

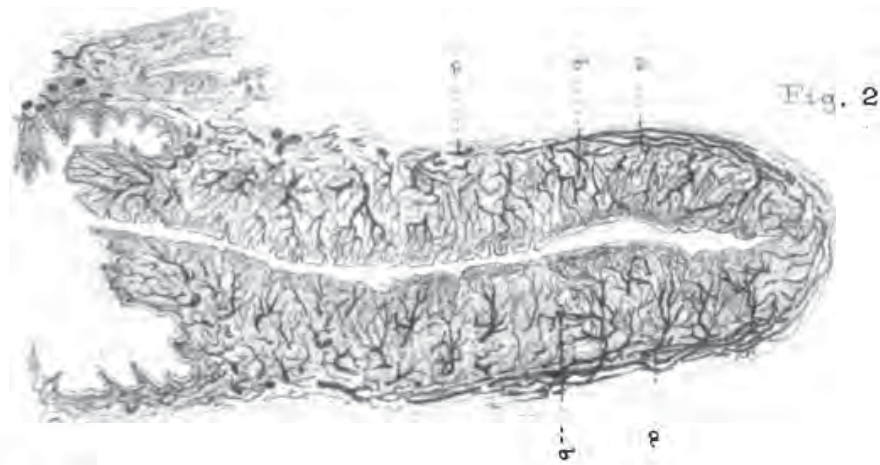
ON THE CIRCULATION IN THE UTERUS, WITH SOME OF ITS ANATOMICAL AND PATHO- LOGICAL BEARINGS.

By JOHN WILLIAMS, M.D., F.R.C.P.

THE sources of the blood-supply of the uterus are well known, but the manner in which the blood is distributed in the organ has been less minutely studied, and yet its importance from both a physiological and a pathological point of view appears to be not inconsiderable.

The uterus derives its vascular supply from two sources, the ovarian arteries and the uterine arteries. The ovarian arteries rise from the abdominal aorta; on reaching the pelvis they enter the folds of the broad ligament on each side and run towards the upper angle of the uterus, near which they divide, each into two branches, an upper and a lower. The upper supplies the fundus of the uterus, while the lower joins the uterine artery of the same side. The uterine artery on each side takes its origin in the anterior branch of the internal iliac; it runs inwards and downwards towards the cervix of the uterus; here it takes an upward course between the folds of the broad ligament and outside the uterus, terminating near the upper part of the organ by joining the lower branch of the ovarian artery.

As it approaches the cervix it gives off branches, some of which run downwards towards the vaginal portion, while others run more or less directly across the cervix before and behind, joining similar branches from the artery of the other side; these form arterial circles around the upper part of the cervix. (Plate I.) Above the level of the cervix the uterine arteries and the two branches of the ovarian already named, give off similar



R. Boxall del

Fig. 1.



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Fig. 3.



DESCRIPTION OF PLATE I.

**Illustrating Dr. John Williams's paper on the Circulation in the
Uterus.**

Distribution of ovarian and uterine arteries (Hyrtil).

DESCRIPTION OF PLATE III.

Illustrating Dr. John Williams's paper on the Circulation in the Uterus.

FIG. 1.—Sagittal mesial section of adult uterus.

a, a. Uterine canal.

b, b. Peritoneal coat.

e, e, e, e. Branches of uterine artery forming circles around uterus by anastomosis, with similar branches from the artery of the opposite side. They run in the submucous connective tissue which lies between the true muscular coat (*f, f, f, f*) and the muscularis mucosæ (*g, g, g, g*).

f, f, f, f. The true muscular coat of the uterus. It lies immediately under the peritoneum, between it and the submucous tissue.

g, g, g, g. The muscularis mucosæ. It lies between the submucous connective tissue and the soft tissue lining the uterine cavity—the decidua—but usually called the mucosa.

h, h. The decidua. Usually called the mucous membrane of the uterus. In the specimen from which these drawings were made it was of extreme thinness. It is sometimes a quarter of an inch or more in thickness. The thickness depends upon the distance in time from a past or a coming menstrual epoch; the nearer a past epoch the thinner is the decidua, the nearer a coming epoch the thicker it is.

