

# Ureteral Injuries

## *Prevention and management during gynecologic surgery for benign disease*

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THE FREQUENCY of ureteral injuries in gynecologic surgery is difficult to estimate. The incidence of this complication in the single experience of any one surgeon is limited. The known cases are mainly a compilation of incidental reports from the literature. These undoubtedly are but a fraction of the actual number of injuries because most of them are unrecognized at the primary operative procedure, or they are later seen by the urologist and not reported in gynecologic literature. Finally, if no fistula develops, and if the injury is unilateral, the surgeon may not be cognizant of the occurrence of such an injury.

Because of the increase in number of total abdominal and vaginal hysterectomies performed for benign conditions, there should be an increase in the number of ureteral injuries. However, considering the number of gynecologic operations that have been performed, the incidence of ureteral injuries is relatively low.

Bland, in 1925, collected 441 cases of ureteral injuries following pelvic operations from the literature. Of these, 81 were bilateral. Feiner, in his review of the literature in 1938, reporting 8 cases of his own, found a total of 710 ureteral injuries, 109 of which were bilateral. Newell reviewed 3122 hysterectomies at the Barnes Hospital in St.

Louis and found 15 ureteral injuries. Six of these were not recognized until found at autopsy. Holloway reported 9 ureteral in-

TABLE 1. GYNECOLOGIC OPERATIONS<sup>a</sup> PERFORMED FOR BENIGN DISEASE AT BETH ISRAEL HOSPITAL (1938-1952)

<i>Operations</i>	<i>No.</i>
1. Total hysterectomy <sup>b</sup>	1114
2. Supracervical hysterectomy <sup>b</sup>	1577
3. Vaginal hysterectomy <sup>a</sup>	1664
4. Vaginoplasty <sup>d</sup>	1080
5. Oophorectomy or salpingectomy <sup>e</sup>	567
6. Myomectomy	279
7. Cervical stumpectomy	7
8. Colpotomy	17
9. Presacral neurectomy	4
TOTAL <sup>f</sup>	6309

<sup>a</sup> Only those gynecologic operations are included where injury to the ureters might have occurred.

<sup>b</sup> Most of the total and supracervical hysterectomies had one or both ovaries removed.

<sup>c</sup> A large percentage of the vaginal hysterectomies had associated vaginoplasties performed.

<sup>d</sup> All types of vaginal plastics where the anterior vaginal wall was repaired. Fistula and prolapse cases are included.

<sup>e</sup> Cases where unilateral or bilateral oophorectomy or salpingectomy were performed as the only procedure.

<sup>f</sup> Uterine suspensions (there were only few) and curettages are not listed.

juries in 4491 gynecologic operations, and only 2 of these were recognized at the time of the procedure. Wallingford had 5 known injuries to the urinary tract in 3750 pan-

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hysterectomies on the gynecologic service of the Albany Hospital. Murphy reported 18 ureteral injuries in an unstated number of total abdominal hysterectomies over a 10-year period. Ashner, a urologist, reports 11 cases of unilateral injury and 2 of bilateral injury he has seen.

Usually the reports do not differentiate between injury to the ureter in surgery performed for benign or malignant disease. The present study includes only gynecologic surgery for benign disease.

Table 1 summarizes the types of major operations performed at the Beth Israel Hospital during the past 15 years. This group of 6309 cases includes both ward and private

patients. There were 5 recognized ureteral injuries.

Approximately 85 per cent of ureteral injuries are unilateral. Total hysterectomies, abdominal and vaginal, and salpingo-oophorectomy, account for the majority of injuries. These include:<sup>1, 3, 4, 17, 21</sup>

1. Partial or complete ligation or crushing of the ureter somewhere along its course in the pelvis,
2. Partial or complete incision,
3. Resection,
4. Angulation,
5. Necrosis due to interference with the blood supply,
6. Perforation with a needle.

