

# Ureteral Injury in Pelvic Surgery

## *Current thought on incidence, pathogenesis, prophylaxis, and treatment*

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### HISTORICAL BACKGROUND

URETERAL injuries date back to the beginning of pelvic surgery, when ureters were inadvertently cut, ligated, or clamped by surgeons in operations for the removal of the uterus and other pelvic organs. In 1841, Berard reported a method of ureteral reimplantation into the bladder to correct ureteral injury. Simon, in 1869, first performed a cutaneous ureterostomy following ureteral injury during an ovarian operation. In 1895, Tuffier reported 40 cases of ureterovaginal fistula following vaginal hysterectomy.

In 1902 and 1904, Sampson published a series of three papers<sup>24, 25, 26</sup> dealing with the incidence, pathogenesis, prophylaxis, and treatment of ureteral injuries. He pointed out that ureteral injuries occurred most frequently as complications of total hysterectomy for carcinoma of the cervix, although

they could follow any pelvic operation. He noted that they were caused in one of two ways: either by direct injury to the ureter by cutting, clamping, ligating, or kinking, usually in an attempt to control hemorrhage deep in the pelvis, or as a result of post-operative necrosis by stripping the ureter of its periureteral sheath and accompanying blood supply.

### CURRENT DATA

#### *Incidence*

It is the consensus that more injuries occur than supposed.<sup>1, 3, 8, 11, 18, 21</sup> First, there are an allegedly high number of silent ureteral injuries in which the patient suffers hydronephrotic atrophy of the kidney without knowing it. Newell reported 6 cases found at autopsy which had been unsuspected. Since other types of hydronephrosis usually give rise to symptoms, one may speculate as to whether the overlooked cases exist due to diagnostic deafness or to silent pathology. Second, injuries are said to be more common than supposed because of the natural disinclination of operating surgeons to publish reports of these complications. This is probably true, as scores of articles have appeared by surgeons repairing these defects in contrast to the handful of those reporting injuries they had caused. In searching the literature,

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we have been able to find only seven such series (Table 1).<sup>12, 16, 18, 23, 24, 26, 33</sup>

*Pathogenesis*

Most direct injuries occur in controlling hemorrhage, or during the removal of large malignant tumors.<sup>1, 5, 8, 18</sup> Total hysterectomies are accompanied by the most injuries, as the final clamps are applied in close proximity to the ureters. All authors agree with Barrett's statement that "Even the most expert and experienced surgeon may find himself one day contemplating an injured ureter, no matter how wary he may be."

2. Ligation with subsequent slough and ureterovaginal fistula, postoperative ureteral necrosis and ureterovaginal fistula,
  - a. Constant dripping of urine from vagina despite normal filling and emptying of bladder,
  - b. Flank pain and sepsis may disappear with the development of the fistula.
3. Ligation with subsequent slough, or ureteral necrosis, with extravasation into the peritoneum.
 

Signs and symptoms of peritonitis.
- B. Bilateral injury,
  1. Ligation,
 

Anuria.
  2. Slough or necrosis,
    - a. Bilateral ureterovaginal fistula. Pa-

TABLE 1. REPORTED INCIDENCE OF URETERAL INJURY IN PELVIC SURGERY

Author	Year	No. cases	Injuries	
			No.	Percentage
Wertheim <sup>33</sup>	1900	500 Radical panhysterectomies	50	10.0
Sampson <sup>24</sup>	1902	995 "Major pelvic gynecologic surgery"	15	1.5
Sisk <sup>20</sup>	1935	Not counted	—	—
Newell <sup>18</sup>	1939	3144 Hysterectomies	15	0.4
Masson <sup>16</sup>	1939	2553 "Major gynecologic surgery"	2	0.078
Rusche and Bacon <sup>23</sup>	1940	30,403 Unspecified gynecologic operations	16	0.05
Herman <i>et al.</i> <sup>12</sup>	1946	7966 Gynecologic operations	4	0.05

Modern authorities agree that postoperative ureteral necrosis due to stripping the ureteral sheath may also result in postoperative ureteral fistulas, even without direct trauma to the ureter.<sup>5, 8, 10, 21</sup>

*Symptoms and Diagnosis*

Signs, symptoms, and diagnosis of ureteral injury following pelvic surgery may be conveniently classified into those resulting from unilateral and bilateral injury, as shown in the following outlines. It will be noted that the only type of "silent" injury results from unilateral ligation in which fistula does not develop.

SIGNS AND SYMPTOMS OF URETERAL INJURY

- A. Unilateral injury,
  1. Ligation without fistula,
    - a. May be asymptomatic,
    - b. More often flank pain and sepsis due to obstruction.

- tient leaks constantly, but without voiding,
- b. Occlusion, gradually increasing obstruction and anuria.

DIAGNOSIS OF URETERAL INJURIES FOLLOWING PELVIC SURGERY

- A. Unilateral injury,
  1. Ligation,
    - a. Excretory urogram—nonvisualization,
    - b. Retrograde urogram—obstruction to passage of catheter.
  2. Ligation with subsequent ureterovaginal fistula,
    - a. Dye test—fill bladder with methylene blue solution. Clear urine will continue to leak from the vagina.
    - b. Excretory urogram—dilatation of affected side of urinary tract above fistula, or nonvisualization. If dye is excreted, leak may be visualized.
    - c. Retrograde urogram—usually obstruction to passage of catheter. If catheter is passed, leak may be seen.
  3. Ligation with subsequent ureterovaginal fistula and intraperitoneal leakage.

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- a. Excretory urogram or retrograde urogram may show leak. Usually there is nonvisualization.
- b. Signs of peritonitis.
- B. Bilateral injury,
  1. Ligation,
    - a. Anuria,
    - b. Bilateral obstruction to passage of ureteral catheters.
  2. Ureteral necrosis,
    - a. Excretory urogram,
      - (1) Bilateral dilatation of urinary tract, or nonvisualization.
      - (2) Leak may be shown if dye is excreted.
    - b. Retrograde urogram,  
Usually bilateral obstruction to passage of catheter.
    - c. Dye test,  
Fill bladder with methylene blue dye, and observe clear urine leaking from the vagina.

