

PRESENT METHODS OF TREATING URETERS SEVERED DURING ABDOMINAL OPERATIONS.

BY WILLIAM R. NICHOLSON, PH.B., M.D.,
OF PHILADELPHIA,

INSTRUCTOR IN GYNECOLOGY IN THE UNIVERSITY OF PENNSYLVANIA, ETC.

THE attempt to treat the ureter severed during abdominal operations is of relatively recent development. Indeed, until within the last few years the repair of injuries to these tubes was a sealed book, it being the general opinion that any injury demanded either a nephrectomy or at least a ligation of the lower end of the upper fragment. Thus, Herman Thompson,¹ of Odessa, writing as recently as eight years ago, advised nephrectomy as giving the only chance of recovery in any case in which the ureter was cut. The dangers, however, incident to the operation of nephrectomy caused abdominal surgeons much concern, and various methods have of late been proposed to avoid this mutilating operation. These procedures may be divided into three classes: First, anastomoses made with other viscera in the abdominal cavity, as into the bladder and bowel; second, reunion of the severed ends of the cut ureter or uretero-ureteral anastomosis; and, third, anastomosis with the external surface of the body, as upon the skin or into the vagina and urethra.

While injuries to the ureters are considered to be one of the rare accidents which occur during the course of abdominal operations, it is quite probable, as remarked by B. B. Davis,² that, if the truth were known, a percentage of deaths ascribed to shock and faulty anæsthetization would be found in reality to be cases in which ureteral injury was the actual cause of the fatality. Injuries to the ureter may arise during the performance of operations in various ways. They may be caused by the inclusion of the ureter by a ligature at some point in its course, or by cutting or tearing it in the enucleation of tumors or inflammatory masses. The most usual situation of the traumatism is in the bottom of the pelvis near the base of the broad ligaments. The success attained in the repair of these structures has enabled operators to conscientiously sacrifice them in the removal of malignant neoplastic growths, and has even emboldened some enthusiasts to advise the extirpation of the whole bladder in cases of either a primary malignancy of the bladder or a malignancy of this organ secondary to carcinoma primarily in the uterus. Early in the serious study of this question the bladder anastomosis appealed to many men as theoretically the

¹ Zeitschrift f. Geburtshilfe u. Gynäk., 1893.

² Journal of the American Medical Association, December 29, 1900.

proper method for the treatment of many of these cases. Hegar and also Paoli and Busachi¹ made various experimental anastomoses between the ureter and the bladder; and Bauman, in 1892, Novaro,² in 1893, and Penrose³ and Krug,⁴ in 1894, performed this operation upon human beings. The method here used was to pass a suture threaded at each end through the wall of the upper end of the ureter, the same having been slit for a short distance in order to prevent stricture. These needles are then passed into the bladder through a slit in its wall made at the point at which the anastomosis will produce the least amount of tension, and are then pushed through the wall, from within outward, a short distance from the edge of the bladder wound. Traction exerted by means of these sutures thus draws the ureteral end within the cavity of the bladder. The suture is then tied and the mucous membrane of the bladder above and below the ureter sutured with catgut, the connective tissue and peritoneal surfaces being closed after the manner of any ordinary bladder laceration. It is always to be remembered that the distal end of the ureter must be tied to prevent a backward flow of urine through the normal ureteral orifice, as this complication has been met with in a certain number of cases reported by Modlinsky⁵ and also by Pozzi.⁶ As to the indications for this form of operation, it will be found that quite a number of men advise the bladder implantation in all cases occurring below the pelvic brim, *i. e.*, where the distance from the point of injury to the bladder is not so great as to preclude the possibility of an anastomosis between them. Among this number may be mentioned Penrose, Baldy,⁷ and Krug. Kelly,⁸ on the other hand, while believing that the operation is a valuable one, thinks that it should not be allowed to invade the province of uretero-ureteral anastomosis. The last-mentioned operator would perform uretero-ureteral anastomosis in cases where both the severed ends of the ureter are easily accessible, when no obstruction is present between the lower end of the ureter and the bladder, and when there is no carcinomatous trouble necessitating the sacrifice of the lower portion. If, however, any of these complications were present he, too, would perform a uretero-cystostomy. One of the strongest advocates of uretero-cystostomy is Baldy, who has seen three cases in which this bladder anastomosis was employed, in every case

¹ Emmet. *American Journal of Obstetrics*, 1895.