### PART I. PREVENTION

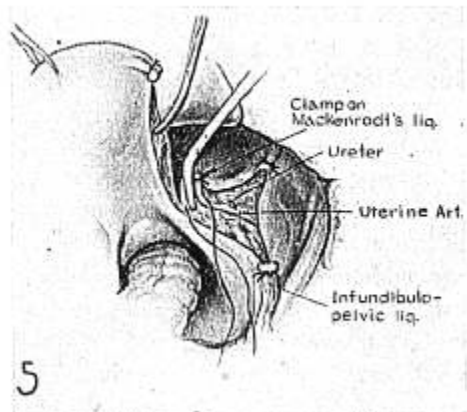
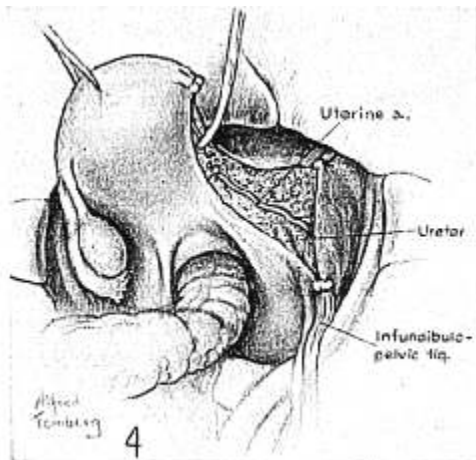
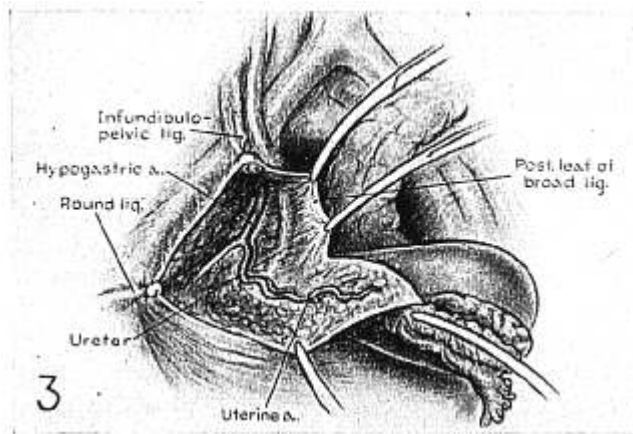
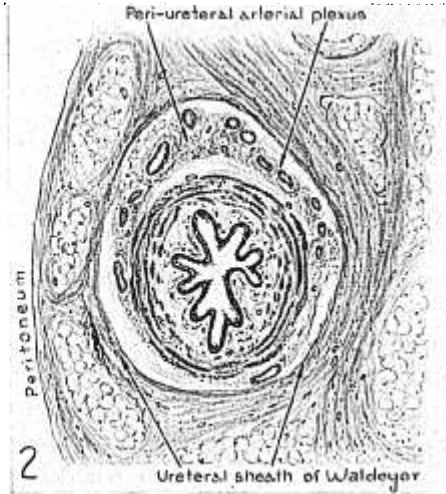
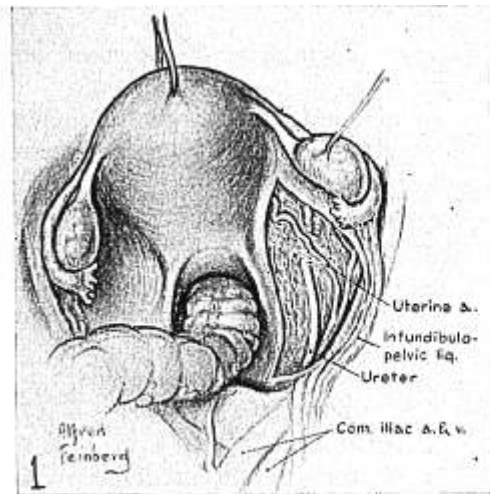
The most important consideration in the problem of ureteral injuries is prevention. Prevention requires an intimate knowledge of the anatomy of the ureter in its course from the brim of the pelvis to the bladder, its possible anomalies, and the displacements that may occur as the result of tumors, exudates, previous operations, malignant infiltrations, or endometriosis.

1. The pelvic portion of the ureter is intimately related to the peritoneum. It crosses the brim of the pelvis slightly medial to the bifurcation of the common iliac artery (Fig. 1). As it curves downward and inward it is medial to and below the infundibulopelvic ligament. To its medial side, and attached to it, is the peritoneum. Laterally is the hypogastric artery. In its approach toward the cervix, it is attached to the peritoneum below the posterior leaf of the broad ligament, and then passes under the uterine artery through the cardinal ligament to the bladder. The ureter is covered by a sheath—the periureteral sheath of Waldeyer which surrounds and protects the ureteral perimuscular arterial blood supply.<sup>22</sup> This sheath is adherent to the pelvic peritoneum (Fig. 2). It is a loose condensation of the areolar

endopelvic tissue through which the ureter passes. When of necessity one must expose the ureter, the surgeon should avoid disturbing the normal relationship of the sheath to the underlying ureteral muscularis or its peritoneal attachment in order not to injure the vessels supplying the ureter.

2. The uterine artery crosses the ureter about 3 cm. above its entrance into the bladder (Fig. 3). The ureter as it courses forward to the bladder lies at least 1.5 cm. lateral to the cervix at the level of the internal os, and 1.5 cm. from the cervix at the vaginal reflection. These distances may be increased during the abdominal hysterectomy when the ureterovesical peritoneal fold is cut and the bladder dissected off the anterior wall of the uterus. Likewise, the cutting of the peritoneum of the posterior leaf of the broad ligament above the level of the internal os (just before ligating the uterine arteries and the uterosacral ligaments) may also allow the ureters to drop away from the field of sutures and dissection.

3. Because the ureter runs under the uterine artery, just lateral and about 3 cm. below the point where the artery is first ligated when performing a total abdominal



**Fig. 1.** The peritoneum of the posterior leaf of the right broad ligament has been removed. The ureter crosses the common iliac artery just before it branches. The ureter is immediately below and medial to the infundibulopelvic ligament at this point. Note the relationship of the ureter to the uterine artery and to the uterosacral ligament. **Fig. 2.** The periureteral sheath of Waldeyer—a loose condensation of the areolar endopelvic connective tissue. **Fig. 3.** Another view of the relationship of the ureter to uterine artery. The infundibulopelvic ligament and the round ligament are ligated and cut. The uterus, tube, and ovary

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hysterectomy, ligation or injury may occur at this time (Figs. 4 and 5). This is more apt to occur should the ligature slip. In the hurried attempt to rescue the retracted bleeding vessel, one may place the clamp too far lateral and downward. In order to avoid this accident, particularly when clamping parametrial or parametric tissue, the instrument should be placed so as to grasp some of the cervical tissue (Fig. 6 B). When incising medial to the clamp, a wide pedicle extending to the point of the clamp should be made (Fig. 5). In this way the chances of the ligature slipping are minimized. Thus, when the ligature is tied around the uterine artery stump (second ligature on the uterine artery), it is medial to the ureter (Figs. 5 and 6). In clamping the uterosacral ligament, the clamp should be placed high on the ligament and cut at right angles toward the uterus, with constant traction on the uterus, thus avoiding injury to the ureter (Fig. 7).

