The Supports of the Pelvic Viscera: A Review of some recent Contributions to Pelvic Anatomy, with a Clinical Introduction.*

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I. Clinical.

If asked to say how the pelvic viscera are supported in their usual position, a modern student of medicine describes all the structures which form the pelvic floor. Beginning, perhaps, with the external surface, he mentions skin, fat, and fascia; the perineal body and the muscles that surround the anal and vaginal openings. Next he describes the pelvic diaphragm or its component parts such as the levator ani and the pelvic parietal fascia. Passing on, he mentions the vagina itself, the pelvic visceral fascia, the ligaments of the uterus—broad, round, utero-sacral and utero-vesical,—and ends with the peritoneum which covers them all. He concludes that the pelvic organs are partly propped up from below and partly suspended from above.

But extended experience in gynæcological work cannot fail to show the observer that this teaching is not satisfactory. While true enough in a general sense, it lacks that accuracy which is essential if the clinician is to have a real grip of his work.

We learn, for instance, in the out-patients' room, that extreme laxity of the perineal muscles can exist without descent of the pelvic viscera. We constantly see cases in which the perineum has been badly torn without any consequent alteration in the position of the uterus. Indeed, in cases of complete rupture extending into the rectum, it is quite exceptional to find uterine prolapse.

The narrow lower opening of the funnel-shaped pelvic diaphragm is not to be felt so often as descriptions would suggest; and in parous women it is often difficult or impossible to recognize the margin of the levator ani. Even in virgins careful examination shows that the cervix uteri does not rest on the pelvic diaphragm any more than the bottom of a hansom cab rests on the ground.

Again, the vagina itself may descend without seriously affecting the position of the other pelvic viscera; for cystocele alone, rectocele alone, or the two combined may be observed with a normally situated uterus. Thus we are gradually driven to the conviction that support from below is by no means necessary to the pelvic organs.

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Similar observations point to the conclusion that suspension by the ligaments of the uterus is even less important. Thus Winter says (*Lehrbuch der gyn. Diag.*, 1897): "The uterus can be drawn against the symphysis, pushed into the hollow of the sacrum, shoved against the side walls of the pelvis; the fundus can be raised almost to the navel, and the cervix can be pulled down to the vaginal orifice without causing any pain. It is therefore obvious that the peritoneum and the so-called ligaments cannot have any real influence on the fastening of the uterus."

The utero-sacral ligaments, we may note, are scarcely recognizable on vaginal examination unless they are thickened by inflammatory deposits.

We learn much more about the so-called ligaments of the uterus during the course of operations by the abdominal route. By direct inspection, when the abdomen is open, we see that the broad ligaments lie loose and slack upon the subjacent structures, and have no supporting action whatever.

As for the round ligaments, each takes a deep curve from its uterine cornu, downwards and backwards, before turning upwards and outwards again towards the internal abdominal ring. To afford support it would have to run a much straighter course. It is also worthy of note that the internal abdominal rings are at the sides, and not in front of the pelvis. In most cases the fundus is actually anterior to the line joining the two internal abdominal rings, so that tightening the round ligaments in a normal case would draw the fundus a little backward and not forward at all. The utero-sacral and utero-vesical ligaments are seen, on inspection, to be mere peritoneal folds. Thus the gynæcological surgeon looks at and handles the so-called ligaments of the uterus day after day with an ever waning sense of their mechanical importance, and becomes convinced that the structures which are generally supposed to hold up the pelvic organs do not perform the functions ascribed to them except in a very minor degree.

But some definite structure or structures do hold up the uterus, vagina and bladder, both in normal subjects and in many whose pelvic diaphragms have been torn or stretched open below.

To the clinical observer, the nature of these real supports is revealed by the operation of vaginal hysterectomy. Suppose that an operator is about to remove a uterus whose only lesion is a small epithelioma of the cervix. Let him incise the vaginal wall all round the cervix, and, after opening the pouch of Douglas, let him freely divide the posterior attachments. Further, let him separate the bladder completely from the uterus, and make a wide opening into the utero-vesical pouch. The uterus cannot as yet be pulled down much more than before the operation was begun. The something which supports the uterus has not as yet been divided. Next

let the operator deliver the fundus through the anterior portion of the incision. This affords another proof that the broad ligaments and round ligaments have no value as suspenders, for they come down freely and without being stretched. Let them be tied and divided, and the uterus still remains fixed by the tissue known as the parametrium, and by this alone. Until this is divided on each side the organ is, for practical purposes, as completely supported as before any incision was made.