### Prophylaxis

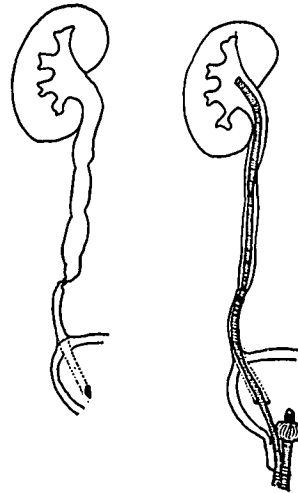
In 1902, Sampson recommended preventing ureteral injury during hysterectomy by the preoperative catheterization of both uterers with silk bougies. He pointed out that the catheterized ureter could be palpated at any time during the operation, and could be avoided by the sense of touch rather than by free dissection of that structure. Sampson, a resident of Dr. Howard Kelly, was an expert cystoscopist as well as a gynecologist. Very few surgeons of the day of Kelly and Sampson possessed their skill with the cystoscope, so this procedure did not come into universal favor then, nor has it subsequently.

Since Sampson's work, many individuals have recommended preoperative ureteral catheterization. Only one dissenting group, Levinthal *et al.* of Michael Reese Hospital, felt that insertion of catheters actually made the ureters more prone to injury by distorting their position and pushing them into the way of the operating surgeon. However, neither this group, nor any authors since, have reported injuries occurring with preoperative ureteral catheterization.

Today, the consensus is that the ureters should be catheterized preoperatively in diffi-

cult pelvic operations.<sup>1, 4, 5, 8, 17, 22, 24, 29</sup> Prentiss and Mullenix have pointed out that this requires cooperative urologists who will perform this service at low cost to the patient.

The authors' own practice is to carry out cystoscopy about 30 to 60 minutes before surgery, while the patient is under the influence of preoperative sedation. Number 5



**Fig. 1.** Diagram of principles involved in carrying out end-to-end anastomosis of severed ureter. 1. A splint tube, preferably polyethylene size 260 to 320, is used. This extends from the kidney pelvis to a point well outside the urethra so that drainage may be recorded, irrigation carried out if necessary, and pyelography done. 2. The redundant tube can be pulled from the bladder with a cystoscope and forceps, as in Fig. 2, or, if the operation is deliberately planned, a ureteral catheter may be inserted up the ureter to the point of stricture. At the time of repair, this is sewn to the splint tube and used to pull it out of the urethra. 3. Tube is secured by tying it to Foley catheter as in Fig. 2. 4. Anastomosis site is extraperitonealized and drained for 7 to 10 days.

ureteral catheters are passed 25 to 30 cm. up each ureter, after which the cystoscope is withdrawn, and a # 16 Foley catheter inserted and the 5 cc. bag inflated. The ureteral catheters are securely tied to the Foley catheter outside the urethral meatus and for a distance of about one inch with circular bindings of black surgical silk. All three catheters are allowed to drain into a sterile urine bottle before and during the operative procedure. At the conclusion of the opera-

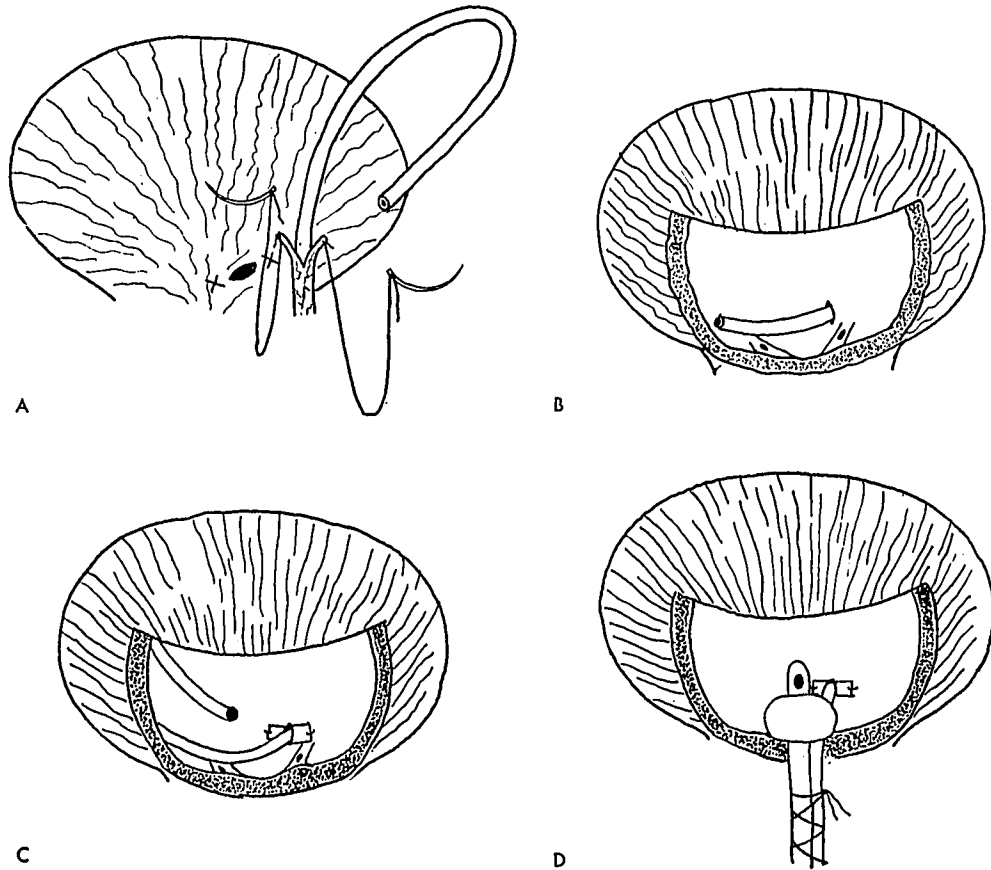
tion, before the abdominal wall is closed, the operator usually withdraws the catheters and notes whether or not any resistance is encountered which would indicate the presence of a ligature around either ureter.

*Treatment*

Treatment of ureteral injuries may be

classified according to the time of recognition of the injury.

IMMEDIATE TREATMENT WHEN THE INJURY IS RECOGNIZED DURING THE OPERATION. No controversy exists as to the method of handling these injuries. If the injury is high, end-to-end anastomosis is carried out over a splinting tube (Fig. 1), and,



**Fig. 2.** Authors' method of ureteral reimplantation. **A.** Posterior view. The ureter has been intubated with a #260 to #320 polyethylene tube, according to its size. The tube extends as high as the renal pelvis, and has an adequate redundancy emerging below. The bladder is secured with two Babcock forceps, and a stab wound made between them. The tube, followed by the ureter, is pushed into the bladder, and the split ureteral ends are secured by sutures emerging at the sites marked "x." **B.** Anterior view. **C.** Tube has been pushed in completely, and the split ends of the ureter secured. **D.** The redundant tube has been pulled from the urethra,\* and secured to a Foley catheter by circular windings of black surgical silk.

