

OPERATIVE INJURIES OF THE URETER

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INJURY of the urethra, bladder, and ureter continues to plague the gynecologic surgeon because of its frequency as a complication of pelvic operations. Of these, injury to the ureter is the most common and most serious. Various observers place the incidence of ureteral ligation as a complication in 1 to 3 per cent of all operations on the female genital organs. Although a fairly large number of case reports of operative injury of the ureter is revealed in a survey of the literature, it is very likely that most of the cases have never been reported and that many of these have passed unrecognized. Caulk and Fischer speak of the accident occurring much more frequently than is generally believed. Sampson, in one of the first comprehensive papers on ureteral trauma, claims that the injury, either in the form of ligation or clamping "is of common occurrence during gynecological work."

A notable presentation by Bland, in 1925, brought the literature up to that date. This paper included Herman's series of 24 bilateral cases, Barney's report on 63 cases, including 32 cases presented by Sampson in 1902, and a group of 159 cases presented by Oeconomes. Thus, Bland collected from the literature a total of 316 cases, and he himself gathered 125 additional cases from men active in abdominopelvic surgery. Nevertheless, he emphasizes the fact that, even with this large array of cases collected, it is probable that a large number of others have not been recorded, or have escaped recognition.

In addition to the 8 cases recorded herein, we

have collected from the literature, both here and abroad, another group of 260 cases, which were reported from 1925 to 1936. This brings the total up to 710 cases, of which 109 were bilateral and 601 unilateral.

TYPES, ETIOLOGY, AND RESULTANT EFFECTS OF URETERAL INJURY

Injury to the ureter may result from direct trauma, such as cutting (complete or incomplete), puncture, crushing by clamps, or by ligation. Occasionally, the wide dissection of the Wertheim technique leads to sloughing of the ureteral wall due to disturbance of its blood supply. In the majority of instances, ureteral injury is unilateral. Bilateral involvement of the ureters occurs in about one-sixth of the cases.

In clinics in which the radical abdominal hysterectomy for carcinoma of the cervix is performed, this operation is most frequently responsible for the occurrence of the accident. Vaginal hysterectomy is next in frequency. Abdominal hysterectomy was the primary operation in 4 of the 8 cases reported in this presentation. In 3 of them, the hysterectomy was performed for multinodular fibroid uteri, and in 2, the hysterectomy was complete. When chronic pelvic inflammatory disease distorts the anatomy during a hysterectomy for a fibroid uterus, or when cervical or intraligamentous myomas change the normal relations of the pelvic course of the ureter, the risk of injury is increased. Operations for intraligamentous tumors are especially prone to this complication. In 1 case of this series, the ureters were bilaterally involved during a Fothergill operation.

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The result of accidental occlusion or injury of the ureters is governed by the location and extent of the damage.

The following summary by Robinson covers all eventualities:

A. Unilateral. 1. Section, followed by leakage and acute infection, either local or widespread.

2. Partial section with subsequent leakage and fistula formation, either uretero-abdominal or, and more likely, ureterovaginal.

3. Ligation, followed by atrophy of the kidney, with or without symptoms of renal inadequacy. In some cases, acute or chronic uremia.

4. Ligation with reflex suppression and complete anuria (1.6 per cent—Barney).

B. Bilateral. 1. Double section, followed by leakage, general infection and death.

2. Double ligation with anuria and uremia; fatal if unrelieved.

C. Partial occlusion or kinking from peri-ureteral adhesions following various abdominopelvic operations.

In the 260 cases collected from the literature during the period 1925-1936, unilateral injury occurred in 236 cases, as follows:

