

URETERAL FISTULÆ AS SEQUELÆ OF PELVIC OPERATIONS.

A GENERAL CONSIDERATION OF THE SUBJECT.

BY JOHN A. SAMPSON, M.D.,
Albany, N. Y.

ASSOCIATED with the advance in all departments of surgery, there arises a new series of complications which must be recognized, remedied, and finally avoided. One of the most serious complications which has presented itself in the advance in pelvic surgery is that of injury to the ureters and, as postoperative sequelæ of these injuries, ureteral fistulæ have often resulted.

In a paper of mine on the relation between cancer of the uterine cervix and the ureter, published in March, 1904 (*The Johns Hopkins Hospital Bulletin*), I called attention to the frequency of injury to the ureter in hysterectomy for that condition. In 156 hysterectomies for carcinoma of the uterine cervix in Dr. Kelly's Clinic at the Johns Hopkins Hospital there had been 19 instances of accidental injury to the ureter, but only 11 instances of ureteral injury in 4513 other major gynecological operations. These injuries were of various kinds, as clamping, ligating, cauterizing, and cutting the ureter, or interfering with its blood supply so that necrosis occurred. Some of these injuries were recognized at the time and the ureter released if clamped or ligated, and repaired if excised, while others were not discovered until afterward. The cases of accidental ligation

and clamping of the ureter have been published (*American Medicine*, November 1902), and also those of ureteral necrosis (*Johns Hopkins Hospital Bulletin*, April, 1904). Of these 30 cases, 10 resulted in ureteral fistulæ. Two fistulæ followed clamping the ureter, six followed necrosis, one ureter was cauterized, a portion of another was excised and the ureter repaired, but a fistula resulted which ultimately healed.

The relation between cancer of the uterine cervix and the uterus caused me to study the latter under normal and abnormal conditions, with a view of ascertaining how injury to them might be avoided. I wish to present, in this communication, a brief general review of the subject, and to especially emphasize certain features which have impressed me in these studies. As this is but a very brief review of the subject, I have presented only some of the results of my own studies and space does not permit me to treat the subject more fully and to refer to the many valuable contributions made by others.

CERTAIN IMPORTANT ANATOMICAL FEATURES OF THE
URETERS FROM THE STANDPOINT OF URETERAL
FISTULÆ.

The ureters pass over the pelvic brim mesial to the ovarian vessels, and follow the sides of the pelvis, just beneath the peritoneum, to the base of the broad ligament, from which point they converge to their vesical openings. The distance between the two ureters varies in different subjects. As they lie just beneath the peritoneum above the base of the broad ligament, this distance corresponds to the internal transverse diameter of the pelvic cavity at this level. Within the base of the broad ligament they converge, and, as they cross the cervix, the distance between them varies from 7.5 to 9 cm.; this diminishes to 4 to 4.5 cm. at their entrance into the bladder. The ureteral orifices are from 2.5 to 4 cm.

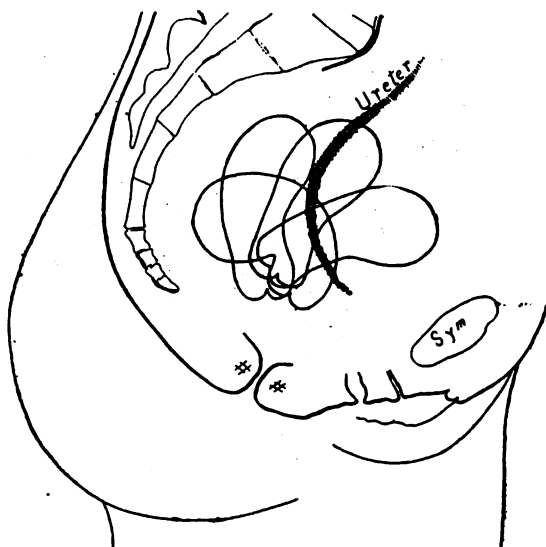


FIG. 1.—Relation between the ureters and the uterus in the various posterior displacements of the latter. $\times \frac{1}{2}$.

In the normal anteposition of the uterus the ureters lie posterior to that organ until they reach the base of the broad ligament, when they cross the cervix from behind in order to reach the bladder in front. In displacements of the uterus, the relation between the uterus and the ureters becomes altered without changing the course of the latter, except as the trigonum of the bladder may be slightly displaced by the displaced cervix. As indicated, the retroverted uterus may be situated posterior to the ureters for their entire course.

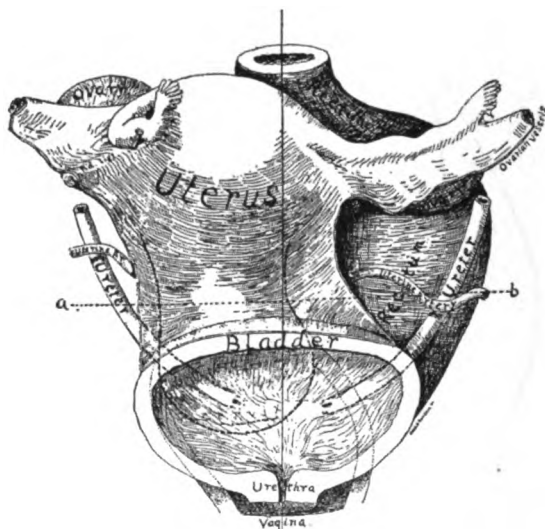


FIG. 2.—Relation between the ureters and the uterus, the latter in retroposition and in the right side of the pelvis. $\times \frac{1}{2}$.

This represents a reconstruction from cross sections of the frozen body of a multipara, aged about thirty years. As shown, nearly the entire uterus is to the right of the median line. The course of the ureters is the same on each side, viewed from the standpoint of the sides of the pelvis and the median line, but on account of the extreme right lateral displacement of the uterus, the right ureteral orifice is situated directly in front of the centre of the cervix, while the left one is situated to the left of the cervix. Had the cervix been in mid-position, it would have been equally distant from each ureter. For cross-section, taken at *a-b*, see next illustration.

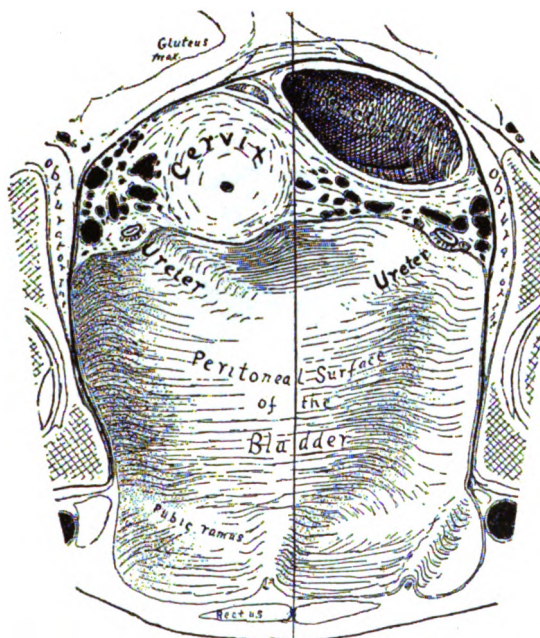


FIG. 3.—Relation between the ureters and uterus as seen in cross section. $\times \frac{1}{2}$.

The situation of the cross-section is indicated by the line *a-b* in Fig. 2, and represents an antero-posterior plane from a point 3 cm. above the symphysis in the anterior abdominal wall to the tip of the coccyx posteriorly, and cuts the uterus at the internal os. The relation of each ureter to the fixed structures of the pelvis is the same, while their relation to the uterus is dependent on the position of the uterus in the pelvis. The right ureter is but 8 mm. from the cervix in this section, while the left is 3.5 cm., or over four times this distance. The uterus rests in the hollow of the sacrum and is posterior to the ureters for their entire course, and therefore the cervix is not crossed by the ureters as when the uterus is in anteversion.



FIG. 4.—Cross-section of the ureter with peritoneum attached, 1.5 cm. above the entrance of the ureter into the parametrium. $\times 5$.

From the same case shown in Fig. 5, but opposite ureter. The ureter by its peristalsis converts the tissue about it into a form of sheath, which in this situation is attached to the peritoneum; in freeing the peritoneum, the ureter, with its sheath, is carried with the peritoneal flap thus formed. Within the sheath and loosely attached to the ureter, the peri-ureteral arterial plexus can be seen in cross-section see (Fig. 5). By freeing the peritoneum from the side of the pelvis the ureter can always be found attached to it if one wishes to locate it, but, if the peritoneum is accidentally freed during an operation, there is danger of injuring the ureter. In an ideal uretero-vesical implantation the sheath and the peritoneum attached to it should be sutured to the bladder, in order to relieve any tension on the implantation and also to preserve the ureteral sheath and thus protect the ureter and its blood supply.

apart, the distance varying in individual cases and with the degree of distention of the bladder.

The relation between the cervix of the uterus and the ureters depends upon the size of the cervix and its position in the pelvis; whether in the right or left side, and, moreover, whether the uterus is in retroposition, ante-position, or descensus. In retroposition of the uterus the ureters may be situated anterior to the uterus for their entire course (see Fig. 1), while in ante-position of the uterus their course is posterior to that organ until they reach the parametrium, when they cross the cervix from behind in order to reach the bladder in front. The independent relations between the ureters and the uterus under *normal conditions* is shown by the fact that, if the cervix is in one side of the pelvis, it is correspondingly nearer that ureter than the other; in fact, any moderate displacement of the uterus in any direction alters but very slightly the relation of the ureters to each other or to the sides of the pelvis (see Figs. 2 and 3).

