Surgery of the ureter / by Christian Fenger.

Contributors

Fenger, Christian, 1840-1902.
Royal College of Surgeons of England

Publication/Creation

[Philadelphia] : [publisher not identified], 1894.

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SURGERY OF THE URETER.

BY

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Reprinted from the Transactions of the American Surgical Association, 1894.

SURGERY OF THE URETER.[1]

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ANATOMY.

THE ureter is a cylindrical muscular canal, in the living subject probably contracted to some extent, with a rather uniform diameter of 3 to 4 mm. throughout its entire extent, from the pelvis of the kidney to the bladder. It varies in length from eleven to thirteen and a half inches according to Henle (28),[2] ten to twelve inches according to Tanquary (69), cited by Van Hook (77), and Tanquary states that it never exceeds fifteen inches.

Its course is straight or slightly curved as it passes down from the kidney, and its direction is somewhat oblique toward the median line. The curve described is sigmoid; above the small pelvis the slight convexity is toward the median line; while the pelvic portion is more strongly curved, almost the arc of a circle (Tanquary), with its convexity directed toward the lateral wall of the pelvis, until it finally reaches the neck of the bladder, the wall of which it penetrates so obliquely that it runs for half or three-quarters of an inch between the muscular and mucous coats (Cabot) (9). In the male it crosses the vas deferens on the posterior wall of the bladder; in woman it crosses the cervix and enters the bladder at a point midway between the meatus urinarius and the cervix.

[1] A short *résumé* made by request of the President of the American Surgical Association to introduce the discussion on this subject at the annual meeting of the Association, May, 1894.

[2] See Bibliography at end of article.

The canal is not absolutely uniform in calibre throughout its entire course; Hallé (27) and Tanquary have pointed out that in normal subjects it is narrowed in three places, namely: (*a*) At a point between one and a half and two and a half inches from the pelvis of the kidney; (*b*) at the junction of the pelvic and vesical portions, and (*c*) at the place where it crosses the iliac artery, found in three out of five subjects. These localities correspond with the places where small stones from the kidney have been found to be arrested.

In the same connection it is well to remember the variations in the upper end of the ureter as pointed out by Hyrtl (29). In the first variety there is no pelvis, but the ureter divides into two branches without dilatation at the point of division, each branch having a calibre a little larger than that of the ureter. In the second variety there is a pelvis; that is, a funnel-shaped dilatation at the point of division. The upper portion is the smaller, and terminates in three short calices; the lower and more voluminous portion terminates in four or five calices. In the third variety there is only half a pelvis; that is, the lower branch divides and is funnel-shaped, forming a narrow pelvis which terminates in one, two, or three short calices; while the upper is not dilated, and extends to the upper portion of the kidney as a continuation of the ureter. The ureter not uncommonly divides far below the kidney, between the kidney and the bladder; sometimes there is no division at all, and two separate ureters enter the bladder.

There is one variation in the point of entrance of the ureters into the bladder which is of especial practical importance, namely, those cases, few in number, in which the ureter instead of entering the bladder high up or low down, posterior to the sphincter of the urethra, opens into the latter at or near its external orifice or even into the vagina (Secheyron) (65). This anomaly causes a congenital partial incontinence of urine, for the relief of which successful operation has been performed.

In passing down from the large to the small pelvis, the left ureter lies between the vertebra and the psoas muscle, while on

the right side, on account of the vena cava inferior, the ureter is situated a little more laterally.

The relation of the ureter to the peritoneum is an important consideration in the surgical anatomy of the ureter. This was first carefully studied by Cabot, who pointed out, that in the extra-peritoneal operations, especially in fat subjects, it is extremely difficult to find and recognize the ureter in the deep wound, unless guided, for instance, by the presence of a stone. The ureter is adherent to the peritoneum, and always follows it when it is stripped up from the parts behind. This fact has occasionally been mentioned before by Crampton (13), Twynam and others, but the condition was not studied until Cabot made microscopical sections of the ureter and peritoneum, and demonstrated that the ureter is bound to the under surface of the peritoneum by fibrous bands.

Cabot further pointed out that the relation of the ureter to that part of the peritoneum which is adherent to the spine is rather constant, the ureter being situated just external to the line of adhesion. Therefore when the operator has stripped up the peritoneum and reached this point, he will find the ureter on the stripped-up peritoneum, a little external to it. On the left side the distance from the line of adhesion to the ureter is from half an inch to an inch; while on the right side the distance is somewhat greater owing to the outward displacement of the ureter by the interposition of the vena cava inferior between it and the spine.

As a guide in the palpation of the ureter on the living subject in examining for stone, dilatation, or extravasation consequent upon rupture, the following landmarks are given by Tourneur (70) (cited from Tuffier) (73): The course of the abdominal portion of the ureter in the large pelvis corresponds to a vertical line erected upon a point at the junction of the internal and middle thirds of Poupart's ligament. Tourneur considers its direction vertical from the border of the kidney down to the small pelvis, over the brim of which it passes $4\frac{1}{2}$ cm. from the median line. The exact location of this point is the intersection of a horizontal line drawn between the anterior superior

iliac spines and a vertical line passing through the pubic spine. At this point, under favorable circumstances, a dilated or tender ureter may be felt by gentle steady pressure backward upon the abdominal wall until the resistant brim of the pelvis is reached.

The vesical portion of the ureter can be palpated in man through the rectum. Guyon (23) has called attention to the exquisite sensitiveness of this portion of the ureter upon rectal exploration in cases of stone, even when located high up. In woman vaginal examination permits the palpation of the ureter to an extent of two or even three inches, as it runs in the broad ligament in close relation to the upper wall of the vagina (Cabot).

Surgical Anatomy.

Access to the ureter, which is most often required for the removal of stones, is gained by two different routes; the trans-peritoneal and the extra-peritoneal.

By means of a median or lateral abdominal incision, the entire course of the ureter can be reached with comparative ease, but intra-peritoneal operations upon a ureter wherein the urine is not absolutely aseptic should not be undertaken if an extra-peritoneal operation is possible, on account of the danger of peritonitis. This is well illustrated by the trans-peritoneal uretero-lithotomy performed by Cullingworth (14), whose patient died from peritonitis.

On the other hand, abdominal examination for diagnostic purposes, to locate a stone or a para-ureteral urinary infiltration following rupture, has been of value when followed by extra-peritoneal operation, as evidenced in the cases of stone operated upon by Hall (26) and Arbuthnot Lane (41), and in the cases of rupture reported by Page (46) and Allingham (2).

Extra-peritoneal access to the ureter is technically much more difficult, because of the depth of the wound; but, as by it the danger of peritonitis is avoided, it is on the whole preferable. The upper two-thirds of the ureter, that is, the abdominal portion and the portion which extends over the brim of the pelvis, can be reached by a continuation of the ordinary oblique incision

for lumbar nephrotomy from the twelfth rib down along and one inch anterior to the ilium, and along Poupart's ligament to about its middle.

Cabot thinks that it would be possible in a very thin subject with lax abdominal walls or in children (Twynam) to gain access to the ureter down to within an inch or two of its entrance into the bladder by extra-peritoneal incision, but on account of the depth of the wound in this place, operation would be difficult.

The lower pelvic portion of the ureter can be reached by the sacral operation, an incision lateral to the sacrum, as proposed by Delbet (16) or better by Kraske's operation, or the osteoplastic resection of the sacrum as proposed by Cabot, who made investigations on the cadaver and found ample space for careful inspection and operation.

In women the pelvic portion of the ureter can be reached through the vagina. Ureteral fistulas opening into the cervix and vagina have been operated upon, and stones in this portion of the ureter have been removed by Emmet (19), when situated low down, close to the vesical orifice, and by Cabot when located higher up, in the broad ligament, close to the cervix uteri.

Injuries to the Ureter.

Accidental wounds, of which Tuffier found only five cases in the literature, three incised or punctured wounds, and two gunshot wounds, have not as yet been treated by direct ureteral surgery, as these cases date back to a time when such a procedure had not been thought of. If positive diagnosis can be made (and intermittent discharge of small quantities of urine at the time might make the diagnosis positive), and if the external wound is extra-peritoneal, there is no reason why the ureter should not be cut down upon, and the wound treated by one of the methods now at our disposal.

Subcutaneous wounds or ruptures of the ureter have been carefully studied by Herbert Page, who collected ten cases from the literature, to which he added one of his own. Five additional cases have been reported by Le Dentu (17) making six-

teen in all. In these cases the traumatism was caused either by a direct blow on the abdomen, such as the kick of a horse (Pye-Smith, Chaput), by a blow in the region of the kidney (Soller), by a blow from the handle of a wheelbarrow (Allingham), by being run over by a wagon (Page, Barker, Godlee, Bardenheuer), by traumatism from overstretching (my case), or by violent displacement of the kidney and pelvis whereby the ureter was ruptured in the upper portion (Le Dentu).

It is uncertain whether by these injuries the ureter is crushed against the transverse process of the first lumbar vertebra, as Tuffier thinks, or is so stretched from the kidney as to rupture in its upper portion, as in my case. Both methods are possible. The fact remains, however, that most of the ruptures are found above the small pelvis.

Early diagnosis is often difficult, if not impossible, because of the uncertainty of the symptoms. Slight transient hæmaturia, which might easily be overlooked, was noted in only three cases (Barker, Allingham and Page). Copious hæmaturia as reported in Hicks' case indicates rupture of the kidney rather than of the ureter. Hæmaturia may be entirely absent, as in Godlee's case.