1. Radical abdominal hysterectomy for cancer.....	54
2. Total abdominal hysterectomy: (a) For uterine and cervical myomas or extensive pelvic inflammatory disease	48
(b) Ruptured uterus.....	1
3. Supracervical hysterectomy: (a) Indication not stated.....	26
(b) Complicated by chronic adnexal disease....	18
4. Vaginal hysterectomy: (a) Cancer of cervix and portio (radical Schauta method).....	13
(b) Prolapse.....	6
(c) Myoma.....	3
(d) Indication not given.....	13
5. Salpingo-oophorectomy: (a) Ruptured ectopic...	5
(b) Ovarian cyst or adnexal disease.....	19
6. Operation for removal of intraligamentous tumors	19
7. Obstetrical procedures: (a) Extraperitoneal cesarean	1
(b) Forceps.....	5
8. One each of the following: inguinal herniotomy, incision and drainage of pelvic abscess, and operation for carcinoma of the rectum.....	3
9. Anterior colporrhaphy.....	2

CASE REPORTS

CASE 1. Unilateral injury—asymptomatic unilateral ligation. Mrs. N. H., aged 31 years. Previous operative procedure 4 years ago: left salpingo-oophorectomy for chronic tubo-ovarian disease. Patient was admitted to the Israel Zion Hospital, March 23, 1932, with complaint of pain in left lower quadrant of abdomen.

Pelvic examination revealed the uterus to be of normal size but displaced to the right by a tense cystic mass, which occupied the left lower quadrant. The impression was that of an intraligamentous cyst.

Operative findings: The left ureter had been ligated at the previous operative procedure, 1 inch from the bladder end, and the result was a huge hydro-ureter. The pelvic portion of the ureter was dilated to the size of an orange; the middle third of the ureter was dilated 1 inch in diameter, narrowing to one-quarter of an inch at the upper end. The kidney was atrophic, the size of a plum.

Procedure. The broad ligament was divided. The pelvic portion of the ureter, which was markedly adherent to the

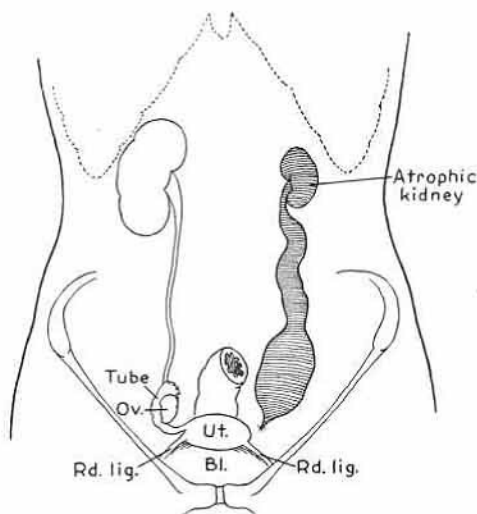


Fig. 1. Giant hydro-ureter resulting from accidental ligation of distal end of ureter; Case 1.

adjacent tissue, was exposed and separated by blunt dissection. The middle portion of the ureter was also exposed, by incising the posterior peritoneum, and freed from its adhesions. The entire ureter and kidney were removed.

Convalescence was complicated by a vesicovaginal fistula which healed spontaneously. The patient left the hospital in good condition, within 3 weeks of the time of operation.

This case illustrates the fact that in many gynecological operations the ureter is tied, yet convalescence is uneventful and any symptoms produced by the ligation are easily obscured by other postoperative symptoms; thus the unilateral ligation goes unrecognized, with the ultimate result that the corresponding kidney dies. We are forced to the conclusion that many deaths, even when "suppression of urine" has been given as the cause of death following pelvic operations, are actually due to ureteral occlusion.

CASE 2. Ureterovaginal fistula treated by end-to-end anastomosis. Y. C., aged 43 years, was admitted to the Israel Zion Hospital, June 24, 1925. Primary operation, bilateral salpingo-oophorectomy, had been done 4 months previously. Eight days later, the patient began to dribble urine per vaginam.

The *cystoscopic* findings were as follows: Bladder capacity was normal, the bladder urine clear. Both ureteral orifices were normal except that the left one did not seem to function. The catheter could be passed up easily on the right side. On the left side the catheter met with an impassable obstruction $4\frac{1}{2}$ inches from the bladder.