4. All broad ligament fibroids take origin in the corpus of the uterus and grow laterally. As a result they are covered by a thin capsule of uterine muscle. This type of fibroid is usually above the ureter which is displaced beneath the base of the tumor (Fig. 8). The ureter will curve behind and medial, or below and lateral, to the mass. Cervical fibroids tend to push the uterine vessels upward and the ureter outward and downward. In the presence of such a fibroid, danger to the ureter may be avoided by approaching the tumor from above or by incising the uterus from the fundus downward through the mass and enucleating the tumor

from within its supposed capsule. Injury to the bladder may thus also be avoided.

5. During the removal of intraligamentous fibroids or cysts, blunt dissection of the tumor from its bed or from within its capsule should be performed ("stick close to the pathology"). In an attempt to ligate bleeding points in the bed of the tumor or in the extraperitoneal cellular tissue, the clamp may include the ureter. To prevent this, the bleeding should be temporarily controlled by tamponade, and the ureter should be exposed (Figs. 6 and 9) in its course below the posterior leaf of the broad ligament almost to where it crosses under the artery. Hemostasis is then secured by clamp and ligature. Packing and drainage to control such bleeding is not advisable because, if injury to the ureter has already occurred, there may be interference with healing and a fistula may form. The same course should be followed in closing the bed of an intraligamentous tumor following myomectomy.

6. Occasionally, following resection of an ovary, unless it has been suspended to the uterus, the ovary may become adherent to the peritoneum over the ureter. A similar situation occurs in old hydrosalpinges or chronic tubo-ovarian abscesses where the abscess wall becomes adherent to the posterior leaf of the broad ligament over the ureter (Fig. 10).

7. In attempting to deliver the diseased tissue en masse, the ureter may be drawn upward since the exudate has extended through the peritoneum and includes the ureter. This makes extirpation of these masses hazardous to the ureter.

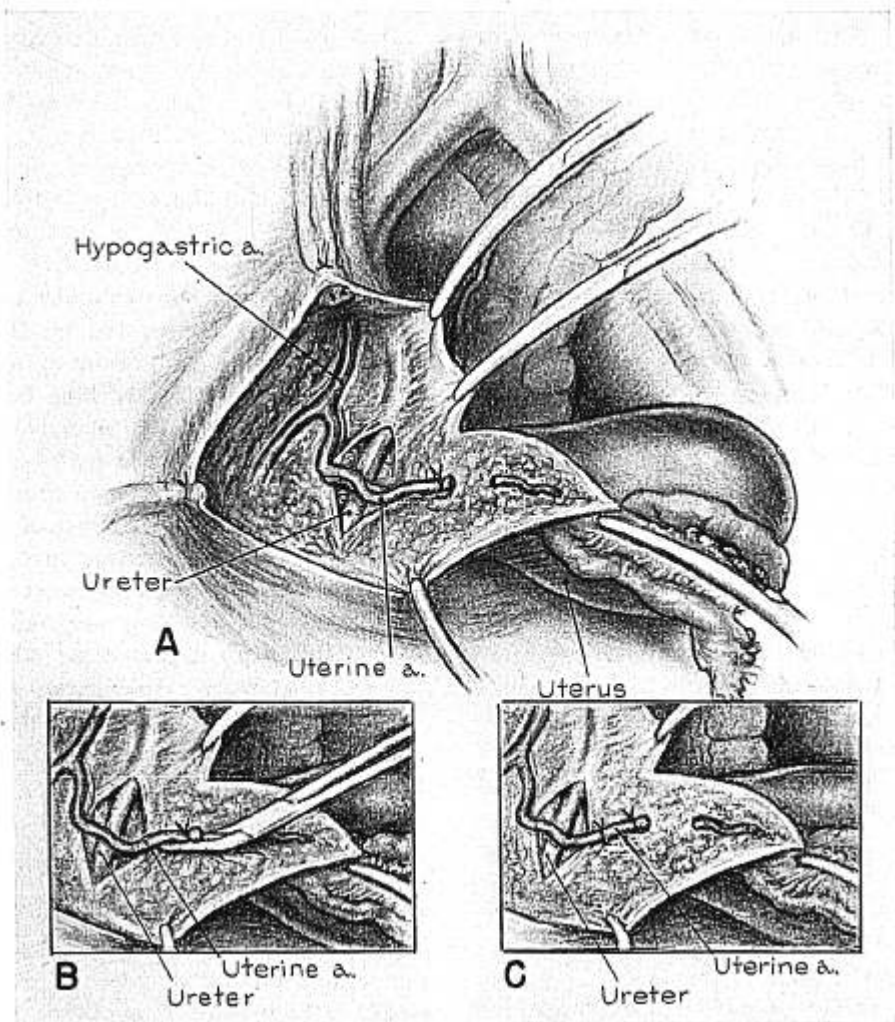
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are drawn to the left exposing ureter and deep vessels. Note the firm attachment of the ureter to the peritoneum, and the uterine artery crossing ureter approximately 3 cm. below the level where the first ligature is to be placed on the uterine artery. The ureter at that level is 1.5 cm. lateral to the internal os and to the vaginal reflection. **Fig. 4.** First ligature on the uterine artery in a total abdominal hysterectomy. The broad ligament has been opened widely. The veins are not shown. The round ligament has been cut, and the right tube and ovary have been removed. Note the relationship of the ureter to the ligated infundibulopelvic ligament. The uterine artery crosses the ureter 3 cm. above the ureterovesical junction, and 3 cm. below the first ligature on the uterine artery. **Fig. 5.** Second ligature on uterine artery in a total abdominal hysterectomy. The clamp has been placed medial to the uterine artery stump and its ligature. Mackenrodt's ligament is cut medial to the clamp leaving a generous stump. The second ligature, including uterine artery and Mackenrodt's ligament, is placed and tied. This is still 1.5 cm. from the ureter.