As I have emphasized elsewhere (*Johns Hopkins Hospital Bulletin*, February, 1904), the ureter, through its peristalsis forms a sheath from the tissues about it. This sheath varies with the tissue along its course, and cannot be considered as a distinct structure belonging to the ureter. It must not be confounded with Waldeyer's sheath, which extends only a short distance above the bladder, and consists mostly of bundles of smooth muscle. It is more marked in some individuals than in others, and is usually better formed about the pelvic than about the abdominal portion of the ureter. For these reasons the sheath can be sometimes definitely demonstrated in cross-section, and in other instances not. This sheath is of great importance, for it not only furnishes a channel in which the ureter may slide as it contracts, but it is also a protection to the ureter from the invasion of cancerous growths and inflammatory processes. This sheath is attached to the parietal peritoneum (see Fig. 4),

which explains why the ureter is carried with the peritoneum above the base of the broad ligament when this portion of the peritoneum is stripped from the side of the pelvis. It arises from the tissues of the base of the broad ligament, is crossed by the uterine vessels, and is surrounded by the vesico-vaginal plexus of veins; in places these veins help to form its wall. It blends with the sheath of Waldeyer, enclosing the upper end of it.

A knowledge of the blood supply of the ureter is also of great importance in its surgical treatment (see Fig. 5). Small branches, which may be called uretero-subperitoneal arteries, arise from the larger vessels, as the aorta, renal, ovarian, iliac, uterine, vesical, and vaginal arteries. These small arteries usually divide into two branches, first a ureteral and second a subperitoneal branch, the latter supplying the tissue about or near the ureter. The ureteral arteries, on reaching the ureter, divide into ascending and descending branches, both running along the duct and united to it by loose fibrous tissue. The ascending branches of one artery anastomose freely with the descending branches of the ureteral artery above, and the descending branches with the ascending branches of the lower ureteral artery; thus, there arise about the ureter relatively large arterial trunks running in a longitudinal direction from the kidney to the bladder. From these large trunks smaller branches arise which are more deeply embedded in the peri-muscular fibrous tissue of the ureter than the larger ones, and some of these anastomose with each other, forming, with the main trunks, a *peri-ureteral arterial plexus extending the entire length of the ureter, up over the pelvis of the kidney and accompanying the ureter through the bladder*. From this plexus small vessels arise which penetrate the walls of the ureter and supply its deeper structures. I do not know whether or not there is a free anastomosis between the deeper branches of these arteries.

This peri-ureteral arterial plexus may be injected for its entire course from such arteries as the renal and the internal iliac; and also probably from any one of the larger arteries which furnish a ureteral artery. A knowledge of this arterial plexus and its blood supply explains why it is possible to free the ureter from the kidney to the bladder, thus severing all bloodvessels coming to the ureter between these organs, without the occurrence of necrosis. It also explains why necrosis may occur if the ureter is roughly handled for a short distance.

PELVIC CONDITIONS IN THE OPERATIVE TREATMENT OF
WHICH THERE IS DANGER OF URETERAL INJURY.

From a review of Stoeckel's monograph (*Ureterofisteln und Ureterverletzungen*, published by Breitkopf and Hartel, of Leipzig, in 1900), and also from the literature, one finds that there have been reported instances of injury to the ureters in the operative treatment of nearly every pelvic condition in which it was possible for the operator to gain access to the ureters, either as the result of carelessness or ignorance on his part, or in conditions where the ureters were unavoidably brought into the field of operation. I wish to consider especially the latter cases in this communication.

Lateral Displacement of the Cervix. Extreme lateral displacement of the cervix brings the cervix very close to, or even in actual contact with, the ureter of the side toward which the cervix is displaced (see Figs. 2 and 3). This displacement may be caused by several conditions, such as a tumor which, either as a newgrowth or an exudate situated on one side of the uterus, pushes the cervix to the opposite side, adhesions which may draw the uterus toward the same side of the pelvis, or contraction of the base of the broad ligament as the result of infection or the invasion of cancer. The displace-

ment of the fundus to one side of the pelvis may tilt the cervix to the opposite side. The lateral position may also be congenital or developmental. Hysterectomy, when lateral displacement exists, is not necessarily associated with danger of ureteral injury, because the ureter is easily pushed to one side unless there are adhesions between the cervix and its sheath as the result of injury, infection, or malignancy. Under the latter conditions the ureter within its sheath will be carried with the cervix when the uterus is drawn upward, and it will be difficult to separate them (see Figs. 6 and 7).

Masses Adherent to Peritoneum Covering the Ureter. A mass, such as the body of a laterally retroposed uterus, an ovarian, tubal or intestinal inflammatory mass, or a new growth, may be adherent to the peritoneum covering the ureter. In freeing such masses there is danger of tearing the peritoneum, which is adherent to it. When this portion of the peritoneum is stripped from the side of the pelvis the ureter, which is attached to it by its sheath, will be carried with it, and may be injured (see Figs. 8, 9, 10, and 11). It has been mistaken for a bloodvessel and clamped, ligated, and cut between the ligatures. In attempting to control bleeding following the freeing of such masses, even when the peritoneum has not been stripped from the side of the pelvis, there is danger of clamping or ligating the ureter lying beneath the oozing area and concealed by peritoneum.

Intraligamentary Tumors. Such tumors in their extension may lie in contact with the ureter, displace it laterally or even downward or upward, the displacement varying with the situation and size of the tumor (see Fig. 12). They may compress the ureter, causing a hydro-ureter, or even surround it. Such conditions are usually caused by a par-ovarian cyst or a myoma developing between the folds of the broad ligament. Unless the surgeon is on his guard the ureter may be injured, especially if it is displaced and dilated, when it may be easily mistaken for a bloodvessel. The

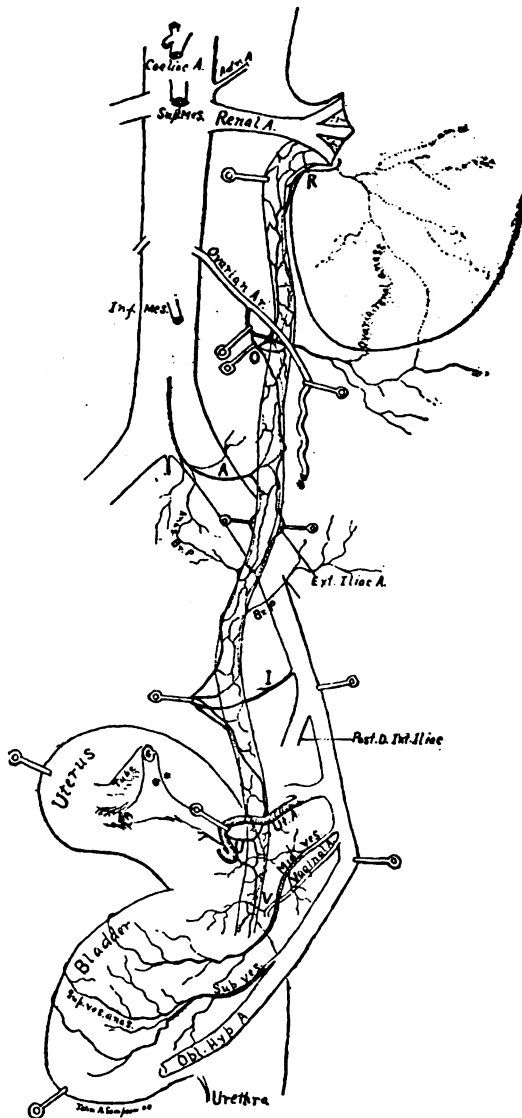


FIG. 5.—Blood supply of the ureter, demonstrating the peri-ureteral arterial plexus. $\times \frac{1}{4}$.

The left renal and the right internal iliac arteries were injected, one hour after death, with a 15 per cent. solution of gelatin colored with ultramarine blue; the abdominal and pelvic organs were removed and hardened in 10 per cent. formalin, and the drawing was made from the dissected hardened specimen. The left tube and ovary have been removed and the uterus drawn upward and to the right; the contracted bladder has been drawn downward. The ureteral arteries, forming the peri-ureteral arterial plexus, arise from the aorta, renal, ovarian, internal iliac, uterine, and vaginal arteries, and are marked, A. R. O. I. U. and V. The plexus is formed by ascending and descending branches of the ureteral arteries, which unite with each other and thus nourish the ureter for its entire length. As one would suppose, the ureter may be dissected free for its entire length, and necrosis will not occur if the plexus is intact, but if the latter is destroyed for only a short distance, necrosis is apt to occur.

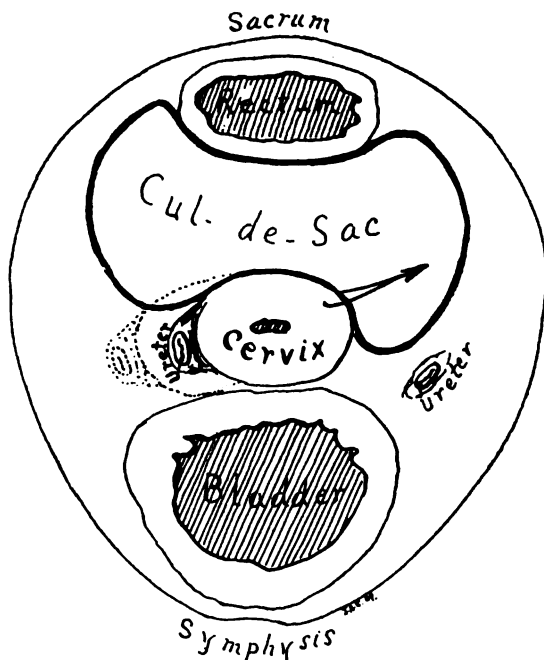


FIG. 6.—Extreme lateral displacement of the cervix in which there is danger of injuring the ureter during hysterectomy. $\times \frac{1}{2}$.