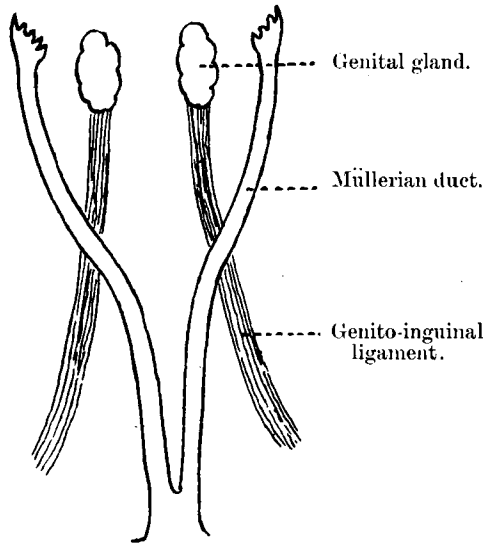
The inevitable conclusion is that the vessels and other structures, with their sheaths or fascial coverings, which lie on each side of the uterus, below the broad ligament and above the lateral fornices, are the structures which support the uterus. These may correctly be called the parametria, for Virchow originally defined the parametric tissues as the loose fatless connective tissue, with abundant blood-vessels and lymphatics, which surrounds the lower part of the uterus and the upper part of the vagina.

If the uterus is supported by the sheaths of its blood-vessels, it follows that the bladder and the vagina are held in their typical position in the same manner, and of this operative experience gives ample proof.

The peri-vascular sheaths attach the pelvic organs to the sides of the funnel-shaped pelvic diaphragm. Without this firm attachment, the plastic viscera would slip through its lower opening like sand through an hour-glass, like fæcal masses from the rectum, and like the products of conception from the parturient canal.

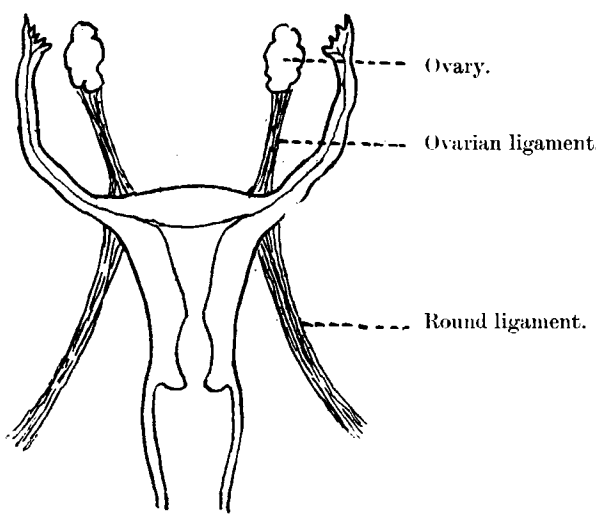
The loosening of this attachment must be regarded as the one constant and essential factor in the causation of prolapse of the pelvic organs. Injuries to the perineum and levator ani doubtless straighten and widen the road from the pelvic cavity to the exterior. If the pelvic organs are freed from their attachments to the higher portion of the pelvic funnel, if they are coming down in any case, their descent is facilitated by injuries to the pelvic diaphragm and perineum; but if the organs remain firmly attached above, no mere enlargement of the opening below will make them come down.

Further clinical evidence in favour of this view is afforded by those cases in which well marked prolapse is cured by pelvic cellulitis. Again, it is into the tissue below the broad ligaments that chemical irritants have been injected, causing an artificial cellulitis and so curing prolapse. An operation has been devised by Alexandroff (*Zentralbl. für Gyn.*, 1903, Nr. 25) for the same purpose, in which, after an anterior colpotomy, the parametric tissues are drawn together in front of the cervix so as to take up the slack. The designer of this measure has been followed by Dr. Hastings Tweedy, who has described a similar one (*Journ. Obstet. and Gyn. Brit. Emp.*, May 1905). Lastly, many operators consider that the success of vaginal hysterectomy, when performed for prolapse, depends upon the taking



A.

FIG. I.



B.