8. When there is any question of the possibility of injuring the ureter, the best procedure is to expose the ureter throughout its course, without freeing it from the perito-

series of ureteral injuries, the most frequent associated pathologic finding was endometriosis.

10. When performing a total hysterectomy



**Fig. 6.** The total hysterectomy technic (same view as Fig. 3). **A**, First ligature on uterine artery. Waldeyer's sheath opened to expose ureter. **B**, clamp applied to Mackenrodt's ligament as in Fig. 5. **C**, Second ligature tied.

neum, before removing the diseased tissue so that the ureter is visible at all times during the dissection (Figs. 6 and 9).

9. Endometriosis may seed the same area of the peritoneum, and it, too, is responsible for the same technical hazard. In Holloway's

tomy in cases of endometriosis involving the uterosacral ligaments, it is best not to clamp or ligate the ligaments. Instead, traction is made on the uterus to draw it upward, and the peritoneum on the posterior wall of the uterus is incised about 1 cm. above the

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endometrial implants on the uterosacral ligaments. As constant traction is maintained and the dissection is carried on at right angles toward the uterus, a plane of cleavage will be found under the peritoneum. The ureters and underlying rectum will then fall away and injury will thus be avoided.

11. In all complicated pelvic operations, besides visualizing the ureter, one should carefully investigate all adherent strands or structures that look like collapsed veins before applying clamps or ligatures. They may be the ureter.

12. Ureteral injury during vaginal hysterectomy can be avoided by first observing the orthodox contraindications to this operation, eliminating particularly those cases where intraligamentous or cervical tumors exist and where previous vaginal surgery has been performed. Second, by making strong downward traction on the cervix while the vagina and pubocervical fascia are incised, the trigonal region of the bladder and the terminal portion of the ureters are separated from, and displaced away from the anterior surface of the uterus. When the vesicouterine fold of peritoneum is opened, the bladder, with the ureters, can be retracted anteriorly (Fig. 11). Third, all parametrial sutures and clamps should be placed as close to the uterus as possible. Occasionally, in those cases having deep scars lateral to the vagina and cervix, the ureter may be included in the scar. To prevent injury one should stick very close to the cervix, using continuous traction on the cervix and place no ligatures or clamps on cut scar tissue until the scar tissue has been bypassed.

13. Another occasion where the ureter is constantly in danger is in the removal of a retained cervix following subtotal hysterectomy. When it is removed vaginally, one should stick very close to the cervix throughout the dissection, leaving a thin shell of cervical tissue, if necessary. In the abdominal approach, after separating the vesical flap, one may split the cervix longitudinally into

the vagina through the posterior lip—then evert the cervix and remove it from within the vagina.

14. When removing the tube and ovary at hysterectomy, one will find the ureter lying very close to the ligated stump of the infundibulopelvic ligament at the lateral pelvic wall (Figs. 1, 3, and 6). One should always look for the ureter before applying a clamp or before tying the ligature on the ligament. When burying this stump, the first suture in the peritoneum must be placed superficially, under vision, and with care in order not to catch the ureter.

These are some of the instances where one would usually be on guard knowing that pelvic masses, inflammatory or new growths, frequently cause distortion of the pelvic viscera and carry the ureter out of its normal course. However, in the typical total hysterectomy, the inexperienced surgeon, if he lacks the fundamental basic knowledge of the anatomy, may injure the ureter. Even the skillful and experienced surgeon will have his share of ureteral injuries in his lifetime because some are unavoidable. This is especially true where there are congenital anomalies or where the ureter passes through inflammatory masses or tumor tissue. Whenever there is any question, the ureter should be visualized completely before peritonealization is begun. However, one must exercise care when dissecting out the ureter to identify it since this may also lead to injury to the ureter or to its blood supply.

The value of the routine use of ureteral catheters preoperatively as a prophylactic measure against ureteral injury is controversial. We have inserted catheters and have been unable to palpate them when performing a vaginal hysterectomy, especially after the pubocervical fascia has been incised and the bladder retracted. In abdominal hysterectomy, the catheters may give a false sense of security and they may alter the normal position of the ureters, thus exposing

them to injury more readily. Some authors contend that mere catheterization of the ureters may initiate urinary tract infection or give rise to oliguria or reflex anuria. One of the advantages of a preoperative catheter in situ is that if a ureter is injured, and the injury recognized, the ureter can be promptly sutured over the catheter. Wharton states

that the use of catheters in the ureter has been relegated to the past and is obsolete. TeLinde, however, recommends it very strongly because it reduces the time necessary to identify the ureter in pelvic surgery, particularly in the extended total hysterectomy he uses in carcinoma in situ. We do not use ureteral catheters routinely.

## PART II. MANAGEMENT

Suddenly confronted with some form of injury to the ureter while performing a pelvic operation, the gynecologist, since he sees this condition rarely, should have as part of his armamentarium a planned technic which allows for quick and easy handling of each particular situation.