Diagrammatic representation of a cross-section of the pelvic contents taken at the level of the internal uterine os. The dotted lines represent the position of the ureter within its sheath and the cervix before the latter was drawn upward and to one side by the operator. On drawing the uterus upward and to one side, as occurs in hysterectomy, in order to ligate the uterine vessels and free the cervix, the ureter is displaced very little and is easily pushed to one side, unless there is a thickening of the parametrium uniting the cervix to the ureteral sheath. If induration is present (inflammatory or the result of the invasion of the tissues by cancer), the sheath will be adherent to the cervix and therefore carried with it when the latter is drawn upward and to one side; the ureter will thus be displaced as shown in the illustration, and may easily be injured. If the adhesions are the result of infection, the ureter and its sheath may be separated by cutting close to the cervix with scissors. If it is due to cancer it is best to split the sheath and shell out the ureter, or else excise the lower end of the ureter.

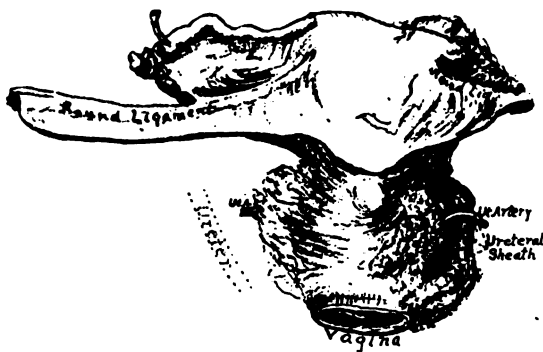


FIG. 7.—Uterus, tubes, and ovaries removed by operation for cancer of uterine cervix, uterus adherent (inflammatory) to the left side of the pelvis, cervix in extreme lateral position. $\times \frac{1}{2}$.

As the result of adhesions, from a previous pelvic peritonitis, the entire uterus was adherent to the left side of the pelvis; note the short left round ligament and the very long right one. The left ureteral sheath is hypertrophied and adherent to the cervix; the ureter was freed by splitting open the thickened sheath and shelling it out. The right ureter was distant from the cervix as indicated, and was easily pushed to one side. The growth was still confined to the cervix and arose from within the cervical canal. The adhesions between the cervix and the left ureteral sheath were inflammatory in origin and probably independent of the cancer, as the entire left side of the uterus, left tube, and ovary were adherent to the side of the pelvis.

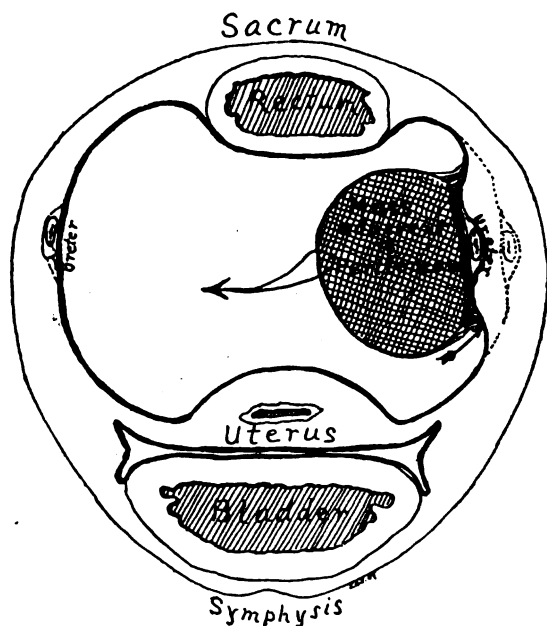


FIG. 8.—Mass adherent to the parietal peritoneum covering the ureter, the removal of which is associated with danger of injuring the ureter. $\times \frac{1}{2}$.

Diagrammatic representation of a cross-section of the pelvic contents through such a mass. The dotted lines indicate the position of the ureter before traction was made on the mass. Such a condition might be caused by an adherent, laterally retroposed uterus; an ovarian cyst; myoma; ovarian, tubal, appendical, sigmoid or other intestinal inflammatory masses, or an intestinal newgrowth, or implantations of cancer or papilloma on the peritoneum. If in attempting to free such a mass the peritoneum covering the ureter is torn and stripped from the side of the pelvis, the ureter will be carried with it and may be easily injured. Fortunately the inflammatory thickening of the peritoneum makes this difficult, and we have also learned to free ovarian and tubal inflammatory masses by lifting them up and thus separate them from the peritoneum to which they are attached. Sometimes there is free oozing from the raw surface caused by separating the mass from the adherent peritoneum, and if one clamps or passes ligatures carelessly there is danger of injuring the ureter concealed beneath the bleeding peritoneum.

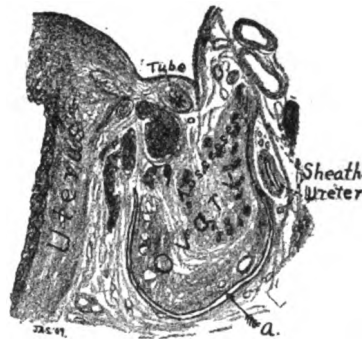


FIG. 9.—Relation between an infected ovary (puerperal) and the ureter (a little less than the natural size).

The pelvic organs with surrounding soft parts were removed at autopsy from a patient who had died from puerperal infection due to criminal abortion induced three weeks before her death. The specimen thus obtained was preserved in Kaiserling's fluid. The illustration was made from a stained (hematoxylin and eosin) perpendicular section taken through the left cornua of the uterus (slightly retroverted), tube, ovary, and ureter. The uterine wall appears normal in this section (showed abscesses in other), the tube is normal, abscesses (dark areas) are present between the layers of the broad ligament along the side of the uterus, about its cornua, and also in the ovary. The ovary is adherent to the peritoneum covering the ureter. The ureter contained within its sheath is normal. The iliac vessels and a small lymph node are situated above the ureter. The operative treatment of such a condition is attended with danger of injuring the ureter if the parietal peritoneum is stripped from the side of the pelvis. This is avoided by lifting the ovary up from below (as indicated by the arrow *a*), when it may be separated from the peritoneum to which it is attached.

FIG. 10

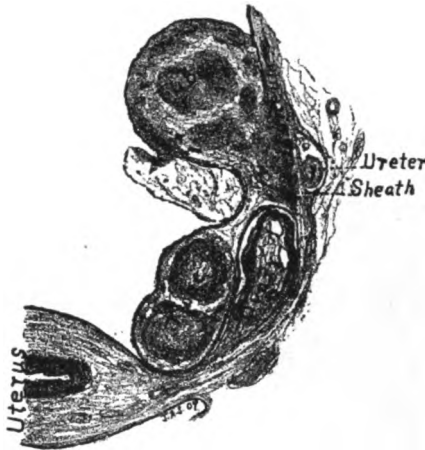


FIG. 11



FIG. 10.—Relation between tuberculosis of the tubes and the ureter (a little less than natural size).

The pelvic organs with surrounding soft parts were removed at autopsy from a patient who had died from miliary tuberculosis; the primary focus was probably in the Fallopian tubes. The specimen thus obtained was preserved in Kaiserling's fluid. The illustration was made from a stained (hematoxylin and eosin) cross-section taken through the left half of the body of the uterus, left ovary, tube, and ureter. The endometrium is thickened as the result of tuberculosis. The tube is enlarged and distended with caseous material, and the tuberculous process has extended through the wall of the tube causing it to become fused with the parietal peritoneum covering the ureter. The peritoneum is greatly thickened, tuberculous, and the ureter is adherent to it. The ovary is normal. The ureteral sheath is shown, and one may see that had an operation been undertaken to remove the pelvic organs, and had the parietal peritoneum been torn, the ureter would be carried with it and easily injured. Fortunately the easiest plane of cleavage is usually between the tubes and parietal peritoneum.

FIG. 11.—Relation between an implantation of cancer on the peritoneum and the ureter (a little less than natural size).

The pelvic organs with surrounding soft parts were removed at autopsy from a patient who had died from general carcinosis secondary to carcinoma of the breast; many peritoneal implantations of cancer were present. This illustration was made from a stained cross-section through the pelvic portion of the ureter over which there was situated a peritoneal implantation of cancer. The ureter and its sheath is shown, and the cancer had invaded the peritoneum directly over the ureter. A similar condition might be present from peritoneal implantations of cancer or papilloma from any source, as the ovary, and if it seemed best to remove them, the ureter might be easily injured. In freeing the peritoneum the ureter, unless carefully dissected out and pushed to one side, would be carried with the peritoneum because its sheath is attached to the latter.

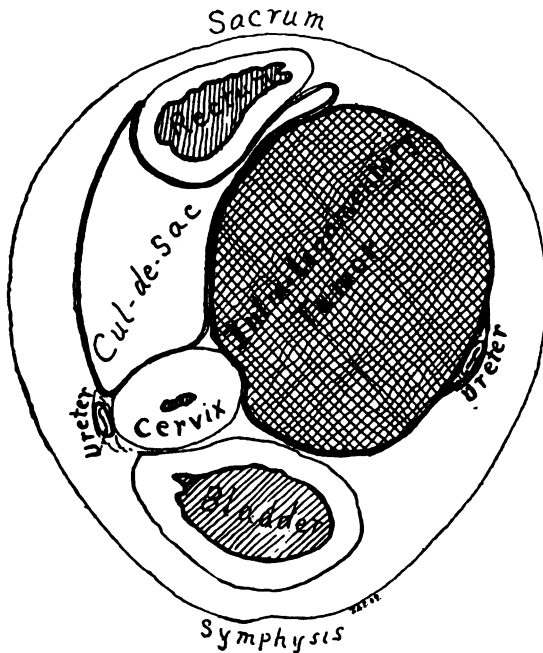


FIG. 12.—Intraligamentary tumor, the removal of which is associated with danger of injuring the ureter. $\times 4$.

Diagrammatic representation of a cross-section of the pelvic contents, taken at the level of the internal uterine os. Such conditions are usually caused by a parovarian cyst or a myoma developing between the folds of the broad ligament. They are often in contact with the ureter, and may strip it from its peritoneal attachment and greatly displace it; the direction of the displacement and the amount varying with the situation and size of the tumor. They may compress the ureter or even grow around it, causing hydro-ureter and hydronephrosis. The tumors often cause a lateral displacement of the cervix, so that if a hysterectomy is done there is danger of injuring the opposite ureter.