\* The tube may be withdrawn by cystoscopic forceps after the operation has been completed. An alternate method which may be employed is to insert a small Robinson catheter into the bladder preoperatively. This is palpated and withdrawn through the stab wound with forceps. It is sewed to the end of the tubing and withdrawn per urethra.

The splinting tube is left in place for two weeks. It is used to irrigate the pelvis and carry out postoperative retrograde urography.

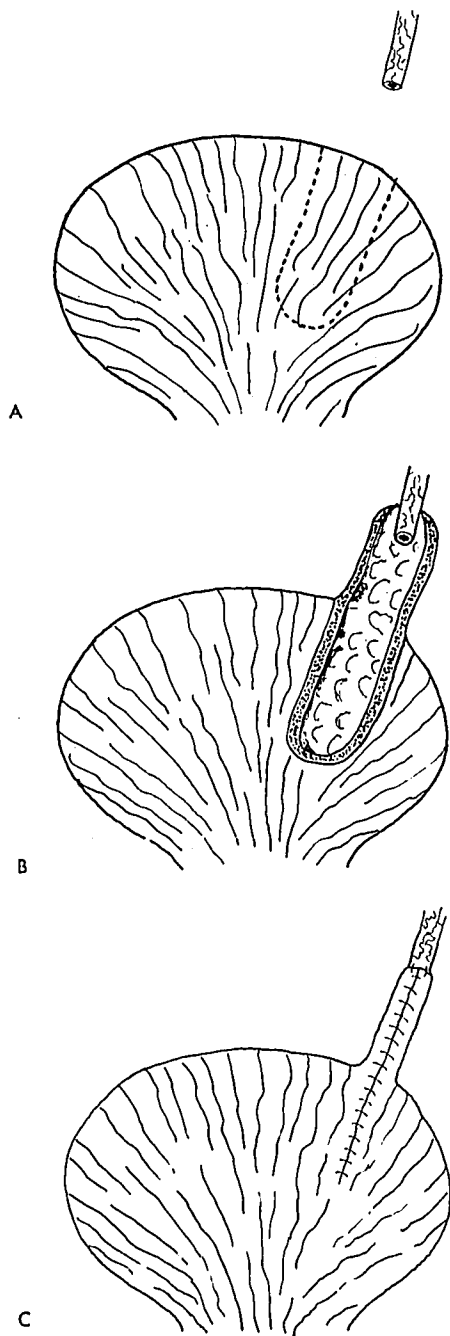
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if the injury is low, reimplantation of the ureter into the bladder is the procedure of choice (Fig. 2). If the lower ureter must be

resected, or is too short to reimplant, a tube constructed from the bladder may be made after the method of Ockerblad (Fig. 3).

TREATMENT OF BILATERAL URETERAL LIGATION RECOGNIZED POSTOPERATIVELY. Considerable variation of opinion exists concerning this particular problem. Caulk, Levintal *et al.*, Nicely, Senger and Johnson, and others feel that bilateral nephrostomy is the procedure of choice. Protagonists of this method point out that it may be carried out under local anesthesia, is a simple procedure, and may be unilateral or bilateral depending on the condition of the patient. This group also feels that de-ligation and repair are inadvisable because of the necessity of invading a freshly operated pelvis of a sick patient, and the possibility of being unable to find the offending ligatures. Caulk, and Senger and Johnson also believed that in many cases spontaneous de-ligation and restoration of the ureteral lumen occurred at a later date. Herman, in 1933, pointed out that nephrostomy per se was inadequate, as spontaneous restoration of the ureteral lumen is exceedingly rare, and recommended immediate direct repair of the injury. He advised that de-ligation be carried out under the combined efforts of a gynecologist and urologist. In this procedure, ureteral catheters or bougies are inserted from below through a cystoscope in the bladder, and used to push the points of ligation up into the operating field where the surgeon can easily see and feel them, and make the necessary repair.

Our experience leads us to concur with Herman's views. In 2 cases of bilateral ureteral ligation, in which the abdominal wound was reopened, no difficulty was experienced in locating the site of pathology. The ureters were followed down to the site of obstruction, freed, and reimplanted into the bladder. This method requires only one operation instead of three, and gives immediate relief from the pathologic condition. Higher obstructions may be recognized preoperatively by the distance the ureteral catheters may be



**Fig. 3.** Reconstruction of the lower ureteral segment by a bladder flap, as originally carried out by Ockerblad. **A.** Line of incision for bladder flap. **B.** Bladder flap in position. **C.** Completed tube.

inserted. The latter may be used to help locate the lower segments, and to pull splinting tubes into the bladder and out of the urethra when the end-to-end anastomosis is carried out.

**LATER TREATMENT.** After the development of a postoperative stricture or ureterovaginal fistula, the first attempt at treatment should be by ureteral dilatation, as recommended by Townsend. Nearly all urinary fistulas will heal, providing there is no obstruction below them. Unfortunately, the majority of these injuries have such severe stenosis of the ureter distal to the fistula as

*Less desirable methods of management.*

1. Ureterosigmoid anastomosis may be performed in cases where there is extensive scarring or loss of the lower ureteral segment. This procedure carries with it the usual difficulties of ureterosigmoid transplantation, including ascending pyelonephritis, wet bowel movements, and hyperchloremic acidosis.

2. Cutaneous ureterostomy carries the disadvantage of a draining urinary fistula which must be managed by bags and other types of appliances.

3. Transuretero-ureteral anastomosis is technically a difficult procedure, and has

TABLE 2. INCIDENCE OF URETERAL PATHOLOGY FOLLOWING PELVIC SURGERY DURING A 5½-YEAR PERIOD AT TEMPLE UNIVERSITY HOSPITAL

Operation		Injuries and postoperative necrosis	
Type	No. performed	No.	Percentage
Abdominal hysterectomy (95.6% total)	1440	11	.76
Adnexal surgery alone	540	1	.18
Vaginal hysterectomy	310	1	.32
TOTAL	2290	13	.56

to make the passage of a ureteral catheter impossible even under spinal anesthesia. Accordingly, some type of plastic procedure must be carried out. These include the following.

*Reimplantation of the ureter into the bladder.* Many varying descriptions of this operation are available.<sup>7, 10, 21, 30</sup> We have found a simple method based on a modification of Chaffin's most satisfactory (Fig. 2). From our postoperative results in 5 patients, involving 7 ureters (Fig. 5), it would appear that oblique reimplantation to preserve a ureterovesical valve mechanism is not necessary, and that the simplest method of reimplantation yields the best results.