Operative procedure. A catheter was passed up the left ureter as far as the site of obstruction. An incision, 6 inches in length, parallel to, and about 0.5 inch above, Poupart's ligament, was made. The muscle was divided by blunt dissection, and the posterior wall of the pelvis was exposed retroperitoneally. After exploration, the lower end of the upper section of the severed ureter was isolated. It was found to be greatly distended, its caliber being about the

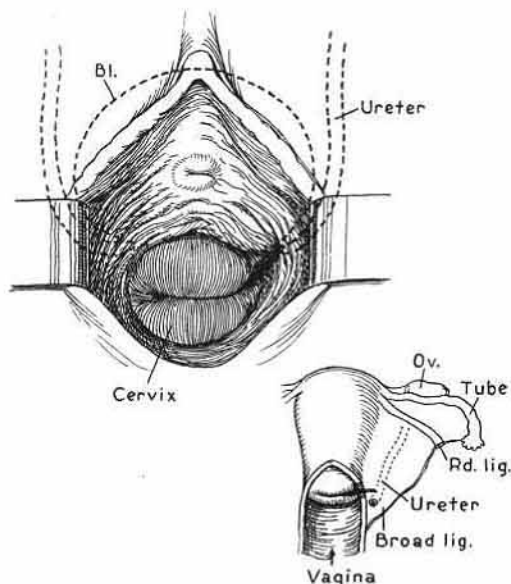


Fig. 2. Deep laceration through the left angle of the cervix, extending up into the broad ligament, and involving the distal end of the ureter. Case 3.

size of one's thumb. The lower segment of the ureter was found collapsed and hugging the ureteral catheter introduced from below. The two ends of the ureter were freed, and an end-to-end anastomosis was performed. The ureteral catheter was passed up through the point of union and on into the upper segment as far as the kidney pelvis.

The convalescence was smooth and urinary drainage via the catheter was adequate. The patient was discharged August 15, 1925. At that time the incision was healed except for a small opening, through which escaped a free watery-urinous discharge (persistent uretero-abdominal fistula). There was no evidence of vaginal leakage.

Bump and Crowe state that when ureteral anastomosis over a catheter is done the kidney pelvis should always be drained through a pyelostomy or ureterostomy above the line of repair. Had such prophylactic drainage been utilized in this case, the poor result obtained perhaps might have been avoided.

CASE 3. Uretrocervical fistula treated by ureterovesical anastomosis. R. R., aged 31 years, was admitted to the Israel Zion Hospital August 25, 1924. Four months before admission, the patient had had a difficult forceps delivery of a dead fetus, with the result that there was a deep laceration through the left angle of the cervix, extending up into the broad ligament. This laceration apparently missed the uterine vessel, but involved the left ureter, as urinary dribbling followed immediately.

Examination on admission showed a thick scar in the cervix, extending up into the base of the broad ligament, and urine was observed escaping from the cervical canal.

Cystoscopic examination, with ureteral catheterization, revealed an impassable obstruction 1.5 inches from the left bladder orifice.

Operative procedure, August 27, 1924. An incision was made just above, and parallel to, Poupert's ligament on the left side. The ureter was identified and separated down to the level of its crossing the uterine artery. The ureter showed no evidence of dilatation, and the point of injury was apparently at that level. The distal end of the ureter was ligated. The proximal end was then implanted into the bladder through a small incision which had been made in the latter viscus, for this purpose.

In the week following operation the patient's condition was fairly satisfactory, except for a profuse seropurulent discharge of urinous odor, through the incision. For 2 weeks thereafter, the patient ran a septic temperature with drainage of pus and urine from the wound. On the twenty-first day after operation there was a profuse hemorrhage from the lower angle of the incision and the patient went into shock. She was taken to the operating room and the wound was explored. It was found that there was extensive retroperitoneal extravasation with free bleeding from a large vessel adjacent to the point of anastomosis. This vessel was ligated, and the wound was cleansed and packed with iodoform gauze. The usual shock treatment was instituted, including blood transfusion, but was unavailing and the patient expired 2 hours later.