FIG. 2—Transverse section of the body of an injected adult uterus.

a. Uterine canal.

b, b. Peritoneal coat.

c. Broad ligament.

d, d. Uterine arteries lying in the broad ligament, outside the uterus. The section has been made through a bend in the artery.

e, e. Branches of the uterine artery which run in the submucous tissue, forming circles around the uterus. Their sections are oval, because they do not run directly transversely, but with a slight inclination upward. The branches given off by these vascular circles run more or less perpendicularly towards the inner surface.

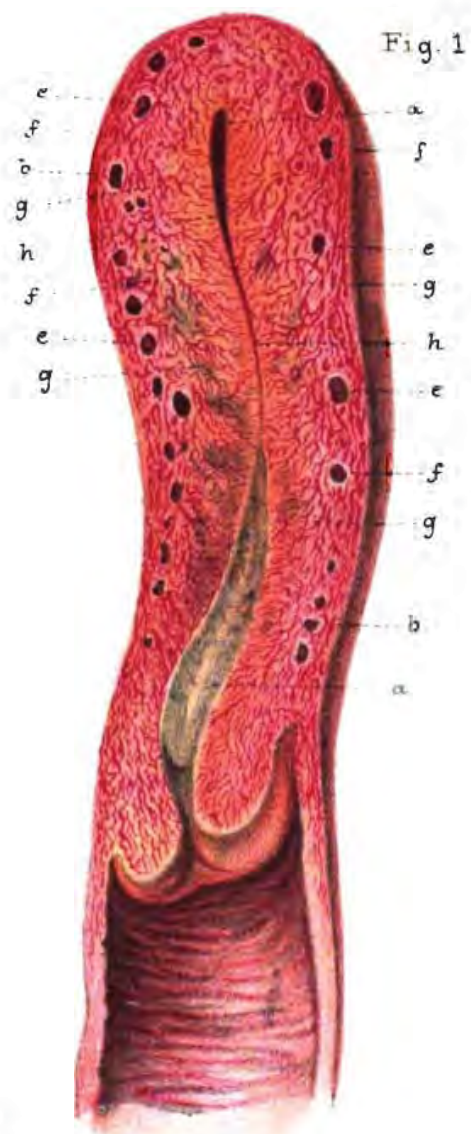
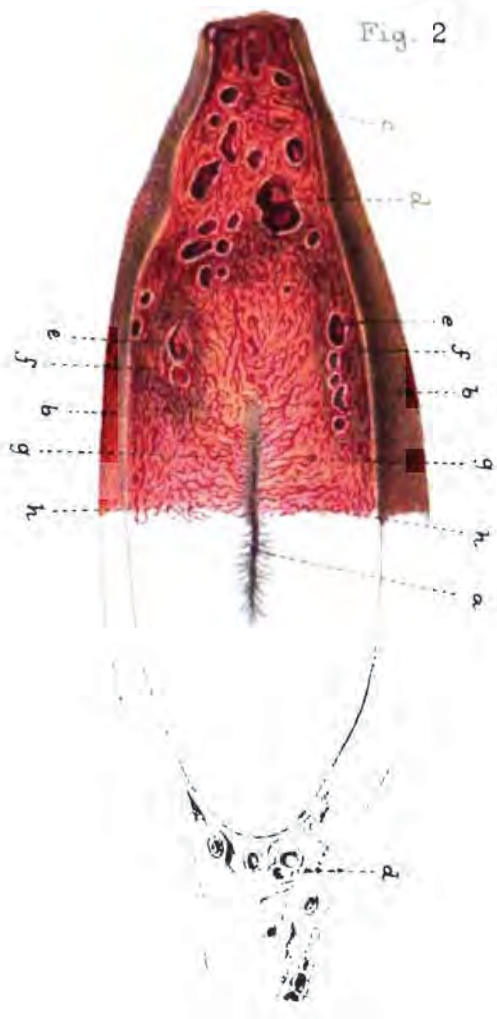
f, f. The true muscular coat of the uterus.

g, g. The muscularis mucosæ.