If no injuries to other organs complicate the ureteral rupture there are no grave symptoms in the beginning.

The next important symptom, swelling from the accumulation of urine around the place of rupture, is not seen until some time after the receipt of the injury; seven days (Allingham); two weeks (Chaput), two to three weeks (Godlee, Page, Barker, Hicks), thirty-nine days (Croft), seven weeks (Stanley), or several weeks (Cabot). The swelling is usually accompanied by pain, is localized, round, oblong, or sausage-shaped, following the course of the canal, and is palpable from the abdomen.

The surgical treatment has never yet been directed in an early stage to the ureter itself, but has consisted in puncture, single (Joel), once repeated (Hicks), or five times repeated (Stanley), all of which were successful; or incision and drainage either through the abdominal cavity (Chaput, Page), or through the lumbar region (Allingham).

In most of the cases septic infection of the kidney took place through the resultant fistula, and secondary nephrectomy was necessary in order to save the patient's life (Godlee, Page, Barker, Chaput, and Bardenheuer). In other cases wherein the collection was not even opened and the patients survived, the kidney remaining, obliteration of the ureter (Haviland) or strictures ensued (Pye-Smith, Soller, and my case).

As before mentioned, suture of the ruptured ureter has not yet been attempted, but, as Page points out, it might possibly be done, although it will probably be difficult to find the rupture, and this so much the more, as an early diagnosis is rarely made. It is ordinarily not until some weeks later, when the swelling from urinary infiltration sets in, that operation is resorted to. Whether or not the ureter can be found in this cavity, which usually contains infected urine, and the rupture successfully dealt with, is as yet an open question.

Operations on the Ureters for Stone.

Stones in the ureter are most commonly arrested in the upper portion and with about equal frequency in the middle and vesical portions. They are removed by different methods, according to their location.

(*a*) *Removal through the bladder.* Stones have been removed by dilatation of the female urethra by Emmet, Berg(6), Richmond, Czerny, and Sänger; by suprapubic cystotomy in two cases (Tuffier). Ureteral stones often protrude into the bladder, and can be recognized by the sound. The mucous membrane covering them may have to be divided, but the stones are usually extracted without difficulty. The wound in the vesical end of the ureter is usually left open, but is sometimes sutured, as in the case reported by Berg. Stones in this location, so far as operative procedure is concerned, should be classed among stones in the bladder.

When the stones are located a little higher up, but not accessible from the bladder, they may be reached from the vagina or rectum by

(*b*) *Ureterotomy through the rectum.* Ceci (11) removed successfully a stone from the ureter by incision through the rectum.

(*c*) *Ureterotomy through the vagina.* Removal of stone by means of vaginal ureterotomy has been performed by Emmet and Cabot.

EMMET'S CASE (19). Female. Click having been elicited by the sound, ureteral stone was suspected. On backward pressure with larger sound stone could be felt through vagina and rectum. Stone cut down upon through vaginal wall by scissors. Opening enlarged forward toward the neck of the bladder, "this being the only safe direction to avoid entering the peritoneal cavity." Opening closed with interrupted sutures. Good recovery.

CABOT'S CASE (10). Woman, aged thirty-nine years. Attacks of renal colic for sixteen years; often followed by passage of stones. Left pyonephrosis felt as distinct tumor. Vaginal examination revealed a small, hard mass in the left broad ligament, close to cervix uteri. Sound in bladder could not be brought within half an inch of mass. Ureterotomy and removal of stone through the vagina. Evacuation of ten to twelve ounces of pus. Tumor in region of kidney disappeared. Uretero-vaginal fistula remained for four months with small amount of pus. The author concludes that the kidney was destroyed so far as secreting tissue is concerned.

(*d*) *Extra-peritoneal ureterotomy* has been performed in five cases by Twynam, Cabot, Ralfe and Goodlee, Kirkham and myself.

TWYNAM'S CASE (75). Boy, aged eight years. Left renal pain; hæmaturia. Laparotomy for diagnosis revealed stone in right ureter just below brim of pelvis. Laparotomy wound closed. Three weeks later extra-peritoneal incision in right iliac region. Ureterotomy, removal of stone, ureterorrhaphy, drainage; recovery. Long ends of sutures brought out of wound.

CABOT'S CASE (9). Man, aged forty years; seven or eight sharp attacks of pain referable to left side of abdomen above middle of Poupart's ligament. During three months before operation sensitive spot on back, midway between crest of ilium and twelfth

rib. Diagnosis, stone in ureter; lumbar incision, ureterotomy, removal of calculus two inches below kidney. Wound in ureter not sutured. Recovery.

RALFE AND GODLEE'S CASE (56). Woman, twenty-six years of age. Nephritic colic persistent on left side; lumbar nephrotomy; no stone in kidney. Exploration revealed stone in left ureter two inches below kidney. Longitudinal ureterotomy; removal of stone. Subsequent right renal colic; lumbar nephrotomy; no stone in kidney or ureter. Subsequent passage of gravel and small stone *per urethram*. Recovery.

KIRKHAM'S CASE (37). Man, aged fifty-eight years. Right renal colic, followed by pain on left side and anuria. Diagnosis, destruction of right kidney by previous attack. Left kidney now affected. Exploratory left lumbar incision. Palpation of kidney negative. Stone in ureter one-half inch above crossing of external iliac artery. Ureterotomy, removal of stone, no sutures; drainage. Recovery.

FENGER'S CASE (20). Man, aged thirty-five years. Increasing attacks of renal colic for two years; no hæmaturia; no tumor. Diagnosis, nephrolithiasis; lumbar nephrolithotomy; no stone in kidney. Palpation showed two stones in ureter, one and a half inches below kidney; longitudinal ureterotomy; no sutures. Recovery.

(*e*) *Intra-peritoneal ureterotomy* has been performed in two cases by Cullingworth and Arbuthnot Lane.

CULLINGWORTH'S CASE (14). Woman, aged thirty years; right renal colic. Vaginal examination showed hard masses to right and left of uterus. Diagnosis, right pyonephrosis and independent ovarian disease; laparotomy; right ureter dilated. Stone immediately above bladder; ureterotomy; removal of stone; escape of pus; ureterorrhaphy, with interrupted silk sutures; glass drain in abdomen. Death from peritonitis in eighty hours. Autopsy revealed right and left pyonephrosis. Sutures in ureter held.

ARBUTHNOT LANE'S CASE (41). Woman, aged twenty-three years. Left renal colic for twenty years; hæmaturia; pyuria; laparotomy; pelvis of left kidney dilated; no stone; ureteral

opening could not be found; eight months later laparotomy; stone in pelvic portion of ureter forced up to crest of ilium; abdominal ureterotomy; removal of stone; ureterorrhaphy with continuous silk suture. No leakage. Recovery.

Diagnosis as to the location of the stone was made before operation only in the cases in which the stone was afterward removed through the rectum or vagina (Ceci, Emmet, Cabot). When the stones are located higher up it is, as a rule, impossible to make a positive diagnosis. In the small pelvis, diagnosis may possibly be made by vaginal examination, but in Cullingworth's case he mistook the stones for diseased ovaries, and positive diagnosis was not made until the abdomen had been opened.

If the stone is located still higher up, diagnosis of location is well-nigh impossible. Cabot made the diagnosis of stone in the ureter, but could not locate it until after lumbar incision had been made.

The location of the stone in the ureter has not been determined until exploratory incision, either extra- or intra-peritoneal, has been made. When the stone has been found in this way, its removal has been accomplished either by pushing it up into the pelvis and extracting it through the opening in the pelvis or kidney, or by longitudinal ureterotomy.

It is often impossible to push the stone up into the pelvis, because of the local dilatation of the ureter—the nest, as Le Dentu calls it; but some operators, such as Israel, Von Bergmann in two cases, Hall, and Tuffier have succeeded in accomplishing this. I once tried unsuccessfully to push a stone into the pelvis by a needle passed through the wall of the ureter. I do not consider this procedure important if the ureter can be reached by an extra-peritoneal incision.

The difficulty in dislodging the stone is well illustrated in the case reported by Hall, who succeeded only by manipulations with one hand in the abdomen.

Hall's Case(26). Woman, aged thirty-six years, had had recurrent attacks of renal colic for four years. Pain in region of left kidney, which could be palpated between the hands. Ex-

amination caused no hæmaturia. No stone could be felt. Diagnosis: Stone in kidney or ureter. Dr. Hall was unwilling to make lumbar incision on uncertain diagnosis, and advised exploratory laparotomy. Examination under narcosis revealed a small tumor in region of left kidney; this was the dilated ureter above the stone. Abdominal section. Stone could now be felt about three inches below the kidney. Diagnosis, impacted stone in ureter. Lumbar incision for removal of stone. Stone difficult to dislodge; finally accomplished by hand in abdomen; incision on convex surface of kidney; invagination of sac consisting of dilated ureter and pelvis; extraction of stone. Recovery.

The dislodgment and removal of the stone was easy in the case reported by Tuffier.

Tuffier's Case (73). Renal colic for nine years, finally with constant pain. Right kidney enlarged. Nephrolithotomy. Examination revealed no stone. Examination of ureter showed hard, ovoid body 3 cm. long, located where ureter crossed the promontory. Stone movable; it was pushed up into pelvis of kidney. Incision of convex surface of kidney. Extraction of stone. Suture of kidney and lumbar wound. No drainage. Healing by first intention.

Longitudinal ureterotomy has thus been done in five cases through an extra-peritoneal incision, all of which were successful, and in two cases through the abdomen, one case being successful, and one patient died from peritonitis.