### INJURIES RECOGNIZED DURING THE OPERATIVE PROCEDURE

#### *Unilateral or Bilateral Ligation or Crushing*

When the surgeon recognizes that he has ligated the ureter while the abdomen is still open, he must immediately remove the ligature. Extreme caution must be exercised in removing the ligature since further injury to the periureteral sheath or ureter can easily occur.

A large rubber ureteral catheter (# 8 or 10) should be passed, if possible, while the abdomen is still open or immediately after surgery, and left in situ for ten days because edema and possible necrosis at the site of the ligature may occur. The catheter should prevent the obstruction and dilatation which may ensue. It is also wise to insert an extraperitoneal drain near the point of injury. (Do not allow the drain to touch the ureter.) This drain should be brought out through a stab wound in the abdominal wall posteriorly or laterally so as to allow drainage in case necrosis does occur. The drain is left in situ for seven to ten days if no leakage occurs. If there is evidence of fistula it will have to

be left in longer. Following the removal of the extraperitoneal drain and ureteral catheter, it is advisable to perform excretory urography to note if there is any stricture or hydronephrosis. This should be repeated in 4 to 6 weeks.

If after removal of the ligature it seems that the vitality of the ureter has been definitely impaired so that a fistula is apt to develop, immediate repair should be accomplished in the form of ureteroureteral or ureterovesical anastomosis. Sampson and others have shown that even when a clamp or ligature has been left on for a short time, the integrity of the ureteral wall may be jeopardized.

When the surgeon discovers that he has crushed the ureter with a clamp, careful examination should be made, and if the injury does not seem to be severe the treatment should be the same as if a ligature had been removed. This decision is a difficult one. Furniss had 2 cases in which clamps were on the ureters for 7–8 minutes, and in each instance a fistula developed. Kayser reports 7 cases in which only the ureteral sheath was traumatized, and in 2 instances fistulas developed. In an experiment on dogs, Harrington crushed the ureter with a forceps from 1 to 30 minutes and noted no fistulas. However, stricture did occur at the point of crushing, and dilatation of the ureter with hydronephrosis followed. Therefore, after crushing, if the trauma involves only a segment of the wall of the ureter, no wider than

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the instrument tip, and if the accessory blood vessels are not destroyed, conservative management should follow. If the crushing injury appears severe, a ureteroureteral or ureterovesical anastomosis may be necessary, depending upon the level of the injury.

### *Partial or Complete Severance of the Ureter*

If the general condition of the patient is favorable at the time partial or complete severance is recognized, several procedures are available.

#### CLOSURE OF PARTIALLY SEVERED URETER.

If not more than one third the width of the ureter has been severed, a few interrupted # 000-# 0000 chromic sutures on an atraumatic needle should be placed in the sheath to approximate the cut edges. The sutures should not pierce the ureteral mucosa. This should be performed over a # 8 or # 10 rubber ureteral catheter. These catheters can be obtained with both ends rounded and provided with two openings for drainage. One end can be passed upward to the renal pelvis and the other into the bladder. The area is peritonealized after a stab wound has been made at a suitable site and a drain placed down to the retroperitoneal space. The drain is removed in about 10 days and the splinting catheter in about 2 weeks. Intravenous urography is performed immediately after removal of the catheter to check the condition of the ureter. This is repeated in 4 to 6 weeks.

If more than one third the ureter has been severed, the severance should be made complete and the management carried on as for complete severance of the ureter.

**URETEROVESICAL IMPLANTATION.** This is the procedure of choice when the injury is below the pelvic brim and not more than 5 cm. from the bladder. Exposure and careful suture of a partially or completely severed ureter at this point is difficult and inaccurate.

The bladder is fairly mobile in women, and an extraperitoneal ureterovesical anas-

tomosis can be performed without too much difficulty.

The ureter and bladder are mobilized so that there will be no tension at the anastomosis. If possible, the ureteroneocystostomy site is made low in the bladder. This is necessary to avoid kinking of the intramural portion of the ureter when the bladder is full.