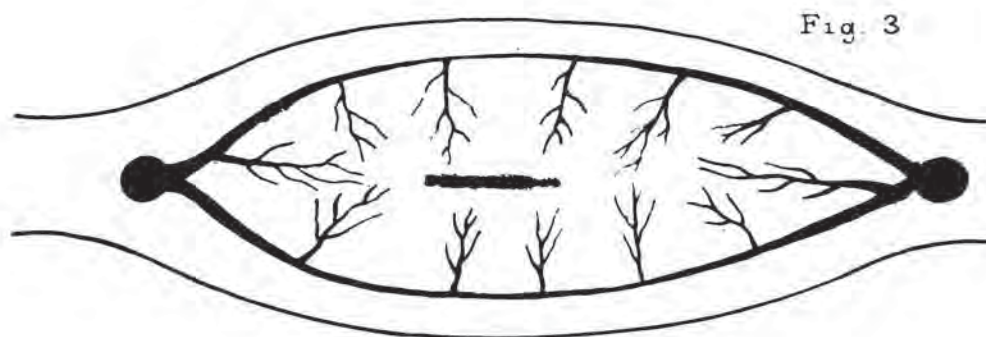
h, h. The decidua.

FIG. 3 (Diagram).—Transverse section of uterus, showing the arrangement of uterine arteries, the arterial circles formed by their primary branches, and the branches of the latter supplying the mucous membrane.

I am indebted to Mr. Victor Horsley, M.S., for injecting the uterus from which Figs. 1 and 2 have been drawn.



E. Burgess del.



West Newman & Co chrom. lith.

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offshoots, which encircle the body of the uterus with arterial channels as the lower branches do the upper part of the cervix. Their course is not directly across the organ but is inclined slightly upwards (Plate I.) All these primary branches enter the uterus on the side; they do not enter deeply into its tissue, but run a somewhat superficial course, being separated from the peritoneum by only a thin layer of muscular fibres (Plates I and III, figs. 1, 2, 3). They run in a distinct (and regarding the structure of the uterus in its other layers) a considerable layer of connective tissue. This layer of connective tissue is more distinct in the foetal and infantile than in the fully developed organ (Plate II, fig. 1). The muscular stratum between it and the peritoneum is thin, while that between it and the canal forms the greater part of the thickness of the uterine wall.

From these arterial circles numerous branches are given off, and these branches run towards the mucous surface and in a direction perpendicular to that surface; they anastomose very freely and terminate under the mucous surface in capillary loops, which are often visible in organs which have not been injected (Plates II and III). I have not referred to the sinuosities of these vessels because they have no bearing on the subject in hand.

The venous circulation in the uterus is but slightly different; the veins in the organ follow a course similar to that of the arteries; these convey the blood into the uterine plexus. This plexus is a network of veins lying with the arteries in the layer of connective tissue already mentioned; the veins are without valves and the connective tissue around them is often very distinctly seen even in the adult. The plexus communicates freely with the ovarian vein, the vaginal plexus, and the numerous veins in the broad ligament, so that the provision for gathering the venous blood from the uterus and its return to the heart is extremely abundant. The return, it is said, is effected usually and chiefly through the ovarian veins; but both these veins can be tied with impunity, and in so

far as is known, without materially affecting the return of blood from the uterus; indeed, as the whole of the pelvic venous system can be injected through any one of its larger trunks, this is not surprising. When the ovarian veins are tied there is ample room for the return of the blood from the uterus by the connections of the uterine plexus with the internal iliacs.

We find then that the uterine arteries run between the folds of the broad ligaments outside the uterus; that their primary branches run across the organ, forming circles around it, lying in a layer of connective tissue near the peritoneal surface; that these circles supply all the thickness of the uterine wall lying between them and the uterine canal by means of branches which run in a direction perpendicular to the mucous surface; that the veins are arranged in the uterus like the arteries; that they form a plexus in the connective-tissue layer near the peritoneal surface which communicates freely with the other venous plexuses of the pelvis.

From these facts certain conclusions of more or less value may be drawn.

1. The layer of connective tissue in which the arterial circles run and in which the venous plexus lies, is the submucous tissue of the uterus.

2. The whole thickness of the uterine wall between this layer of connective tissue and the inner surface of the uterus is the *mucosa uteri*; and the thin layer of soft tissue at the inner surface of the uterus, which periodically increases in thickness, and is shed, is the decidua; and although it has been called the mucous membrane of the uterus, yet it is only a very small portion of that structure.