The treatment of the wound is different in the extra- and intra-peritoneal operations. In the intra-peritoneal operations the immediate absolute closure of the ureter is of vital necessity; as the urine above a stone is almost always infectious, the question of accurate suturing is one of great importance. In the extra-peritoneal operation, where the infected urine can be drained out effectually until the wound closes, the question of suturing is of little import. In his trans-peritoneal operation Arbuthnot Lane used a continuous silk suture with perfect success. In Cullingworth's intra-peritoneal operation he employed interrupted silk sutures, and post-mortem examination revealed no leakage from the wound in the ureter.

In an extra-peritoneal operation Twynam applied interrupted silk sutures, the long ends of which were brought out through the wound. As might be expected, these sutures did not hold.

In some of the extra-peritoneal operations no sutures were used, but drainage was employed, and the wound closed in Kirkham's case in forty days; in my case of stone, in a month; in my case of exploratory longitudinal ureterotomy in fifty days, and in Cabot's case the wound also closed without disturbance.

Whenever practicable, the stone should be removed through a lumbar incision rather than through the abdomen. Stones located low down in the small pelvis, which cannot be pushed up within the reach of an extra-peritoneal incision like that for ligation of the iliac artery, might be reached by a sacral operation, although no case of this kind is as yet on record.

Laparotomy for the purpose of diagnosing the location of the stone has been of value in several instances. In Arbuthnot Lane's case the stone was thus located after exploratory lumbar incision had failed. In this case, however, it might have been possible by opening the kidney or ureter and exploring from above, to locate the stone through the lumbar incision. In Hall's case the stone was located through a median abdominal incision, and removed through a lumbar incision into the kidney. As in this case it had already been determined which ureter was the seat of the stone, the laparotomy might have been omitted.

In Twynam's case, however, the exploratory laparotomy was absolutely necessary, since the symptoms pointed to stone in the left ureter which was healthy, while the stone was found in the right ureter and was removed three weeks later by an extra-peritoneal ureterotomy.

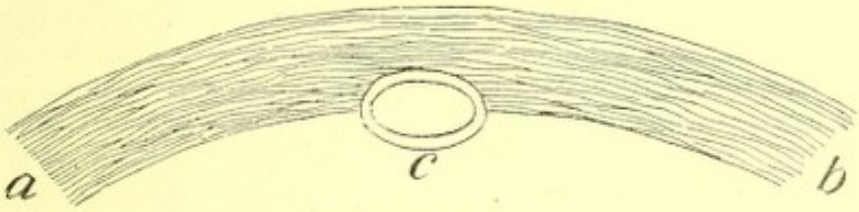
Operations for the Relief of Valve-Formation.

As valve-formation always causes an intermittent or a permanent impediment to the flow of urine, the pelvis of the kidney is in a state of hydro- or pyonephrosis. The so-called sac is accessible through the peritoneal cavity or by an extra-peritoneal operation through the lumbar region. The first attempt

after Simon's (67) to operate on the valve was made in 1890 by Trendelenburg (71), who opened the anterior wall of a large hydronephrotic sac by lateral laparotomy, saw the ureteral opening on the side of the sac, divided the ureter down to the lower part of the sac, to the inner wall of which he sutured the divided borders of the ureter. The ureteral opening was thus displaced from the side to the bottom of the sac, in order to keep the ureter patent. The result of this operation is uncertain, as the patient died from ileus.

In 1891, Küster (39) in his celebrated case of resection of the ureter and implantation of the distal end into the pelvis, opened the hydronephrotic sac from the lumbar region, found the ureteral opening and divided it through its course in the sac wall, with the intention of stitching the divided border to the inner wall of the sac as Trendelenburg had done (see Figs. 1 and 2). Before finishing this operation, however, he explored

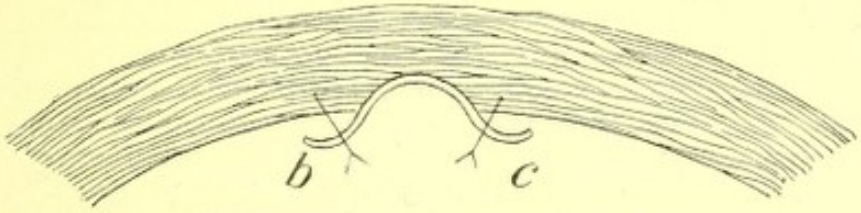
FIG. 1.



(Same as Trendelenburg's.)

a, *b*. Wall of sac. *c*. Transverse section of ureter.

FIG. 2.



FIGS. 1, 2. KÜSTER'S INTENDED OPERATION ON THE VALVE.

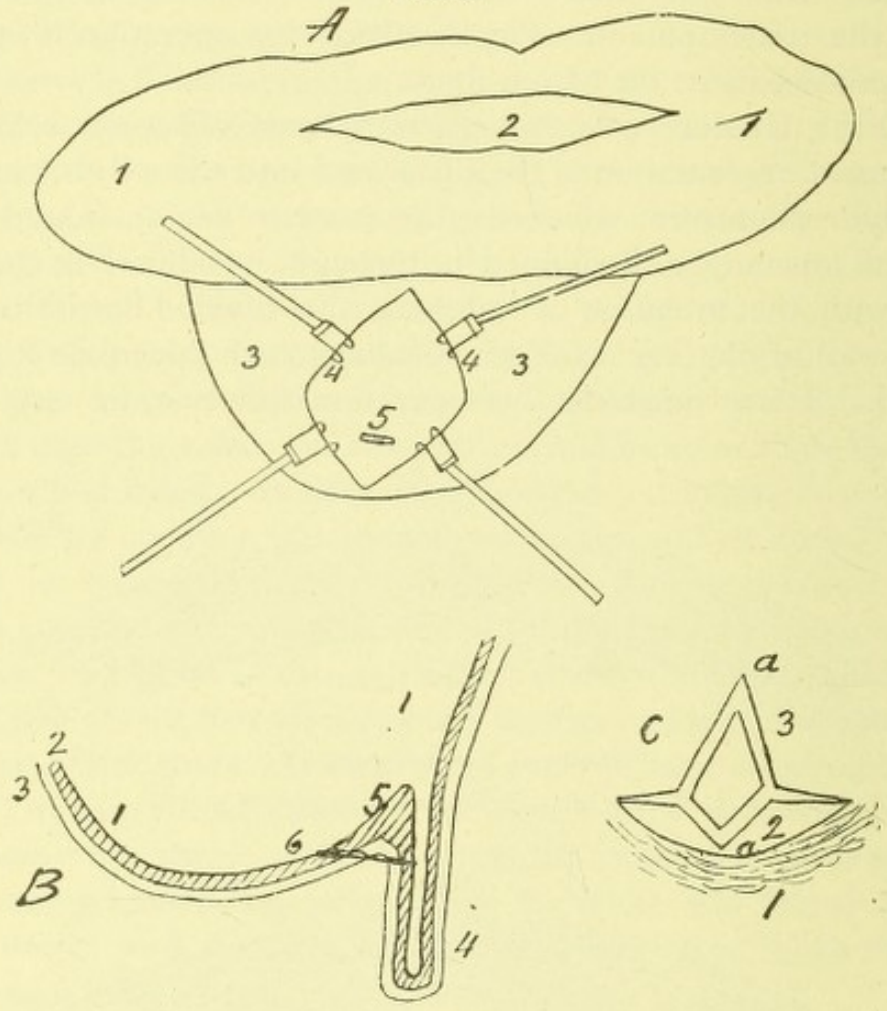
b. *c*. The ureter divided on its anterior surface. Near *b* and *c* are sutures uniting the borders of the divided ureter and the walls of the sac.

the ureter and found a stricture which caused him to abandon the operation for valve-formation and to resect the stricture.

The third, and first successful, attempt at operating for valve-formation was made by me on May 31, 1892 (21).

FENGER'S CASE. Woman, aged twenty-eight years. Valvular stricture or stenosis of pelvic orifice of ureter in a somewhat floating kidney. Intermittent hydronephrosis for eight years with

FIG. 3.



ILLUSTRATING OPERATION FOR VALVE-FORMATION.

A. Kidney and dilated pelvis. 1, kidney; 2, opening on its convex surface after nephrotomy; 3, dilated pelvis; 4, with opening on its posterior surface from pelviotomy; 5, opening of the ureter into the pelvis—a small transverse crescent-shaped slit.

B. Dilated pelvis and ureter, showing valve-formation. 1, pelvis; 2, mucous membrane; 3, muscular and external coat; 4, ureter; 5, valve; 6, line of the incision dividing valve.

C. Valve seen from the pelvis and divided, to illustrate the plastic operation. 1, Inner wall of pelvis above the ureteral opening; 2, ureteral opening; 3, the divided valve; *a* and *a'* the corners of incision, to be united by a suture.

more and more frequently recurring attacks, until one a week. Nephrotomy between attacks. No stone could be found in the pelvis. Pelvic orifice of ureter could not be found through the opening in the kidney. Incision of pelvis, whereupon valvular opening of ureter could be seen. Plastic operation on valve; bougie left in ureter for two days; pelvic wound sutured; fixation of floating kidney; recovery without fistula. (Fig. 3.)

The second successful operation was performed on August 14, 1893, by Herman Mynter, of Buffalo.

