all of the ordinary phenomena of menstruation, it does not seem to me to satisfactorily explain certain cases of vicarious menstruation, nor fully to account for some of the mechanical effects witnessed in connection with the generative organs, such as the rupturing of veins, the rending of the ovarian stroma, etc.

Take, for instance, the following case of vicarious menstruation which occurred within my own experience. An unmarried woman, twenty-six years of age, applied to me for treatment for supposed womb disease. She was of spare habit and anemic, having always suffered from derangement of the digestive organs, and since puberty had experienced many distressing nervous symptoms. Menstruation was scanty and painful, and at each period, for some months previously, on the first or second day, red splotches, of variable size and shape, would make their appearance on the upper parts of the chest and arms. These were undoubtedly ecchymoses from ruptured cutaneous capillaries. After a few days they would fade away, leaving the skin, in so far as an ocular inspection could determine, in a perfectly natural state. Could these vessels have been ruptured in consequence of an increase in the general blood pressure? I think not. There are capillaries, more delicate than those of the skin, which would have yielded in preference. In the experiments of Worm-Muller, when the vascular system was filled to repletion, the first extravasations occurred on the surface of the serous membranes. It is impossible for this extreme distention of the capillaries to arise from any action of the blood-vessels, for the arteries, being more muscular than the veins, would contract with the greater force, and capillary anemia, rather than plethora, would be the result. The efficient cause must be extraneous to the blood-vessels. The corium, the deeper layer of the true skin, is rich in involuntary muscular fibres, which surround the blood-vessels that pass to and from the

more superficial or papillary portion; a contraction of these would have the effect of damming up the blood in the capillaries, for the walls of the venous radicles are thinner and more yielding than those of the arterioles. That some subsidiary influence is exerted by this class of muscular fibres is sustained by the fact that vicarious menstruation is common from the cutaneous and mucous surfaces, the mucous membranes being also largely provided with muscular tissue (*muscularis mucosa*), while it never takes place from serous membranes in which this histological element is almost, if not entirely, wanting.

In looking to the generative apparatus for some means through which the blood stasis may be intensified in uterine menstruation, we find a system of muscular fibres apparently especially adapted to this purpose. Of these Virchow gives the following description: "In the alæ vespertilionum we find, moreover, very beautifully displayed a condition which is of frequent occurrence in the appendages of the generative organs, . . . the vessels, namely, are accompanied by flat bundles of smooth muscle in considerable quantity, which do not belong to them, but only follow the course of the vessels, and in part receive the vessels into them." Furthermore, the uterus itself is encompassed by a layer of subserous muscular tissue (sero-muscular platysma), resulting from a spreading out of these bundles upon its surface, which is in close relation to the blood-vessels as they emerge from its external cortex. I think it exceedingly probable that these muscular fibres participate in the determination of the local phenomenon of menstruation. They "do not belong to" the blood-vessels, yet their relation to them is so direct and intimate, that there can be no doubt of their being associated with them functionally, and this, together with their close proximity, renders it likely that they receive their nervous supply from the same source. It is true they surround the arteries as well as the veins, and their contraction would exercise an equal pressure upon both sets of vessels, but the walls of the veins would collapse more readily than those of the arteries, and their circulation would be the first to be impeded.

Whether or not these are the same muscles that are concerned in the erection of the internal organs of generation I

will not attempt to decide; but even if they are, I see no reason why they should not take part in both processes. The essential difference between the circulatory disturbance of menstruation and that of erection is, that the former is slowly established, and during its continuance the tonicity of the walls of the arteries is increased; while the latter is sudden in its occurrence, and an emotional or cerebral element entering into the nervous influence, by which it is produced, there is relaxation and enlargement of the arteries. Hence it is that erection at the time of menstruation is attended with danger to the integrity of the tissue; of ten cases of catamenial hematocele reported by Voisin, seven began during sexual intercourse.