*End-to-end anastomosis.* This is carried out when ureteral injury is too high to allow reimplantation. It is the consensus that this should be done over a splinting tube of good caliber, preferably one of the new plastics which does not become coated with urinary salts (Fig. 1).

been reported by only 2 surgeons, Davis and Higgins.

4. Nephrectomy should be considered when marked destruction of the kidney has occurred due to ureteral stricture. This, of course, can only be carried out if there is a normal kidney on the opposite side. Nephrostomy may be done if there is an injury to a ureter draining a solitary kidney, and would be the safest procedure under these circumstances.

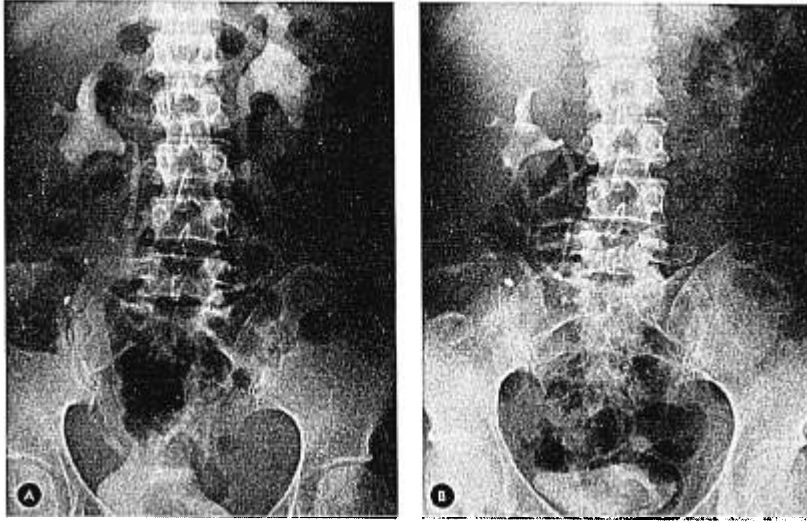
5. Ligation of the ureter is only mentioned to be condemned. No modern author recommends this procedure, which results in the creation of a hydronephrosis or pyonephrosis.

ANALYSIS OF URETERAL INJURIES OCCURRING DURING A 5½-YEAR PERIOD AT TEMPLE UNIVERSITY HOSPITAL

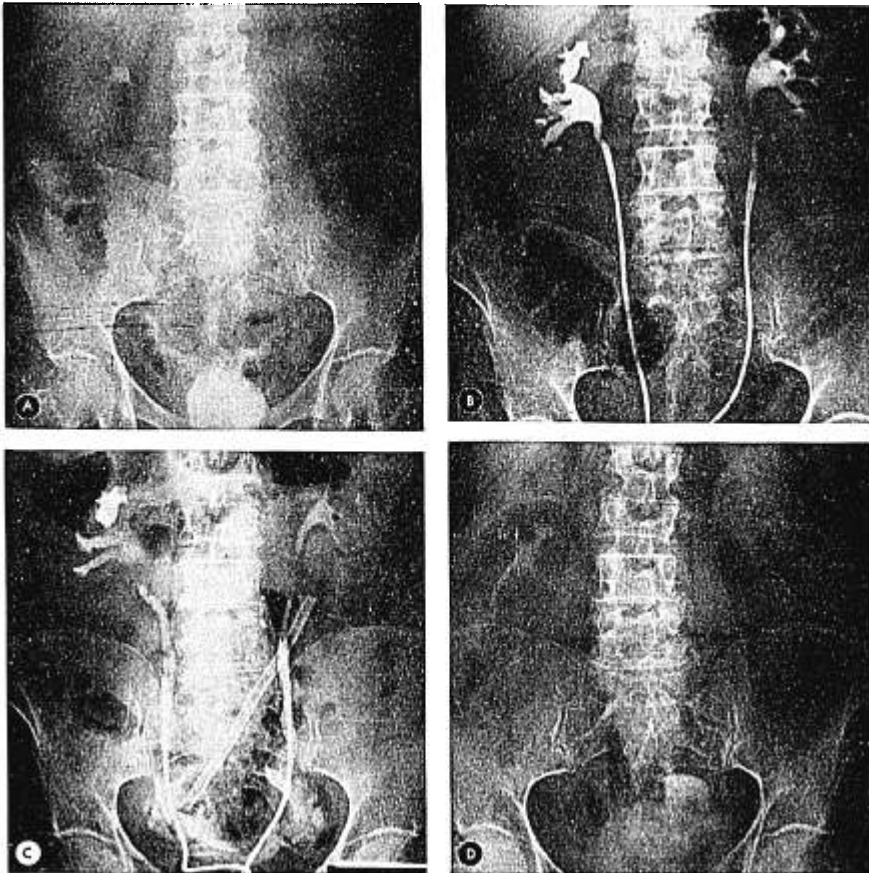
*Incidence*

During a 5½-year period, a total of 2290 major pelvic surgical operations were carried

Pyelograms illustrating postoperative ureteral necrosis.



**Fig. 4. Case 2.** A. Urogram done on seventeenth postoperative day before development of fistula. B. Urogram, 3½ months after operation, showing left hydronephrosis.



**Fig. 5. Case 3.** A. Urogram, 13 days after hysterectomy, showing bilateral ureterovaginal fistulas with dye-filled vagina. B. Urogram after bilateral reimplantation over splinting tubes. C. Ten days after reimplantation showing development of new slough at sites of anastomosis. D. Spontaneous implantation of left ureter into sigmoid 3 months later.

out. Thirteen ureteral injuries were seen during this period of time, or a total of 0.56 per cent (Table 2).