FIG. I.—Origin of the round ligament.

A. Early relations of the genito-inguinal ligament, which forms the gubernaculum testis in the male, and the ovarian ligament and round ligament in the female.

B. Later stage in the female.

of effective measures to secure good union between the parametria of the right and left sides.

It is thus clear that many gynæcologists have realized the truth of this matter; but the text-books at present in use are not clear on the subject, nor is a great deal of current clinical teaching any more explicit. This is doubtless because writers and teachers prefer to have a definite basis for their anatomical statements in the writings of professed and competent anatomists.

Authority of this kind is no longer wanting, for descriptive anatomy has recently changed in a way exactly parallel with that in which clinical gynæcology has moved.

II. Anatomical.

The so-called ligaments of the uterus.

The utero-sacral and utero-vesical folds demand no reconsideration from the anatomical part of view. The broad ligament is well known to be merely a mesosalpinx and mesovarium. Before passing on to the recent work referred to, it is perhaps worth while to dwell for a moment on the round ligament, and to call to mind the fact that this is a vestigial structure which plays its little part during the early months of fœtal life. Just as the *gubernaculum* pulls down the testis from its place of origin on the posterior wall of the fœtal body cavity, so the round ligament pulls down the ovary and the Müllerian tube. A peritoneal fold runs from the Wolffian ridge to the groin. From the rudiments of the transversalis and internal oblique muscles of the abdominal wall, muscle cells grow into this fold, and form a strand of tissue, the genito-inguinal ligament, which extends upwards towards the genital gland, and at one point crosses the Müllerian duct. In the female this strand of tissue forms the ovarian ligament and the round ligament. It is attached to the Müllerian duct at the point at which it crosses the latter. This particular point is that up to which, in the human subject, the two Müllerian ducts fuse to form the vagina and uterus. Thus the ovarian ligament and the round ligament are both attached to the uterine cornu, and when the growth of the body outpaces the growth of the ligaments, the ovary and the fundus uteri are drawn down into the pelvis. It would thus appear that the two names "round ligament" and "ovarian ligament" might well be given up, and that the term "*gubernaculum ovarii et uteri*" might well be applied to this structure, whose function is to pull the organs down during embryonic life, and not by any means to hold them up throughout post-natal existence. A structure whose origin and antecedents are of this nature can hardly be expected to occur with that constancy and uniformity of bulk which would be required to justify its use as a suspender in surgical work.

The superficial perineal muscles.

Professor Peter Thompson ("Myology of the Pelvic Floor," 1899) describes the pelvic floor as a compact mass in which may be recognized two distinct layers of muscles whose arrangement and functions are in striking contrast. "The upper layer . . . forms a more or less complete pelvic diaphragm; the lower layer, designed for purposes of control, forms sphincters for the openings of the canals which perforate the floor to reach the exterior. The two layers are not only functionally but morphologically different."

In the lower or sphincter layer of muscles Thompson "includes the sphincter ani externus, the transversus perinei superficialis, the bulbo-cavernosus, the ischio-cavernosus, the constrictor urethræ, the transversus perinei profundus and the ischio-pubicus. These superficial perineal muscles are to be regarded as derived from a layer of muscle known to embryologists as the *primitive sphincter cloacæ*—a muscular ring which surrounds the cloaca and has attachments to the bones at the pelvic outlet; and which, on the disappearance of the cloaca, becomes subdivided into groups one of which surrounds the urino-genital canal while another encircles the anus. Thus the muscles of the lower layer in the pelvic floor have a common origin and a common sphincteric function.

We must be very cautious in assuming that this sphincteric layer of muscles has any share in holding up the pelvic viscera. It is indeed improbable that the muscles surrounding the vaginal orifice support the uterus any more than the sphincter ani supports the rectum. If the uterus, bladder and vagina had no firm attachment to the sides of the pelvic diaphragm, they would be liable to slip through the vaginal sphincter with every considerable elevation of intra-abdominal pressure. This indeed is what actually happens in many patients who have prolapse, but whose sphincters retain their functions. The uterus and bladder descend into the inverted vagina when the woman's bowels are moved or, perhaps, when she turns the mangle. When pushed up again the organs remain within the pelvis until another muscular effort drives them through the sphincter once more. To put the matter in another way: in a patient with a loose uterus, the sphincter layer just makes the difference between the "prolapse" and the "procidentia" of some books. But in a normal subject the sphincter layer has no action upon the uterus.