FIG. 13

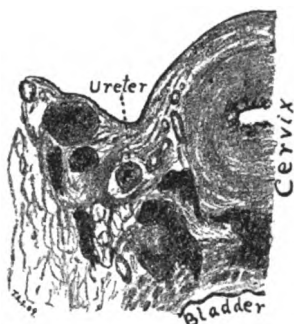


FIG. 14

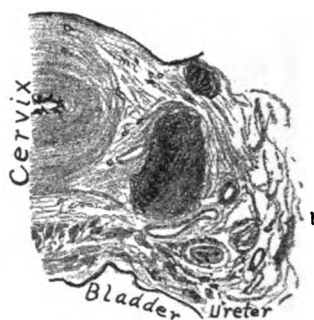


FIG. 13.—Relation between parametrial infections and the ureter (a little less than natural size).

The illustration was made from a stained (hematoxylin and eosin) cross-section of the right half of the cervix, parametrium, and portion of the bladder wall; from same case shown in Fig. 9. The cervix appears normal in this section (abscesses were present in other sections), the parametrium is swollen (indurated on palpation) and contains several abscesses (see dark areas). An abscess is situated between the cervix and the bladder wall and has partly destroyed the latter. The ureter is normal, its sheath, *i. e.*, the surrounding tissue, is greatly hypertrophied as the result of the inflammatory reaction. One may see the danger of cutting the ureter in incising the parametrium or clamping it should there be free bleeding.

FIG. 14.—Relation between parametrial infections and the ureter (a little less than natural size).

The illustration was made from a similar section as the one shown in Fig. 13, except at a lower level and the opposite side, same specimen. Two abscesses are present, the bladder wall is not involved in this section. The ureter is shown and the sheath about it is composed mostly of bands of muscle, *i. e.*, Waldeyer's sheath, and must not be confused with the other sheath described in this paper. After evacuation of the abscess, the shrinkage resulting would draw the cervix toward the side of the pelvis, and is one cause of lateral displacement of the cervix.

ureter has been injured more frequently in operations of this kind than in any other except in hysterectomy for cancer of the uterine cervix. These tumors, as well as any other tumor situated to one side of the uterus, may cause a lateral displacement of the cervix, so that, in a hysterectomy, there is danger of injuring the opposite ureter.

Inflammatory Exudates in the Base of the Broad Ligament. Exudates in this situation may push the ureter to one side and the cervix to the other, or they may push them together; after the evacuation of the exudate or its absorption, the contractions which result are apt to draw the cervix toward the side of the pelvis and the ureter of that side. This is one cause of lateral displacement of the cervix. The ureter is protected from the abscess or exudate by its sheath, which becomes greatly thickened, thus better protecting the ureter (see Fig. 13). As the ureteral sheath is more or less fixed, the ureter may be injured in the incision and drainage of such an abscess, whether it is approached from above or below; or it may be clamped in controlling the bleeding which may arise from the incision of the parametrium.

Retroperitoneal Tumors. A tumor mass lateral to the ureter will push the peritoneum with the attached ureter toward the median line; and in the operative treatment of such a mass the ureter may be injured (see Fig. 15). I have encountered but two such cases, one a recurrence of cancer of the uterine cervix in a pelvic lymph node and the other a large retroperitoneal cyst which was probably a large hydro-nephrotic kidney.

Cancer of the Uterine Cervix. The ureter has been injured more frequently in hysterectomy for cancer of the uterine cervix than in all other conditions combined. The parametrium is the tissue most frequently involved either by direct extension or by metastases of the growth, and the ureter with its sheath passes through this tissue (see Fig. 16). In attempting a wide excision of the growth the ureter is ex-

posed, and, unless one is familiar with its anatomy, it is easily injured when ligating the uterine artery, which crosses it, and still more easily when controlling hemorrhage arising from the injured vesico-vaginal plexus of veins which surrounds the lower portion of the ureter (see Fig. 17). The parametrium becomes indurated by the invasion of cancer, and it may also be thickened as the result of an apparent inflammatory reaction in cases where cancer is still confined to the cervix (see Fig. 7). This induration causes the cervix to become adherent to the tissues surrounding the ureter (its sheath), and on making traction on the uterus the ureter is drawn up with it, and, unless great care is exercised, will be injured. In the lateral extension of the growth the ureter may be, but is rarely actually invaded by the growth (see Fig. 18). The sheath usually becomes involved first; this hypertrophies, thus protecting the ureter (see Fig. 19) and later compressing it. The renal insufficiency resulting from compression of the ureters often causes the death of the patient.

In extreme prolapse of the bladder and uterus the ureteral orifices may be situated outside the vulva; the lower end of the ureters are thus greatly displaced, but the ureters are rarely injured in the operative treatment of this condition.

Injuries of the Ureter which may Result in Fistulæ. If the ureter is completely cut across by a knife, scissors, or cautery, and is not repaired, and if there is an avenue for the escape of urine, a fistula will result which may persist indefinitely; only in very exceptional cases and after a long period of time will it close spontaneously, and then only as a result of occlusion of the ureter. If the urine escapes into the peritoneal cavity or into the retroperitoneal tissues, the patient may die as the result of infection, or if the operation has lowered her resistance (and operations in which the ureter is accidentally injured are usually severe), the absorption of urine combined with renal insufficiency is very likely to

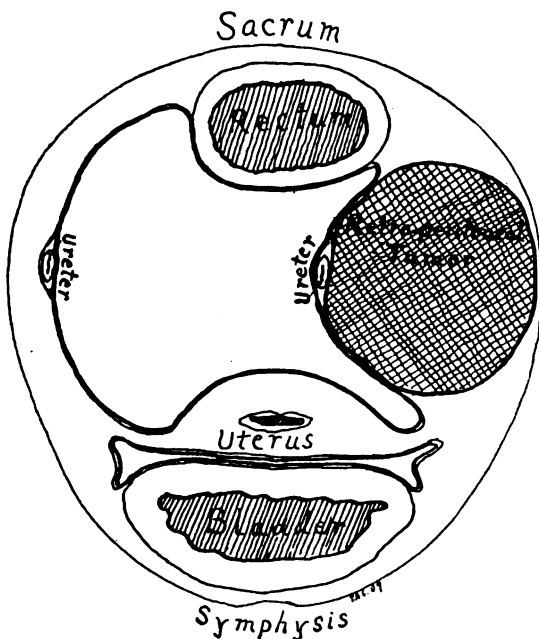


FIG. 15.—Tumor lateral to the ureter, the removal of which is associated with danger of injuring the ureter. $\times \frac{1}{2}$.

Diagrammatic representation of a cross-section of the pelvic contents, taken above the level of the internal uterine os. Fortunately this condition is a very unusual one. The peritoneum with ureter attached has been displaced toward the median line and unless the condition is recognized at the time of operation the ureter is liable to be injured.

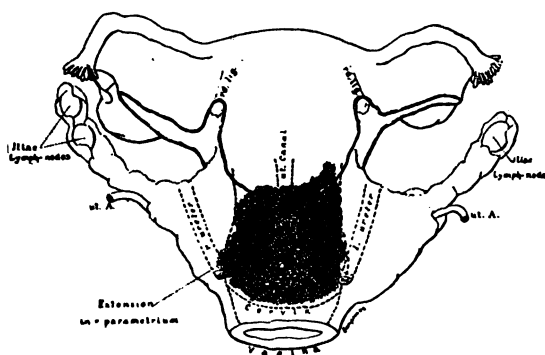


FIG. 16.—Relation between cancer of the uterine cervix and the ureters. $\times \frac{1}{2}$.

Reconstruction of cancer in a specimen, removed at operation, in which the lower portion of both ureters were sacrificed and the renal ends were implanted into the bladder. The ureters are indicated, and one may see that they would soon become compressed by the growth (see next illustration).

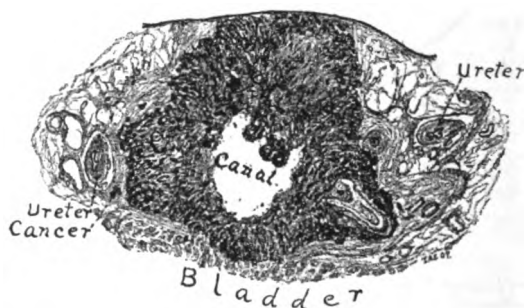


FIG. 17.—Relation between cancer of the uterine cervix and the ureters (a little less than natural size).

This illustration was made from a stained cross-section through the lower third of the cervix of the specimen shown in the preceding illustration. It shows very well the marked hypertrophy of the mesial wall of the sheath of the right ureter, and that the sheath is derived from the tissues along the course of the ureter, and at this level the outer wall is partly formed by the vesico-vaginal plexus of veins. This specimen emphasizes the proximity of the ureters to the lower end of the cervix, that it takes but a very little invasion of the parametrium by cancer for the sheath of the ureters to become involved and once involved that the dangers of ureteral injury during operation are great. On drawing the uterus upward during the operation the ureters are carried with the cervix, because the sheath of each is adherent to it. The ureters may be freed from the cervix by splitting the sheath along its lateral side and shelling the ureters out. This may be done (could have been done in this instance) and necrosis of the ureter will not occur if the ureter is handled gently and the peri-ureteral arterial plexus is not injured.