MYNTER'S CASE (42). Man, aged twenty-five years. Valvular stricture of pelvic orifice of ureter, intermittent hydronephrosis for twelve years. Periodical attacks of pain every two or three months in right lumbar region. Diagnosis, right renal calculus producing occlusion of ureter. Exploratory nephrotomy. No stone found. Ureter permeable with valve-formation at pelvic orifice. Plastic operation on valve. Gauze drain. Recovery without fistula.

The operation for valve-formation can be best done by the extra-peritoneal lumbar incision. The dilated pelvis or hydronephrotic sac is easily found and opened by a longitudinal incision. The opening of the ureter into the sac should be looked for, but cannot always be found, as in some cases it is very narrow. In such cases it may be located by incising the ureter below the sac and passing a probe upward toward the pelvis. The valve or inner wall of the ureter running in the sac is now divided longitudinally from the opening in the sac and the resultant wound treated in one of the three following ways:

(*a*) By turning the flaps out and uniting them to the inner walls of the sac by sutures (Trendelenburg, Küster).

(*b*) By drawing the corners of the longitudinal incision together with one suture, transforming the longitudinal into a transverse wound as in my operation, or

(*c*) By uniting the wound longitudinally with numerous fine silk sutures, "taking in the two outer coats of the ureter and sac and avoiding the mucous membrane" (Mynter).

Compression of the Ureter for Diagnosis of Kidney Affections.

This has been done in order to collect urine from each ureter separately. It has been attempted from the rectum by Weir (79) and Sands (62). Tuchmann (72) has compressed the ureter from the bladder by an instrument resembling a lithotrite, between the jaws of which the ureter was caught. Silbermann (66) attempted to compress the ureter from the bladder by a balloon which, after introduction, was filled with mercury and was expected in this manner to make compression. All these attempts were, however, abandoned and gave way to catheterization.

Catheterization of the Ureter.

Catheterization of the ureter has reached a state of practical usefulness, as indicated by Simon (67), only in women, on account of the ease of access to the vesical opening of the ureter in the female. Pawlik (48) was the first to put this procedure in extensive practice. He has employed it since 1881. Pawlik was followed by Newman (44), and the method has now been made reasonably practical, chiefly through the arduous work of Howard Kelly (34), who introduces a Pawlik catheter through Simon's speculum guided by a head mirror.

Strictures of the ureter and accumulations of urine above strictures have been successfully treated in this way by Pawlik and Kelly.

Kelly (35) made a diagnosis of stricture low down in the left ureter by catheterization. The patient was catheterized about six times at intervals of ten to twelve days, each catheterization being followed by marked exacerbation of the pain for a few days. The consequence, however, of the repeated catheterization was marked relief for several months. The symptoms finally returned, the ureter was opened from the vagina and a small calculus removed from the ureteral orifice.

Pawlik (48) mentions a case of pyonephrosis from Billroth's

clinic, in which he introduced through the ureter from the bladder a long elastic catheter with a metal point, which passed through a stenosis of the ureter up into a cavity above. The patient had an abdominal fistula, the result of a previous nephrotomy, and a probe passed through this fistula would touch the metal tip of the ureteral catheter. On attempting to withdraw the catheter the tip was caught in the stenosis and broken off, and Dr. Von Hacker removed it through the abdominal fistula.

Pawlik (49), cited by Albarran and Lluria (1), reports two cases of pyonephrosis in which this method was employed. In one case cure was effected after thirty successive soundings of the ureter; in the other, the ureter was impermeable and nephrotomy had to be made.

The treatment of tuberculosis of the bladder has been assisted by permanent catheterization of the ureters by Guyon (24), cited by Albarran and Lluria (1), who burned the tuberculous ulcers with the Paquelin cautery, packed with iodoform gauze, and was able to leave the ureteral catheters in for nine days.

As regards leaving the catheter permanently in the ureter, Pawlik mentions a case of uretero-vaginal fistula in which a catheter was left in for seven days. Force was required to remove it, and it was found to be incrusted with salts.

Weil (78) in a case of uretero-vaginal fistula caused by a pessary, was enabled to stop the flow of urine by leaving a tube in the ureter for six days, when pain in the region of the kidney necessitated its removal.

A catheter left in the ureter for some time is apt to cause inflammation of the ureter just as we find permanent urethral catheterization followed by inflammation of the urethra.

Poirier (53) cautions against leaving a catheter in the ureter. He mentions a case of Segond's of exstrophy of the bladder wherein catheterization caused pyelonephritis, and a case of his own in the service of Tillaux, in which thirty-six hours after catheterization of the ureter, obstruction occurred, which caused an attack of renal colic. He also cited the experience of Sinitzin, who was never able to allow a sound to remain for more than four

hours, and concludes that the harmlessness of the procedure is not altogether beyond question.

Catheterization of the ureters in man is difficult and uncertain of accomplishment. Perez (51) concludes that it is of no importance as it can be done only by epicystotomy. Poirier (52), however, has succeeded in introducing a catheter with the aid of the Nitze-Leiter cystoscope; but other attempts in this direction have not as yet brought practical results. It cannot be denied that catheterization through epicystotomy possesses some practical value. In one instance catheterization of the ureter to the healthy kidney in a case of left pyonephrosis in which granular casts were found in the urine, deterred Iversen (30) from performing nephrectomy.

Keen (33), in a case of hæmaturia and suspected tumor of the bladder, made an epicystotomy, but found no tumor. As he was unable to determine from which of the ureteral openings bloody urine was evacuated, he introduced a catheter through each ureter and collected the urine separately, as a result of which he ascertained that the hemorrhage was from the left kidney.

It is to be hoped that by means of the cystoscope or in some other way, catherization of the ureter in man may be made more practical.

Operations for Stricture of the Ureter.

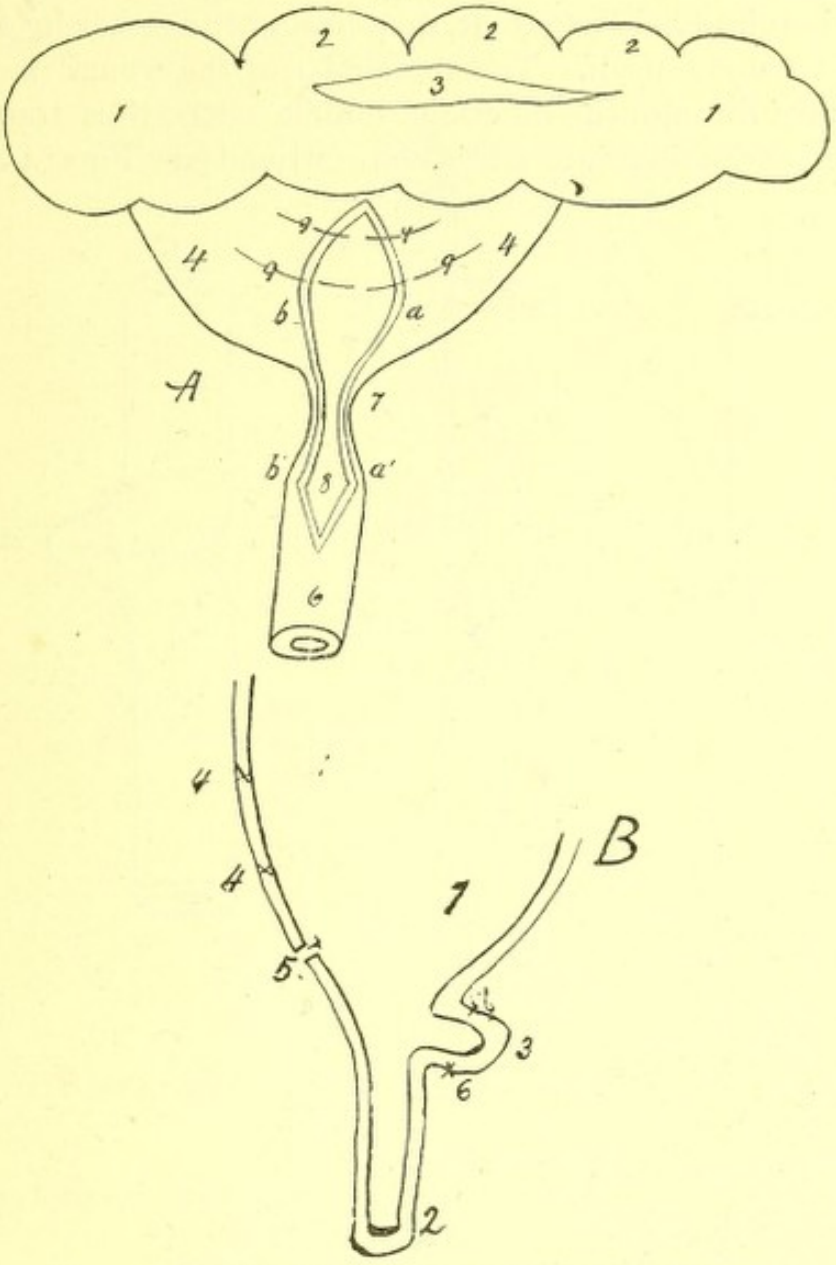
It is probable that only strictures situated in the upper abdominal portion of the ureter are accessible for operative interference. Such strictures have been dealt with in three ways.

(*a*) *Dilatation by bougie*, as reported by Alsberg.

Alsberg's Case (3). Lumbar nephrotomy in a case of left hydronephrosis. For ten days all urine passed through fistula, from which it was concluded that the other kidney was defective in function. Ureter successfully dilated from wound by thin bougies. After several days urine passed through bladder. Some months later fistula closed. Hydronephrosis did not reappear.