The muscles of the pelvic diaphragm.

The muscles of the upper layer form, with their aponeuroses, the structure which was first named by Meyer "the pelvic diaphragm," a funnel-shaped sling encircling the pelvic viscera, deep behind, shallow in front, widely open above, and with a narrow outlet below. Dickinson describes it as a muscle, shaped like a horse shoe, whose

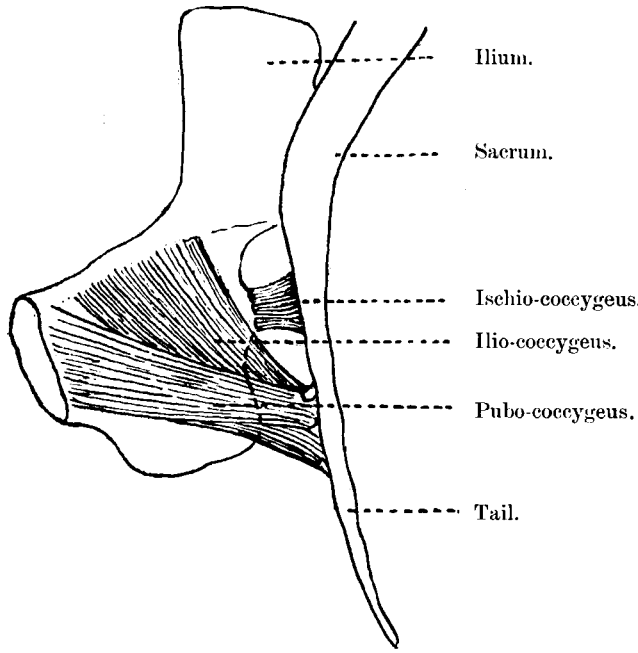
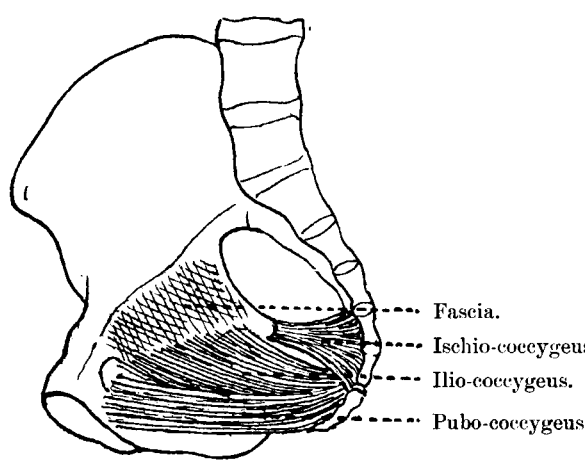


FIG. H. A.



B.

FIG. H.—Origin of the levator ani.
A. Tail moving muscles in an ape.
B. The same muscles in man forming the levator ani and coccygeus muscles. (After Keith.)

ends are attached behind the pubes, while the urethra, the vagina, and the anal canal pass between its right and left sides.

In four-legged animals with tails, certain muscles are inserted into and serve to move the tail. Those which raise the tail are of no present interest, but those which lower it and those which move it from side to side concern us deeply.

The muscles which lower the tail and pull it between the animal's legs arise from the inner aspect of the side walls of the pelvis, namely from the back of the pubic bones and from the ilio-pectineal lines or the sides of the pelvis beneath it. They are inserted into the fronts of the vertebræ forming the tail, and are called the pubo-coccygeus and the ilio-coccygeus muscles. The tail-wagging muscles arise from the ischial bones and from neighbouring fasciæ, and are inserted into the sides of the caudal vertebræ. They are accordingly called the ischio-coccygei. These two sets of muscles are profoundly modified in animals which have lost their tails. In the human subject they are represented by the muscles of the pelvic diaphragm. The pubo-coccygei and the ilio-coccygei together form the levator ani, while the ischio-coccygeus is the coccygeus of human anatomy.

But with the loss of the tail as a movable organ, the glory of these muscles has departed. Their insertions being reduced with the caudal vertebræ, and their range of movement being gone, they are indeed mere faint adumbrations of the masses of contractile tissue which subserve the locomotion of the prehensile ape and the tripod kangaroo.