CASE 4. Uretrovaginal fistula treated by nephrectomy. S. G., aged 40 years. Hospital No. 2778. Patient was admitted to hospital with fibroid tumor of the uterus. Pelvic examination revealed an irregular, hard tumor mass, the size of a grape fruit, in the fundal portion of the uterus.

On November 25, 1921, panhysterectomy was done.

Urinary leakage was observed from the vagina on the second day after operation. The patient had a stormy convalescence for the next 4 weeks, during which time there was considerable discomfort in lower abdomen with intermittent temperature, varying from 99 to 103 degrees. Marked frequency and urgency of urination were also present.

The patient was re-admitted to the hospital March 12, 1922. At that time there still was a free leakage of urine from the vagina. Cystoscopic examination revealed that the "bladder now practically normal. Ureteral catheter passed without difficulty up the right ureter. On the left side, an obstruction was encountered about 1 inch or 1.5 inches from the bladder. The right ureteral orifice was excreting normally, with a good functional reaction in 3½ minutes. No urine was excreted on the left side."

On vaginal examination urine was observed escaping from the left upper angle of the vaginal vault. The impression recorded on the chart was that there was present a ureterovaginal fistula secondary to incomplete section of the ureter at the time of the original hysterectomy.

In view of the poor general condition of the patient, it was considered inadvisable to attempt ureteral anastomosis or implantation of the ureter into the bladder. Therefore, a nephrectomy was done March 16. Convalescence following nephrectomy was uneventful, all urinary symptoms gradually disappeared, and the patient was discharged April 15, 1922. The family physician reports that at present the patient is in fairly good health with no direct sequelæ resulting from her operative complication.

CASE 5. Bilateral ligation treated by deligation. S. S., aged 33 years, was admitted to the Israel Zion Hospital, November 8, 1929. Following a curettage performed for incomplete abortion, the patient went into extreme shock. Accidental perforation of the uterus was suspected. At laparotomy, 2 hours later, the abdomen was found full of blood-clots from a tear involving almost the entire breadth of the uterus and extending into the left broad ligament. Hysterectomy was performed with marked difficulty because of continuous bleeding from retracted vessels, which

made it necessary to take deep bites with mass ligatures in order to control the bleeding. A transfusion of 1000 cubic centimeters of whole blood was given. Eight hours after operation, 12 ounces of urine was obtained on catheterization. No urine was voided in the following 24 hours, at which time it was determined by catheterization that the bladder was empty.

Cystoscopy was now done under local anesthesia. "Both ureteral orifices were congested, flaccid, gaping, with no visible peristalsis. No urine was seen coming from either ureter. Catheters could not be passed beyond 4 centimeters from the bladder on either side."

An immediate laparotomy was done. The previous mid-line incision was opened. *Cystoscopy* was done at the same time, with ureteral catheters in place. On the left side, the ureteral catheter was palpated at the point of obstruction, and the sutures in that region near the cervical stump were cut. The catheter was then introduced beyond the obstruction and urine began to flow. The same procedure was followed on the right side, but the obstruction was found near the base of the ovarian ligament. Urine also began to flow freely from this side. The abdomen was closed. Both catheters were left *in situ*. Convalescence was stormy, in spite of the fact that urinary secretion was adequate. The patient died on the fifth day.

Opinion. Sepsis, pneumonia, paralytic ileus.

CASE 6. A. S., aged 39 years, was admitted to the Beth Moses Hospital, January 12, 1933. A total hysterectomy for fibroid uterus and lacerated, eroded cervix was followed by complete anuria for 24 hours.

The general condition of the patient appeared good. The abdomen was soft. Her only complaint was nausea with occasional vomiting. No pain or tenderness was noted over either kidney region. She was taken to the operating room 24 hours after operation and cystoscoped. *Cystoscopy* showed the following: "Both ureteral orifices appear motionless; no urine is seen escaping from either orifice. Ureteral catheterization was attempted and both ureters were found obstructed 1 inch from the bladder end."