(*b*) *Longitudinal incision* as practised by me. When the stricture is not too extensive it is divided longitudinally after

FIG. 4.



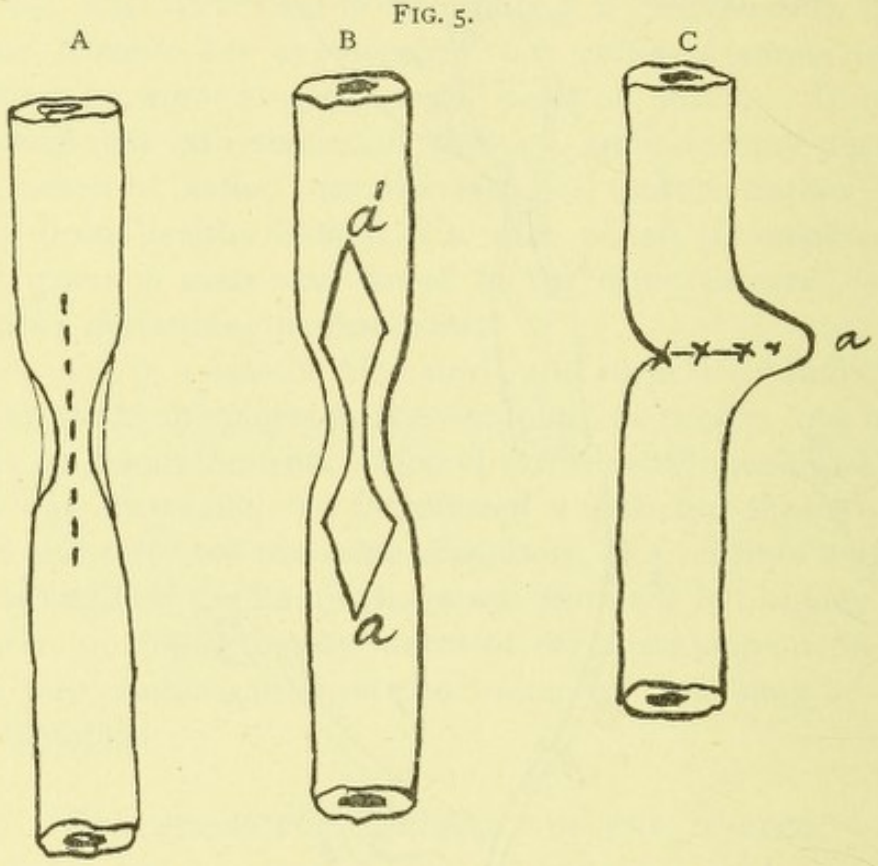
ILLUSTRATING OPERATION FOR STRICTURE OF URETER.

A. Sacculated kidney, dilated pelvis, ureter with stricture at its upper end. 1, kidney; 2, sacs corresponding to dilated calices; 3, nephrotomy; 4, dilated pelvis; 5, opening in posterior surface of pelvis, pelviotomy wound; 6, ureter below stricture; 7, stricture in upper end of ureter; 8, opening in ureter below stricture, extending up through the stricture into the pelvis; 9, sutures closing the upper half of the wound in the pelvis; *a*, *a'* and *b*, *b'*, points of incision in ureter and pelvis to be united by sutures after folding the ureter upon itself at the place of stricture.

B. Pelvis and ureter after union by sutures. 1, pelvis; 2, ureter; 3, fold of ureter at place of stricture; 4, sutures of wound in pelvis; 5, place of sutures between points *a*, *a'* and *b* and *b'*; 6, additional sutures, as many as needed, to close the borders of the fold formed by approximation o *a* to *a'* and *b* to *b'*.

opening the ureter above or below. The upper and lower ends of the longitudinal wound are then brought together by folding the ureter upon itself. The remainder of the wound is united by sutures through the outer and middle coats, thus transforming the longitudinal into a transverse wound (see Figs. 4 and 5).

FIG. 5.



MY PLAN OF OPERATING FOR URETERAL STRICTURE ON EXTRA-PERITONEAL SURFACE OF URETER.

A. Ureter showing stricture and line of incision.

B. Opening through the stricture extending into the proximal and distal portions of the ureter. The extreme ends of the incision *a* and *a'* to be united.

C. Ureter after suturing; *a*, the bend at the site of the stricture.

FENGER'S CASE (21). Traumatic stricture of ureter close to entrance into pelvis of kidney, intermittent pyonephrosis for twenty-four years; increased frequency of attacks. Nephrotomy; no stone in sacculated kidney; ureteral entrance could not be found. Longitudinal ureterotomy revealed stricture at upper end of ureter; longitudinal division of stricture, and plastic operation on ureter. Recovery without fistula.

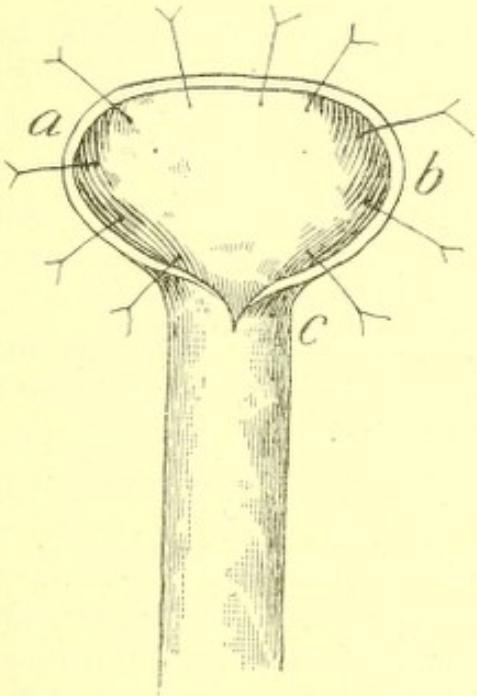
(*c*) *Resection of the ureter and implantation of the distal end*

into the pelvis, as practised by Küster in the following case (see Figs. 6 and 7):

FIG. 6.

a. Upper end of ureter (*a*, *b*) running in the wall of the sac.
c. Slit in upper end of ureter.

FIG. 7.



KÜSTER'S OPERATION FOR IMPLANTATION OF THE URETER INTO THE SAC (PELVIS).
The divided end of the ureter unfolded and in the extent of *a*, *b*, *c* sutured to the wall of the sac.

KÜSTER'S CASE (39). Boy, aged eleven years. Two years previously, left hydronephrosis. Braun made lumbar nephrotomy, which was followed by vesical anuria and lumbar fistula. Two years later dilatation of fistula and digital exploration of dilated pelvis. Catheterization of ureter from pelvis impossible. Septic pyelitis followed operation. Two months later patency of ureter secured in following manner: lumbar extra-peritoneal incision; ureter could not be found; incision of dilated pelvis revealed the ureter. On attempting to introduce probe into ureter, stricture was encountered. Transverse division of ureter below stricture and at pelvic entrance. Union of ureter to pelvis by dividing upper end of ureter, unfolding divided end and suturing it to opening in sac. Remainder of wound closed by catgut sutures. Urine passed through fistula for four months, when fistula was closed. Recovery.

WOUNDS OF THE URETER.

(*a*) *Longitudinal wounds of the ureter* have already been considered in the discussion of the operations for stone. An intra-peritoneal longitudinal wound should be carefully united with extra-mucous sutures. In addition to the suture Van Hook (77) makes a suggestion which appears valuable in cases where the incised ureter is covered with peritoneum; namely, to slide a fold of peritoneum from both sides over the sutured wound and unite the peritoneum over it. If no peritoneum can be used, an omental graft may be employed.

(*b*) *Transverse wounds of the ureter* are much more difficult to treat satisfactorily, as there is a tendency to retraction and gaping of the wound, and as, if direct suturing is resorted to, there is always a tendency to stenosis even if the sutures do not tear out.

Van Hook proposes in incomplete transverse wounds to transform the transverse into a rhomboid-shaped longitudinal wound by opening longitudinally upward and downward from the transverse wound and cutting off the four corners, thus creating a condition similar to that produced when a stricture of the

ureter is opened longitudinally. The rhomboid wound may then be united transversely by folding the ureter upon itself in the manner proposed by me in the operation for stricture.

This operation will probably be safe in extra-peritoneal wounds. If, however, the wound opens into the peritoneal cavity it is not certain that covering with a fold of peritoneum would be sufficient. It might be safer to divide the ureter completely and then resort to Van Hook's method of lateral implantation. The first method has not yet been tried for intra-peritoneal wounds; the latter has been tried with good results.

Attempts to unite complete transverse wounds of the ureter have, as a rule, failed in experiments upon animals and in operations on the human subject. In Tuffier's (74) experiments on dogs, death from peritonitis usually followed, and when union took place there was so much cicatricial constriction as to cause stenosis.

In the only case in which direct union has been attempted in the human subject the result was also unsatisfactory. This case was reported by Schopf (64).

SCHOPF'S CASE. During laparotomy for the extirpation of an intra-ligamentous ovarian cyst he divided the ureter near the brim of the pelvis. Having secured the divided ends by artery forceps, he united the ureter by eight silk sutures, which did not pass through the mucosa, and which probably invaginated the borders of the transverse wound. The patient made an uneventful recovery, but died seven weeks later from tuberculosis. The autopsy showed that the right ureter, at the place where it crosses the psoas muscle, was imbedded in cicatricial tissue, and a cicatrix existed in the entire circumference of union.