Thompson says of the levator ani: "The dorsal portion of the muscle is wholly converted into fibrous tisue, so that only the lateral and ventral parts exist. There is also a great change in the thickness of the muscle. Whereas in tailed apes the levator ani attains a thickness of more than 5 mm., in anthropoids it is thin and almost transparent."

"In the human subject the origin and insertion of the pubo-coccygeus conform to what is constant in the lower mammals: it arises from the pubes and is inserted into the rudimentary caudal vertebræ. On the other hand, the muscle has been profoundly modified in such a way that, as its influence over the caudal vertebræ has diminished, its influence over the rectum has increased, and a large number of fibres, losing their connexion with the coccyx, pass round the rectum to form a sling."

"In the human subject the ilio-coccygeus . . . may fail entirely or be replaced by fibrous tissue as in anthropoids, and only in a comparatively small number of subjects is the muscle strongly developed. It is usually thin and transparent, and the muscular bundles are separated so frequently by broad membranous intervals, that . . . the ilio-coccygeus must be regarded as a degenerating

muscle whose primary function has been lost. In virtue of its position, however, it contributes to the formation of the pelvic floor."

"Little difference is observed between the ilio-coccygeus in the male and female, and it is difficult to say in which sex degeneration of the muscle is carried to the furthest point. According to my dissections the muscle is usually thinner and more membranous in the female, though probably this is due to stretching of the muscle during parturition."

Of the coccygeus or tail-wagging muscle, Thompson says: "As the tail becomes rudimentary the coccygeus tends to lose its muscular character and to become transformed into fibrous tissue. It is noteworthy, however, that in man the muscle is subject to considerable variation. In some cases the coccygeus is strong and fleshy, in others the retrograde changes have taken place to such a degree that the fleshy fibres have disappeared altogether, and a thin fibrous layer on the deep surface of the small sacro-sciatic ligament represents the muscle."

Can it be seriously maintained that the contractile power of these degenerated muscles is of importance in holding the uterus, vagina and bladder in their normal position? The pubo-coccygeus, or lowest portion of the levator ani, remains functional, and by its action the rectum can be raised and drawn towards the symphysis; it also has an important sphincter action on the bowel; and, as Thompson has well shown, it co-operates with the sphincter vaginæ in narrowing the vaginal outlet. But as a muscle the levator ani probably has no further action. As a sheet of tissue it of course forms the major part of the pelvic diaphragm.

The pelvic fascia.

We must next dwell for a moment on the nature of fascia, and, in particular, the pelvic fascia, which has long been a bug-bear to students and to teachers.

"It has been customary," says Keith ("Human Embryology and Morphology," 1902) "to regard fasciæ as separate structures forming distinct sheets with devious and complex courses. It is possible, by dissection, to prepare and display them according to accepted descriptions; but the structures so displayed are artificial, and not the true structures with which the surgeon or physician has to deal." Keith explains that the undifferentiated mesoblast forms the connective tissue or fascial system of the body. Thus the fasciæ and septa must constitute a continuous formation of sheaths each being in continuity with that of every contiguous structure. "The pelvic fascia," Keith goes on, "is composed of the sheaths of four muscles, the levator ani, the obturator internus, the pyriformis, the constrictor urethræ and deep transversus perinei. The fibrous capsules of the

