secured her a refreshing sleep, and the headache and nausea disappeared.

"I used the solution on my return voyage with the same good effects. The solution is very palatable and easily taken."

THE SURGERY OF THE URETERS: A CLINICAL, LITERARY AND EXPERIMENTAL RESEARCH.

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(Concluded from page 916).

The Writer's Plastic Methods for Making a Vesical Diverticulum.—When the ureter has been injured in intra-abdominal operations in such a way that the duct can not be there implanted into the bladder, or when morbid processes are found to have brought about the same result, I would recommend strongly the following procedure:

1. Implant the ureter upon the skin of the abdomen in the median line as near the bladder as possible. Close the abdominal walls as usual, except for the presence of the ureter.

muscles or fascia, and the end of the ureter is held in position by light catgut sutures which pass through loose peri-ureteral connective tissue, if possible, and through the muscular structures near at hand.

5. We are now in position to sew together the edges of the flap to form a tube, into the upper end of which the ureter is introduced, and to carry a similar row of light catgut sutures down the bladder wound itself. The lower angle of the vesical opening would best be left open for the sake of drainage. It will in all probability cause no trouble in healing. The upper part of the skin wound together with the fasciæ may be closed. Under careful antiseptic treatment this procedure ought to be as practicable and as easy as the majority of operations daily undertaken.

I have practiced the method only upon the cadaver. Fig. 8 shows the appearance of the parts after the flap is dissected up from the bladder. In this subject, a female of medium height, the distance from the pubes to the umbilicus was 17 cm.; from the pubes to the peritoneal reflection upon the bladder, 5 cm.; from the pubes to the upper end of the vesical flap, 10 cm. Hence we may safely say that without opening the peritoneum the bladder can be plastically extended to meet the ureter, when that duct is brought out upon the abdomen at any point more than 8 cm., (about three and one-fourth inches) inferior to the umbilicus.

This is not, however, the limit of such plastic procedures upon the bladder. For, if the peritoneum is opened, the flap can be considerably increased in size. The ureteral fistula

Fig. 3.—Cadaver lying on the left side. Incision made to expose the ureter, which is seen upon the hook at the right.

2. When the patient has fully recovered from the primary operation, open the structures composing the abdominal wall between the ureter and the pubes down to the peritoneum and bladder. The peritoneum must not be opened. The bladder may be distended and raised exactly as in supra-pubic cystotomy.

3. Make two incisions in the bladder parallel to the median line, beginning as near as possible to the peritoneum without prejudice to its integrity, carry them down at a distance of about 15 mm. apart towards the neck of the bladder under guidance of the finger. With scissors curved on the flat the two incisions are now united at the lowest point and hemorrhage is controlled with pressure forceps. It will be seen that we now have at our disposal a vesical flap of considerable extent hinged above by a nutrient pedicle.

4. The ureter is loosened from the skin and brought well down towards the flap which is simultaneously raised to meet it. The vesical flap is firmly fastened back in its new position by catgut sutures passing through the neighboring

having been established as before, as low down as possible the secondary operation is begun by (1) making an incision to expose the attachment of the peritoneum to bladder; (2) the peritoneum will then be opened transversely at or very near its vesical reflection, and fastened by some points of catgut suture (or by a continuous suture) to the fundus of the bladder as far back as possible. In other words, the peritoneum is transplanted backward upon the bladder. The point to which the peritoneum is transplanted must be marked by a silk suture, with ends left long if the operation is not completed at once. The remainder of the procedure may be performed at once if the urine is aseptic, and if the peritoneum has been well fastened down to the base of the bladder. If these conditions are absent, the final steps may be deferred some days. The remainder of the operation is the same as that already described except that the peritoneum being farther back, a much larger flap can be secured. Experiment upon the cadaver convinced me that with care the bladder flap may, by opening the peritoneum, be made to meet

the ureter at any point one inch (2.5 cm.) or more below the umbilicus.

This operation has the following advantages:

1. The normal relations of kidney and bladder are restored.
2. It is entirely safe, the technique annulling the dangers of peritonitis from the urine, if septic.
3. The bladder can be utilized by plastic procedure to make good a defect of several inches in the ureter.
4. No other viscus than those at first implicated is called upon to make good the loss.

Fig. 4.—The suture armed with two needles holding the upper end of the ureter in its loop.

Symphysiotomy for exposure of the bladder to operation naturally suggests itself, since the attention of surgeons has been called to this method of reaching pelvic organs and of increasing intra-pelvic space. It has been formally proposed as a method of gaining access to the bladder by Wickhoff.⁷⁶ The bladder distended with six to twelve ounces of water, may be brought into view and be made easily accessible when the symphysis is divided. The harmlessness of the procedure when carefully performed would render it justifiable as a preliminary step in the writer's methods of making a vesical diverticulum to meet a shortened ureter.

Rydygier's Method.—An ingenious method of extra-peritoneal ureteroplasty was suggested by Ludwig Rydygier.⁵⁷ He advises that in cases of injury to the ureter during surgical operations, the two ends of the ureter be brought out through the abdominal wall and the wall be allowed to close about them. He would then prepare for the urine an artificial channel of skin by making two parallel incisions between the two openings, suturing together the edges of the isolated piece of skin so as to form a tube and depressing this tube by sewing over it the severed edges of skin drawn from each side.