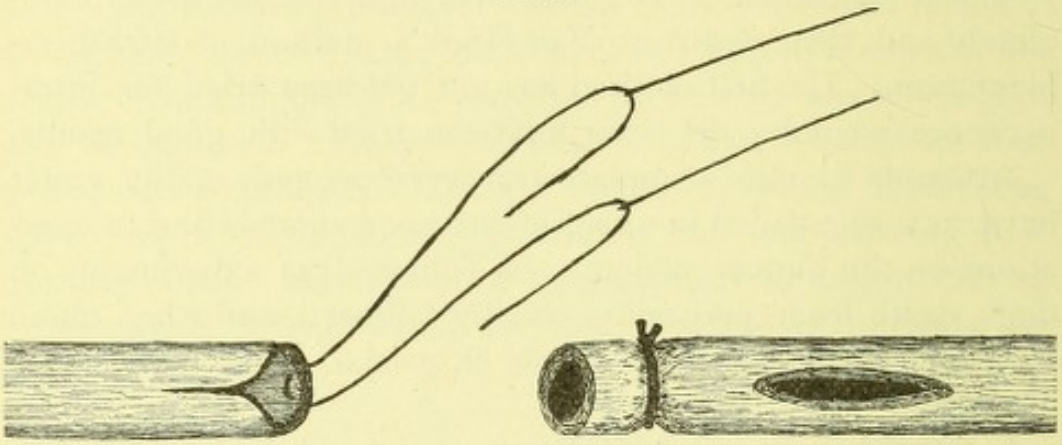
The operator was dissatisfied with this result, and proposes in the next case to unite the transverse wound over a ureteral catheter brought out through the urethra and left in place during the healing of the wound, to prevent leakage and also stenosis.

Van Hook's method of invagination or uretero-ureterostomy, as Kelly calls it, is an important step forward in this direction, as it has proven on animals and on man sufficient to prevent

leakage, and also stenosis (see Figs. 8, 9, and 10). His method is as follows:

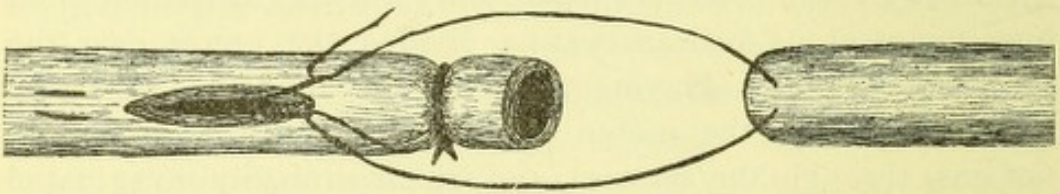
1. Ligate the lower portion of the tube one-eighth or one-fourth of an inch from the free end. Silk or catgut may be used Make with fine, sharp-pointed scissors a longitudinal

FIG. 8.



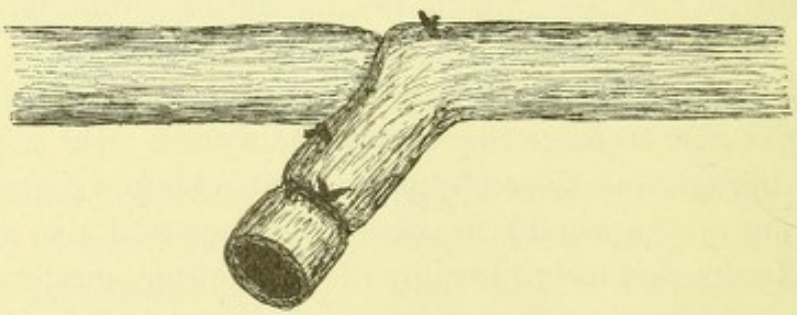
The needles have been introduced into the wall of the renal portion of the ureter. The end of the vesical portion of the tube has been ligated, and a slit made in its wall.

FIG. 9.



The needles carrying the traction suture attached to the renal portion of the ureter have been passed into the slit in the wall of the vesical portion, carried down a short distance, and pushed out through the wall.

FIG. 10.



URETERO-URETEROSTOMY (VAN HOOK'S METHOD).

By means of the traction suture the renal portion of the ureter has been implanted into the vesical portion. The ends of the traction suture have been tied together.

incision twice as long as the diameter of the ureter in the wall of the lower end, one-fourth of an inch below the ligature.

2. Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up one-fourth of an inch. This incision insures the patency of the tube.

3. Pass two very small cambric sewing needles armed with one thread of sterilized catgut through the wall of the upper end of the ureter one-eighth of an inch from the extremity, from within outward, the needles being from one-sixteenth to one-eighth of an inch apart, and equidistant from the end of the duct. It will be seen that the loop of the catgut between the needles firmly grasps the upper end of the ureter.

4. These needles are now carried through the slit in the side of the lower end of the ureter into and down the tube for one-half an inch, where they are pushed through the wall of the duct side by side.

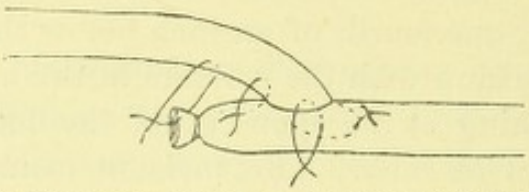
5. It will now be seen that the traction upon this catgut loop passing through the wall of the ureter will draw the upper fragment of the duct into the lower portion. This being done, the ends of the loop are tied together securely, and as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

6. The ureter is now enveloped carefully with peritoneum, as already described in other operations, provided an intra-peritoneal operation has been done.

Bloodgood (7) has repeated Van Hook's experiments with equally satisfactory results. In addition to Van Hook's procedure, Bloodgood applied two sutures through the external coats only, as an additional security against leakage. His drawing of the united ureter (see Figs. 11 and 12) shows not only no narrowing of the calibre at the point of union, but even a little diverticulum of the canal.

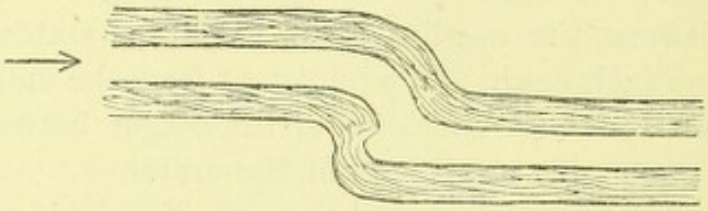
A most important and interesting proof of the value of this method has been furnished by Kelly (36) in the first operation of this kind on the human subject. This important case was the following :

FIG. 11.



BLOODGOOD: URETERO-URETERAL ANASTOMOSIS (EXPERIMENTAL). Ureter anastomosed, traction sutures tied, and two fixation sutures in place ready to be tied.

FIG. 12.



Longitudinal section of ureter showing new lumen and diverticulum.

KELLY'S CASE. Woman, aged twenty-five years. During hystero-myomectomy the right ureter was accidentally ligated and transversely divided. Uretero-ureteral anastomosis by ligating lower end close to cut surface and making a slit 1 cm. long in its anterior wall one-half cm. below ligature. Invagination of upper into lower portion of ureter. Edges of slit sutured to the intussuscepted ureter; iodoform gauze drainage. Patient passed urine voluntarily on second day. Union by first intention. Recovery.

DIVISION OF URETER WITH LOSS OF SUBSTANCE.

Division of ureter with loss of substance so considerable as to make reunion of the two ends impossible requires different operative procedures, namely, implantation into the bladder, into the bowel, or upon the skin.

(*a*) *Implantation of ureter into the bladder.* When the upper end of the divided ureter is long enough to reach the bladder, implantation into this organ is preferable to all other procedures, as the danger of subsequent infection of the ureter and kidney is thereby avoided.

The experiments of Paoli and Busachi (47) in 1888 upon dogs were successful. Their method consisted in splitting the distal end of the ureter and uniting it by sutures to an incision in the bladder.

1. *Extra-peritoneal implantation of the ureter into the bladder* has been made in one case by Baumm (5). The patient had a double ureter on the right side, one ending at the mouth of the urethra, and causing partial incontinence of urine. Baumm made a suprapubic operation, cut an opening through the bottom of the bladder, and connected it with the proximal end of the accessory ureter, the distal end of which was ligated. The author himself does not recommend this operation, which he chose because the patient was a virgin, as he considers it under ordinary circumstances unnecessarily severe. He considers the operation through the vagina preferable.

2. *Intra-peritoneal implantation of ureter into bladder.* In February, 1893, Novaro (45) operated successfully by the Paoli-Busachi method in the following case:

NOVARO'S CASE. The patient had had vaginal hysterectomy performed for carcinoma extending into the broad ligament. The operation was followed by uretero-vaginal fistula. Two months later laparotomy in Trendelenburg's position was made, the ureter dissected out from the vagina, divided for 1 cm, unfolded and united by sutures to an incision in the bladder 1½ cm. long, situated two fingerbreadths above the normal point of insertion. Gauze drainage out through the abdominal wound. For several days the gauze was impregnated with urine, showing leakage at the point of union. This was only temporary, however, and ten days after the operation the function of the urinary organs was normal and so remained.