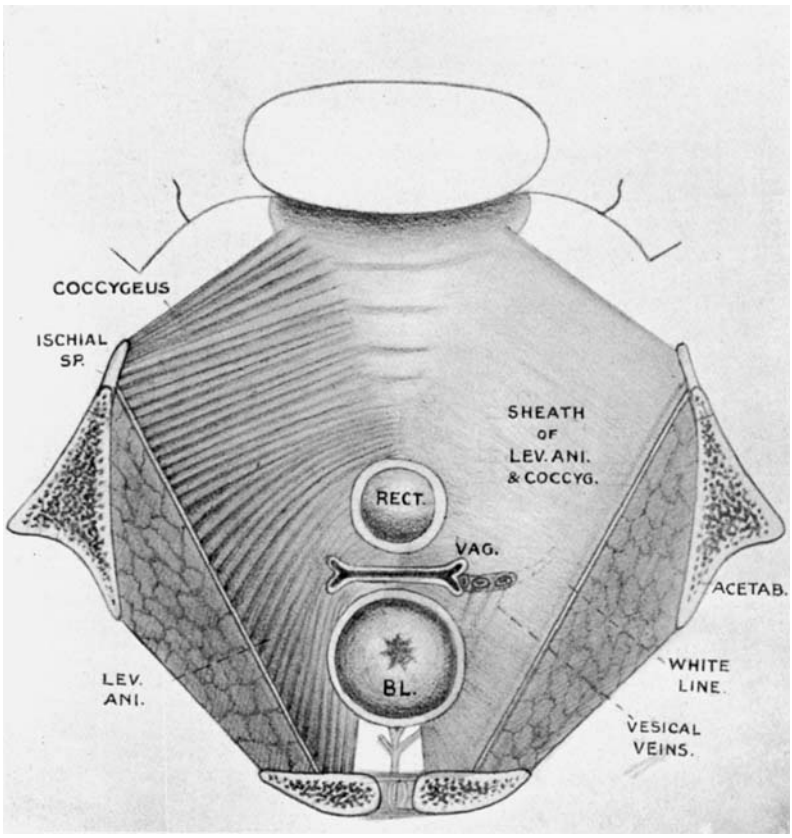


FIG. III.—Cameron's Diagram of the Pelvic Diaphragm seen from above.
(Journ. Anat. and Phys.)

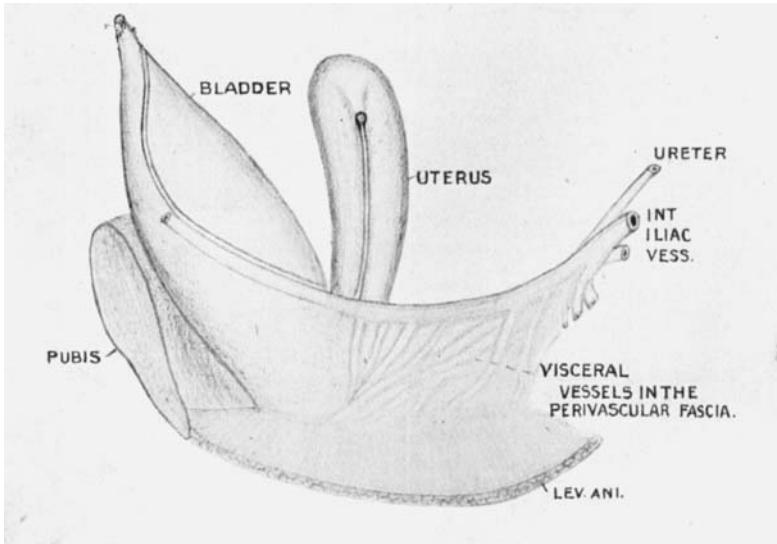


FIG. IV.—Diagram of the relation of the hypogastric artery to the uterus, vagina, and bladder in the fœtus. The vessel forms the upper margin of a mass of tissue whose firmest portion consists of perivascular sheaths. (Cameron: *Journ. Anat and Phys.*)

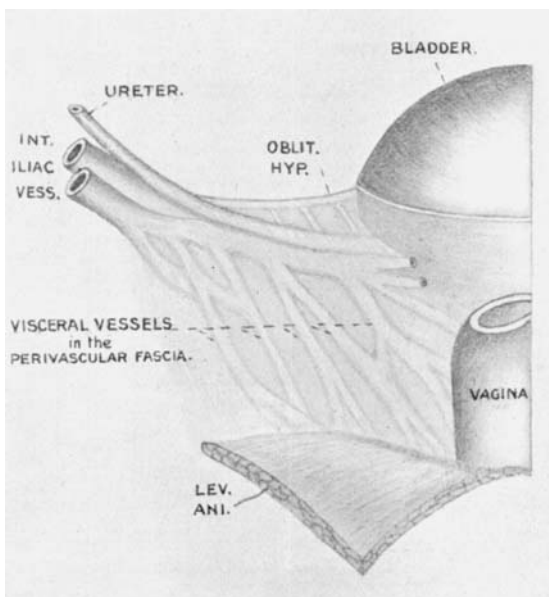


FIG. V.—Diagram of the vascular structures and viscera in the female, with uterus removed. (Cameron: *Journ. Anat. and Phys.*)

vagina and uterus, the bladder and the rectum also form part of it, the so-called visceral fascia."