The conclusions, then, to which I am led as to the nature and cause of the menstrual function are:

1st. *That menstruation is the result of a general condition of the vascular system, the local manifestations occurring, as a rule, in the generative organs, from the fact that they are especially adapted, anatomically and histologically, for their display.*

2d. *That the general disturbance of the vascular system is of a nature to elevate the blood pressure throughout the entire organism, and arises from a contraction of the muscular coats of the arteries and veins.*

3d. *That, in all probability, when the tension of the vascular system reaches its greatest degree, activity is imparted to certain muscular fibres, which, from their collocation and only possible function, must be regarded as accessory to the vaso-motor muscles, and through their co-operation the local phenomena are intensified.*

If this view of the proximate cause of menstruation be accepted, the periodicity of the function admits of a very simple explanation, as it may be attributed to the intermittent action of involuntary muscular fibres. As is well known, the energy of this kind of muscular tissue is exerted paroxysmally, periods of activity alternating with states of rest. Each muscle or set of muscles, however, has a rhythm of its own; the heart, for instance, contracts and relaxes with great regularity seventy or eighty times a minute, and the uterus only once in from two to thirty minutes or more; while the vaso-motor mus-

cles seem to have allotted to them a longer time for repose and correspondingly slower mode of action.[1]

I have elsewhere[2] taken the ground that the physical changes of puberty are nothing more than hypertrophies of certain tissues called into being through an altered state of the nerves, which preside over their nutrition, and that the nervous system itself must undergo a certain degree of structural development in order to engender them.[3] These changes are of the same nature in the two sexes, but affect different parts. The most notable in the male are the development of the larynx and the growth of hair upon the face; and in the female the expansion of the pelvis, the enlargement of the breasts, and the increased deposit of fat; but there are others of a less obvious character, which pertain to almost every organ and tissue in the body, and among these I believe there is in the female a hypertrophy of the muscular fibres in the walls of the blood-vessels. It is this hypertrophy that enables, it may be impels, them to assume their periodic function, just as we see in the pregnant uterus the muscular fibres more prone to spasmodic contraction in proportion to their development.

Many physiologists of the present day hold to the doctrine first enunciated by Haller, that muscular fibres possess an intrinsic irritability, by virtue of which automatic movements may be accomplished. The alternate relaxations and contractions of the heart and uterus and the peristaltic actions of various viscera are regarded "as expressions of this peculiar vital endowment of their muscular tissue." Others, to the contrary, maintain that all muscular movements are instigated by nervous influence. My own convictions are with the latter. I can see no sufficient reason for believing that muscular fibres have an inherent power of altering their condition, and am

[1] Sleep and hibernation are periodic phenomena, to some extent at least, of an intrinsic nature. In the former, the arterioles of the brain are contracted, while in the latter there is general contraction of the blood-vessels throughout the organism, and there is every reason to believe that the two states are due, respectively, to these vascular conditions; thus affording us other examples of slow rhythmical action on the part of the vaso-motor muscles.

[2] Richmond and Louisville Medical Journal, November, 1875.

[3] I do not wish to be understood as asserting that the nerves necessarily exert a *trophic* action. All of these hypertrophies may arise from modifications of the circulation, and that the vaso-motor nerves regulate the amount of blood sent to a part cannot be denied.

forced to adopt the opinion that all of their *functional* movements at least arise from excitations emanating from nervous centres. There can be no doubt but their equilibrium may be disturbed by chemical or mechanical irritants directly applied, but it is impossible to prove that such impressions are ever concerned in determining their functional action, except in a reflex manner through the intervention of the nervous system, in which process the motor impulse in reality proceeds from a nervous centre.

The rhythmic movements of various organs evidently depend upon sources of power resident within their structures. The heart of the alligator will pulsate for hours after excision. The intestinal canal presents its vermicular motions when removed from the body, and the separated ovaduct of the turtle has been seen to contract so as to expel its ova. It is even claimed by some that the action of the heart continues in vacuo. Phenomena of this kind, where the parts were disconnected from all recognized nervous centres, led the older physiologists to conceive the idea of a motility belonging to the muscles themselves; but we now know that, interspersed among the organic muscular fibres, there are innumerable ganglia, ganglion cells, and nucleated fibres, which are capable of generating nervous force, and it cannot be shown that contractions can occur independently of them. Friedländer states that he has demonstrated the constant existence of ganglion cells in still pulsating portions of the heart of the frog, in which there were not in some instances more than two or three muscular fibres.