1. The end of the injured ureteral segment on the bladder is ligated with a silk suture if possible.

2. A stab wound is made in the fundus of the bladder large enough to visualize the ureteral openings.

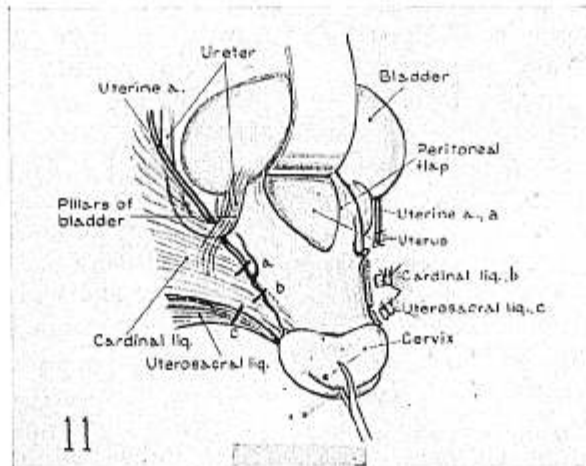
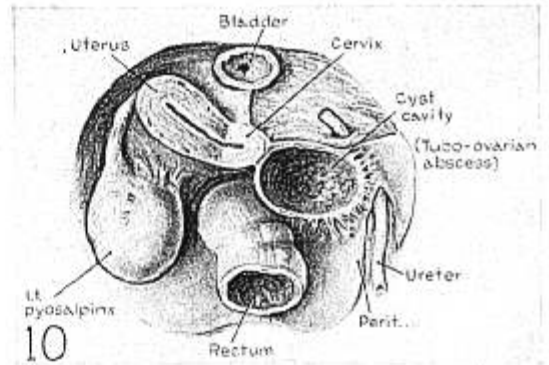
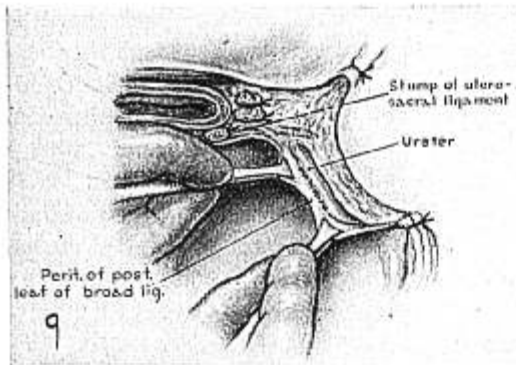
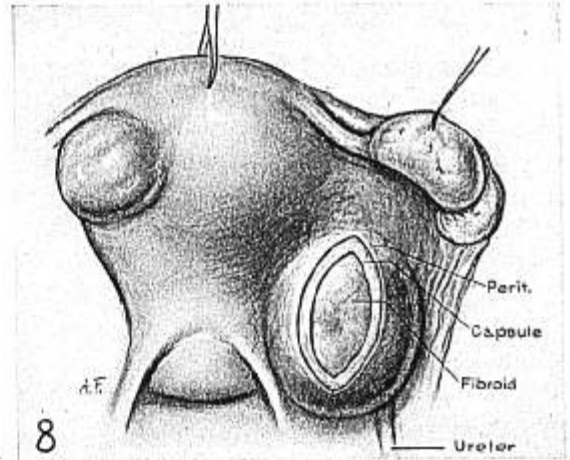
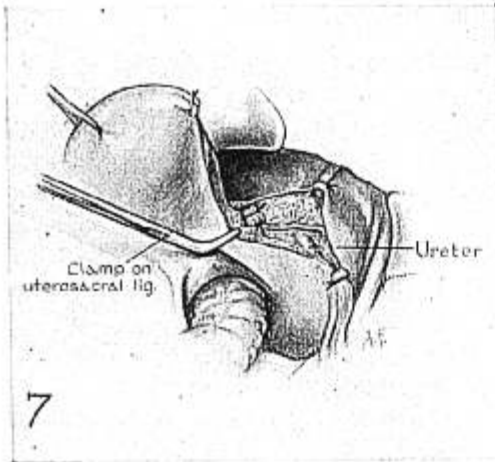
3. A stab wound or an oblique tunnel is made with a curved clamp through the muscularis and mucous membrane of the bladder just above the original ureterovesical junction. A # 8 or # 10 ureteral catheter with both ends rounded is passed from within the bladder through the oblique stab wound. The cut end of the ureter is threaded on the catheter (as a splint) for a distance of 10 to 15 cm. The cut end of the now terminal portion of the ureter may or may not be split (Fig. 13).

4. The lower end of the ureteral catheter may be passed out of the urethra or the cystostomy wound.

5. The split ends of the ureter may be approximated to the inner side of the bladder as shown in Fig. 12 A, or just to the edge of the mucosa so as to bring the edges of the two mucous membranes together. (Some urologists believe that it is not necessary to attach the terminal ureteral flaps to the bladder mucous membrane.) The outer surface of the splinted end of the ureter is approximated to the bladder muscularis with interrupted fine chromic sutures in two layers. The sutures should include only Waldeyer's sheath and the bladder muscularis (Fig. 12 B). A drain is placed near the ligated ureteral stump site and brought out extraperitoneally through the original incision or preferably through a stab wound (Fig. 16).

The drain is left in situ for about seven





**Fig. 7.** The total hysterectomy technic. The clamp is placed high on the uterosacral ligament. This is cut at right angles towards the uterus, with constant traction on the uterus and on the clamp so as to avoid injury to ureter. **Fig. 8.** An intraligamentous fibroid. The lower portion of the right broad ligament is filled with the tumor, and the right ureter usually lies below it. To insure the safety of the ureter, it is best to incise the peritoneum on the superior surface of the tumor and stay within the pseudocapsule of the fibroid. "Stick close to the pathology." **Fig. 9.** Exposure of the ureter following total hysterectomy. Posterior layer of peritoneum grasped with Allis clamps. Blunt dissection parallel to the ureter is made against the peritoneum. The ureter is followed to point where it runs under the uterine artery. Care should be taken not to injure Waldeyer's sheath. (The method of exposing the ureter in other cases is shown in

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days and the catheter is removed on the tenth day.

6. The opening in the fundus of the bladder (Step 2) is closed. Many urologists, however, would prefer to leave a cystostomy tube in the fundus of the bladder and bring the ureteral catheter through this opening. If this is not done, a Foley catheter is passed postoperatively to drain the bladder and the ureteral catheter stitched to the labia (Fig. 14) or attached to the Foley catheter.

**END-TO-END URETEROURETERAL ANASTOMOSIS OF THE COMPLETELY SEVERED URETER.** The technic advised by Curtis consists in passing a # 8 ureteral catheter through a longitudinal ureterotomy slit in the ureter, about 5-6 cm. above the injury, downward toward the bladder, threading the lower end of the cut ureter over the catheter. Through this same longitudinal ureterotomy incision, another # 8 ureteral catheter is passed upward to the kidney pelvis. These catheters and an extraperitoneal drain are brought out through a stab wound in the flank after peritonealization has been performed.