Again, Derry remarks (*Journ. Anat. and Phys.*, October 1907): "The viscera, therefore, are simply invested by the remains, in this mesenchymatous form, of the tissue in which they were originally developed, and the same applies to the vessels which supply them. This tissue is condensed in places to form definite ensheathing layers, particularly in the neighbourhood of the . . . vagina and lower part of the uterus in the female. But any attempt to give definiteness to such layers is not only artificial, but makes the description unnecessarily complicated and confusing, for the simple reason that these layers, though well-marked in the regions named, and also round the rectum, pass gradually into the general mass of subperitoneal tissue which fills the whole pelvic cavity, and are then no longer traceable."

Cameron says (*Journ. Anat. and Phys.*, October 1907): "The fascia on the pelvic surface of the levator ani and coccygeus forms one continuous fascial plane in relation to these muscles, there being no actual splitting of this fascia into layers as is frequently described."

We may therefore say good-bye to the pelvic fasciæ of classical descriptive anatomy, and may take it on good authority that the only fascia which concerns us is the aponeurotic covering on the inner or upper surface of the muscles which form the pelvic diaphragm, together with the fibrous investments of the structures which lie within it.

We have now to learn how the pelvic organs are attached to the connective tissue which lines the inward sloping walls of the pelvic diaphragm, which could not, in virtue of their shape alone, support a plastic mass like that formed by the viscera they contain.

Professor Thompson (*Journ. Anat. and Phys.*, January 1901) says: "At any rate we know that a fibrous sheath envelops the obliterated hypogastric artery, and the vessels supplying the bladder, uterus, vagina and rectum, and it may be that the supporting layers of the pelvic fascia are primarily derived from this by lateral extension on to the fascia covering the upper portion of the levator ani."

Dr. John Cameron (*Journ. Anat. and Phys.*, October 1907) writes: "It is most convenient to devote attention first of all to the internal iliac vessels. The anterior divisions, along with their visceral branches, are found to be bound together by a dense connective tissue —the perivascular sheaths. The resultant compact mass will be found to lie in a more or less vertical plane, and to possess fairly definite borders of attachment. Thus it is firmly united by its external border and antero-external surface to the innominate bone close to the sciatic notch, and, lower down, to the obturator fascia. From this origin the mass passes forwards and inwards along with

the vessels to blend internally with the posterior part of the lateral aspect and base of the bladder, the seminal vesicles and the lower part of the rectum." "The upper margin is free, and contains the anterior division of the internal iliac artery with its continuation the obliterated hypogastric. Note particularly that the ureter is bound down by fibrous tissue, first to the upper border and then, as it approaches the bladder, to the posterior aspect of the mass. The lower margin is intimately blended with the sheath on the pelvic surface of the levator ani. *It may now be recognized that we have here a sort of fascial mesentery which must constitute an effective support to the pelvic viscera.* The fascia tends to become denser and stronger as it is traced downwards towards the pelvic floor. The latter part corresponds to the suspensory ligament of the genito-urinary organs recently described by Paterson." "In the female the relative development of the connective tissue round the visceral branches of the internal iliac vessels is just as pronounced as in the male. The perivascular fascia is closely attached to the vaginal and uterine walls by the dense sheaths of the vessels passing to these structures."

Derry, in the paper quoted above, gives a very similar description of the structures to which Cameron has directed attention. It is a remarkable coïncidence that their papers both appear in the same number of the *Journal of Anatomy and Physiology.*

The recent anatomical work now cited has been foreshadowed in some degree. Thus Waldeyer says (*Das Becken.*, Bonn. 1899, p 368): "It is clear that all those structures which are in relation to the uterus help to hold it in place. The vagina, the perineum, the parametrium, the perimetrium, specially the broad ligaments, the round ligaments and utero-sacral ligaments; also the blood-vessels. The prime importance has been given now to one now to another. In my own opinion," Waldeyer continues, "it is the vagina and perineum and, next, the blood-vessels with their firm connective tissue sheaths which should be named as of the first importance. I willingly agree that the parametric connective tissue plays a weighty part in fastening the uterus." In his enumeration Waldeyer mentions the blood-vessels last of all, and in expressing his personal opinion he gives the chief place to the vagina and perineum. Hohl, however, cut away, in the cadaver, both vagina and perineum without causing any change in the position or mobility of the uterus, thus affording a proof of the fallibility of Waldeyer's judgment.