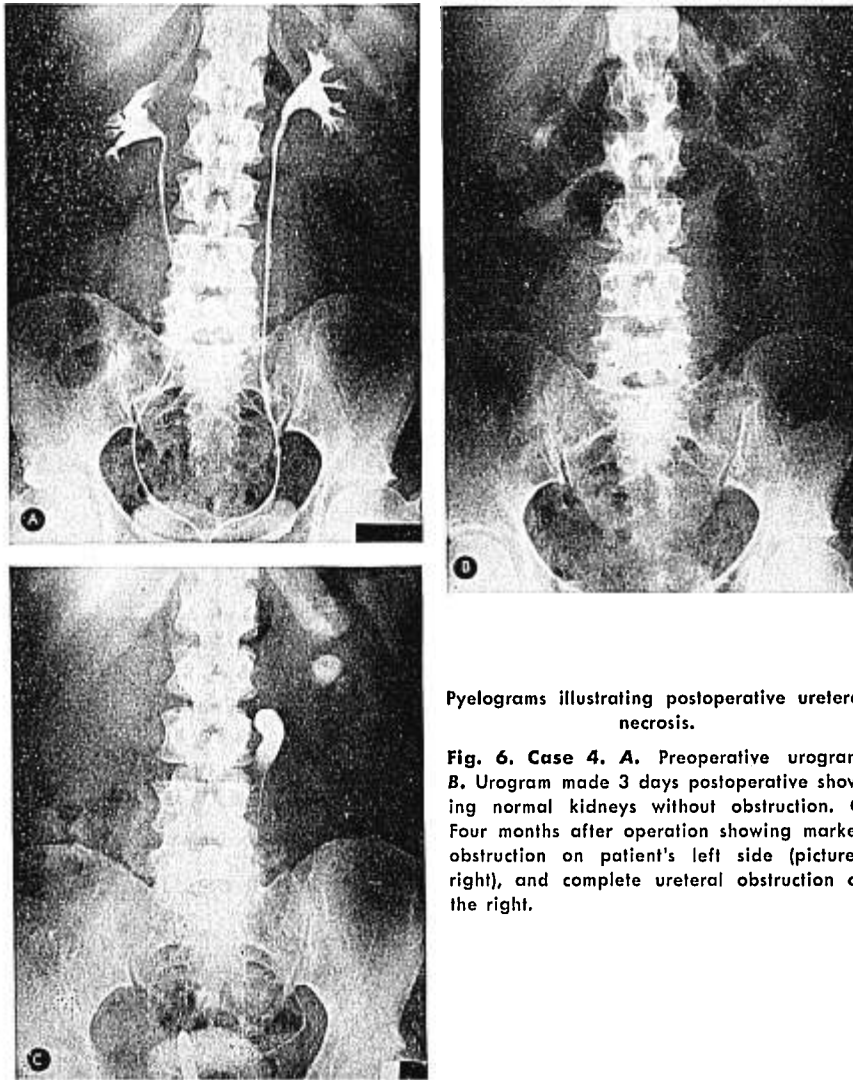
*Case Reports*

GROUP I. POSTOPERATIVE NECROSIS (4 CASES)

*Case 1.* F. B., age 37, on July 12, 1947, had a radical panhysterectomy and lymph node resection for a Stage 1 squamous cell carcinoma of the cervix. Postoperative course was uneventful, and she was discharged on the tenth day. On the twentieth postoperative day, the patient was readmitted to the hospital with all the signs and symptoms of diffuse peritonitis. A lower

quadrant incision drained a large quantity of pus and urine from the peritoneum. The patient's condition was too poor for further surgery. Two sump drains were placed in the pelvis. Death occurred four days later. Autopsy revealed a Grade II pyelonephritis and hydronephrosis of the left kidney. The right ureter had sloughed at the pelvic brim, allowing urine to start an ammoniacal peritonitis.

*Case 2.* M. A., age 44, with a Stage 3 squamous cell carcinoma of the cervix, received a 2500 r. tumor dose. Following this, a radical panhysterectomy and node dissection was done in January, 1948. On the twelfth day, the patient developed tenderness in the left flank. Intravenous pyelograms on the twelfth and



Pyelograms illustrating postoperative ureteral necrosis.

**Fig. 6. Case 4.** A. Preoperative urogram. B. Urogram made 3 days postoperative showing normal kidneys without obstruction. C. Four months after operation showing marked obstruction on patient's left side (picture's right), and complete ureteral obstruction on the right.



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seventeenth day demonstrated dilatation of the left ureter, but no fistula was evident (Fig. 4A). On the eighteenth postoperative day, a profuse watery discharge indicated an obvious ureterovaginal fistula. Further unsuccessful attempts were made to pass a ureteral catheter beyond an obstruction 5 cm. from the vesical orifice. The patient's films, repeated 3½ months postoperative, revealed a hydronephrosis (Fig. 4B). Since the etiology was clearly a sloughing necrosis due to deprivation of blood supply, rather than ureteral injury, nephrectomy was done. Pathology study revealed hydronephrosis with severe secondary pyelonephritis.

*Case 3.* S. F. aged 60, on January 20, 1950, had a panhysterectomy and node dissection for a Stage 2 squamous cell carcinoma of the cervix. On the twelfth postoperative day, the patient began to drain urine from the vagina. Intravenous urograms revealed bilateral ureterovaginal fistulas (Fig. 5A). Both ureters were obstructed low, and could not be catheterized. On the twentieth postoperative day, bilateral ureteroneocystotomy was performed over splinting #10 rubber catheters. A large wound abscess was drained three days later. Retrograde pyelograms (Fig. 5B), were done on the tenth postoperative day. Four days later, vaginal leakage recurred, and pyelography (Fig. 5C) demonstrated ureterovaginal fistulas at the site of the anastomosis. No further therapy was carried out, and about one year later, the urinary leakage had discontinued. Intravenous pyelography demonstrated spontaneous transplantation of the left ureter into the colon. Apparently this was the end result of a pelvic abscess rupture into the sigmoid (Fig. 5D). This is the first case to be reported of a spontaneous ureterosigmoidostomy. Because of recurrent bouts of nausea, vomiting, acidosis, and uremia, it was thought best to drain the non-functioning right kidney. A nephrostomy was done, but the patient resented the tube and pulled it out on several occasions. Death from uremia occurred in September, 1951.

*Case 4.* D. W., age 50, had a clinical Stage 1 squamous cell carcinoma of the cervix treated by radium and x-ray. Six months later, a radical panhysterectomy and lymph node dissection was carried out. Preoperative pyelograms were normal (Fig. 6A). Postoperative pyelograms revealed normal function although the ureters were not visualized (Fig. 6B). After discharge from the hospital, and 1 month postoperative, the patient developed a watery vaginal discharge. She did not return to the Gynecologic

Tumor Clinic until 4 months postoperative. She was wet continuously, and had lost 40 pounds in weight. Her hemoglobin was 4.9 Gm., and blood urea nitrogen 100. Cystoscopic and pyelographic studies revealed an obstruction at 6 cm. (Fig. 6C) on the left, with hydronephrosis and hydroureter above this. On the right, a complete obstruction to the catheter was found 2 cm. from the bladder. Bilateral nephrostomy effected prompt improvement in the condition of the patient, and cleared the vaginal drainage. We are considering bilateral ureteroneocystotomy sometime in the future while maintaining drainage from above.