The damaged ends of the cut ureter are freshened, and special care taken not to allow the mucosa to evert at the line of approximation. Approximation of the cut ends is made over the catheter going towards the bladder using interrupted # 0000 chromic catgut, not including the mucosa. No attempt is made to make this approximation watertight. The lower end of the catheter is brought out through the urethra and is kept in situ by placing a Foley catheter into the bladder from without and fixing the ureteral catheter to it.

The splinting catheter and the upper ure-

teral catheter are removed after 10 days. Of course, a newly created ureteral fistula exists for a short while, but since it is a longitudinal one, it usually heals spontaneously. The Penrose drain in the flank is removed about 14 days after the repair.

The disadvantage of this method is that there is kinking of the ureter at the ureterostomy site. It is now advised to insert a T-tube through the newly created longitudinal ureteral opening and to perform the anastomosis over the lower limb of the tube (Fig. 15). Some urologists believe that the T-tube may also cause kinking at the new ureterostomy site. They recommend threading the cut ends of the ureter on a double rounded-end rubber ureteral catheter # 8 or # 10, passing one end up to the renal pelvis and the other down into the bladder. The injured ureter is sutured as described over this catheter. A stab wound is always made in the flank, and a Penrose drain inserted near but not touching the anastomosis before peritonealization. The lower end of the catheter can be drawn out of the urethra by way of the cystoscope. When this procedure is carried out, it is advisable, after the closure of the abdomen or as soon as the patient's condition warrants, to perform a pyelotomy or nephrostomy on the involved kidney through a flank approach.

The end results of ureteral anastomosis, despite the integrity of the repair and the maintenance of continuity of the ureter, are not all that is to be desired. Some degree of stricture and hydronephrosis frequently result. Careful follow-up occasionally discloses partial or complete loss of kidney function 1 to 10 years after the repair.

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Fig. 6.) **Fig. 10.** A cross section showing a tubo-ovarian abscess firmly adherent to posterior leaf of the broad ligament. The ureter, under the peritoneum, is included in the inflammatory mass. In an attempt to enucleate the mass from its bed by blunt dissection, the peritoneum may be torn, and the underlying ureter may be torn or cut. **Fig. 11.** The ligamentous attachments of the uterus which are ligated and cut in performing a vaginal hysterectomy. The cervix is pulled downward, and the vagina and pubocervical fascia are incised. The bladder, mainly in the trigonal area with the ureteral orifices and the terminal portion of the ureters, is retracted. Injury to the ureter is avoided by ligating and cutting the uterine vessels, at the level of the uterovesical fold, as near as possible to the edge of the cervix (modified from Martius).

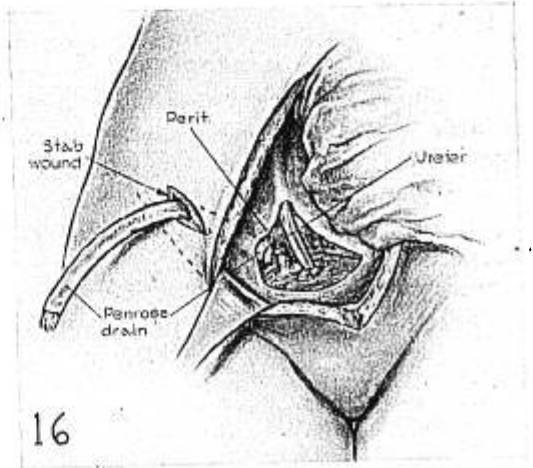
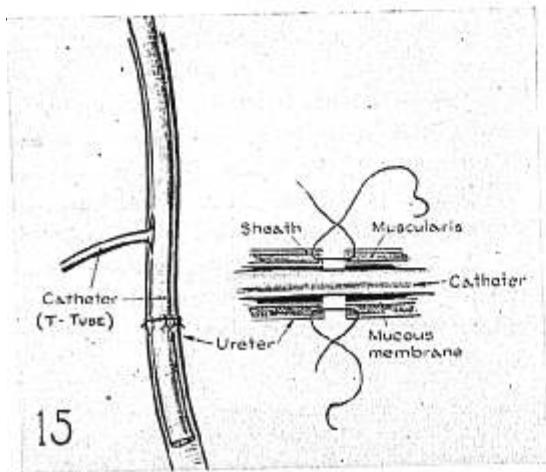
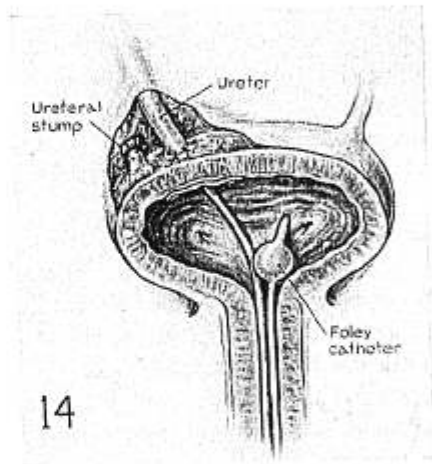
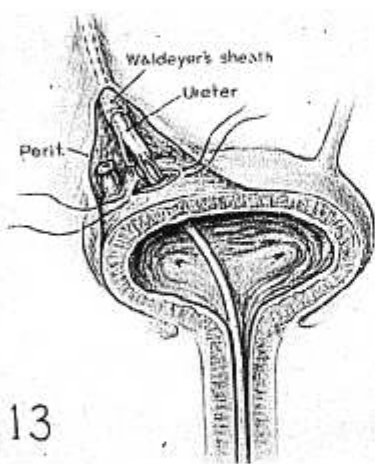
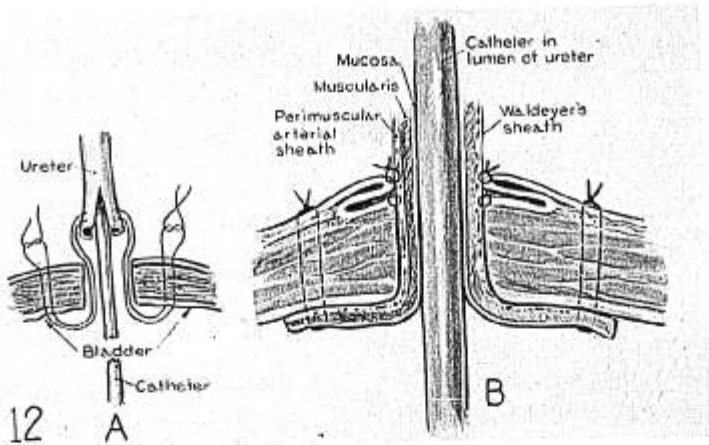