Fig. 5.—The needles passed down the ureter through the slit and emerging from the ureteral wall.

The theoretical possibility of success by this method can not be doubted. For just as Rosenberg,⁵³ has shown that intestinal mucous membrane is speedily replaced by bladder epithelium when the bowel is implanted into the bladder, so Bardenheuer⁵ has shown that even very large masses of skin when transplanted into the oral cavity can speedily do full duty as mucous membrane by becoming overgrown with the epithelial cells peculiar to the oral mucous membranes. We would expect that in a comparatively short time after the turning in of the skin, according to the suggestion of Rydygier, the epithelium of the new tube would gain the essential characters of the ureteral mucous membrane. The plausibility of the plan is much diminished, however, when we remember how difficult it would be to overcome the influence of the urinary pressure at the points of desired junction. The method might be successful, however, by affording abundance of drainage at first, until healing had occurred at all points except those of junction.

In a case of this description (i. e., where the two ends of an injured ureter were implanted into the abdominal wall at some distance from one another) the writer suggested the formation of a new channel by implanting into a gutter between the two openings, a labium majus from the same patient. It was suggested that if this large piece of double mucous membrane were split after being removed it might be implanted by the Thiersch method and made to serve as mucosa for a new ureter. I am not aware that the suggestion was acted upon.

Vaginal Plastic Methods.—The ureter not infrequently

opens congenitally upon the vulva or within the vagina. These cases are usually amenable to treatment by making an incision around the orifice of the duct, at a distance from the ureter sufficiently great to leave a piece of mucous membrane attached to the tube. The ureter is then dissected back to the extent necessary to enable the operator to readily insert it into the bladder through an incision made for the purpose. Such a case is that of McArthur³⁵ which was entirely cured by this method.

The paper of Secheyron⁵⁹ upon the abnormal openings of the ureter upon the vulva and in the vagina should be mentioned in this connection.

Vaginal plastic methods, applicable when the ureter has been injured in surgical operations especially the modern kolpo-hysterectomy, have been frequently devised and put in practice. When the ureter discharges its fluid into the vagina and the duct itself can not be implanted directly into the bladder, two general plans are at our disposal:

1. The vaginal wall may be utilized to make a new channel to the bladder.
2. The vagina may be closed (kolpokleisis) particularly when the uterus has been extirpated.

The first of these plans has been repeatedly utilized and has given satisfactory results. The procedure was projected by T. A. Emmet,¹⁵ in a case in which the mouth of the ureter opened "on a line with the os uteri." Dr. Emmet formed a channel out of vaginal tissue to carry the urine from the mouth of the ureter to a point well beneath the bladder, intending to turn the new opening of urinary discharge into the bladder by a temporary vesico-vaginal fistula. The first part of the plan, the making of a new duct, was carried out without difficulty but the patient died of pneumonia in the interval between this and the final procedure.

Fig. 6.—The ends of the suture having been used to invaginate the upper in the lower fragment, are tied together.

Of course the lengthening of the ureter is unnecessary when it discharges into the vagina at a point well under the bladder. In this condition a vesico-vaginal fistula is made, and the ureteral opening is turned into the bladder. This was successfully accomplished by Dr. Wm. H. Baker of Boston, at the suggestion of Emmet, in a case in which the ureter opened congenitally into the vagina at a point near the urethral meatus.

The most interesting communication yet written upon the subject of vaginal ureteral fistulae comes from Arie Geyl²¹ whose work appeared in 1892. He describes minutely a case in which, after a difficult forceps delivery a woman was found to have a fistula of both ureters, on one side emptying into the vagina near the uterus, on the other side discharging into the uterus at some unknown point. To get rid of the discharge from the uretero-vaginal fistula, Geyl used a portion of the vagina to form a pouch which he caused to communicate with the bladder by means of a permanent fistula. This was readily accomplished by first making a large opening into the bladder from the vagina and then removing an oval strip of vaginal mucous membrane surrounding this opening and the end of the ureter. By approximating the denuded surfaces from side to side the uretero-vaginal fistulae were made to communicate. This operation was a success. The subsequent attempt to close the uretero-uterine fistula failed and the patient declined further interference. The uretero-vaginal fistula was thus closed by a procedure easier and safer of execution and far more desirable than nephrectomy. Baum⁴ describes an ingenious procedure by which he succeeded in closing a supernumerary ureter opening into the vagina. He opened the bladder supra-pubically; then after incising the base of the bladder freely, he closed the peripheral end of the sacculated ureter thoroughly and stitched the edges of the ureteral dilatation to the edges of the wound in the base of the bladder. In other words, he used the *sectio alta* in order to turn the supernumerary ureter into that viscus.

Very interesting recent cases of uretero-vaginal fistulae have been studied by Weil.⁷⁵ Other cases have since been observed and operated upon, but it is not the purpose of this paper to make more than an allusion to this possibility, which readily does away with one of the commonest excuses for removing the kidney.