Kocks (*Die normale und path. Lage und Gestalt des Uterus.* Bonn, 1880) gave to the perivascular sheaths of the parametrium the importance of ligaments. He called them the *ligamenta cardinalia,* and stated that they hold the uterus in position, and that it moves on them as on a transverse axis.

Mackenrodt (*Uber die Ursache der normalen u. path. Lagen des Uterus, Arch. f. Gyn.*, Bd. xlviii., 1895) lays stress on the firm, con-

nective tissue sheaths derived from the pelvic fascia which are interspersed with muscular fibres, accompany the uterine arteries and are firmly attached to the cervix. He named them the transverse ligaments of the uterus; but they are not transverse, and they are not ligaments, which is probably the reason why the work of Kocks and of Mackenrodt has not been universally accepted.

Relations of the rectum to other pelvic organs.

There is another point upon which light has recently been thrown, namely the relation of the rectum to the urino-genital organs. Professor Paterson has pointed out (*Journal of Anat. and Phys.*, January 1907) the complete independence of the rectum from the other pelvic organs. He says: "The floor of the pelvic basin is constituted so as to provide a posterior rectal channel in which the rectum lies loose, and an anterior portion containing the genito-urinary passages which are firmly fixed to the pelvic floor and walls by an investment of pelvic fascia." "The rectum, occupying the posterior section of the pelvis, is altogether free and separate from adhesions of the pelvic fascia, and lies loose in its special channel clothed by extra-peritoneal tissue." We have seen that the uterus, vagina and bladder are attached to the sides of the pelvic funnel by the masses of tissue which carry their blood supply. These run from behind forward, and Paterson's rectal channel lies between the two masses of tissue which support the other organs. The rectum has its main blood supply from a separate source, and is supported by its own separate attachment to the back of the pelvis. These anatomical facts explain the well-known clinical observation that, in prolapse, the uterus with its appendages and the bladder comes down with the vagina, the posterior vaginal wall being separated from the anterior rectal wall and leaving the latter in its ordinary position.

Rectocele forms an apparent exception to this rule: but in this condition the anterior rectal wall is pathologically adherent to the posterior vaginal wall, owing to the formation of cicatricial tissue between them during the healing by granulation of infected lacerations of the perineum and posterior vaginal wall. When the recto-vaginal septum is thus matted into one sheet of tissue, distension of the rectum cannot be accommodated by sliding upwards of the rectal wall upon the vaginal wall. The result is that rectal distension bulges the recto-vaginal septum forwards and then downwards through the vaginal orifice.

Summary of Conclusions.

1. The so-called ligaments of the uterus lie loosely upon the subjacent structures, and have no supporting action. The broad ligament is simply a mesovarium and mesosalpinx. The utero-sacral and

utero-vesical folds are incapable of resisting downward pressure, as is the round ligament, which moreover is a vestigial structure (gubernaculum ovarii et uteri).

2. The external muscular layer of the pelvic floor has a sphincteric rather than a supporting action.

3. The internal muscular layer of the pelvic floor being the degenerated representative of the tail muscles of lower animals, has largely lost its muscular action: and the lower part of the levator ani merely acts as an adjuvant to the sphincters of the rectum and the sphincter vaginæ.

4. The classical descriptions of the pelvic fascia should be given up, and the fascia should be regarded as the sheaths of the muscles, the vessels and the viscera.

5. The internal muscular layer, with its fascial investment, forms the funnel-shaped pelvic diaphragm.

6. The pelvic diaphragm does not support the pelvic organs by its muscular action.

7. The pelvic diaphragm could not support the pelvic organs in virtue of its shape, were they not firmly attached to its sloping lateral walls.

8. This attachment is accomplished by the fibrous sheaths of the blood-vessels and accompanying structures which supply the pelvic viscera. The one constant essential cause of prolapse is relaxation of the perivascular sheaths.

9. The rectum has attachments to the back of the pelvis quite distinct from those of the urino-genital organs to its sides. It does not descend with them in prolapsus. When the anterior rectal wall descends in rectocele it is united with the posterior vaginal wall by cicatricial tissue, the result of infection during the healing of perineal tears.