² *Centralblatt für Chirurgie*, 1893, vol. xxvii.

³ Penrose. *University of Pennsylvania Medical Magazine*, April, 1894.

⁴ Krug. *Journal of Obstetrics and Gynecology*, 1894.

⁵ *Centralblatt für die Krankheiten des Harn-Sexual Organs*, vol. v. 1894.

⁶ Pozzi. *Annales des Maladies des Organes Genito-Urinaires*, 1891.

⁷ Baldy. *American Journal of Obstetrics*, vol. xxxiii., 1896; and *New York Journal of Gynecology and Obstetrics*, November, 1894.

⁸ Kelly. *Bulletin of the Johns Hopkins Hospital*, October, 1893, and February, 1895; *Annals of Surgery*, January, 1894; *Journal of the American Medical Association*, October 6, 1900.

with a satisfactory result. This operator claims that the limits of ureteral destruction, as set by some men, beyond which they do not advise the performance of the bladder anastomosis, are too narrow. He, with others, claims that this operation may be done with success at any point of the pelvic portion of the ureter. In his own case the ureter was cut above the iliopectineal line, but by passing a catgut stitch through the wall of the bladder, and thus attaching it to the stump of the ovarian artery, he was able to avoid tension on the ureteral stitches at the point of anastomosis. Kelly in a similar case of high ureteral injury dissected the bladder loose from its pubic attachments and dropped it back into the pelvis, thus producing an apparent lengthening of the ureter amply sufficient for the operation. Baldy calls attention to the fact that the majority of ureteral injuries occur in the lower portion, where most men are agreed that a uretero-ureteral anastomosis is a very difficult operation. He calls attention likewise to the apparent increase in ureteral length resulting from its dissection from beneath the peritoneum, by which its markedly curved course is converted into a straight line. The majority of those who have used the operation under discussion favor the technique of Van Hook,¹ or what may be called the free-hand method, in contradistinction to the method by the use of anastomosis forceps. This is the method which has been given above in brief. Kelly, however, at one time advised that Sanger's forceps, passed into the bladder by the urethra, and then through an incision in its wall, should be employed. The same author has more recently called attention to a ureteral guide, which he introduces into the bladder through a small incision in the wall and then passes out through the usual bladder incision. Upon the bar of this instrument thus passed the upper fragment of the ureter is threaded, and then is easily drawn into the bladder and the usual stitches applied. While this instrument does not have the objection of Dudley's forceps in that it is not passed by the urethra, it nevertheless necessitates the making of an extra incision in the bladder wall, which seems an unnecessary traumatism, since on the basis of the cases reported as done by the free-hand method the operation has not presented any marked difficulty. Among the objections urged against the operation of uretero-cystostomy there are some which bring interesting points into discussion. Thus Emmet² claims that the chance of infection in bladder anastomosis is greater than in the case of uretero-ureteral anastomosis, on the ground that in the former the normal orifice of the ureter is not preserved. Later studies have, however, shown that the so-called ureteral valve is probably non-existent, and that the real safeguard against infection is the presence of uninjured

¹ Journal of the American Medical Association, 1893.

² Loc. cit.

vesical mucous membrane. The absence of infection in the cases reported also offers strong evidence in support of this last-mentioned belief. As further evidence, it may be mentioned that in the experiments to be referred to later, in which the ureters were implanted in the bowel, it was found that the mere implantation of the ureteral orifices alone did not prevent infection, while if a portion of surrounding mucous membrane were transplanted uninjured with the ureteral orifice the chance of infection was greatly reduced. Bovée¹ is of the opinion that one of the possible dangers of the bladder implantation is that either a constriction of the ureter will be caused, with its resulting evils of slow hydronephrosis, or that a too free opening, with the absence of the valve, may permit a backward flow of urine, with the same result. These complications, however, have not, as far as our knowledge goes, been seen in practice, and theoretically it would seem unlikely that the tendency to stricture after uretero-cystostomy would be as great as in the case of either a uretero-ureteral anastomosis of the oblique, the end-to-end, or the end-in-end methods, since healing in all these takes place in a circular direction; while in the uretero-cystostomy, on the other hand, it occurs in an ellipse, and so may be considered comparable to the method of healing as observed in the end-in-side method of uretero-ureteral anastomosis. The backward flow of urine in any case of uretero-cystostomy, which is certainly even theoretically only problematical, will in practice be prevented by the high point in the bladder wall at which the anastomosis is made and by the use of the catheter at suitable intervals after the operation. It is, of course, true that the ureteral muscle-bundles running in the normal bladder from the ureteral orifice downward cannot be imitated by this operation, and likewise that the course of the anastomosed ureter is not oblique with reference to the muscular wall of the bladder, but perpendicular. While, however, these may be theoretical objections, they have not apparently given rise to any practical difficulties in the cases which have been reported as operated upon by this method.