A ready conclusion from these considerations is to be found in the recommendation which I would unhesitatingly

and urgently make to those performing vaginal hysterectomy. When a ureter is injured during the course of the operation and the condition is realized, the ureter should be drawn down into the vagina and fastened to the vaginal wall well under the base of the bladder so that a subsequent plastic procedure may cause it to discharge normally. It should be covered by mucous membrane.

The second method of getting rid of uretero-vaginal fistulæ, by closing the vagina permanently and establishing a vesico-vaginal communication, has been applied in several cases. It is not objectionable after kolpo-hysterectomy except in those cases in which marital relations would be interfered with by vaginal closure.

These two methods are so easily practicable and so nearly devoid of danger in their application that they should wholly supplant the destructive operation of nephrectomy for the relief of this form of ureteral fistula.

Urine Discharged Extra-Vesically.—It is within the experience of almost every surgeon to have seen cases of ureteral fistulæ discharging upon the skin. It is also easily understood that such fistulæ may readily be produced at will, when the ureter has been severed, by simply splitting the

one of these he sutured both ureters into the lateral abdominal walls. On the right side the abdominal wall suppurated and a pyelonephritis arose; on the left, more than five weeks after the operation the kidney was found healthy. In the second case, the same experiment being tried, the dog showed itself after several weeks to be perfectly well, with normal urine. From the first of these experiments we must conclude that bacterial activity about the mouth of the ureter is fraught with the gravest danger—a fact to which we shall frequently have to revert. The second experiment is a demonstration that even in the case of the dog the ureters may discharge upon the skin for a time without a resulting pyelonephritis.

Implantation of the Ureters into the Small Intestine has been practiced experimentally by a number of persons, in recent years. But I am not aware that any one now seriously recommends the procedure in practical surgery. The disadvantages of the small intestine as a receptacle for the urine are so much greater than those of the rectum that they must be obvious to all. Of these the most important are the facts that the urine discharged into the small intestine would have to traverse, before extrusion, a much greater

Fig. 7.—Writer's method of lateral implantation of the ureter, illustrated upon a piece of human ureter. The upper portion is being drawn into the lower by the two threads.

ureter slightly to enlarge its external opening and suturing it carefully upon the skin. Obviously, care must be taken that the ureter is not too sharply bent upon itself at any point in bringing it out of its natural bed, and that it is not compressed by other tissues or organs. It is not necessary to mention the many disastrous consequences which might arise as a result of compression in this way. The ureter has been purposely brought out upon the abdominal wall in this way, as in the cases of LeDentu³² and Pozzi.⁴⁸ Trekaki⁶⁸ goes so far as to recommend this operation in tumors of the bladder which compress the lumen of the ureter, in compression of the ureter by inoperable carcinomas and myomas of the ureters or inoperable tumors lying higher in the abdominal cavity. He regards partial lesions of the kidneys and not too extensive inflammations of these glands as by no means contra-indications for the procedure, but rather as indications, since they are more likely to recover when the urinary pressure is removed. He adds also that in complete ruptures of the ureters, after a trauma or surgical operation, suture of the ureter into the wound is indicated instead of nephrectomy. Trekaki supports his opinions by citing two experiments which he has made upon dogs. In

extent of intestine than would be the case with implantation into the rectum; and that the structure of the small intestine is still more complicated than that of the rectum.

I have made two experiments upon dogs to establish the value of the procedure. In both cases a single ureter was implanted into the bowel, about eighteen inches above the ileo-cecal valve. In both instances no serious inconvenience to the animal was observed. But upon killing the animals about ten days after the operation, the kidneys corresponding to the implanted ureters were found swollen and showed all the signs of pyelonephritis. The patency of the opening into the bowel was in both instances slightly compromised, so that there was a collection of a couple of drachms of purulent urine in the pelvis of the kidney and the ureter. As the result of these experiments does not differ from that of some of the implantations into the rectum, I would regard the upper portion of the intestine as less suitable than the rectum, solely on account of the a priori reasons already advanced.

Implantation of the Ureters into the Rectum was suggested by Roux and put in practice by John Simon in a case of exstrophy of the bladder, with an unfavorable result. Chaput

has, according to Rosenberg, recently practiced the method successfully in two cases. Morestin, according to the same writer, successfully practiced the operation in experiments upon the lower animals. Whether one or both ureters were implanted in the rectum is not stated.

Novaro,³⁷ an Italian, published in 1887 an elaborate account of an experiment upon a dog in which both ureters were implanted in the rectum. The dog recovered from the operation and was killed about thirty days afterward. The ureters were found neatly healed into the rectum and a microscopic examination of the kidneys was made. The testimony of the pathologist who made the examination is not absolutely unequivocal as to inflammatory changes, and no bacteriologic examination of the mucous membrane of the pelvis of the kidneys and the mucous membrane of the ureters was recorded.

Tuffier³⁸ describes his own experiments in this direction, and reached such unsuccessful results that he advised against the procedure.

Gluck and Zeller³⁹ experimented upon this subject without success, and emphasize the importance of stricture formation with hydronephrosis.

fore does not so easily undergo decomposition, and more important still, it can not mechanically carry bacteria to the kidneys, as is the case with fluids.