Operative procedure and findings. Immediate laparotomy was done through the previous incision. Although only 24 hours had elapsed since primary operation, the pelvic tissues were markedly thickened and edematous. The normal anatomy was completely distorted by a massive exudate which completely buried the cervical stump. The tissues on either side of the latter were separated by blunt dissection. The right ureter was isolated and found to be dilated to about the size of one's little finger. It was freed downward toward the bladder until the point of obstruction was reached. The offending ligature was found to be that which included the dense basal segment of the broad ligament on each side of the cervix, together with the vascular plexus adjacent to it. Both ligatures were cut with considerable difficulty because of the depth of the pelvis, the dense exudate, and the general oozing. The ureteral catheters, which had been previously passed through the cystoscope, were now advanced up on both sides to the pelvis of the kidney and urine was immediately excreted on both sides.

The postoperative reaction was poor; the patient was in moderate shock. She was transfused 4 hours later. She was catheterized and 14 ounces of urine was obtained. During the following 24 hours the patient excreted 60 ounces of urine. Her condition, nevertheless, gradually grew worse and she expired 36 hours after operation.

In explaining such mortalities, Barney has pointed out that the suppression of urine alone is not the determining factor. In neither of these

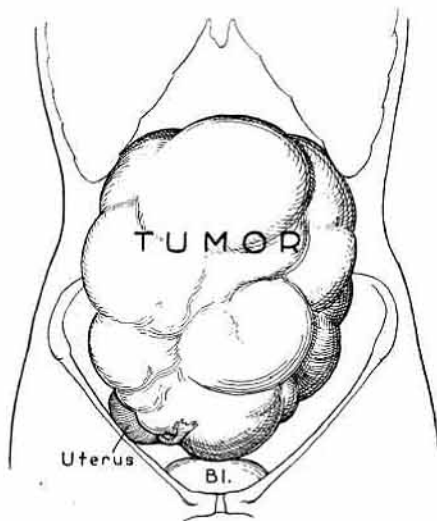


Fig. 3. Huge tumor mass, originating from the left intraligamentous fossa, occupying the entire abdominal cavity, and displacing small uterus to the extreme right. Case 7.

cases was it long drawn out; as a matter of fact, the condition may exist for a much longer period of time before death ensues. Morris cites a case of anuria of 17 days' duration, while another surgeon with whom Barney corresponded, saw in consultation a patient who had passed no urine whatever for 23 days. Both these cases terminated fatally, but they serve as proof that the human system can sometimes offer good resistance to this particular onslaught. In the type of case under consideration, Barney ascribes the high mortality to other factors, such as severe and prolonged operation in a patient who is already below par and to whom the ureteral injury is merely the last straw. In our experience, deligation has proved a formidable operation which presents unusual technical difficulties. These are, chiefly, the extreme anatomical distortion, the extensive exudate, and the inevitable bleeding in the operative region.

CASE 7. Bilateral ligation treated by nephrostomy. Case No. 65218, Mrs. A. J., aged 43 years, was admitted to the Beth Moses Hospital, September 20, 1934. Her chief complaint was intermittent vaginal bleeding and marked enlargement of the abdomen. The previous history was essentially negative, except for a cesarean section 7 years ago. Pelvic examination revealed a normal size uterus which was displaced to the extreme right by a tumor mass filling the entire pelvis. Abdominally, the same tumefaction, reaching up to the costal margin on both sides, could be palpated.

Operative procedure and findings. At operation, a huge tumor mass, which originated from the left intraligamentous space, displacing the uterus to the extreme right and

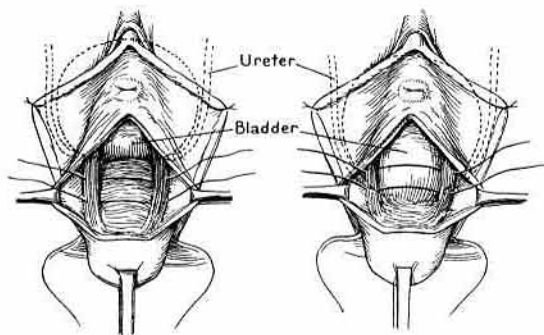


Fig. 4A, left. Fothergill operation with bladder and ureters mobilized and pushed above range of sutures. Case 8.