The other method which has recently received the greatest amount of attention is the rejoining of the severed ureteral ends, or uretero-ureteral anastomosis. One of the chief drawbacks of this method of repair is the inherent difficulty of the operation, which Kelly² likens to the most difficult of those done upon the eye. The flaccidity of the walls and minuteness of structure of the ureter, as well as the depth at which most of these injuries occur, which necessitates that the repair be carried out in the bottom of the pelvis, have constrained Baldy³ to urge that bladder anastomosis be done whenever practicable. Kelly⁴ does not feel that these operations—*i. e.*, bladder anastomosis and

¹ *Annals of Surgery*, 1897.

² *Loc. cit.*

³ *Loc. cit.*

⁴ *Loc. cit.*

uretero-ureteral anastomosis—are to be considered as rivals, but thinks that there are indications for the employment of each. He would prefer to do a uretero-ureteral anastomosis when both ends are accessible, when no obstruction is present between the lower end and bladder, and when the lower end does not have to be sacrificed to meet the indication of malignancy. If the above conditions are not fulfilled he would do a uretero-cystostomy. Kelly¹ advocates the use of his ureteral guide, previously mentioned, as an aid to the performance of the operation of uretero-ureteral anastomosis.

Different investigators have advocated different methods of uretero-ureteral anastomosis, and these may be grouped into four classes, as follows :

1. Lateral implantations, or the end-in-side method. Originated by Van Hook.
2. Transverse end-to-end approximation.
3. Oblique end-to-end approximation. Bovée's method.
4. End-in-end. Done by various experimenters, and once in a human case, the result in the latter being a success.

The dangers of these methods of anastomosis may be considered in the main to be those of urinary leakage, fistulæ, and constriction. These dangers are particularly threatening, as may be imagined, in the case of the end-to-end approximation—*i. e.*, without invagination—and the end-in-end, with invagination. Bovée's method has only been used once in a human being, and there has been no experimentation carried out in animals, so there is not enough evidence upon which to base a verdict. Van Hook's method, on the other hand, originated in 1893, as a development of the experimentation of Poggi,² published six years previously, seems, on the authority of his own animal experimentation and also upon that of others, to be free from these objections to a great extent. Kelly³ was the first to use this method in a patient. His operation was performed in 1893, and Emmet⁴ followed with the second case in 1894.

Bovée,⁵ in 1897, was able to collect twelve cases of anastomosis of the divided ends of the ureter. Of these seven were done in Europe and five in America. Among these twelve cases three of the European cases died, but in no one of them could the death be attributed to the ureteral complication. The American cases all lived. In the series there was only one case which showed a leakage, and this soon ceased. But four of these twelve cases were drained, and the author is emphatically against the use of drainage for the ureteral injury *per se*, only advising it if pus be present. Three of the cases in the series reported

¹ Loc. cit.

² Loc. cit.

³ *Riforma Medica*, 1887.

⁴ Loc. cit.

⁵ Loc. cit.

were done by Van Hook's method. All of these recovered, but no positive statement is to be found regarding the development or absence of constriction as a late result. One case done by Poggi's method—the end-in-end invagination—was a success. Seven of this series were end-to-end approximations; and, although three died, there was no leakage in any of the seven, and the deaths were not due to the ureteral condition, as far as can be ascertained. The author's case was the twelfth, and was performed by making an oblique end-to-end anastomosis. It was successful.