### GROUP II. MECHANICAL INJURY TO URETERS (9 CASES)

*Case 5.* A. F., age 38, in June, 1949, had a panhysterectomy for a large fibroid uterus. Much bleeding was encountered in both parametrial areas so that the operator blindly placed several ligatures in this supporting structure. With no urinary output in 24 hours, cystoscopic examination revealed bilateral ureteral obstruction at 4 cm. on the right and at the ureterovesical junction on the left. At reoperation, done immediately after the cystoscopy, the right ureter was found dilated, ligated, and completely severed. The left ureter had been ligated and was leaking urine above the ligation. Both ureters were reimplanted into the bladder. The patient's postoperative course was uneventful, and she left the hospital on the twelfth postoperative day. Intravenous urograms (Fig. 7) taken 3 months later were normal.

*Case 6.* K. M., age 38, in December, 1950, had a vaginal hysterectomy with anterior and posterior colporrhaphy for prolapse and vaginal relaxation. There was no urinary output in 24 hours, and cystoscopy revealed bilateral obstruction. At laparotomy, 1000 cc. of urine were found in the abdominal cavity. Both ureters were found cut and leaking urine into the peritoneal cavity. Both ureters were implanted into the bladder over splinting polyethylene tubes. The postoperative course was uneventful. Pyelogram (Fig. 8) 18 months later was normal.

*Case 7.* E. W., age 41, had a panhysterosalpingo-ovarian cystectomy in April, 1950. A great deal of bleeding was encountered around the vaginal cuff, but hemostasis was obtained without too much trouble. On the thirteenth postoperative day, urine started leaking from

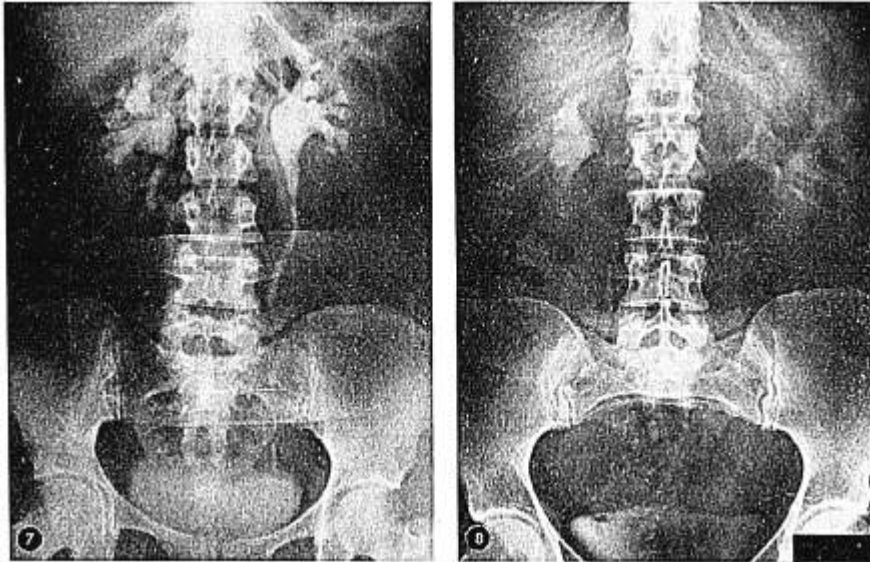
the vagina. Cystoscopy revealed a stricture of the left ureter at 2 cm., and pyelogram (Fig. 9A) demonstrated left hydronephrosis. Six weeks later, reimplantation was successfully accomplished. Two years later, excretory urogram showed a normal left kidney (Fig. 9B).

*Case 8.* H. K., age 44, had a panhysterectomy for fibroids in March, 1950. Hemostasis about the vaginal cuff was difficult to obtain due to varicosities. On the tenth postoperative

day, urine was found leaking from the vagina. At cystoscopy, an obstruction was found at 2 cm. in the left ureter, but it could be dilated with difficulty through a # 9 F ureteral catheter. Despite frequent dilatations, the fistula persisted (Fig. 10A). Two months postoperative, her left ureter was reimplanted into the bladder. Excretory urograms 2½ years later revealed a normal left urinary tract (Fig. 10B).

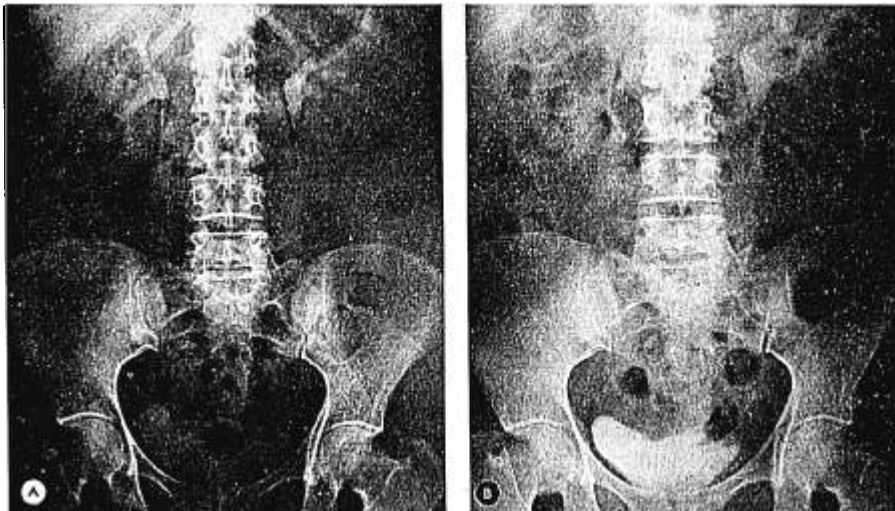
*Case 9.* A. F., age 40, had received 3000

Seven normal postoperative pyelograms in patients treated by ureteral reimplantation.



**Fig. 7.** Case 5. Three months following bilateral reimplantation.

**Fig. 8.** Case 6. Eighteen months following bilateral reimplantation.



**Fig. 9.** Case 7. A. Pyelogram showing left hydronephrosis before repair. B. Pyelogram 2 years after reimplantation.

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mg. hrs. of radium for dysfunctional bleeding 9 years previously. This afforded only temporary relief, and, at the age of 40, a panhysterectomy was done to control bleeding. Dissection of the ureters and vagina was made difficult by old fibrosis. On the seventh postoperative day, pain occurred in the left flank, but disappeared shortly thereafter, and the patient was discharged the following day. On the twenty-first postoperative day, after her return home, urine started leaking from the vagina. Studies re-

vealed an obstruction at 1 cm. on the left, with secondary hydroureter and hydronephrosis (Fig. 11A). Reimplantation into the bladder was carried out 6 weeks after her original operation. Postoperative excretory urograms 3½ years later were normal (Fig. 11B).