3. The provision for the flow of blood into and out of the uterus is such that the process can with difficulty be disturbed by mechanical causes. The entrance and the exit take place at the sides of the organ at numerous points, and not at the extremities of it; while in the uterus the direction of the current is transverse to its length and perpendicular to its surfaces; so that a ligature

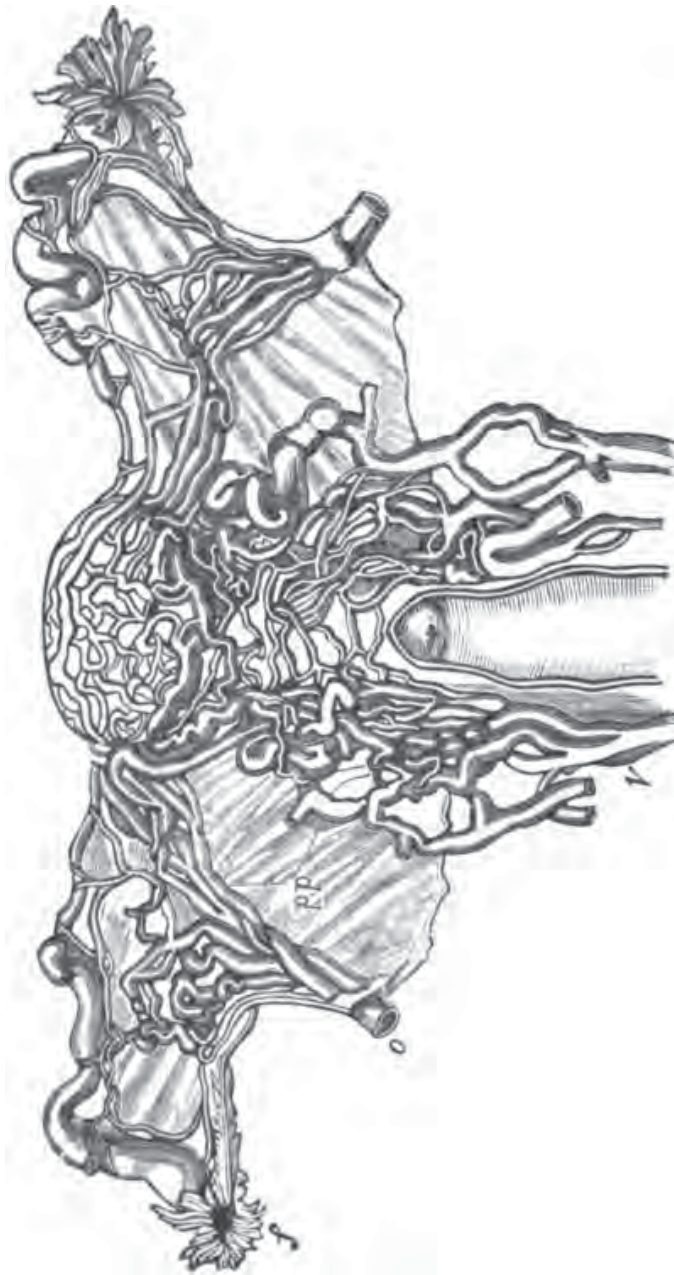
might be placed around the uterus at any point without affecting the circulation above and below.

The only ligature which could materially interfere with the flow of blood into or out of the uterus is one surrounding the broad ligaments (their upper borders being included within it), together with a portion of the uterus. In this case the inflows to, and the outflow from, the parts above or within the ligature would be diminished or stopped. Conditions similar to this are found when the uterus forms a hernia, be it in the inguinal canal or in the canal or pouch of Douglas. When the fundus of the uterus is found in the pouch of Douglas the condition is spoken of as retroflexion or retroversion, but it is really a great deal more, and it would be just as correct to speak of the condition found when the uterus is in the inguinal canal as anteflexion or anteversion. Both are true herniæ and the symptoms are due in great part to the constriction at the neck of the sac—in posterior hernia the sacro-uterine ligaments.

There is another condition which may interfere with the return of blood from the uterus, and that is procidentia. Here all the veins of the broad ligaments may be so stretched that their channels may be considerably diminished, and thus all the channels for the return of blood from the uterus may be narrowed and the organ consequently suffer from passive congestion.

These two herniæ of the uterus and great procidentia appear to be the only displacements of the uterus which can give rise to congestion of the organ.