As to the actual method of performing the operation of uretero-ureteral anastomosis, it is, first of all, as Kelly insists, of importance to determine the presence of any anomalies, and also to find out whether the ureter is "alive," or, in other words, patulous. Kelly was able to collect five cases from the literature in which the ureter was so occluded by disease that no urine could pass, and the operation, of course, was not indicated. If on palpation the kidney be found atrophic or sclerotic the operation is useless. It may be noted that the soiling of the peritoneum by the escape of urine is an accident of no importance, provided the latter is normal; but as abnormalities may readily be present it is well to try to avoid the soiling of the peritoneum in all cases by the use of pads during the suturing. The use of Kelly's guide is self-explanatory, the transverse bar being introduced into the lower fragment through an incision, and passed out of the ureter through the upper end of the lower fragment and into the lower end of the upper fragment, which is then invaginated into the lower and the suture inserted. The use of this guide enables one to have the aid proposed by Pawlik without the disadvantages of the catheter. Pawlik advised the retention of the catheter to assist drainage, but this is not advisable. In Van Hook's method the lower end of the ureter is ligated, and an incision is made into the wall a quarter of an inch below the point tied. This incision should be twice as long as the diameter of the ureter. By the application of traction sutures the upper end of the ureter is then drawn within the incision and the sutures are applied.

Early in the study of this subject the possibility of intestinal anastomosis presented itself to investigators. As early as 1851 it was performed in a case of exstrophy of the bladder by Simon, upon the suggestion of Roux. This case died in a year with marked kidney changes. Chaput and Leet were more successful, the former having one and the latter two cases which recovered. It is very easy to understand the desire of investigators to prove the applicability of intestinal anastomosis, as if feasible the operation would be much easier of accomplishment than uretero-ureteral anastomosis, on account of the size of the tube into which the ureter is introduced, and also because there would be a complete avoidance of the dangerous traction, which has been

one of the causes of many of the failures of the latter method of operation.

Notwithstanding the encouragement met by some investigators in this field, there seems to be one factor which is insurmountable, namely, the ascending infection, which involves the vast majority of all ureters thus anastomosed. Aside from this difficulty, there seems little reason why the intestines should not be thus utilized, as it has been found, as mentioned by Peterson,¹ that the large bowel in the dog can assume the functions of a urinary reservoir, and that sphincteric control will be maintained. It is to be noted also that while it seems to be the current belief that the mere presence of the urine in the intestines will cause a diarrhoea, there does not seem to be a unanimity in this opinion among many of the men who have had experience in both the human and the experimental cases in which this form of operation has been done. Thus Martin² expresses himself as not in accord with the view that urinary absorption is a great danger, and in quite a number of experimental and also of human cases it will be found that nothing more than a rather increased frequency in evacuations was caused, and that the incontinence of the bowels, so much feared by many, has not, as a rule, been observed.

Unfortunately, however, the question of the liability of ascending infection is one which no one as yet has been able to surmount. By this, of course, is not meant that no case has ever recovered from such an operation and lived for a long period, but that the percentage of cases exhibiting this form of infection is so high that the operation cannot be at present considered as justifiable. Of all the papers published on this subject, that by Peterson³ is the most thorough. The author is rather enthusiastic on the results of his method, which is a modification of Maydl's operation, by which the trigone is transplanted as a whole, thus avoiding any injury to the ureteral orifices, a point upon which Tuffier first insisted, with the idea that infection was prevented by the presence of the supposed ureteral valves. Later investigation seems to show, however, that, as is claimed by Peterson and others, the ureteral muscle in its sphincteric action has no preventive power as regards the ascending infection, and that there is no demonstrable valve at the ureteral orifices; but that the mucous membrane in the immediate vicinity of the orifices has the selective power. Peterson places the mortality of experimental intestinal implantations of the ureter as 61 per cent. in the case of the unilateral and 85 per cent. in the bilateral, and was unable to find a case in which kidney

¹ American Gynecological and Obstetrical Journal, 1900.

² Journal of the American Medical Association, January 28, 1899.