2. An amply sufficient argument in itself against a comparison of the species lies in the fact that birds' ureters are supplied with a mucous membrane evolutionally accustomed, as it were, to contact with infected solids and fluids; while the ureters of man are normally accustomed to the most absolute and perfect protection from the action of injurious microbial influences. This inherited ability of specialized tissues to resist invasion by micro-parasites is termed "resisting power," and is known to vary with the situation and needs of the different tissues. The ducts of all the secreting glands are more or less capable of repelling these invaders, as for example those of the liver and pancreas which normally open into the bacterially filthy bowel; the ducts of the salivary glands similarly open into an exceedingly "septic" cavity; the Bartholinian glands open upon the septic vulva. These various ducts rarely carry back to the glands which they supply the materials for their inflammatory destruction. It is true that some of them are protected by a slightly or relatively perfect valve action of

Fig. 8.—Writer's method of making a vertical flap to meet the ureter when the peritoneum is opened. The flap reaches to within an inch of the umbilicus, which is not shown in the drawing.

Bardenheuer⁵ studied the same questions with more encouraging results. Unfortunately his original work is not accessible to me.

In our own country, Dr. Harvey Reed⁵² of Mansfield, Ohio, presented before the AMERICAN MEDICAL ASSOCIATION in 1892, a paper recording twelve experiments upon this subject. Dr. Reed recommends the implantation of a single ureter in the rectum, but thinks we are not justified in attempting the operation upon both ureters at once.

The arguments in favor of the feasibility of implantation of the ureters in the rectum begins with the fallacious *a priori* reference to the urinary apparatus of birds. The argument is: (major premiss) birds urinate through the rectum (the usual loose statement); (minor premiss) man is a featherless biped; (conclusion) man should or may upon occasion urinate through the rectum.

But, neglecting the absurdity of the conclusion, the argument of analogy may be substantially controverted by these propositions:

1. The urine of birds is very slightly moistened. It there-

the mucous membrane at their outlets, but their main strength in opposing microbes must lie in their resisting power, acquired by evolutionary cycles of association with their enemies. The ureters, however, are among the most perfectly protected structures in the whole human anatomy. It is true that they stand in mechanical communication with the external filth. But the commerce of fluid is all in one direction—*nulla vestigia retrorsum!* Two powerful sets of gates close after the departing urine—first, the valve-like folds of the cystic mucous membrane at the mouths of the ureters; second, the sphincter vesicæ at the exit of the bladder. Each of these barriers is effective for a long time in repelling invaders. A violent urethritis often occurs without a cystitis. A violent cystitis often occurs without a urethritis. These well-protected ducts, the ureters, are therefore guarded so carefully that they need only in pathologic circumstances to meet microorganisms, and are therefore weak and well-nigh impotent to resist such enemies. How absurd and unthinking it is, then, to thrust the ends of these delicate tubes into the filthy rectum or small

intestine, filled with not only solid but liquid and gaseous materials to distend and defile the ureters and pelves of the kidneys.

The statement made by Dr. Reed that, in recto-vesical fistula, "the rectum usually becomes reconciled to the presence of the urine, and were it not for the escape of the feces into the bladder and the production of acute cystitis, there would be little to fear from this malady except some possible inconvenience," shows a pathetic regard for the powerful rectum, but no thought or consideration for the defenseless ureters. In vesico-rectal fistulæ the feces might lie in contact for some time with the bladder wall without setting up inflammation of the ureters. But we all know from daily experience that the great danger in all cases of septic cystitis lies in possible uretero-pyelo-nephritis. In chronic cystitis this extension of inflammation does not always produce an immediately fatal result. The process may be slow and the patient may die months or years after the inception of the cystitis, from some acute exacerbation of the nephritis.

The arguments in favor of rectal implantation of the ureters from analogy and from pathology are therefore wholly fallacious.

Experimental evidence upon this subject has been, (1) negative, as in the work of Tuffier, one of the most reliable and accurate experimental surgeons; (2) incomplete, as in the case of Bardenheuer, Morestin and Novaro; or (3) incom-

ration and was killed eight or ten weeks later; specimen "rendered useless by wanton mutilation."

(2). Dog killed twenty-four days after operation; kidney "congested and shows evidence of acute nephritis," attributed to hydronephrosis caused by external adhesions.

(3). Dog killed twenty-five days after operation; no renal congestion, no hydronephrosis; patent opening into rectum.

The first of these experiments is not to be considered, as an examination of the specimen was not reported. The second is clearly demonstrative of the dangers of the procedure. The specimens of the third case, which is the most favorable, were not examined bacteriologically or even microscopically. Without these examinations we can not form an accurate judgment. Finer changes may contradict gross appearances, and the presence of bacteria, even if the kidney were normal, would obviously be a most serious menace to the future integrity and activity of the organ.

In six bilateral implantations, Dr. Reed reports three deaths from acute general peritonitis; one death from acute nephritis; one death from abscess of the abdominal wall; and one death from peritonitis and nephritis. In one-third of these cases, nephritis was confessedly present. No bacteriologic or microscopic examination of the pelves and kidneys of the other cases was made.