Further evidence respecting the effects of a ligature placed round the uterus at any point, or of an acute flexion of the organ, upon the venous circulation may be obtained by experiment; that is by injecting its system of veins. If an acute flexion interferes with the return of blood from the organ and causes congestion of its body, it does so by pressure on the veins returning the blood from the body of the uterus, and consequently would occasion some difficulty in the process of injecting the



Uterus and vagina with their venous supply seen from behind (Luschka).

veins of the part. To test this point I have stitched the fundus of the uterus closely to the cervix, thus securing the acutest flexion possible; then injected a coloured fluid into one of the veins of the broad ligament, and immediately the veins on the other side of the uterus became distended with the injecting fluid. On making a section into the walls of the body of the organ, the veins of that structure were also found well injected. It is not meant by this that a perfect microscopical injection of the uterus was thus made; to obtain such is, as is well known, a very difficult task; but the finer branches of the veins throughout the organ were well injected. This appears to show what the arrangement of the blood-vessels has already taught us; that the acutest flexion does not interfere with the flow of blood from the uterus.

Dr. GRAILY HEWITT considered that the Society was under great obligation to Dr. Williams for the valuable addition now made to our knowledge of the circulation in the uterus, although he could not agree with him in regard to the conclusions he proceeded to draw from these observations. He was not at all astonished to find the arrangements as regards the blood-vessels of the uterus adapted in an elaborate degree for preventing interference with the free passage of the blood when the organ was flexed. No doubt bending of the uterus was common and the arrangement described would sufficiently provide against obstruction when the flexion was temporary or slight in degree. But he considered that when severe, and especially when sudden in occurrence, there would be great liability to congestion at the two extremities of the uterus. An illustration of this was afforded by the somewhat analogous event of congestion and swelling following forced and continuous bending of one of the limbs resulting in a certain obstruction to the free circulation. His own experience had taught him that congestion of the uterus co-existing with marked flexion was very decidedly relieved by straightening the uterus, and hence the explanation had suggested itself that the compression at the central part of the uterus was operative in causing the congestion. Another explanation as regards the congestion in retroflexion was given by Dr. Williams, viz. compression and incarceration of the fundus by the uterosacral ligaments. He considered this occurrence very rare, although he had carefully looked for it: certainly such incarceration was absent in the large majority of retroflexion with congestion. But this explanation, admitting its force for retro-

flexions, had no bearing on the congestion liable to occur in antelexions. He had seen several cases of very severe congestion with antelexion and there were no ligaments capable of incarcerating the uterus in front of it. The extremely rare case of antelexion with hernia in the inguinal canal had no bearing on the question. Another consideration was of great importance. He had observed very frequently congestion and swelling of one lip of the cervix uteri alone and had noticed that this swelling was almost invariably on the anterior lip in antelexion and on the posterior lip in retroflexion. In fact in many cases the diagnosis could thus be predicted. This was confirmatory evidence of the effect of the flexion in producing the congestion which could not be disregarded.

Dr. HERMAN said that the clinical bearings of Dr. Williams's paper were very important. Dr. Williams's deductions from his anatomical researches were confirmed by the great frequency with which flexion of the uterus was met with without symptoms. That flexion of the uterus was often combined with congestion was sufficiently explained by the great frequency of flexion, and if it were not often found along with congestion, that would be a good reason for thinking that flexion prevented congestion. The occurrence of congestion, both with antelexion and with retroflexion, was thus accounted for by coincidence. But there were cases of suddenly produced backward displacement of the uterus, attended with acute symptoms, quickly relieved by replacement of the organ, to which no analogous cases of antelexion were seen. There were also cases of retroversion of the uterus, without flexion, with congestion, which were relieved by elevation of the uterus to the axis of the pelvic brim. These cases were not explained by the theory of flexion, while the effect of the utero-sacral ligaments which Dr. Williams had pointed out, did explain them. Cases of congestion of the uterus by pressure of the veins of the broad ligament against the utero-sacral ligaments were not common, and cases of incarceration of the uterine body in Douglas's pouch were quite exceptional; this was because the shape and position of the utero-sacral ligaments varied so much in different cases, it being only seldom that they were tense enough, and close enough together, to be capable of incarcerating the body of the uterus. When they had this exceptional development, they were generally higher up than usual, and this might explain why observers had not been always able to feel with the finger.