Fig. 4B. Fothergill operation. Bladder insufficiently mobilized, ureters within range of sutures. Case 8.

occupying the entire abdominal cavity, was found. The operative procedure consisted of supracervical hysterectomy and bilateral salpingo-oophorectomy, which was attended by great technical difficulties because of the unusual distortion of the anatomy. During the course of the operation, the bladder, which was densely adherent as a result of the previous low two-flap cesarean, was accidentally incised. At no time during the operation were the ureters visualized. The perforation in the bladder was repaired and a drain was inserted into the space of Retzius. At the end of the operation, a Pezzer catheter was introduced into the bladder *per urethram*. The immediate postoperative course was uneventful, except that no urine was expelled through the catheter. After 20 hours of anuria, it was suspected that the ureters had been occluded by ligatures.

A cystoscopy was performed and attempts to pass ureteral catheters up to the pelvis of the kidney failed on both sides. Both met with impassable obstructions about 2 inches from the ureteral orifices. Indigo-carmin injected intravenously did not appear from either ureter after 20 minutes.

A right nephrostomy was done at once. The kidney appeared large, hydronephrotic, and congested. A curved Kelly clamp was thrust into the pelvis of the kidney and a considerable amount of bluish fluid (urine discolored by indigo-carmin) gushed from the wound. A Pezzer catheter was inserted.

The patient was given a direct blood transfusion of 350 cubic centimeters and rallied immediately. For the first 48 hours there was very little secretion through the nephrostomy tube, but on the third day a flood of urine was excreted, saturating the bed. This profuse drainage continued until the eighth day after operation when bloody fluid of urinous odor was removed from the bladder by catheter. Drainage through the nephrostomy wound decreased to almost nil and the tube was removed on the twelfth day after operation.

The blood chemistry figures in this case were extremely interesting, showing enormous nitrogenous retention. On the second day after the nephrostomy, and before any urine had appeared, the urea nitrogen was 110 and the creatinine 10 milligrams. Two days later, with urinary excretion, the urea nitrogen was 76 milligrams and the creatinine 4.35 milligrams. Eight days later, the urea nitrogen was 17 milligrams.

On the twenty-fourth day after operation cystoscopy was done and again both catheters met with obstructions at the same level as before the nephrostomy, but the indigo-

carmin was recovered from both sides within 5 minutes after intravenous injection of the dye.

The patient was discharged from the hospital on the thirty-fifth day after admission.

In retrospect, the question that arises in this case is whether the ureters had been ligated with catgut and the lumen restored as soon as the catgut was absorbed. It has been shown experimentally that plain catgut is not absorbed before the end of the third week, whereas this patient developed spontaneous restoration of ureteral function 8 days after the nephrostomy. It would appear that the obstruction in this instance may not have been due to encircling ligatures, but to kinking and inflammatory swelling, on the subsidence of which the ureters opened spontaneously.

CASE 8. Bilateral ligation treated by vaginal deligation. F. B., aged 56 years, was admitted to the Israel Zion Hospital, March 10, 1936.

Operative procedure. Anterior colporrhaphy, Fothergill method. The immediate postoperative reaction was good. However, during the following 24 hours, no urine was excreted through the retention catheter, thereby arousing the suspicion of the operator that both ureters had been occluded by the ligatures. At this time a cystoscopic examination revealed the following: "Right ureter identified, and showed marked edema and pouting. All attempts to pass a ureteral catheter into the orifice were unsuccessful, due to edema. The same condition was found on the left side. It is believed that the edema is secondary to ligation of the ureters higher up. Following intravenous indigocarmine, no dye appeared in the bladder after 30 minutes."