From this consideration of Dr. Reed's experiments we must conclude that, so far as the feasibility of rectal im-

Fig. 9.—Writer's method of turning upward a vesical flap to meet the ureter. Although the peritoneum is unopened, the flap reaches a point within three inches of the umbilicus, seen at the upper edge of the cut.

plete and imperfectly observed, as in the report of Dr. Reed already cited.

The first of these classes requires no discussion. The evidence of these surgeons is clearly against implantation of the ureter in the rectum.

By "incomplete evidence," I mean that while the results of these experimenters were favorable, their published trials of the procedure were too few in number to convince us that their successes were more than exceptional. We have no reason to believe that they could repeat the effort at will without disaster. Moreover, the observation of the strongest case yet recorded, that of Novaro, in which both ureters of a dog were implanted in the rectum and healing was found perfect after thirty days, is imperfect in that no bacteriologic examination of the pelves of the kidneys was made.

Dr. Reed reaches the strange conclusion, "that the unilateral implantation of the ureter in the rectum is a possible and practicable surgical procedure." He bases this conclusion upon a priori reasoning which I have already refuted, and upon three experiments upon dogs:

(1). Unilateral implantation—dog recovered from the ope-

plantation of the ureter is concerned, his researches are in part directly contradictory evidence, and in part entirely incomplete.

Tuffier's⁶⁹ experiments gave evidence contradictory to the possibility of utilizing the bowel as a receptacle for urine.

It seems to me that the feasibility of this operation rests upon a satisfactory answer to the following inquiries:

1. Does our mechanical technique assure us of reasonable safety in opening the septic rectum and fastening into it the ureter?

2. Does the rectum tolerate the urine and satisfactorily extrude it?

3. Do the ureter and the corresponding kidney tolerate the new anatomic arrangement?

4. Does our technique insure us against stenosis of the duct at the point of junction with the rectum?

The first of these questions can be answered with a hesitating affirmative. The trials of the procedure which have thus far been made upon human subjects have not all been published; of this I am assured by personal communications to which I am not at liberty to make specific reference. These unpublished failures are doubtless due to peritonitis

from infection through the rectal opening. Dr. Reed's technique is in the main good. There is no need of especial care in excluding the aseptic urine from the peritoneal cavity; it is in no such degree "irritating," as is the case with sublimate and other antiseptic solutions. The main immediate danger lies in the escape of fecal matter from the bowel. It is evidently proper, as Dr. Reed has done, to take up with the ureter a fold of peritoneum which is carried into the rectum. Dr. Reed passes a loop of thread over the end of the ureter, and by means of a needle threaded upon the loop carries the thread down the rectum a short distance and out through the rectal walls. Traction upon the thread draws the ureter well into the bowel, and after sutures are passed through the loose tissue about the ureter, the loop is released by cutting short the thread and allowing it to retract into the bowel.

Novaro's technique is very minutely described. It involves a V-shaped incision into the bowel, and seems to me unnecessarily complicated.

The method I have employed experimentally is as follows: Raise an ample fold of peritoneum with the ureter. After severing the ureter, ligate the cystic end of the duct, and then split the opening of the renal portion of the tube with fine scissors upward for a distance equal to three times its diameter. Cause two small needles armed with a single

The second of these queries, as to the toleration of the urine by the rectum, can be quickly disposed of. Experience has amply proved that the rectum can easily maintain its integrity in the presence of the urine. And indeed, no one seems to have seriously raised the question except to answer it in the affirmative.

But the third question—involving the tolerance of the ureter and kidney for the new anatomic conditions—has not attracted the attention which it deserves, although infection has long been known to travel up the ureters with facility, as shown, for example, by Poirier.⁴⁵ For in reality this is the most important of all the questions. It is not to be expected that the rectum will refuse to submit to contact with the urine; but that the ureter, with its delicate mucous membrane leading to the easily inflamed pelvis, calyces and tubules of the kidney, should be expected to withstand the effect of being suddenly implanted into a reeking culture ground of the most various bacteria, is more than I can comprehend.

The experiments of previous investigators have not been directed to a solution of this question. From Dr. Reed's paper we gather that in two out of six unilateral implantations there were marked gross evidences of nephritis. It is probable that the number would have been much greater if the animals had been allowed to live longer.

Fig. 10.—A section from the junction of a knuckle of small intestine and the bladder wall. On the right the cylindrical cells of the implanted bowel; on the left the flat epithelial cells of the bladder displacing the cylindrical cells. Rosenberg, Virchow's Arch., Band 131.

fine silk or catgut thread to pass from within outward through the split end of the ureter. The ureter is thus grasped in the loop. Now pass the two needles into the bowel through a small longitudinal slit on the free border and carry them downward about one-half inch. When they are now pushed out through the rectal walls, the ends of the thread may be lightly tied together, drawing the ureter into position and permanently maintaining it there. The operation is completed by covering in the knot with two or more Lembert sutures, closing the rectal wound as well as possible without compressing the ureter, and applying a peritoneal graft. I made eight experiments by implanting a single ureter into the rectum after this manner. Three of these dogs died of general peritonitis. I have no hesitation in saying, however, that further practice would diminish this death rate. Still, it is apparent that the primary mortality from peritonitis must be high, since we are not at liberty to apply sutures tightly about the opening in the bowel, but must depend partly upon rapid peritoneal proliferation to close the wound. But even if closure could be perfectly secured at once, the escape of septic matter which almost inevitably occurs when the bowel is opened exposes the peritoneum to great risk of infection.