*Case 10.* H. T., age 33, in March, 1948, had a panhystero-bilateral ovarian cystectomy for massive pseudomucinous cystadenocarcinoma. During dissection, the left ureter was cut, and immediate end-to-end anastomosis

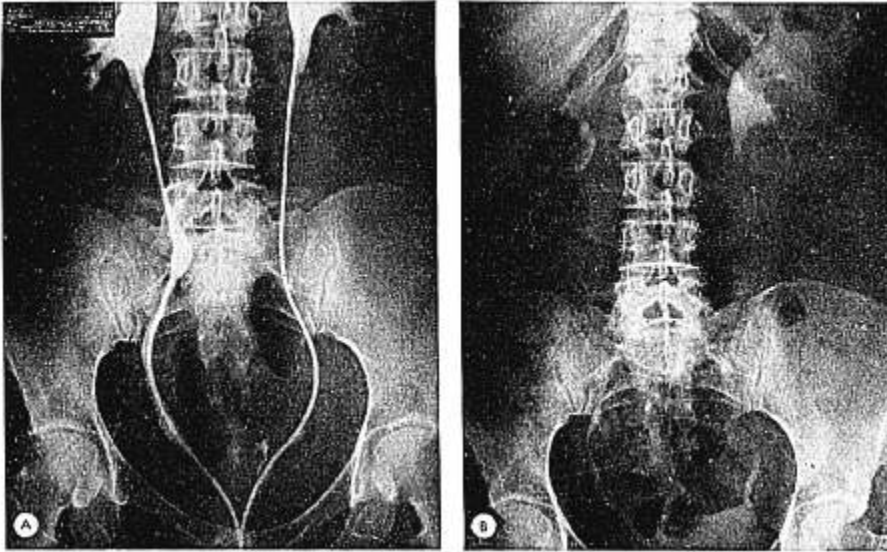


Fig. 10. Case 8. A. Pyelogram showing fistula, lower left ureter. B. Pyelogram 2 years after reimplantation.

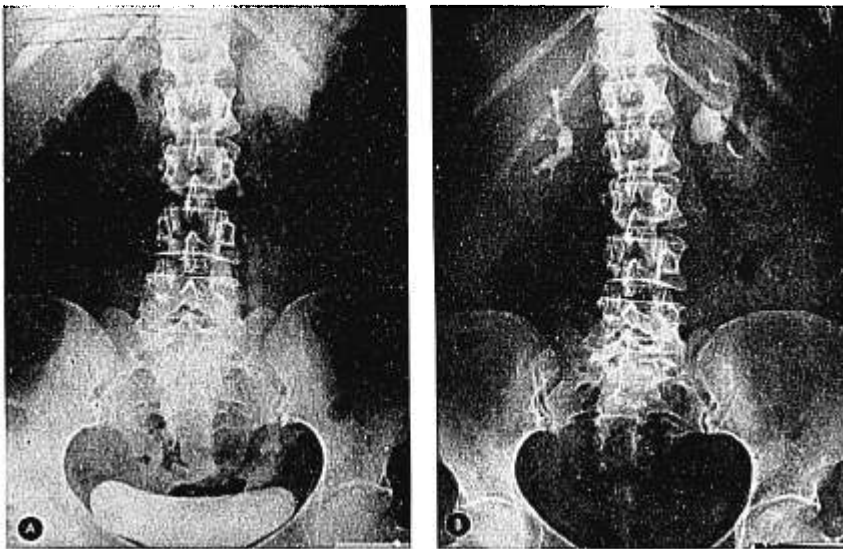
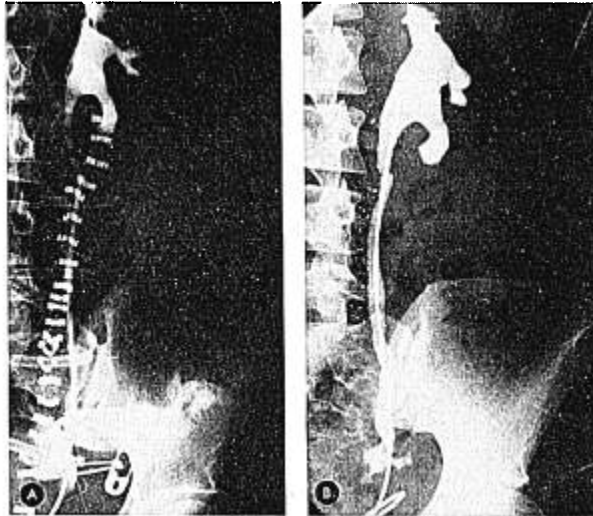


Fig. 11. Case 9. A. One month after original operation showing left hydronephrosis. B. Three- and one-half years following reimplantation.

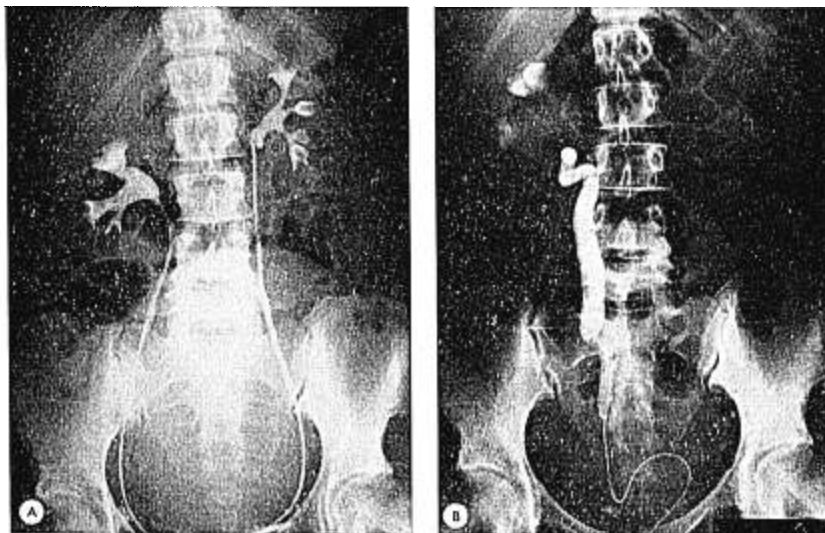
was done over a # 9 splinting ureteral catheter (Fig. 12A). This catheter was inserted into the bladder during the operation, and removed by cystoscope 14 days postoperative. Retrograde pyelogram is shown in Fig. 12B. The patient did well for 3 months, when urine leaked from the vagina. This drainage disappeared after a few months. She died of recurrent carcinoma 3 years later, at which time autopsy showed that recurrent tumor had completely obstructed the ureter.