An immediate deligation from below was decided upon. The repaired anterior perineal wall was reopened, and the superficial sutures were incised, the three interrupted sutures approximating the lateral pubocervical tissues (bladder pillars) being laid bare. All three sutures were cut, thus revealing the uppermost of the three to be the culprit. The area thus freed was packed with iodoform gauze and the mucous membrane approximated with continuous locked sutures of chromic catgut. A cystoscope was then introduced into the bladder, and a No. 4 F. catheter met with obstruction on both sides, about 4 centimeters from the bladder (probable point of ligation); with great difficulty, this obstruction was overcome, and both catheters were passed up to the level of the kidney pelvis; urine immediately returned from both sides, and it was tinged with the blue dye; the catheters were left *in situ* for drainage. In the next 24 hours, 32 ounces of urine was excreted through the catheters. The ureteral catheters were then removed and the patient was catheterized at intervals of 6 hours for the next 5 days. On the seventh day after operation, the patient voided spontaneously, and from that time on the convalescence was uneventful.

Fortunately, this type of injury as a complication of anterior colporrhaphy is extremely rare. This is confirmed by a personal communication from Dr. William Fletcher Shaw, of Manchester, who writes: "In this city we do some hundreds of this operation every year and have done so for the last 30 or 40 years, and I have never known a case in which even one ureter was tied. I can only suggest that this accident occurred because: (1) the

should be done, in the form of uretero-ureteral or ureterovesical anastomosis.

Where both ureters have been ligated and it is not discovered until the following day or later, the condition is a serious one. The combination of complete anuria and threatening uremia makes immediate surgical intervention imperative. The three alternative procedures to be considered are: deligation of the ligated ureter, nephrostomy, ureterovesical anastomosis.

CONCLUSIONS

1. From the large number of cases of ureteral damage recorded in this paper, it is evident that the accident is a surgical complication far more common than is generally assumed.

2. It is quite likely that a certain number of unilateral ligations occur during the course of pelvic operations which are not recognized and which do not provoke immediate symptoms, with ultimate autonephrectomy on the corresponding side.

3. This accident may be sustained during any pelvic operation, but it is more common following radical abdominal or vaginal hysterectomy and notably in operative procedures for the removal of intraligamentous tumors. In selected cases in this group, catheters may be inserted into the urethra before the operation is started, as an additional safeguard.

4. The majority of cases are those of unilateral injury; more rarely, both sides are involved, the proportion being 6 to 1.

5. As an index of the seriousness of ureteral injury may be mentioned the mortality figures quoted by Bland of 33.3 per cent for the bilateral, and 18.8 per cent for the unilateral cases.

6. The most common sequelæ of ureteral injury are vaginal and abdominal fistulas.

7. If the ureter is divided during the course of a hazardous or markedly prolonged operation, the operator may be compelled to resort to ureteral ligation; but this is justifiable only when the risk of reparative procedure for the restitution of function of the injured ureter appears too great.

8. If a ligature or clamp has been placed on either one or both ureters, and the injury is detected at the time it is inflicted, and there is evidence that the vitality of the ureter has been so imperiled that fistula is likely to develop, immediate repair should be done in the form of uretero-ureteral or ureterovesical anastomosis.

9. In the case of bilateral occlusion, discovered after operation, with imminent danger of uremia, immediate deligation is the operation of choice, provided the patient's condition is such that she can endure this hazardous and time-consuming operation.

10. Nephrostomy may be the most feasible procedure when intra-abdominal work is contra-indicated by gravity of patient's condition. This drainage should preferably be bilateral.

11. In view of our results of 100 per cent mortality with two intra-abdominal deligations, the writer feels that nephrostomy with subsequent operation for ureteral anastomosis or bladder implantation, when found necessary, is a much safer and, therefore, a preferable procedure.

12. Finally, the operator, when confronted with a damaged ureter, should be prompted in his selection of the reparative procedure with the fundamental aim in mind of the preservation of both ureteral and kidney function.

The author is indebted to those members of the staff who permitted him to utilize the records of their private patients as part of this study; and he gratefully acknowledges the co-operation of Dr. Maxwell Dorr and Dr. Harry Ehrlich for their assistance in assembling the preliminary data. He also desires to express his appreciation of the assistance given him in the completion of this survey by the Literary Research Department of the American College of Surgeons.

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