Of eight dogs in which I implanted one ureter in the rectum three died. In each of these three cases the kidney belonging to the implanted ureter was violently inflamed, being swollen, turgid and heavy, with muco-pus upon the mucous membrane of the pelvis. The following is a detailed account of one of the cases:

April 26.—Dog of thirty pounds weight; curly female. Following the technique already described the right ureter was implanted in the rectum. A small amount of fluid fecal matter escaped from the rectal wound, but was wiped away as carefully as possible. The operation was completed by a careful toilet of the peritoneum and closure of the abdomen. Forty-eight hours later the dog was found in a dying condition and was killed. A careful examination of the abdominal cavity showed a moderate amount of peritonitis about the site of implantation. There was no leakage from the bowel. The left kidney and ureter were normal in all particulars. The right ureter and kidney were in a state of violent inflammation. They were swollen and intensely red. In the pelvis of the kidney, which was opened with a red-hot knife, were a few drops of muco-purulent fluid with a tinge of blood in it. Cultures were made under all the indicated precautions. The patency of the ureteral canal was demonstrated by passing a small probe into the bowel. Microscopic examination shows violent hemorrhagic inflammation of the pelvis and pyramids of the kidney, as shown in the micro-photograph. Cultures of staphylococcus pyogenes aureus and other bacteria grew in the gelatin tubes inoculated, in a few days.

The five remaining dogs recovered from the immediate effects of the operation and were killed between the four-

teenth and twenty-first days after the operation. In three of these dogs the kidneys corresponding to the implanted ureters were in a state of morbid suppurative inflammation, pus being found in the pelves of the kidneys. The patency of the opening into the rectum was not so perfect in three cases as in those already described, as it required a small probe to pass into the rectum.

(Dr. Reed mentions in one case, (Exp. 11) of the implantation of both ureters that the right ureter was somewhat obstructed, the left freely open; nevertheless, there was violent inflammation of both kidneys.)

Implantation of both ureters in the rectum simultaneously, is an unmistakable test of the tolerance of the ureters and kidneys, provided the subject escape death by peritonitis. I performed six operations for the implantation of both ureters in the rectum. All the dogs died within six days. Four deaths were due to general peritonitis alone; the two other deaths were due to nephritis without compli-

the experiments thus far recorded, inasmuch as the dogs were killed too early to admit of scar contraction taking place at the point of implantation. But when we remember that the lumen of the ureter is exceedingly small; that this lumen is diminished rather than enlarged by the act of securing it in the rectum; that scar contraction must inevitably occur at the circle of cicatrization at the opening into the rectum; and above all that during the first few days of wound healing, as well as later, the constant tendency of the muscular fibers of the rectum is to lessen the circumference of the communicating opening between the ureter and rectum, we can not feel any confidence whatever in the permanent patency of the opening after the lapse of months and years. No implantation of a single ureter into the rectum either experimentally or in the human subject, should be accepted as favorable evidence, unless an autopsy has been made a long time after the operation.

Of all these arguments the readiest and most conclusive is

Fig. 11.—Implantation of the ureter upon the skin of the back. Le Dentu.

cating general peritonitis. In one of those dying of peritonitis and nephritis, there was moderate obstruction of the ureter causing retention of the urine in the pelves of the kidneys. The same thing occurred in one of those dying of nephritis. In none of these cases were the kidneys in such a condition that they could be expected to regain the performance of their functions in the face of so much infection.

It will thus be seen that in no single permanent introduction of the ureter into the rectum has it been demonstrated that inflammatory reaction on the part of the kidneys was absent. On the contrary, in a large majority of the implantations indications of pyelonephritis were glaringly evident even upon gross examination. My conclusion is, therefore, that the ureters and kidneys are absolutely intolerant of this interference.

The answer to the last question can not be gained from

that the infection of the upper urinary passages is inevitable. This is proved by the observation which I have recorded, showing that in one instance violent infection of the ureter and pelvis of the kidney occurred, with hemorrhagic purulent inflammation and the presence of abundant bacteria in the bloody pus at the end of forty-eight hours.

From this study of the possibility and practicability of implantation of the ureters in the rectum, the conclusion is inevitable that intestinal or rectal implantation of the ureter is primarily and remotely an extremely dangerous procedure unjustified by reason and condemned by experiment, and second that, inasmuch as the vital objections to this expedient are fundamental and not dependent upon criticism of a faulty technique, this operation must be regarded hereafter as unjustifiable in practice upon the human subject.

Stopping the Secretion of Urine may be accomplished by ligating the ureter, or by the obvious alternative of removing the kidney.

The immediate and remote consequences of complete ureteral obstruction have been the object of study by a number of physiologists as well as pathologists. Arnold Holste⁸ has given some study to this subject and finds that, after ligation, the pelvis of the kidney is first dilated, then the tubuli recti and finally the remaining tubules are distended.