Dr. GALABIN thought that the author had successfully shown that the arrangement of the vessels was such as to diminish as much as possible the chance of any congestion being produced by flexions of the uterus. He was not, however, convinced that the action of the utero-sacral ligaments was in general so important in retroflexions as the author contended. He had examined

them in all cases of retroflexion since Dr. Williams's view was first stated, and had only exceptionally found them appear to constrict the fundus. If there were such constrictions the resistance of the fundus to reposition ought suddenly to cease when it was pushed past the constriction, and he had only rarely found this to be the case. In retroflexion most observers would agree that there was often evidence of congestion in the fact that the menstruation was excessive, and that this symptom was relieved by the use of a pessary. He thought that in most cases the utero-sacral ligaments had only a minor effect upon the uterus resting against them, and that the stretching and twisting of the broad ligaments, and possibly even the flexion itself, ought also to be taken into account. The transverse arrangement of the vessels might be expected to prevent congestion above the level of the bend being produced by flexion, but not congestion of the interior at the part involved in the bend. Moreover, in the section of the foetal uterus shown by Dr. Williams, there appeared to him to be longitudinal vessels as well as transverse. The facility with which a slight displacement of tissue interfered with venous circulation was easily seen by the change of colour which often took place when the cervix was extruded externally in procidentia, even though there was no apparent constriction at the vulva around its neck. He did not agree with Dr. Herman that the frequent occurrence of antelexion without signs of congestion proved that flexion could never have anything to do with congestion. In antelexion the uterus had in most cases grown in the shape in which it was found. But if flexion ever produced congestion, this could only be expected when the flexion was acquired, and even then the vessels would probably accommodate themselves to the changed state after a time.

Dr. AUST LAWRENCE (Clifton) considered that very few cases of displacement of the uterus could be used either for or against Dr. John Williams's assertion "that flexions of the uterus *per se* did not produce congestion of that organ owing to the arrangement of the blood-vessels," as cases of simple retro- or ante-flexion were exceedingly rare; he could only call to mind three cases of pure and simple retroflexion of the uterus uncomplicated with any other condition of that organ, and all these three cases went to prove that the displacement by itself was sufficient to cause increase of hæmorrhage at the catamenial period, the inference from this increase being that there existed a congested condition of the uterus. The first case was a girl, aged twenty-two, unmarried, who was thrown from a cart; from having had no uterine trouble, her very next period was excessive; she was then seen by Dr. Aust Lawrence, and he found acute retroflexion of the uterus. With some difficulty, owing to the uterus being held tight between the utero-sacral ligaments, it was replaced. The hæmorrhage entirely ceased upon replacement and

the next period was normal, evidently the congestion being relieved by the return of the uterus to its normal position. The other two cases were in their history precisely similar; in neither of them was there any abnormal discharge at the catamenial periods until, having had falls, one from a carriage and the other downstairs, a retroflexion of the uterus was produced and the following periods were excessive until the organ was replaced and then they became normal.

Dr. CHAMPNEYS pointed out that the arrangement of vessels in the uterus was very similar to that in the intestines, which the uteri of many of the lower animals greatly resembled. The intestines were marked by acute flexions every few inches, but no harm to the circulation resulted from them. In fact, the vascular arrangements in both cases were directed to maintaining an equable supply of blood under flexion, and in one case they were certainly always competent to provide for such a condition. He thought congestion was often diagnosed on insufficient grounds, indeed, he believed congestion of the fundus was generally impossible of verification. He believed that the influence of the utero-sacral ligaments was not commonly exercised; this belief was the result of careful examinations. In cases of retroflexion with profuse menstruation there was the influence of descent of the fundus, and it had repeatedly happened to him to lift up the fundus with a pessary to find the symptoms relieved and the uterus high up, indeed, but as much flexed as ever.

Dr. MURRAY saw the correctness of Dr. Williams's views and explanation; for although there were cases of congestion with flexion, there were also many flexions without congestion. So also, an excess of menstruation, amounting to menorrhagia, did take place without flexion. The prolapse of the uterus would clearly tend to produce congestion by the upper and lower circulation of the uterus being both mechanically interfered with.

Dr. WILLIAM DUNCAN thought that congestion of a retroflexed uterus was not unfrequently due to the flexed fundus being caught between the utero-sacral ligaments, especially where these had been thickened and shortened from a previous cellulitis; he had seen such cases. He did not think that the thickening of the posterior cervical lip in cases of retroflexion proved that the circulation in the uterus was impeded, for the condition was sometimes found where the uterus was perfectly normal in position. He found that many cases of congestion occurring in flexed uteri could be cured without the use of any mechanical support whatever.