*Case 11.* A. S., age 42, in September, 1952, had a hysterectomy for a large fibroid uterus. Anticipating trouble, the surgeons had ureteral catheters inserted preoperatively, and retrograde pyelograms were done (Fig. 13A). In spite of the indwelling ureteral catheters, the surgeon completely severed the right ureter. An immediate end-to-end anastomosis was done over the same splinting # 6 catheter. On the second postoperative day, a nurse accidentally pulled out the ureteral catheter, and an

Results following end-to-end anastomosis.



**Fig. 12.** Case 10. A. Two days after anastomosis over splint tube. B. Fifteen days after anastomosis showing leakage at site of repair.



**Fig. 13.** Case 11. A. Preoperative retrograde pyelogram. B. Pyelogram one month after end-to-end anastomosis over a splinting tube which was probably of insufficient caliber.

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adequate calibered one could not be replaced. One month later, retrograde pyelograms showed a right hydroureter and hydronephrosis (Fig. 13B). However, no ureteral fistula developed, and the patient has remained asymptomatic to this time. She refuses corrective surgery.

*Case 12.* A. L., age 32, in August, 1948, was operated upon for carcinoma of the cervix,



Results following end-to-end anastomosis.

**Fig. 14. Case 12.** Nine days after injury. This end-to-end anastomosis was made without any splinting tube.

Stage 0, complicated by severe tuberculous peritonitis. At the time, the right ovarian blood supply was cut and ligated, and the right ureter was also severed. An end-to-end anastomosis was done without a splinting catheter. Studies 11 days later revealed a severe ureteral stricture with marked hydronephrosis and hydroureter (Fig. 14). The patient died of tuberculosis 2 years later.

*Case 13.* D. A., age 50, in August, 1948, had a panhysterectomy for fibroids. Cervical fibroids made dissection difficult and bleeding excessive. The patient seemed to have an uncomplicated hospital course, yet developed urinary leakage at home on her twenty-third postoperative day. Studies demonstrated a complete obstruction at 6 cm. on the left, with hydronephrosis. This patient preferred nephrectomy, so this was carried out at her request.

### *Pathogenesis of the Foregoing Cases*

We feel that the first 4 injuries were caused by necrosis. This diagnosis was established

by autopsy in the first, by normal pyelograms before the development of fistula in the second patient, and by the bilaterality of the fistulas in the third patient. Had both these ureters been tied, this patient would obviously have been anuric. In the fourth patient, a normal excretory pyelogram was obtained on the third postoperative day.

The remaining cases were accidental injuries, with pathogenesis as noted in Table 3.

### INCIDENCE OF UNRECOGNIZED URETERAL INJURIES

There is considerable disagreement as to the incidence of unrecognized ureteral injuries. No authors, except Eddy and Miller, have reported any series of postoperative

TABLE 3. ETIOLOGY OF 13 CASES OF POST-OPERATIVE URETERAL PATHOLOGY SEEN AT TEMPLE UNIVERSITY HOSPITAL IN 5½ YEARS

Group	Pathology	No. cases
I.	Postoperative necrosis, caused by stripping the ureter <sup>a</sup>	4
II.	Direct surgical trauma	9
	Troublesome hemorrhage	4
	Inexperience	2
	Miscellaneous	
	Extensive tumor	1
	TBC peritonitis	1
	Radium scar	1

<sup>a</sup> Of these, 2 had received preoperative irradiation.

pyelograms to detect these silent injuries. These authors carried out 200 postoperative studies of the urinary tract following gynecologic surgery, and found only one instance of hydronephrosis due to ureteral stricture, an incidence of 0.5 per cent.

Two of the authors<sup>14</sup> carried out preoperative and postoperative pyelograms on 200 patients undergoing major gynecologic surgery at Temple University Hospital. While this is admittedly a small series, the results may be noted in Table 4. It will be seen that 11 incidental anomalies were found. Preoperative obstruction to the urinary tract existed in 24. These were corrected by subsequent surgery. In 200 postoperative cases,

only 1 case of silent ureteral obstruction was found.

SUMMARY

1. In a 5½-year study at this hospital, including 2290 major gynecologic cases, there were 13 ureteral injuries, or an incidence of 0.56 per cent.

2. Ureteral injuries may result from the postoperative necrosis which results from stripping the ureter of its blood supply, or

5. Most ureteral injuries are correctible. Excellent results may be obtained by reimplantation of the ureter into the bladder by a simple method described in this paper.

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TABLE 4. AN ANALYSIS OF PREOPERATIVE AND POSTOPERATIVE PYELOGRAPHIC STUDIES ON 200 PATIENTS UNDERGOING MAJOR GYNECOLOGIC SURGERY

	No. patients	Percentage
SURGERY		
Panhysterectomy	151	
Radical panhysterectomy and lymph node dissection	18	
Vaginal hysterectomy	17	
Salpingo-oophorectomy	6	
Removal of cervical stump following previous subtotal hysterectomy	3	
Miscellaneous	5	
PREOPERATIVE FINDINGS		
Incidental anomalies	11	5.5
Duplication anomalies	4	
Ureteropelvic strictures	3	
Horseshoe kidney	1	
Hypoplastic kidney	1	
Pelvic ectopia	1	
Bilateral nephrocalcinosis	1	
Preoperative obstruction caused by pelvic pathology (disappeared postoperatively)	24	12
Right hydronephroses	12	
Bilateral hydronephroses	9	
Left hydronephroses	3	
Extrinsic pressure defects of bladder caused by pelvic pathology	41	20.5
POSTOPERATIVE FINDINGS		
Complete ureteral obstruction due to impassable stricture of the terminal ureter	1	0.5

by direct injury to the ureter itself, usually during operations for carcinoma of the cervix.

3. Both types of injury can be prevented ordinarily by the preoperative insertion of ureteral catheters. This makes the ureter easy to locate by the sense of touch, and makes dissection of the ureter unnecessary.

4. The incidence of unrecognized ureteral injuries in a series of 200 cases was low (0.5 per cent).

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