When obstruction is complete, secretion stops as soon as extravascular urinary pressure equals intravascular blood pressure. The kidney, as a whole, becomes larger in all cases of obstruction, and especially is this the case when the stoppage is effected gradually or when it is intermittent, as is the case with compression of the ureters in carcinoma uteri or in intermittent hydronephrosis from calculi of the bladder or pelvis. Orth⁴⁰ formulates the rule that the more slowly the total obstruction is reached the greater will be the saccululation.

The facts that secretion stops entirely when the ureter is ligated, that saccululation is slight when there is absolutely no leakage, and that atrophy of the parenchyma of the kidney occurs later on, have led some authors to recommend ligation of the ureter as an expedient to be adopted when it is incapable of performing its function and when lesions are irreparable. This recommendation has been made by one of the French writers.

The idea seems chimerical for a number of reasons. LeDentu³² counsels against it for two reasons:

1. Because of antecedent infection (which is liable to convert a simple hydronephrosis into a pyonephrosis).

2. Because "grave accidents" are liable to occur.

These grave accidents which LeDentu does not specify are indeed sufficiently grave. One readily thinks of slipping of the ligature; infection of the ligature which would allow infected pent-up urine to escape into the retro-peritoneal space if not into the abdominal cavity itself; rupture of the distended kidney, etc. Again, the sudden stoppage of the ureter in experimental animals always produces an enormous venous congestion, especially of the veins upon the capsule of the organ. Rupture of these veins with dangerous hemorrhage would not be inconceivable in patients whose vascular systems are in an abnormal condition. An entirely different problem which the suggestion brings up, is as to the ability of the remaining kidney to bear the additional burden of secreting the urine which would have been discharged from the other kidney. This danger would be equal to that which we fear in primary nephrectomy.

To me the greatest objection to the method, except of possible infection, lies in the fact that the kidney is sacrificed as completely as if removed. The kidney is an organ which has heretofore been sacrificed for ureteral disease or injury far more frequently than it should have been—more frequently than the immediate future will justify.

Nephrectomy for simple ureteral fistulae has been performed many times, usually with success. It is unnecessary to refer to the many reports with which periodical medical literature abounds.

Kidneys have been sacrificed also for many other equally simple conditions, as intermittent hydronephrosis, cicatricial stenosis of the ureter, etc. But it is well-known that the process of compensatory hypertrophy of the remaining kidney always adds gravity to nephrectomy and, as one kidney is liable to many forms of disease while its fellow remains intact, it follows that the possession of two kidneys is a great safeguard to the patient. These facts are amply sufficient to make it unjustifiable to sacrifice a kidney, except when every means has been resorted to in order to repair the morbid condition. Indeed, it is just as improper to remove a kidney for remediable ureteral disease as to remove a kidney because it is movable.

CONCLUSIONS.

1. The extra-pelvic portion of the ureter is most readily and safely accessible for exploration and surgical treatment by the retro-peritoneal route.

2. Hence all operations upon the ureters above the crossing of the iliac arteries should be performed retro-peritoneally, except in those cases in which the necessity for the ureteral operation arises during laparotomy.

3. The intra-pelvic portion may be reached by incision through the ventral wall, the bladder, the rectum, the vagina in the female, the perineum in the male, or by Kraske's sacral method.

4. The ureter is not only exceptionally well protected from

injury, but by its elasticity and toughness resists violence to a remarkable degree.

5. The histology of the ureters furnishes most favorable conditions for the healing of wounds.

6. Longitudinal wounds of the ureter at any point, heal without difficulty in the absence of septic processes, under the influence of ample drainage.

7. In all injuries where the urine is septic before the operation, or where the wound is infected during the operation, drainage must be effected.

8. The chemic composition and reaction of the urine must be studied in all injuries to the ureter, the urine being rendered acid, if possible, and the specific gravity kept low.

9. The pelvis of the ureter is, *ceteris paribus*, the most favorable site for wounds of the ureter, since scar contraction is not so likely there to be productive of ill results.

10. In aseptic longitudinal wounds of the ureter occurring in the course of laparotomy, suture may be practiced and the peritoneum protected by suture.

11. Transverse wounds of the ureter involving less than one-third of the circumference of the duct, should be treated by free drainage (extra-peritoneal), and not by suture.

12. In transverse injuries in the continuity of the ureter, involving more than one-third of the circumference of the duct, stricture by subsequent scar contraction should be anticipated by converting the transverse into a longitudinal wound and introducing longitudinal sutures.

13. In complete transverse wounds of the ureter at the pelvis, sutures may be used if the line of union be made as great as possible.

14. In complete transverse injuries of the ureter in continuity, union must not be attempted by suture.

15. In complete transverse injuries of the ureter in continuity, union without subsequent scar contraction may be obtained by the writer's method of lateral implantation, as described.

16. In complete transverse injuries of the ureter very near the bladder, the duct may be implanted, but with less advantage, into the bladder directly.

17. At the pelvis of the ureter, continuity after complete transverse injury may be restored by Kuester's method of suture, providing the severed ends can be approximated by slightly loosening the ureter from its attachments.