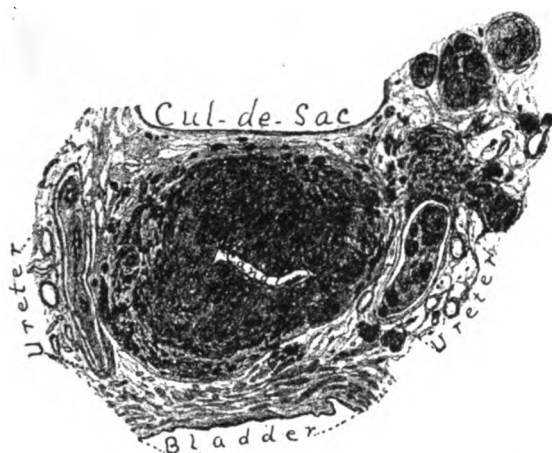


FIG. 18.—Unusual relation between cancer of the uterine cervix and the ureters (a little less than natural size).

A patient, with adenocarcinoma of the uterine cervix, suddenly died, and at autopsy the cause of death was found to be a cerebral embolism secondary to a vegetative endocarditis. The pelvic organs with surrounding soft parts were removed and preserved in Kaiserling's fluid. This illustration was made from a stained cross-section through the lower third of the cervix, both ureters and a portion of the bladder wall. The cervix has been replaced by cancer; the bladder wall is not involved in this section and the right ureter with its sheath is normal. The left ureter has been invaded by the growth and the lateral walls of the sheath are intact, but the posterior wall has been invaded by cancer, and at a little higher level cancer may be seen extending through the sheath and invading the ureter. Usually the ureter does not become invaded by the cancer but the invasion of the sheath causes the sheath to hypertrophy and this hypertrophy compresses the ureters, causing renal insufficiency and often the death of the patient.

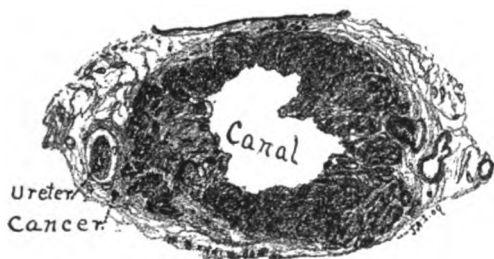


FIG. 19.—Relation between cancer of the uterine cervix and the ureter (a little less than natural size).

The illustration was made from a stained (hematoxylin and eosin) cross-section through the lower third of the cervix of a specimen removed at operation in which the lower portion of the right ureter was removed with the growth and the ureter was implanted into the bladder. The growth has extended into the right parametrium and has invaded the mesial portion of the ureteral sheath and as a result the sheath has become hypertrophied, thus protecting the ureter and later, in the course of the disease, this hypertrophy will increase and the ureter will become compressed, causing renal insufficiency.

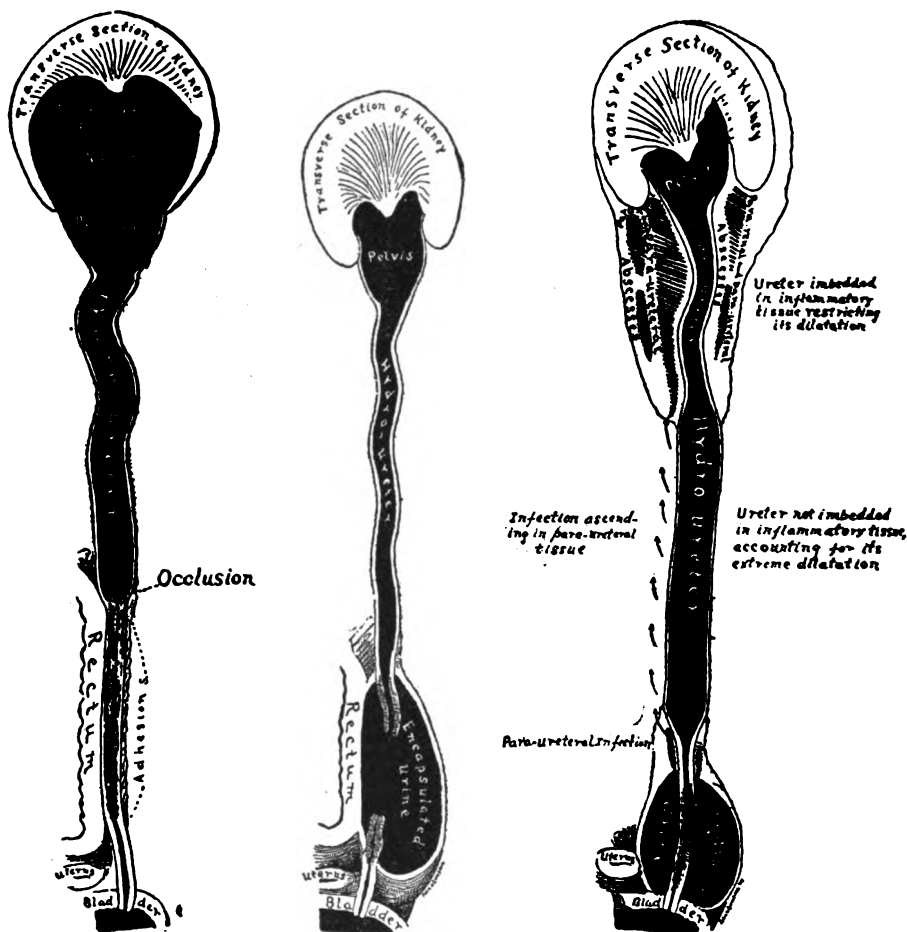


FIG. 20.—Experimental ureteral necrosis resulting in occlusion of the ureter.

The larger vessels of the peri-ureteral arterial plexus of a dog were stripped from about 1 cm. of the lower portion of the left ureter and both uterine arteries were ligated. The dog was killed at the end of three weeks. The result was ureteral necrosis with occlusion of the ureter and formation of hydro-ureter and hydro-nephrosis. The necrosis began in the inner coats of the ureter and a thin shell of the outer coat was still living. A fistula did not form because the outer coat was still living and it became adherent to the rectum and surrounding tissues which splinted and nourished it. The blood supply of the ureter of a dog and man are quite similar, and the experiment simulated what might happen in the rough handling of the ureter in hysterectomy for uterine cancer. Had infection been present, or the blood supply of surrounding parts destroyed by mass ligatures or cautery, or had gauze been in contact with the ureter, the latter would probably have ruptured.

FIG. 21.—Experimental ureteral necrosis resulting in rupture of the ureter.

The experiment was similar to the one demonstrated in the preceding illustration. In this instance the necrosis was so extensive and the adhesions so slight that the ureter ruptured. The extravasated urine became encapsulated and eventually the urine would become absorbed and probably the ureter occluded and the function of the kidney would cease. Had an outlet been provided for the escape of urine, a ureteral fistula would have resulted and of the total type (see Fig. 24).

FIG. 22.—Experimental ureteral necrosis resulting in rupture of the ureter and associated with infection. The experiment was similar to the preceding ones except that the dog was killed earlier, i. e., at the end of six days.

The result was quite similar to the preceding one except for the presence of infection and that the ureter had not been completely severed. Had infection not been present, the opening in the ureter might have closed and the encapsulated urine would have become absorbed and the function of the kidney would have been preserved. Had an avenue been provided for the escape of urine, a ureteral fistula would have resulted and of the partial type (see Fig. 25).

cause her death. If infection is absent, the opposite kidney sufficient, and the patient is in good condition, she will recover, and unless an avenue for the escape of urine appears, the ureter will become occluded and the urine will be absorbed. Such cases have undoubtedly occurred and the condition has not been suspected.

In 1904 I began a series of experiments on dogs in order to determine the effect of the presence of urine in the peritoneal cavity. In two dogs one ureter of each was cut across and the abdomen closed. To my surprise the convalescence of both dogs was most uneventful. They were quiet and did not like to be disturbed for the first two or three days, but after that seemed well. They were killed, one a week after the operation and the other three weeks. The ureter of each had become occluded, resulting in a moderate hydro-ureter and hydronephrosis, and there was no urine in the peritoneal cavity or in the tissues about the end of the retracted ureter. I found later, in the literature, that similar results had been obtained by others.

Longitudinal incisions of the ureter heal spontaneously, and often with very little leakage of urine, if there is no obstruction below the opening. Transverse incisions do not heal as well as longitudinal ones, because separation of the cut ends occurs and a persistent fistula is apt to result. Clamping the ureter, even for a few minutes, may so injure it that a fistula develops later, which usually manifests itself a few days after the operation. On the other hand, this does not necessarily follow. A temporary ligature does less harm than a clamp, and probably very rarely causes sufficient necrosis to lead to a ureteral fistula. A ureter may be cut and ligated and the ligature, if of catgut, may later be absorbed, a fistula resulting. A tight ligature about the ureter may cut through its walls and cause a fistula. This is especially liable to occur if silk is used and infection is present. In one dog in which I had ligated the bare ureter with fine

silk, the suture cut through the wall of the ureter and its lumen was reëstablished; an end-to-end anastomosis had resulted and the urine escaped into the bladder.

From our knowledge of the blood supply of the ureter one would infer that the ureter could be dissected free for its entire length without the occurrence of necrosis if the peri-ureteral arterial plexus was preserved. Clinical experience has confirmed this. On the other hand, one would infer that, if this plexus was injured for only a short distance, necrosis might occur, and clinical experience has shown that if the lower end of the ureter is roughly handled in the removal of a cancer of the uterine cervix, a fistula is likely to result, the urinary discharge appearing one or two weeks after the operation.