In the two following cases of implantation into the bladder, the operators acted upon Van Hook's suggestion of uretero-ureterostomy, and the effect of the operation in each case was complete, as undoubtedly no leakage of urine took place:

KRUG'S CASE (38) (kindly communicated to me by Dr. Krug). "The case was operated on in Philadelphia. The patient was a colored woman about thirty years of age, who had suffered from a fibroid for over six years. During most of this time she had been subjected to electrical treatment. When I saw her on the morning of the operation I found her very much emaciated, with a poor pulse. The tumor filled the entire pelvis and

extended to about the umbilicus. On opening the abdomen universal adhesions were found. After having removed the greater part of the omentum, I commenced by tying off the tube and ovary on the left side. The next ligature was placed around the round ligament and the excess of the broad ligament on that side. Although I expected to meet with some difficulty in shelling out the tumor, which was entirely intra-ligamentous, and, therefore, paid particular attention to the ureter, I found that in cutting off the round ligament I had cut off the left ureter in front of the tumor. The tumor had evidently grown intra-ligamentous, unfolding the two sheets of the broad ligament, lifting up the ureter, and the injury was done at a place where I felt absolutely secure. Putting clamp forceps on the proximal and distal ends respectively, I finished the operation, which was an extremely difficult one. Finding, then, that I could reach the bladder without putting too much tension on the proximal end of the ureter, I decided to graft the ureter into the bladder. An incision being made into the bladder, the ureter was treated in a manner similar to that employed by Dr. Van Hook in invaginating the cut ends of the ureter. In sewing up the incision in the bladder, care was taken to prevent leakage without constricting the lumen of the ureter. Several tiers of running sutures were made, and all the available peritoneum used to build up a solid wall around the ureter. A permanent catheter was introduced into the bladder, which remained for four days. For two days more the patient was catheterized every four hours. A normal amount of urine was passed right after the operation. There was no rise of temperature, nor any other untoward symptom. The patient left the hospital about four weeks after the operation; she is now doing hard work and feeling splendidly."

Penrose's Case (50). Woman, aged forty years. Serious carcinoma of cervix uteri involving left broad ligament and about one inch of ureter involved therein. No obstruction of ureter. After removal of uterus, excision of one inch of ureter, distal end of ureter was ligated, and proximal portion implanted

into the bladder after Van Hook's method. Abdomen closed without drainage. Good recovery.

The perfect success of this operation in these cases would seem to indicate that Paoli and Busachi may be right in proposing the application of this operation to uretero-uterine and uretero-vaginal fistulas. If this operation is as safe and certain as the above cases indicate, and if the future function of the implanted ureter remains undisturbed, this method would seem to be superior to the older plastic operations through the vagina, which are difficult in technique, uncertain in results, and sometimes fail entirely.

Operations for uretero-uterine and uretero-vaginal fistulas. The prevention of the incontinence of urine caused by these infirmities is accomplished in three ways:

(*a*) Plastic operations with a view to displace the fistula from the vagina or cervix into the bladder.

(*b*) Kolpokleisis.

(*c*) Nephrectomy, the operation of last resort.

(*a*) *The plastic operations* known by the names of their originators—Simon, Landau, Bandl, Schede, and Pozzi—who have brought them to their present state of perfection, I shall not detail here, but merely recall the main steps in the development of the operations.

Simon (68), through a vesico-vaginal fistula, artificial if not pre-existent, opened the proximal end of the ureter from the bladder for some distance, cauterized the divided borders until cicatrization had taken place, thus securing against reclosure, and finally closed the vesico-vaginal fistula.

Landau (40) passed a catheter into the ureter through the vesico-vaginal fistula, bringing the distal end of the catheter out through the urethra, and by immediately closing the vesico-vaginal fistula invaginated the opening of the ureter into the bladder.

Bandl (4) employed a combination of the methods of Simon and Landau.

Schede (63) inverted the ureteral opening into the bladder,

together with a zone of the surrounding mucous membrane, with the intention of preventing subsequent cicatricial stenosis.

Pozzi (55) employed with advantage a method by splitting similar to that devised by Gerdy for vesico-vaginal fistula.

These plastic operations are often difficult in technique, repeated attempts at closure have frequently to be made, and in some cases inflammation of the ureters and kidneys has resulted. The operations on uretero-uterine and uretero-cervical fistulas are especially difficult. The operations are, however, rather more taxing to the patience of the operator and patient than dangerous to life. They have always been attempted before the indirect methods of obliteration have been resorted to.

(*b*) *Kolpokleisis*, proposed by Vidal du Cassis and Simon, and first practised by Hahn (25), consists in closure of the vagina on the distal side of a vesico-vaginal fistula, and possesses the disadvantage that the latter may contract and that marital relations are made impossible, excepting in the cases wherein partial kolpokleisis as devised by Kaltenbach (32) can be made.

(*c*) *Nephrectomy*, the operation of last resort, really means the abandonment of the struggle with the fistula. It has been necessitated in some instances by infection of the kidney, and although not very fatal, as in fourteen cases on record only one patient died, it is applicable only to cases where the other kidney is healthy.

The operative results as collected by Nebe (43) in 1890, and Iversen (31) in 1892, were as follows: Of fourteen uretero-uterine and uretero-cervical fistulas, all following childbirth, eight were operated upon; one with hysterokleisis (Duclout); one kolpokleisis (Hahn), both relatively successful. The remaining six cases (Zweifel, Crede, Fritsch, Netzel, Traub, and Iversen) were unsuccessful and nephrectomy had to be made. It will thus be seen that direct displacement of the ureter into the bladder was not found applicable to this class of cases.

Of uretero-vaginal fistulas 32 cases were collected by Nebe, 5 by Iversen, 1 by Arie Geyl, 1 by Pozzi, and 1 by Hergott (cited by Pozzi)—a total of 40 cases, of which 10 were secondary to operations or pelvic abscesses, 28 followed childbirth, and in 2

the cause was unknown. Of these 40, 24 were operated upon as follows: Plastic invagination into the bladder through the vagina was successful in 10 cases (Bandl 2, Lannelongue, Geyl, Parvin, Schede, Solowjeff, Schauta, Pozzi, and Hergott), kolpokleisis was performed in 5 cases (Gusserow 2, Kehrer, Schede, and Kaltenbach, partial), and nephrectomy in 5 cases (Schede, Gusserow, Czerny, Heilbrunn, and Fritsch). In the remaining 4 cases attempts at operating were abandoned as unsuccessful.

In the 10 cases which did not follow childbirth, 5 followed vaginal hysterectomy, 3 pelvic abscess, and 2 operation on vesico-vaginal fistula. 2 were cured by direct closure (Nicoladoni, Emmet), 3 by kolpokleisis (Kaltenbach 2, Hempel), in 3 nephrectomy was performed (Stark, Böckel, Bardenheuer, whose patient died), the remaining 2 cases, both following pelvic abscess (Emmet), were not operated upon.

It will thus be seen that in 34 cases of ureteral fistula, this condition was remedied by plastic operations in 11 cases, by kolpokleisis in 7, hysterokleisis in 1, and nephrectomy in 15.

Taking into consideration the fact that in almost all, if not all, the cases the kidney in question was healthy from the beginning, it seems to be a reproach against our present methods of treatment that in 44 per cent. the kidney should have been sacrificed.

A pyelonephritis in its early stage is amenable to cure, as has been shown experimentally by Rovsing (60), and Geyl (22) may be right in calling attention to the possibility that a non-advanced stage of pyelonephritis may disappear when the distal end of the ureter is implanted into the bladder.

The successful implantations of the ureter into the bladder by Novaro, Krug, Penrose, and Baumm lead us to believe it possible in these cases to save the kidneys, which would otherwise be sacrificed.

The congenital abnormal opening of the end of the ureter outside of the bladder, in the urethra or the vagina, causing partial incontinence of urine, is naturally treated in the same way as uretero-vaginal fistulas, either by vaginal, suprapubic or abdominal implantation into the bladder.

The vaginal implantation, as probably the safest method, was chosen by Davenport (15) in the following case:

DAVENPORT'S CASE. Woman, aged twenty-nine years; incontinence of urine from early childhood, due to malposition of the ureter. Incontinence increased by menstruation and pregnancy. One ureter was found in the vesico-vaginal septum running forward, its orifice being close to the external orifice of the urethra. Operation for displacement of ureter and implantation of its orifice into the bladder. Recovery.

Bois (d'Auvillac) (8) reports the following case:

BOIS' CASE. Congenital incontinence of urine, although the bladder acted regularly. Fine canal in left wall of urethra from which urine continually dribbled. A probe at this point passed into the left ureter. Operation; division with tenotome of wall between ureter and bladder, and opening kept open by bougies. The closure of the peripheral end of ureter was postponed on account of pregnancy.

(*b*) *Implantation of the ureter into the bowel.* Implantation into the small intestine, colon, and rectum has been studied experimentally by Rosenberg, Novaro, Morestin, Tuffier, Gluck and Zeller, Harvey Reed, Van Hook, and others. The technical difficulties of this procedure have been fairly well overcome, but there seems to be a serious objection to this plan of implantation on account of the liability to infection of the ureter and kidney by intestinal microbes, and also because of some tendency to constriction at the place of implantation. Van Hook found both these conditions present as early as ten days after the operation. Reed (57) found acute nephritis in one dog killed twenty-four hours after the operation, but in another similar case the kidney was apparently healthy.

In man the implantation suggested by Roux was tried unsuccessfully by Simon, but successfully, according to Rosenberg (59), by Chaput in two cases. Chaput (12) has recently published the following case:

CHAPUT'S CASE. In a case of uretero-vaginal fistula following vaginal extirpation of the uterus he implanted the ureter into the colon. He made a laparotomy, divided the peritoneum on

the posterior wall, isolated the ureter, divided it transversely, and fixed its renal end into the colon by a double row of step sutures. The vesical end of the ureter was ligated. The patient recovered, and was well satisfied with her condition. She was obliged to void mixed urine and feces three or four times a day. Five months after the operation there were no signs of infection of the kidney.