In reply, Dr. WILLIAMS thanked the Society for the criticism bestowed on his paper; at the same time he expressed his regret that one part of the paper—and that an important one physiologically, pathologically, and clinically—had not been discussed. This part was that which referred to the

division of the wall of the uterus into four layers—a peritoneal, a proper muscular, a submucous, and a mucous. The muscular coat proper consisted of a thin layer placed immediately under the peritoneum, and was composed of longitudinal and circular muscular-fibre cells. Next to this came the submucous layer of connective tissue in which the circles of vessels lay; and then the thick layer inside the latter which was the mucous membrane. In the human uterus the mucous membrane was very thick, and was composed of a thin soft superficial layer (the decidua) and a thick layer of muscular-fibre cells (the muscularis mucosæ). The soft superficial layer or decidua had been generally regarded as the mucous membrane of the uterus, and it had been generally believed that the mucous membrane was directly attached to the muscularis without the intervention of a submucous layer of connective tissue. This was not the case, however. It was true that the decidua was imposed directly upon the muscularis and that glands passed into the muscularis, but the decidua was only a thin layer of the mucosa, for the mucosa consisted of the decidua and a considerable thickness of muscular tissue. It was under this layer of muscular tissue that the submucous connective tissue was to be sought and was found. It was seen very distinctly in the foetal uterus and under certain conditions in the adult uterus, as specimens on the table showed, and also in the uteri of some animals. Dr. Hewitt characterised the argument adduced in the paper as an *a priori* argument. Dr. Williams did not think any the worse of it, or that it was less true, for this reason. Indeed the arrangement of the blood-vessels was such that congestion of the body or of the cervix as a result of a constriction of the uterus above the insertion of the vagina was palpably impossible. The illustration given by Dr. Hewitt of congestion occurring in a flexed limb presented no analogy to conditions present in a flexed uterus; a flexed finger would have been nearer the mark; and a permanent flexion of the finger gave rise to no congestion of it. The congestion of a flexed limb when present resulted not from the flexion, but from the dependent position of the part congested. The arrangement of the blood-vessels in a finger and in a limb were so different from that in the uterus that no argument based upon the results of flexion in these parts was applicable to the results of flexion of the uterus. Dr. Hewitt thought that temporary flexion would not produce material disorder of the circulation, but that a permanent one would. Dr. Galabin, on the other hand, believed that a sudden flexion would produce congestion, but that after a time collateral circulation would be established, and the congestion would disappear—so that a recent flexion would give rise to congestion, while an old-established one would not. These two views appeared to be contradictory, and were certainly opposed to what might be expected from the arrangement of the vessels in

the uterus. Dr. Hewitt based his conclusions upon clinical observation. There was no doubt that congestion, or enlargement or engorgement of the uterus and flexion of the organ were frequently met with together, but it did not follow that the congestion resulted from the flexion. For clinical observations to be of any value in settling the question under discussion a very careful selection of cases should be made. Certain cases should be excluded as being inapplicable. Congestion might be present without flexion, and, as is well known, it was often present as the result of pregnancy and labour. The only cases which could be of service in solving the question were those in which the uterus was presumably healthy previous to the occurrence of flexion; so that all cases of women who have been pregnant or who have had attacks of inflammation in the neighbourhood or around the uterus should be excluded from, and only those who have never been pregnant should be taken into, the reckoning. Dr. Williams did not know whether Dr. Hewitt used the latter kind of cases only or all cases of flexion indiscriminately in drawing his inferences; taking the latter class of cases only into account, Dr. Williams had never found congestion or enlargement follow flexion. Dr. Aust Lawrence's first case was important and bore out the views stated in the paper. A young, healthy woman suffers from sudden hæmorrhage from the uterus, the result of an accident. On examination hernia of the uterus into the Douglas pouch is found; the hernia is reduced and the hæmorrhage ceases. His other cases were given in insufficient detail to bring them to bear on the question. The immediate results of replacing the uterus in a few cases, however, formed a very unsafe foundation upon which to base an argument; in some cases arrest of hæmorrhage appeared to be the result, in others again the bringing on of menstruation, as in Dr. Murray's cases; indeed, Dr. Robert Lee pointed out long ago that a mere vaginal examination brought on hæmorrhage in some cases in which the uterus was apparently healthy. The swelling of the lip corresponding to the angle of flexion on which Dr. Hewitt laid stress and which was met with in some, but by no means in all cases of flexion, was explicable by the arrangement of the vessels in the cervix. Below the insertion of the vagina the vessels ran longitudinally in the lips of the uterus, and not transversely, as specimens on the table showed.