Experiments on dogs showed that this necrosis began as a hemorrhagic infarct of the walls of the ureter, that the inner coats are first affected, and that the infarcted area first appears in the tissue beneath the epithelium lining its lumen. The size of the area involved and the extent of the process depended on the severity of the circulatory disturbance. Rupture of the ureter did not always occur, because the necrosis was not always extensive enough, and even when extensive the injured portion of the ureter sometimes became embedded in adhesions which splinted it and nourished its outer coat through vessels derived from the surrounding tissues. The effect of the necrosis was a stricture due to the swelling of the necrotic tissue. This stricture was temporary in some instances; in others it became permanent, due to the replacement of the necrotic tissue by scar tissue, and in still others was so extensive as to cause complete occlusion of the ureter with loss of function of the kidney (see Fig. 20). Rupture of the ureter occurred in two instances and led to an extravasation of urine which become encapsulated (see Fig. 21), and in one instance the encapsulated urine became infected, causing a peri-ureteral and pararenal infection

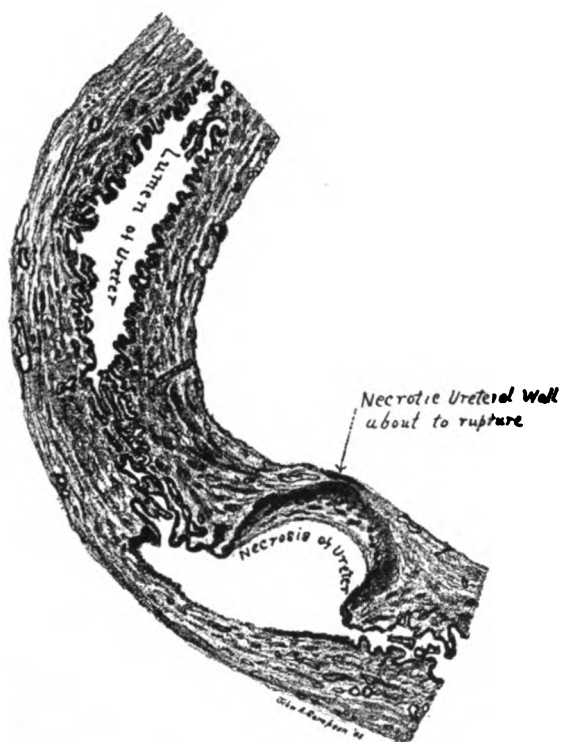


FIG. 23.—Longitudinal section of ureter showing localized necrosis about to rupture and cause a ureteral fistula. $\times 4$.

The ureters had been freed in a radical operation for cancer of the uterine cervix. The patient died on the sixth day. The cause of death was not determined. Had the patient lived, a fistula of the partial type see (Fig. 25), would have probably resulted, and this would have healed spontaneously.

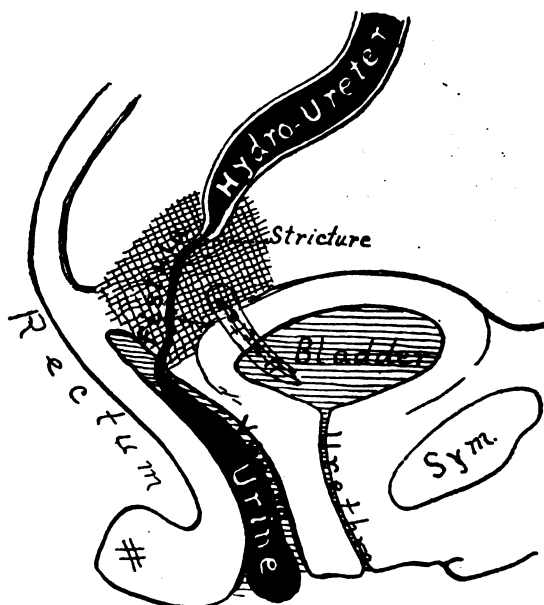


FIG. 24.—Total uretero-vaginal fistula. Diagrammatic representation of one.

A stricture is always present after the fistula has persisted for a short time, and infection is often present. All the urine from the kidney escapes through the vagina except as the fistula may become temporarily or permanently occluded. On palpation one may often feel the induration about the fistula. On cystoscopic examination the ureteral orifice is "dead," urine does not escape, and there is no motion about it. A ureteral catheter may be passed a short distance, and on injecting colored fluid into the catheter it does not appear in the vagina, but flows back into the bladder (a very exceptional case might occur where the severed ends of the ureter communicated with the vagina through separate openings). The fistula persists indefinitely, and if it heals spontaneously, it is only after a long period of time and with occlusion of the ureter and destruction of the function of the kidney.

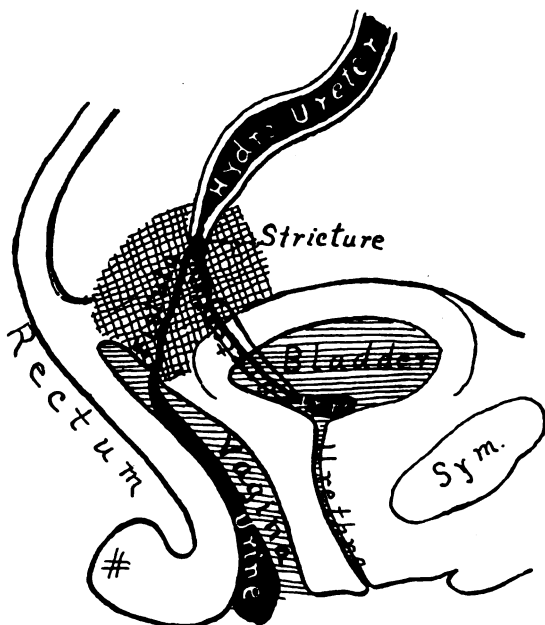


FIG. 25.—Partial uretero-vaginal fistula. Diagrammatic representation of a partial uretero-vaginal fistula due to a lateral opening in the ureter.

A stricture may be present, but often is very slight or entirely absent. The amount of urine escaping into the vagina and bladder varies with the size of the lateral opening and also the degree of patency of the ureter below the opening. On palpation one may often feel the induration about the fistula. On cystoscopic examination, urine may or may not be seen escaping from the orifice, but if it is not seen, a "tug" will usually be noticed due to the contraction of the ureter above. A ureteral catheter may be passed beyond the opening, if a stricture is not present, and colored fluid injected into the catheter, whether the end of the catheter is passed beyond the opening or not, will appear in the vagina. The fistula usually heals spontaneously, in a short time, and often with very little stricture formation.

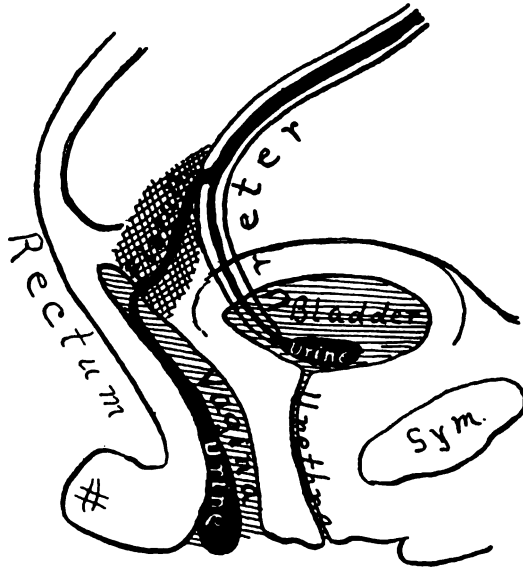


FIG. 26.—Partial uretero-vaginal fistula. Diagrammatic representation of a partial uretero-vaginal fistula, in which there is a complete severance of the ureter with retraction of the cut ends, but there is still a communication between these ends through a sinus, as well as a communication with the vagina. A stricture is always present if the fistula has persisted for any length of time. The symptoms and physical signs are similar to those of the preceding except that a stricture is always present. Such a condition probably exists for only a short time, as either one or the other fistula will close, thus forming either a total uretero-vaginal fistula or a total uretero-vesical fistula. If the latter form persists, the discharge of urine from the vagina ceases but the kidney is injured by the persistent ureteral stricture, and eventually the stricture may close, thus destroying the function of the kidney.

(see Fig 22). Had an avenue for the escape of urine been formed in these cases, ureteral fistulæ would have resulted, in the first case of the total type, and in the second probably of the partial type. The encapsulated urine would have undoubtedly been absorbed and the ureter occluded in the first case; in the second one, if infection had not been present, the opening in the ureter might possibly have healed. I believe that ureteral necrosis in human beings results in a similar manner and follows a similar course. The most important factor in its etiology is injury to the peri-ureteral arterial plexus arising from tearing or otherwise injuring the plexus, as may occur in dissecting the ureter free or handling it roughly after it has been freed. Other etiological factors must be considered, as the ligation of vessels supplying the plexus, the interference with the formation of adhesions from which the ureter may be nourished, occurring in the presence of exudates, infection, gauze, and the destruction of the tissue about the ureter from mass ligatures and the use of the cautery. Pressure on the ureter, stricture below the injury, and general lowered resistance of the individual, also favors necrosis and fistula formation. I have had the opportunity to study but one instance of the formation of a ureteral fistula from necrosis in a human being. The patient died on the sixth day following hysterectomy for cancer of the uterine cervix, where the lower ends of both ureters had been freed. The cause of death was not determined at autopsy, but a localized necrosis in the lower end of the right ureter was found, and the ureter was about to rupture at this place (see Fig. 23).

Ureteral fistulæ may result in other ways; as the failure of ureteral repair either in uretero-ureteral anastomosis or in the implantation of the ureter into the bladder or intestines. The removal of a ureteral calculus may also be followed by a fistula which usually heals spontaneously in a short time.

THE CLASSIFICATION OF URETERAL FISTULÆ.

Ureteral fistulæ may be grouped according to their etiology, whether unilateral or bilateral, or combined with a vesico-vaginal fistula. They may also be designated according to the portion of the ureter involved as, the renal, abdominal, pelvic, or vesical, and with what part of the body the fistula communicates, as the abdominal wall, uterine canal, vagina, or intestines.

The above classifications have their importance because the symptomatology, diagnosis, prognosis if untreated, and treatment vary with these types.