³ *Ibid.*, February 16, 1901.

involvement did not occur sooner or later. The deaths in Peterson's series were due to peritonitis from giving way of the stitches or from uræmia. He collected a series of thirty-three operations by different men in human beings, and found a primary mortality of 33 per cent., with a final mortality still higher. He is able to show one case of unilateral implantation living after eight years, and one of double implantation alive and well after three and a half years. Of the twenty-two cases recovering from the immediate operation there were three subsequent deaths from pyelonephritis and two from uræmia. The author says he is unwilling to call any operation a success which will not bear the test of the double implantation. The above statistics apply to what the author calls the simple anastomosis—*i. e.*, an anastomosis in which the ureters were cut and the free ends inserted into the bowel. In forming his conclusions on the subject, Peterson made three series of experiments. The first of these comprises twenty-eight bilateral anastomoses, without preservation of the trigone. Of these dogs twenty-three died and five recovered, and among these recoveries there was no case which did not show gross lesions of kidney infection. In but one of the five, indeed, was the ureter not patent; but in four there was a distinct enlargement of the lumen, showing that a constriction was present. One of the most interesting facts brought out by this paper is that in one of the five recoveries it was found that the kidneys had been able to overcome the infection, and that they were sterile. The same was true in another of the five cases, in which instance the kidney was at the time of the examination recovering from a pyelonephritis, thus showing that immunity to the colon bacillus was being established. Of course, the cost of the development of such immunity was the production of contracted kidneys.

The second series of experiments comprised sixteen lateral uretero-intestinal anastomoses. Of this number there were but three recoveries. Twelve died from peritonitis because of leakage through stitch holes, and one from hemorrhage. The three recoveries were simply operative, as death followed in all after a short time from kidney infection and pyæmia.

His third group of experiments are those devoted to the implantation in the intestinal wall of the trigone of the bladder, and, while the results obtained are not particularly good, he explains a considerable number of the failures of his earlier operations as due to the fact that, inadvertently, the blood-supply of the trigonal area was destroyed, he believing that it was obtained from the ureteral arteries instead of the superior vesicals, as is really the case. This fault in technique he claims as the cause of the deaths in twelve of the cases of the series. He performed the experimental operation in twenty-one dogs, and reports the results as follows: Twelve deaths from peritonitis, due to

sloughing of the bladder-flap; four from peritonitis, due to other causes; and five recoveries. Of these five cases there was one which showed an occlusion of the ureter, with atrophy of the kidney, caused by poor technique; one showed a kidney free from infection on the side upon which a trigonal implantation had been done, while the other kidney, the ureter of which had been cut and simply anastomosed with the bowel, was the seat of an infection; another of the five died in forty-four days of pyelonephritis, but in this case, while the trigone had been transplanted, it is to be noted that the mucous membrane had been removed from around the ureteral orifices. The fourth case showed a similar result with the one just reported, though the process was more rapid, there being found after its death on the eighth day a pyelonephritis on the side upon which a simple anastomosis had been done, while on the other side, which had been the seat of a uretero-trigono-intestinal anastomosis, the kidney was free from infection. The last case of the series lived for a period of two months without signs of kidney involvement. The author, as the result of his studies, claims that the operation of uretero-trigono-intestinal anastomosis, while admittedly very serious, is justifiable in cases in which the only alternative is removal of the kidney after ureteral injury, or in which malignant disease demands the removal of a large portion of the bladder. He feels that the ordinary operation of anastomosis is not justifiable, on account of the great preponderance of the cases in which infection follows, and, moreover, because of the difficulty, which he regards as insurmountable, of anastomosing without causing more or less constriction of the ureter, the bad results of which in the production of cystic disease of the kidney are self-evident.

Martin,¹ in a paper advocating the removal of the bladder in cases of malignant disease of that viscus or of the uterus involving it secondarily, admits that the main difficulty is not in the removal of the bladder, *per se*, but in the after-disposition of the ureters. He advises that they be anastomosed, by Maydl's operation, to the bowel because of the reservoir space and sphincteric control which is obtained. He admits the grave dangers of subsequent infection, but is able to collect a series of sixty-two cases in which there were forty-eight recoveries. Of these recoveries thirty-three were done according to the method of Maydl, which is an additional proof of the claims made by Peterson. Unfortunately, however, this operation cannot be done if the whole bladder is sacrificed, and the author in such cases advises that the ureters be anastomosed in such a manner that they will enter the bowel in a direction from above downward, and that they be buried in the musculature of the wall for an inch or more. This is, in essentials,

¹ American Gynecological and Obstetrical Journal, May, 1900.

the position advanced at one time by Tuffier, but other experimenters, among them Peterson, have not found that the actual results obtained will support this claim.