Van Hook condemns the operation very strongly on account of the liability to infection, and he is undoubtedly right. The bowel, therefore, should never be chosen when it is possible to implant the ureter into the bladder. If this be impossible on account of defect in the ureter, it is still an open question whether or not implantation into the colon should be tried before resorting to implantation on the skin in the lumbar region or the abdominal wall, or nephrectomy.

(*c*) *Implantation of the ureter on the skin.* Le Dentu (18) was the first to implant the ureter on the skin for anuria in a case of absolute impermeability from cancer in the small pelvis. The symptoms were relieved, but the patient died thirteen days later from cancerous cachexia. This case, however, established the operation as an effective procedure to be employed in combating anuria due to incurable mechanical causes, as it at least prolonged life.

Pozzi (54), in the removal of a retro-peritoneal parovarian cyst by laparotomy divided the ureter at about its middle. The upper end was dissected out for 5 or 6 cm., and implanted into the skin in the lumbar region through a button-hole opening. The distal portion of the ureter was sutured to the lower end of the abdominal wound. The patient recovered from the operation, and three months later nephrectomy was resorted to, which was followed by recovery. Microscopic examination of the kidney showed that it was healthy with the exception of a few small islands of interstitial nephritis. No septic invasion had taken place, as no micro-organisms were found.

The integrity of the kidney in this case, after so long a period of exposure through the open ureter, is remarkable, and according to Albarran, due to the antiseptic precautions in the after-

treatment. This case was one in which uretero-ureterostomy might have been performed with advantage.

Losses of substance of the ureter too extensive to permit of uretero-ureterostomy, or located too high up to permit of implantation of the upper end into the bladder, will require either implantation on the skin or into the bowel. As both of these methods are objectionable, on account of the liability to infection sooner or later, and the consequent necessity of nephrectomy, operative procedures to effect a connection with the bladder have been proposed by Rydygier and Van Hook from dissections on the cadaver.

Rydygier (61) proposes to implant the two ends of the ureter on the abdominal wall, and by plastic operation to make a channel of skin between them, to make good the loss of substance of the ureter.

Van Hook proposes by plastic operation on the bladder to create a diverticulum long enough to meet the upper end of the ureter.

In both of these methods it is proposed to place the newly-formed channels in the abdominal wall. Theoretically, these methods appear feasible, but they have not as yet been practised in animals or the human subject.

Reichel (58) reports the following unique case of ureter in an inguinal hernia :

Reichel's Case. Boy, aged nine and one-half years; movable right inguino-scrotal hernia for four and one-half years. Herniotomy revealed small sac containing a little water. Behind this was another tortuous sac adherent to its surroundings. This was the ureter. Incision of sac. Palpation revealed a canal narrow down to the bladder but dilated up to the kidney; hydronephrosis. Extra-peritoneal nephrectomy seven days later. Recovery.

Conclusions.

Accidental wounds and subcutaneous ruptures of the ureter have not as yet been objects of direct surgical procedure upon

the ureter at the seat of lesion. It will be advisable, however, when and as soon as the diagnosis can be made, or when lumbar opening of a peri-ureteral cavity containing extravasated urine is made, to look for the seat of rupture, and if practicable to restore the continuity of the canal.

Catheterization of the ureters from the bladder for purposes of diagnosis of diseases of the kidneys has given valuable information affecting the decision for or against operation on the kidney. The procedure is reasonably practicable in the female by the methods developed by Simon, Pawlik, and Kelly.

In man catheterization is practicable only through epicystotomy. The danger of this operation is steadily decreasing. The old mortality, which varied from 27 to 20 per cent., has been reduced in the more recent series of operations (Ultzmann) (76). Albert has had 20 cases with 1 death; Assandelft, 102 cases with 2 deaths; Ultzmann 9 cases with 1 death; Bergman 10 cases, Von Itersen 12 cases, Trendelenburg 6 cases, and Antal 8 cases, all without a death. Therefore, this procedure is justifiable in selected cases.

Catheterization of the ureter from the bladder as a curative measure for the evacuation of hydro- or pyonephrosis has occasionally been performed successfully (Pawlik). It is more difficult and more uncertain than nephrotomy and the attempt to find and remedy the stenosis of the ureter from the pelvis of the kidney.

Dilatation of strictures of the ureter by elastic bougies or catheters has been tried from the bladder by Kelly with temporary success, and from the pelvis of the kidney by Alsberg successfully; consequently this procedure is of use in isolated cases.

Permanent catheterization of the ureter from the bladder, a fistula, or an implanted ureter, is often tolerated only for a limited time, and must be employed with caution for fear of causing ureteritis.

Uretero-lithotomy, longitudinal incision over a stone for its removal, is a safe operation by the extra-peritoneal method. The wound heals without stenosis. In extra-peritoneal opera-

tions, suturing is unnecessary, drainage down to the wound being sufficient.

Intra-peritoneal ureterotomy should be done only when access outside of the peritoneal cavity is impossible, and it should be completed by careful suturing, covering with a peritoneal or omental flap and drainage.

Opening of the peritoneal cavity to locate the seat of the stone may occasionally be necessary, but when the diagnosis is once made, ureterotomy for the removal of the stone should be done through an extra-peritoneal incision, and the abdomen closed.

In valve-formation or stricture of the ureter, causing pyo- or hydronephrosis or a permanent renal fistula, nephrotomy should be followed by exploration of the ureter in its entire course from the kidney to the bladder.

Exploration of the ureter as to its permeability should be done from the renal wound by a long, flexible, silver probe (a uterine probe) or an elastic bougie, either olive-pointed or not. If the bougie passes into the bladder the examination is at an end. The size of bougie that will pass through a healthy ureter is from 9 to 12, French scale.

If the pelvic orifice of the ureter cannot be found from the renal wound it should be sought for by opening the pelvis (pyelotomy), or by incising the ureter (ureterotomy).

A longitudinal incision, half an inch to an inch long, in the posterior wall of the pelvis can be made while the kidney is lifted upward against the twelfth rib. This procedure is easy if the pelvis is dilated, but may be impossible if the pelvis is of normal size.

Operation for valve-formation should be done through the wound in the pelvis. If the opening cannot be seen or found from the pelvis ureterotomy should be performed immediately below the pelvis, a small incision should be made in the ureter and a probe passed up into the pelvis. The valve should be split longitudinally and the incised borders so treated as to prevent re-formation of the valve.

A stricture in the ureter, if not too extensive, can be treated

by a plastic operation on the plan of the Heinicke-Mikulicz operation for stenosis of the pylorus, namely, longitudinal division of the stricture and transverse union of the longitudinal wound. This method of operating for ureteral stricture seems to me preferable to resection of the strictured part of the ureter (Küster's operation) for the following reason: It is a more economical operation, and preferable when the elongation of the ureter is not sufficient to permit the two cut ends of the ureter after excision of the stricture, not only to come in contact, but even to permit of closure and invagination without stretching.

Resection of the upper end of the ureter and implantation of the distal end into the pelvis may be useful in rupture or division or stricture of the upper end of the ureter, as described by Küster.

In a similar case of stricture in the upper end of the ureter, especially if the ureter were not elongated or the kidney movable, I should prefer the plastic operation proposed by me, as it is easier of technique, and as it proved successful in my case of traumatic stricture in the ureter below the pelvic orifice.

The ureter is accessible through an extra-peritoneal incision, a continuation of the oblique incision for lumbar nephrotomy, from the twelfth rib down along and one inch anterior to the ilium and along Poupart's ligament to about its middle. This incision gives access to the upper three-fourths of the ureter and down to within two or three inches above the bladder.

The vesical and lower pelvic portions of the ureter may be reached, as Cabot has pointed out, by means of the sacral operation, or Kraske's method, modified by osteoplastic temporary resection of the sacrum. In woman the vesical portion of the ureter is accessible through the vagina.

The vesical orifice of the ureter may be reached from within the bladder by suprapubic cystotomy in man, and by dilatation of the urethra, or suprapubic or vaginal cystotomy in woman.

Uretero-uterine fistulas can be treated satisfactorily by plastic closure of the vagina or by nephrectomy. Implantation of the ureter into the bladder is, under favorable circumstances, the operation of the future for this condition.

Uretero-vaginal fistulas and congenital urethral or vaginal terminations of the ureter should be treated by vaginal plastic operation for displacement of the proximal end of the ureter into the bladder. If these attempts fail, and the kidney is not infected, extra- or trans-peritoneal implantation into the bladder should be done, and finally, as a last resort, nephrectomy.

Complete transverse wounds in the continuity of the ureter should be treated by uretero-ureterostomy after Van Hook's method of lateral implantation, if possible.

Complete transverse wounds of the upper end of the ureter should be treated by implantation of the ureter into the pelvis of the kidney, as devised by Küster.

Complete transverse wounds of the ureter near the bladder should be treated by implantation into that viscus either by splitting the ureter or by invagination.

Loss of substance of the ureter too extensive to permit of uretero-ureterostomy, or too high up to permit of implantations into the bladder, may be treated by implantation on the skin or into the bowel.

Implantation into the bowel is objectionable on account of the infection which is almost certain to follow sooner or later.

Implantation into the rectum should not be resorted to when implantation into the bladder is possible.

Implantation on the skin in the lumbar region, or the abdominal wall, may have to be followed by secondary nephrectomy, which, however, is much less dangerous than the primary operation.

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