A still more important grouping of ureteral fistulæ presents itself, according to whether the fistula is total or partial, indicating by total that there is not any communication with the bladder, and that all of the urine from that kidney escapes by the fistula (see Fig. 24). A partial ureteral fistula implies that a communication with the bladder still remains, either due to the fact that the ureter is not completely severed (see Fig. 25), or if the ends of the severed ureter are separated, a sinus connects them (see Fig. 26). The importance of this classification is evident from the standpoint of symptoms, diagnosis, and especially prognosis if untreated, because the partial ureteral fistulæ will nearly always heal spontaneously with more or less complete preservation of the function of the kidney, unless a stricture of the ureter is present; on the other hand, the total fistulæ will continue indefinitely, or if they "heal" it will be by occlusion of the ureter.

SYMPTOMATOLOGY OF URETERAL FISTULÆ.

The symptoms of ureteral fistulæ are but the manifestations of normal anatomy and normal physiology as altered by the condition present. They vary with the portion of the

body with which the distal end of the fistula communicates, and also with the type of fistula, whether total or partial, whether bilateral or unilateral, and whether or not complications are present.

In a total ureteral fistula all the urine from the kidney escapes through the fistula; the fistulous tract interferes with the discharge of urine, and thus harms the kidney, and the dangers of renal infection are great. Thus, in addition to the symptoms arising from the fistula, there are usually those arising from obstruction to the outflow of urine and the resulting insufficiency of that kidney; these symptoms are often aggravated by infection.

In a partial ureteral fistula usually only a part of the urine escapes through the fistula; there is also usually less obstruction to the outflow of urine and therefore less harm to the kidney, and the dangers of infection are less than when a total ureteral fistula is present.

If complications or other conditions exist, corresponding symptoms are present.

DIAGNOSIS OF THE VARIOUS TYPES OF URETERAL FISTULÆ.

One of the greatest aids in the diagnosis of the possibility of a ureteral fistula is the conscience of the operator. It is a postoperative sequela which is often expected but is not always realized, and it rarely occurs when least expected.

An exact diagnosis is of great value, not only to ascertain whether or not a ureteral fistula is present and which ureter is injured, but also to determine whether it is a total or partial fistula, and whether or not other conditions are present, because the treatment varies with the conditions present, as shall be shown later. The patient complains of a urinary discharge and also voids urine, unless there is a bilateral uretero-vaginal fistula; a vesico-vaginal fistula is also present, or the other kidney has been removed or has ceased to func-

tion. The amount of discharge varies with the activity of the kidney at the time and is influenced by many factors, as amount of water taken, etc. The urinary discharge may appear a few hours after the operation, as when the ureter has been incised and there is a free exit to the escape of urine, or it may not appear for several days, or even as long as two weeks after the operation. The delay in the appearance of the urine may be due to the failure of a free exit, or if the injury causes necrosis it usually does not result in a fistula until several days, or even two or three weeks, have elapsed. If the patient is at times dry and remains so for several hours, it suggests that either a partial fistula is present or there has been a temporary blocking of the ureter. The blocking of the ureter may occur in either type of fistula, but more often in the total one, and is often associated with discomfort. On abdominal palpation there may or may not be tenderness or a tumor mass in the region of the kidney; this depends on the condition of the kidney. On vaginal palpation one usually feels induration on the side of the pelvis where the fistula is situated, if a uretero-vaginal fistula is present. On inspection of the vaginal vault, in such a case, the opening of the fistula may often be seen, but it may be difficult to detect, and its situation may be misleading in determining which kidney is involved. The distention of the bladder with colored fluid will show the presence of a vesico-vaginal fistula; and the failure of the appearance of colored fluid in the vagina indicates an intact bladder; still a small vesico-vaginal fistula situated high up in the bladder may leak but very little. The greatest aid is obtained from the use of the cystoscope. If one sees urine actively coming from one ureteral orifice and none from the other orifice, the diagnosis of the side involved is made; in a partial uretero-vaginal fistula some urine might escape into the bladder through the affected ureter, but it would be much less active than the intact side. In a total ureteral fistula there is no

sign of activity about the orifice of the side affected, because the ureter is severed from the bladder. In a partial one, even though urine does not escape into the bladder, there may be periodic retractions of the orifice, due to the pulling of the ureter still connected with the bladder. If a small renal catheter is passed into the "silent" ureteral orifice it can probably be passed only a short distance if a total ureteral fistula is present, and even if it is a partial one, stricture may be present, preventing the passage of the catheter. If colored fluid is injected through the catheter, as in the induction of artificial renal colic or renal lavage, it will flow back around the catheter into the bladder if the fistula is total, or, if the fistula is partial, some will appear in the vaginal or abdominal opening of the fistula, as the case may be. In this way we may determine whether we are dealing with a total or a partial ureteral fistula, a most important differential diagnosis to make. If the end of the catheter should pass by the opening of a partial ureteral fistula, the colored fluid would be forced into the kidney, but would be discharged through the fistula after the withdrawal of the catheter. I tried to reverse the process in one case by passing a small catheter into the opening of the fistula in the vaginal vault and then forcing colored fluid into the fistula. I later catheterized the bladder to see if it appeared in the bladder. It was a dangerous experiment, as the patient was sick several days with the symptoms of renal infection. I have concluded that it is unsafe to insert catheters through the vaginal opening into a fistula. The use of a segregator may give valuable information, but the cystoscope is our greatest aid in studying these conditions. Chromo-cystoscopy is undoubtedly of great aid, especially in the water-distended bladder, but in the air-distended bladder the activity of the ureteral orifice, as well as whether or not urine is escaping, can usually be readily detected, even if the urine is not colored. In certain partial ureteral fistulæ, the ureter may be severed

but a communication between it and the bladder may still exist through a sinus, the vesical end of the severed ureter having remained patent. The differential diagnosis between this form of partial ureteral fistula and the form where the injured ureter is not severed would be impossible, especially if there was a stricture present in the latter case.

COURSE OF URETERAL FISTULÆ UNOPERATED UPON.

Partial ureteral fistulæ usually interfere very little with the outflow of urine, and thus with the function of the kidney; they usually heal spontaneously in a short period of time, *i. e.*, a few days or a few weeks, and with the preservation of the function of the kidney, unless some other conditions are present which would tend to maintain the fistula, as obstruction to the ureter below the fistula, cancer, or a foreign body, as a silk suture or gauze about the ureter.

Total ureteral fistulæ are always associated with stricture, interfere with the outflow of urine, and therefore injure the kidney. They persist indefinitely and are often associated with attacks of ureteral obstruction and renal infection. If they heal spontaneously, which is unusual, and then only after a long period of time, the ureter becomes occluded and the function of the kidney ceases.

A partial ureteral fistula, where the ureter is severed but the ends are united by a sinus, also interferes with the outflow of urine and therefore the function of the kidney. Such a condition, I believe, is temporary, and that one sinus will close, and, as a result, either a total ureteral fistula or a total uretero-vesical fistula will persist. Even if the result is a total uretero-vesical fistula, and the patient is apparently cured, a portion of the ureter has been replaced by a sinus, a stricture is present, the function of the kidney is impaired, renal infection is apt to occur, and there is the possibility of eventual occlusion of the sinus, and thus occlusion of the

ureter. The course of ureteral fistulæ associated with other conditions may or may not be altered by these other conditions.

TREATMENT OF URETERAL FISTULÆ.

When a urinary discharge appears after an operation, I believe that it is best to make the patient as comfortable as possible and not to attempt an exact diagnosis until after she has regained her strength. A knowledge of what was done at the time of the operation, together with subjective symptoms, usually furnishes a very good clue as to the diagnosis. The discharge may cease entirely in a few days or within two or three weeks, before we have been able to make an exact diagnosis. A small vesico-vaginal fistula or a partial ureteral fistula will often close in that length of time. After the patient has regained her strength, the first step should be to determine whether or not a vesico-vaginal or a uretero-vaginal fistula is present, if the urine is discharged through the vagina. The distention of the bladder with sterile colored fluid will usually clear up this point unless both conditions are present. After three to four weeks have elapsed since the operation, we should attempt to determine whether the fistula is partial or total, as has been outlined under diagnosis. If the fistula is partial we may wait longer, but a persistent partial fistula demands the same treatment as a total ureteral fistula, and the patient should be relieved before the kidney has been injured by a persistent stricture and the repeated attacks of infection which are so apt to occur. Another class of cases present themselves, *i. e.*, those where several months or even years have elapsed since the operation causing the ureteral fistula. Their condition is one demanding operative interference whatever the type of fistula may be.

What is the treatment of a total ureteral fistula or a persistent partial one? The ideal treatment should be not only to close the fistula, but also to reëstablish a permanent *unob-*

structed channel for the discharge of urine from the kidney into the bladder. The presence of a stricture of the ureter is a constant menace to the health of the individual, as is also a kidney with an occluded ureter; these are the results of many so-called cures of ureteral fistulæ.

According to the conditions present and the general health of the patient, three methods of treatment seem rational: first a uretero-vesical implantation, second nephrectomy, and third the maintenance of the ureteral fistula. A uretero-ureteral anastomosis of the same side or into the opposite ureter does not seem to me to be adapted to those cases. A successful uretero-vesical implantation is the ideal operation; it both cures the fistula and relieves the stricture of the ureter so that the function of the kidney may not be interfered with. A truly successful uretero-vesical implantation is adapted only to those cases in which the ureter may be implanted into the bladder without tension and in which the kidney is worth saving. Implantation of the ureter of a kidney which has been practically destroyed by a stricture of long duration and repeated attacks of infection is contra-indicated, hence the importance of the early operative interference in ureteral fistulæ. Implantation of the ureter into the bladder when the tension will be so great that the function of the ureter will be greatly impaired or destroyed, is also contra-indicated. A nephrectomy is indicated in those cases in which the opposite kidney is known to be sound and in which an ideal uretero-vesical implantation is not possible, especially if the surgeon has reason to believe that the kidney involved has been greatly injured by the fistula. The maintenance of the fistula is indicated only in those cases in which both a uretero-vesical implantation and a nephrectomy are contra-indicated.