18. Rydygier's method of ureteroplasty, in such injuries may be tried if other methods can not be utilized. The primary operation should at least fix the ends of the tube as nearly as possible together.

19. In both transperitoneal and retroperitoneal operations the ureteral ends can be approximated by my method even after the loss of about an inch of its substance.

20. The use of tubes of glass and other materials for the production of channels to do duty in place of destroyed ureteral substance must be rarely satisfactory, and even if temporarily successful, the duct is almost sure to be choked by scar contraction.

21. The implantation of the cut ends of a ureter into an isolated knuckle of bowel is objectionable; 1, because the bowel is not aseptic; 2, because the operation is too dangerous.

22. In injuries of the portion of the ureter within the pelvis, with loss of substance, the ureter should be treated as follows: if possible, the continuity of the ureter should be restored by the writer's method.

23. If this is not possible, the ureter if injured in vaginal operations should be sutured to the base of the bladder with a covering of mucous membrane as far forward as possible, with a view to a future implantation or formation of vesico-vaginal fistula with kolpocleisis.

24. In injuries to the pelvic ureter during laparotomy, where the continuity can not be restored, and where temporary vaginal implantation can not be effected in the female or vesical implantation in the male, the proximal extremity of the duct should be fastened to the skin at the nearest point to the bladder.

25. In ventral ureteral fistulae opening near the bladder, the ureteral extremity may in some instances be planted directly into the bladder without opening the peritoneum.

26. In such cases where the ureter will not reach the bladder a flap may be raised from the anterior vesical wall and reflected upward, extra-peritoneally, to meet the ureter and form a tubular diverticulum.

27. Such a flap may be so elongated by a preliminary operation to transplant the peritoneum back of the fundus, or by accurately suturing it there at a single sitting, that median ventral fistulae of the ureter may be cured if they open at any point an inch or more below the umbilicus.

28. Symphyseotomy is a valuable and justifiable preliminary step in these plastic vesical operations.

29. It is legitimate when both ends of a cut ureter open upon the abdominal wall to try Rydygier's method.

30. Implantation of one or both ureters into the rectum is absolutely unjustifiable under all circumstances because: (1) the primary risk is too great; (2) there is great liability to stenosis of the duct at the point of implantation; (3) suppurative uretero-pyelo-nephritis is almost absolutely certain to occur, either immediately or after the lapse of months or years.

31. Ligation of the ureter to cause atrophy of the kidney is unjustifiable.

32. Extirpation of a normal kidney for injury or disease of the ureter is absolutely unjustifiable, except where the ureter can not be restored in one or other of the ways cited.

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AMPUTATION AT THE HIP-JOINT, BY WYETH'S BLOODLESS METHOD.

Read before the Southern Surgical and Gynecological Association, at New Orleans, La., Nov. 14, 1893.

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Dr. John A. Wyeth read a paper on a "Bloodless Method of Amputation at the Hip-joint,"¹ at the meeting of the AMERICAN MEDICAL ASSOCIATION in 1890. He had previously reported two cases successfully operated on by the method, to the Section of Surgery of the New York Academy of Medicine. He again described his method at the Pan American Medical Congress in Washington.

These cases were sarcomatous tumors of the thigh. In addition to these two successful cases, he gives also in detail in the paper referred to, two cases operated on successfully by McBurney and Fluhrrer, the first being an infiltrating sarcoma of thigh, the second an osteo sarcoma.

As to bleeding in these four cases Wyeth reported that in his own two cases there was "no bleeding at all;" in Fluhrrer's not more than four ounces of blood was lost during the whole operation, while in McBurney's perhaps "not an ounce in all." In Fluhrrer's the operation lasted one hour and a half, in McBurney's case the time is not stated, but the operation is said to have been finished "with great rapidity."

Since these cases were published a number of surgeons have employed the method, and some valuable contributions have been made to the literature of amputation of the hip. I have been able to collect the following cases, which I shall give without any attempt to report them in chronological sequence:

Case 5.—Case of Dr. John B. Deaver.—The patient, female, age 20, fell down stairs in 1886 and sustained an injury of the hip. In August, 1888, an abscess formed and was opened. In October, 1889, the femoral head was excised for necrosis. In September, 1890, another abscess formed. There were sinuses and manifest enlargement of femur. There was evidently a mild septicemia in progress. Oct. 21, 1890, under ether, the limb being rendered bloodless by Esmarch's bandage, Wyeth's amputation was done. On November 30 the patient was entirely well.

Case 6.—Case of Dr. Nancrede.—T. M., age 31. Patient had suffered of strumous disease of left knee-joint, which had been treated by tapping, washing and iodoform injection. Two months later another surgeon performed a supra condyloid amputation using diseased tissues for his flaps. Wound did not heal, lower half of thigh becoming

¹ Dr. Wyeth first employed the method successfully in an amputation at the shoulder joint. The hemorrhage was so well controlled that he was led to resort to the same expedient in hip amputation. Dr. J. H. Brinton has reported two cases (one successful) in which he employed the method of Wyeth in shoulder amputation (Annals of Surgery XVIII, 93, 321.)