Kalabin¹ made a series of experiments as to the feasibility of rectal implantation, but his results simply accentuate those obtained by the investigators already quoted in showing the dangers of the operation, particularly the simple form. His series was a short one, only comprising four operations. Of these dogs three died, two from peritonitis and one from uræmia. The fourth lived for a year, and was then killed for the purposes of his paper. There had been an entire absence of symptoms, and the post-mortem showed an entirely normal condition of the intestinal and ureteral mucous membrane. The kidney of the side upon which the transplantation had been done showed, however, a somewhat extensive change of a cirrhotic nature.

Barbat² has favored a rather unique method of anastomosis. His plan is to isolate a piece of intestine long enough to reach to the bladder from the proximal end of the ureter. This piece of gut is carefully cleansed, a solution of formalin (1 to 1000) being used for the purpose, and after the ureter has been introduced the other end is inserted into the bladder. In the case of a double anastomosis being demanded he would isolate a loop of gut long enough to permit its point of greatest curvature to reach down to the bladder, and would anastomose the ureters to its ends. Great care should, of course, be exercised not to injure the mesentery. There seems absolutely no use for this procedure, in our opinion, since it demands for its performance the presence of the bladder, and adds to the always formidable anastomotic operation the dangers incident to a resection of the gut. Moreover, it does not seem possible that the dangers of infection from the bowel can be obviated by the formalin sterilization. That the author is enabled to report two successful cases in a series of three operations upon dogs speaks well for his skill and for the recuperative powers of the animals, but we fail to see that there are any other deductions possible.

It is plain, therefore, from this hurried review of the subject of uretero-intestinal anastomosis, that the difficulty is one of infection of the ureters and kidneys, and to a less extent the causation of a certain amount of constriction leading to kidney enlargement. It may further be accepted that the simple anastomosis of the ureters to the intestines is not a permissible operation, as if an immediately fatal result is avoided there will be certainly a gradual kidney involvement, sooner or later manifest. The operation as proposed by Maydl, and

¹ Centralblatt für Chirurgie, December 23, 1899.

² Journal of the American Medical Association, August 3, 1901.

elaborated experimentally by Peterson, may in the future give better results; but at present, while his results seem more favorable than those of any other experimenter, they are not sufficiently encouraging to render their adoption justifiable in the human patient. There seems to be a certain amount of evidence to show that some cases may develop an immunity to infection, as in some of the human cases of anastomosis reported there was history of back pains, gradually disappearing; and among the experiments of some of the authors mentioned cases were noted at autopsy in which there was found a condition of contracted kidneys, and also in one case of Peterson's the dog's kidneys were found to be recovering from a pyelonephritis. Moreover, it is a well-known fact that the ureteral orifices, which in cases of exstrophy of the bladder are often liable to the contact of septic material, because of faulty care in diapering, sometimes resist infection for long periods. Reasoning from analogy, there seems some evidence also, as it is a well-known fact that in birds the urine and feces are deposited in a common receptacle or cloaca. This bird analogy has been advanced by Martin, among others, in support of his position, and he assumes that the production of this immunity to kidney infection may not be a matter of hereditary cycles, but that by improved methods of operating and after-treatment we may in the future be able to surmount the dangers of ureteral infection as we have already done in respect to infection of the peritoneal cavity. Van Hook, on the other hand, denies the applicability of the bird analogy, taking the ground that heredity plays an essential part in the production of such immunity, and, moreover, because of the difference between the character of the excrement voided by birds and that voided by human beings, the urine of the former being much less liquid than is the case with man, and therefore not as likely to carry an infection upward. Of course, arguments by analogy are rather dangerous until all of the facts of the case are in our possession; but it certainly seems a very questionable procedure to admit, as an operation of election, the anastomosis of the delicate ureter—perhaps the most carefully guarded excretory duct in the human economy—into an excretory system which, without exception, is always actively septic.