There has been much discussion as to the route to be used in making a uretero-vesical implantation. In an ideal uretero-vesical implantation the ureter must not be compressed and

the implantation must be made without tension, for the *function of the ureter must be preserved*. I agree with those who believe that this can be done by the intraperitoneal route better than by any other. A median incision is made, the pelvis is walled off with gauze, and both ureters inspected, The peritoneum is incised below and parallel to the pelvic brim, and a flap of peritoneum carrying the ureter is then dissected from the side of the pelvis, thus forming the extraperitoneal part of the operation. By this method the ureter may be freed from the peritoneal flap for only a short distance; the access to the bladder is easy, and it may be freed and drawn up toward the ureter and fastened to the side of the pelvis, so as to make up for any loss in the length of the ureter. If this is not sufficient the ureter may be freed and drawn down. The bladder wall should be sutured to the ureteral wall by three or four interrupted sutures, and should not be sutured around the ureter. After making the implantation, the peritoneal flap should be sutured to the bladder, thus relieving tension. The field of operation may be made extraperitoneal and drained through the vagina or through the groin, as by the extraperitoneal route. I believe that this route is better than the inguinal extraperitoneal one. I have implanted the ureter into the bladder six times by the inguinal extraperitoneal route with one death, and that from the anesthetic on the operating table. In each operation I found that it was more difficult to expose the ureter than by the intraperitoneal route, and it was also necessary to free the ureter more. The peritoneal cavity was opened unintentionally in each instance and the access to the bladder was difficult. I have never had any experience with the intraperitoneal uretero-vesical implantation, except following the resection of the lower end of the ureter or ureters in hysterectomy for advanced cancer of the uterine cervix, where the procedure is similar to that just described. The above suggestions are based on my experience in the uretero-vesical

implantations in these latter cases, as compared with the six cases by the extraperitoneal route.

PROPHYLAXIS OF URETERAL FISTULÆ.

The prophylaxis of any undesirable post-operative sequela is intelligently handled only after the sequela has occurred and especially after its severity and the difficulty in relieving the patient have been fully realized.

The prevention of postoperative ureteral fistulæ must be based on the prevention of injuries to the ureter during operations, the ability to recognize them if they occur, and, if necessary, to successfully repair them at that time. The surgeon must be familiar with the normal anatomy of the ureter, especially its relation to the other pelvic structures and how these relations may be altered by disease and various operative procedures.

When the cervix is in extreme lateral position it lies very near or in actual contact with the ureter of that side, but usually there is little danger in hysterectomy in these cases if the cervix is freely movable, because on drawing the uterus upward the cervix is usually drawn away from the ureter and the latter is easily pushed to one side. If the cervix is more or less fixed and there is any induration in the base of the broad ligament, the tissues about the ureter, *i. e.*, its sheath, is apt to be adherent to the cervix, so that on drawing the uterus upward the ureter is carried up with the cervix and freed from it with great difficulty. The ureter is easily injured in these cases in the control of the uterine vessels or in freeing the cervix, unless the ureter is first isolated and drawn to one side. In all cases except cancer, injury to the ureter may be avoided by using scissors and cutting the tissues close to the cervix. If any doubt exists as to situation of the ureter, it had best be exposed by freeing a flap of peritoneum above and tracing it down to the field of operation.

The ureter is apt to be injured in freeing masses which are adherent to the peritoneum covering the ureter, if this peritoneum is stripped from the side of the pelvis. In attempting to control the oozing which may result in freeing the mass, the ureter covered by the peritoneum is in danger of being clamped or ligated. We have learned that tubal and ovarian inflammatory masses are best freed by beginning below them and lifting them out of the pelvis, as we say we are able to get into the right layer, *i. e.*, we work between the mass and the peritoneum and separate the two and do not strip the peritoneum from the pelvis, as we are likely to do if we begin at or near the pelvic brim, where the peritoneum is often continuous with that covering the mass. This procedure protects the peritoneum covering the ureter, and for this reason the ureter is seldom injured in the removal of pelvic inflammatory masses. Fortunately the peritoneum is also usually thickened by inflammation and not easily torn.

We have learned that intraligamentary tumors are often in contact with the ureter and may even displace it, and unless great care is used it will be clamped in the control of hemorrhage or it may be mistaken for a large bloodvessel, ligated, and cut. We are therefore constantly on our guard in removing these tumors.

In retroperitoneal tumors situated lateral to the ureter, the ureter with the peritoneum covering it is displaced toward the median line and must be recognized to be avoided. If in any operation doubt exists as to whether a certain structure is the ureter, it is best to first expose the ureter, as can always be done by dissecting downward a flap of the parietal peritoneum above the field of operation; the ureter will be found adhering to it and can thus be easily traced downward.

The lower ends of the ureters require special attention in the radical operations for cancer of the uterine cervix. The ureters pass through tissue which should be removed

in every instance. This should be done by freeing the parametrial portion of the ureters down to the bladder, carefully drawing this portion of the ureters to one side, and then removing the uterus with a wide incision of the parametrium. Injury to the ureter may be prevented in the following manner: First expose the ureter above the base of the broad ligament, by dissecting the peritoneum from the side of the pelvis, as has been described; the ureter can readily be seen attached to this flap, and without disturbing it in any way it can be traced into the parametrium. On following the ureter through the parametrium the uterine vessels are next encountered as they cross the ureter, and may be ligated and cut at this point. In some instances the bladder and ureters may be easily pushed to one side by the finger covered with gauze, but more often the parametrium is thickened and the ureteral sheath is adherent to the tissues about the cervix, so that it is difficult to free them. Under these circumstances, the sheath should be split open when the ureters can readily be shelled out, and, if handled carefully, there is very little danger of ureteral necrosis.

A ligature placed about the ureter may be removed at the close of the operation, and the dangers of the formation of a fistula are slight. The ureters have been released after forty-eight and fifty-eight hours, and the patients have recovered without the formation of fistulæ.

A clamp does more harm, and fistulæ have followed clamping of a ureter even when the clamp has remained on the ureter for only a few minutes. In such an instance a gauze drain should be placed down to the site of the injury, but should not come in contact with the ureter.

Longitudinal wounds of the ureter heal with very little leakage, and sutures are usually not necessary. Transverse wounds with retraction of the cut surface should be sutured unless they are near the bladder, when a uretero-vesical implantation is usually safer.

What shall be done when the ureter is completely severed or a portion is excised? If a uretero-vesical implantation is possible, it is the best procedure, and this may be done when the injury is quite high up, by freeing the bladder and drawing it toward the ureter, and fastening it to the side of the pelvis, and if that is not sufficient, the ureter may be freed and drawn down. If a uretero-vesical implantation is impossible on account of the high situation of the injury, the ends of the severed ureter should be united if they can be approximated without too much tension. Several of the successful cases of uretero-ureteral anastomosis have probably amounted to ligation of the ureter.

What shall be done if either a uretero-vesical or a uretero-ureteral anastomosis is impracticable? The ureter may be permanently ligated; this has been done several times and the patients have recovered without any discomfort referable to this procedure. The dangers of this procedure are, first, renal infection; second, the ligature may cut through the ureter and a fistula result; third, renal insufficiency may result, due either to insufficiency of the other kidney, or the patient may be very weak as the result of the operation and the added shock of ligation of the ureter, and the increased work thrown on the other kidney, which is unprepared for that work, may cause the death of the patient. It is much safer to ligate the ureter of a kidney whose function is already partly destroyed, than it is to ligate the ureter of a normal kidney, for in the former case the opposite kidney has had an opportunity to adjust itself to the insufficiency of the kidney whose ureter is ligated. If the ureter is ligated, the ligated end should be brought out near the surface through a small incision in the groin or lumbar region, so that any of the above complications may be relieved by freeing the end of the ureter. I believe that the deliberate formation of a ureteral fistula by bringing the cut end of the ureter to the surface of the abdominal wall, and then later removing the

kidney if the opposite one will permit, it a safer procedure than ligation of the ureter. The nephrectomy in the latter instance is undertaken when the patient is in good condition, and, furthermore, as the ureteral fistula will have interfered with the function of the injured kidney, the efficiency of the opposite will have increased and will be better prepared for the increased work which necessarily follows a nephrectomy, than had the kidney whose ureter is injured been normal and removed, or its function suddenly destroyed by ligating its ureter. Other things being equal, it is much safer to do a nephrectomy or ligate the ureter of a kidney whose function has been impaired, than if the kidney is normal, and this is especially true if the patient has been greatly weakened by a severe operation.

The ureter may be freed for its entire length with very little danger of necrosis if the peri-ureteral arterial plexus is uninjured, and, in the radical operations for cancer, the lower end may be freed but must be handled very carefully, as injury to its peri-ureteral arterial plexus is apt to lead to necrosis. This danger is lessened by preserving the blood supply of the surrounding tissues. Nothing is gained by ligating the internal iliac artery in these operations, as the blood supply to the pelvic structures is impaired, thus increasing the chances for necrosis and infection; mass ligatures and the extensive use of the cautery have the same effect. The freed ureters should be covered as far as possible with peritoneum and the area drained, being careful not to let the gauze come in contact with the ureters.

The prophylaxis of ureteral fistulæ should be carried still further. The occurrence of pelvic conditions, whose operative treatment is associated with ureteral injury, in a large measure can and should be prevented. In the present age of preventive medicine we should do all that we can to prevent the failure of the recognition of every pelvic disease before it has reached an advanced stage. It is the treat-

ment of the advanced stages of pelvic diseases that is particularly liable to be associated with danger of injury to the ureters, and the operative treatment of the advanced stages of cancer of the uterine cervix has been associated with ureteral injuries more frequently than the treatment of all other pelvic conditions combined. The earlier diagnosis of pelvic diseases is possible in the majority of cases by obtaining the coöperation of our patients and by instructing them as to the significance of certain symptoms referable to the pelvic organs. The most important symptom of all is uterine bleeding, and especially when slight, inconstant, and painless, the one type that women are so apt to neglect, and the very type which beginning uterine cancer often causes.