It is to nervous centres of this class, located in the walls of the blood-vessels, which, it is presumable, partake of the puberal development that affects the muscular tissue with which they are intimately associated, that I would ascribe the dynamic cause of the periodic activity of the vaso-motor muscles. As elaborators of nervous force, they are independent agents, but in the exercise of this force they are doubtless subject to disturbing influences originating in other sympathetic ganglia and in the cerebro-spinal centres, on the same principle, but not to the same extent, as is known to be the case with the intermuscular ganglia of the heart. What the process is by which their action is rendered intermittent, I will not

discuss. It may consist of a recurring series of physiological acts, or it may be simply an alternation of exhaustion and recuperation of nervous energy. In either case there is a repetition of similar events in regular order of succession from first to last, and then returning to the first. Hence, I have entitled this exposition of the cause of woman's peculiar attribute, THE CYCLICAL THEORY OF MENSTRUATION.

The effect of conception upon the vascular changes of the menstrual cycle is worthy of note. The mere presence of the fecundated ovum makes an impression upon the organism of the female, and creates a powerful reaction, the first effect of which is, that the parts in the immediate vicinity of the point where it comes in contact with the maternal tissues become the seat of an active hyperemia, which gradually extends, until, in normal pregnancy, it involves the whole uterus. A rapid and progressive development of all the tissues of the womb now sets in, and the arteries continuing to enlarge, the supply of nutritive material increases with the demand, and it is not until months have elapsed and gestation is drawing to a close that any retrograde metamorphoses are witnessed in the hypertrophied mucous membrane that lines the cavity of the body of the organ (Engelmann). In all varieties of extra-uterine fetation, a similar influence is exerted upon the structures where the implantation occurs; but, what is more curious, in such cases, when the generative organs are not implicated, the uterus undergoes the same development as in ordinary pregnancy.[1] This shows that the inhibitory reaction of the vitalized ovum upon the blood-vessels is not of a purely local character, but extends to the system at large, the vascular apparatus of the uterus responding more readily to the impression than that of other parts, in consequence of its peculiar muscular endowment. During gestation the periodic contraction of the vaso-motor muscles is in this way inhibited and menstruation suspended. But I do not believe that the physiological steps of the nervous cycle are arrested, since it sometimes appears that the antagonistic influence is insufficient, and actual menstruation persists for a time after conception, and, as a general rule, evidence of their continuance may be detected under favorable circumstances. Most women experience some

[1] Parry on Extra-Uterine Pregnancy, page 73.

indications of the return of the menstrual epochs in pregnancy, and it is a well-established fact that abortions are most apt to happen at such times.

The surgical, physiological, and therapeutic bearings of this theory are numerous and important, but in view of the length to which this article has already extended, their consideration must be postponed to a future occasion. There is just one practical point to which I would at present call the attention of the profession. This has reference to the timing of surgical operations upon the female. In my opinion, no operation should be performed upon a woman during the increment of the cycle; that is, for six or seven days anterior to a menstrual epoch, and this rule should be rigidly observed whenever the individual is the subject of any derangement of the menstrual function. Some years ago, I came very near losing a patient from whom I had removed a small tumor, situated in the vesico-vaginal septum, six days before menstruation, the hemorrhage coming on twenty-four hours after the operation. Churchill mentions the case of a young lady who suffered from vicarious menstruation. Upon one occasion, having been already reduced by bleeding from the mouth and gums, she was cupped for pain in the side, when it was found impossible to arrest the hemorrhage from the scarifications, and in less than six hours she died.[1] I have met with several cases in which serious losses of blood followed the extraction of teeth at or about the menstrual period.