With regard to the remaining sites of ureteral implantation but little need be said, as from a practical stand-point none is of sufficient value to make its detailed consideration worth while. Though Bovée considered skin implantation about on a par with that into the bowel, and Martin has reported two cases of implantation upon the surface of the body, other men have determined that from the stand-point of infection it is even less trustworthy. Aside from this, the fact that a patient is debarred from all social duties, and becomes personally disgusting, would be sufficient to exclude this procedure from the list of legitimate

operations. The propositions of Van Hook, Nussbaum, and Rydygier, to connect the severed ends of the ureter by implanting each in the skin, and then, by plastic operations, to construct in various ways a channel between these ends, are, while interesting as experiments, of no value practically, as either bladder, uretero-ureteral, or bowel anastomosis are far preferable. Kelly considers skin implantation in the same class with nephrectomy.¹

The vagina as a site for ureteral implantation has the advantage of reservoir space, but this is the only possible advantage which it possesses, although Bovée has considered it to be preferable to the bowel, and, indeed, places it immediately after the method of anastomosis with the bladder. He considers that uretero-ureteral anastomosis is the best method of all. It is to be remembered that he considered the simple bowel implantation only, and not the trigonal implantation, which had not at that time been brought to the attention of the profession by Peterson.

Among the curiosities of the subject is the case reported by Boari² (case operated on by Nichaus), in which an anastomosis was made between the ureter and the urethra. This man recovered from the operation. Adolfo and Schwarz report anastomoses made in animals between the same structures, in which after a time a new bladder was formed from the urethra, and continence maintained by the development of a vesical sphincter from its muscle. Finally, there are two methods of dealing with a severed ureter to which consideration should be given, in order, in the one case, to unreservedly condemn, and in the other to advise the limitation of its application to the case alone in which the condition of the patient is so precarious that there is no time for a formal operation of anastomosis. The procedure to be condemned is nephrectomy, done first by Simon, in 1871, to meet the indications of ureteral fistulæ. While formerly there was an excuse for recourse to this operation, at the present time none can be offered. The other procedure is the aseptic ligature of the severed ureter—an operation hardly less dangerous than nephrectomy, and whose only claim for recognition rests upon the fact of the short time necessary for its performance. It is, of course, of paramount importance to be very careful that the ligation be done under the most rigid aseptic precautions, as otherwise a pyonephritis or peritonitis may result. As soon after ligation as the extravascular urinary pressure equals the intravascular blood-pressure

¹ Of interest but of no practical application to this question are the researches of Rosenberg and Bardenheuer on the subject of the metamorphosis of the epithelium of transplanted mucous membranes, upon which Van Hook based his supposition that the skin surface used as a link would finally exhibit the characteristics of the ureteral membrane.

² *Annales de Maladies des Organes Génito-Urinaires*, vol. xiv., Paris, 1896.

the function of the organ will be abolished, and atrophy of the kidney will in the majority of cases follow. The organ at first enlarges; but if the ligature has been well applied, thus insuring a sudden cessation of excretion, there will be, according to Orth, but little sacculation. Indeed, the danger of hydronephrosis is less in the case of complete ligature of the ureter than in many cases of uretero-ureteral and other forms of anastomosis. Guyon, who advised the use of the ligature in cases demanding speed, supports this claim, as do also Cohnheim, Straus, Albarran, Germont, and Byron Robinson. Wladimiroff,¹ however, while finding his results, as a rule, in accord with those of the investigators just mentioned, reports two cases of pyonephrosis in a series of nineteen ligations. Of course, this may be looked upon as due to some failure in technique; but notwithstanding the rather favorable results as reported by some men on the basis of animal experimentation, the operation should be considered as only applicable to the few cases in which the time element is of paramount importance.

In addition to the references given in the article the papers by the following authors have aided in the compilation of this review:

- Reynolds. Boston Medical and Surgical Journal, January 24, 1901.
 Schopf. Allgemein Wiener medicinische Zeitung, 1886, No. 31.
 Cushing. Annals of Gynecology and Pediatrics, February, 1893, vol. vi.
 Bloodgood. Johns Hopkins Hospital Bulletin, 1893, vol. iv. p. 89.
 Reed. Journal of the American Medical Association, 1895.
 Smith. Philadelphia Medical Journal, October 19, 1901.

¹ Zeitschrift für Geburtshilfe und Gynäkologie, 1898.