Fig. 12. A, Method of drawing split end of splinted catheter into bladder. B, Ureteral mucosa sutured to bladder mucosa. Note peritoneum sutured to Waldeyer's sheath in two layers. Fig. 13. Cystostomy wound has been made in the fundus of the bladder. Upper end of a double rounded tip # 8 or # 10 rubber catheter has been passed through oblique wound in posterior inferior portion of bladder, and the lower end of the ureter is threaded on the catheter for about 10-15 cm. Lower end of the catheter may be brought out through the cystostomy wound or passed down the urethra. Splinted end of the now terminal portion of the ureter is ready to be drawn into the bladder. Ligature on the distal end of the proximal

## URETERAL INJURIES

This may be on a physiologic basis for it has been noted that the peristaltic waves in the upper portion of the ureter are feeble. It has been stated that peristaltic waves do not pass beyond the cicatrix in the healed repair. Finally, there may be a disappearance of the peristaltic mechanism of delivering urine from the kidney to the bladder, producing back pressure and upper urinary tract dilatation.

In spite of these factors, end-to-end anastomosis is the procedure of choice if the end of the ureter cannot be brought down to the bladder. The success of this procedure will depend upon the prevention of any leakage around the anastomosis. Leakage at the anastomosis site causes disruption of the suture line, marked scarring and contractures with stricture formation, and subsequent hydronephrosis and possible loss of the kidney. The use of pyelostomy, nephrostomy, or the T-tube should prevent this accident.

**URETEROSIGMOIDOSTOMY**—WHERE A SEGMENT OF THE URETER HAS BEEN EXCISED. This procedure is not a desirable choice because it is best done after a period of bowel preparation. In this procedure there is a greater probability of ultimate failure from hydronephrosis, infection, and loss of the kidney.

**LIGATION.** When the patient's condition is poor, and considerable loss of ureter has been sustained, some urologists have recommended ligation of the proximal ureter. This is unsurgical, the condition of the opposite kidney is not known, and ligation is followed frequently by hydronephrosis (not by primary renal atrophy as is usually stated), and this in turn followed by nephrectomy. It is not safe because a few of the patients will

die of the infection and reflex anuria. Hepler states that about 15 per cent will require early nephrectomy because of infection, and about one fourth will develop fistulas. An operation of ligation is only justified if the patient's condition is poor and the condition of the other kidney is known to be good.

**SKIN IMPLANT.** If the surgeon must terminate the operation, he may bring the cut proximal end of the ureter out through a stab wound to the skin and fasten it there until the patient is in better condition for ultimate management. It also gives time to investigate the other kidney, and one may later transplant the cutaneous ureteral end to the bowel after the latter has been properly prepared.

### INJURIES RECOGNIZED AFTER COMPLETION OF THE OPERATIVE PROCEDURE

#### *Ligation of the Ureters*

In order to recognize bilateral ligation of the ureters, it is a good routine to catheterize the bladder immediately after the operative procedure and then again 6 and 12 hours postoperatively if the patient has not voided spontaneously. The small amount of urine found immediately postoperative is that which has come into the bladder during the operative procedure. It may indicate potential trauma to the bladder or ureter if it is bloody or smoky. The absence of urine 6 to 8 hours after surgery requires immediate investigation by a urologist.

Ureteral ligation must be ruled out by prompt cystoscopy and ascertaining the presence of unilateral or bilateral occlusion. Some men regard intravenous urography as dangerous because of azotemia and the possible retention of iodine in the blood stream.

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portion of the cut ureter is shown. **Fig. 14.** Anastomosis completed, and sutures in place. Foley catheter, passed postoperatively, serves to splint ureteral catheter and drain bladder, if ureteral catheter has not been brought out through a cystostomy wound. **Fig. 15.** Anastomosis performed over the lower arm of a soft rubber T-tube. The latter is introduced through a longitudinal slit in the ureter above the anastomosis site. Never bring the T-tube through the anastomosis site. Always insert an extraperitoneal drain near but not at the anastomosis site. **Fig. 16.** Anastomosis completed. Penrose drain brought through stab wound (extraperitoneally).

TABLE 2. RECOGNIZED CASES OF URETERAL INJURIES. FIVE FROM BETH ISRAEL HOSPITAL AND 7 REFERRED FOR MANAGEMENT

<i>Operative procedure</i>	<i>Preoperative diagnosis</i>	<i>Postoperative complications</i>	<i>Time of clinical appearance (post-op.)</i>	<i>Diagnostic findings</i>	<i>Method of treatment</i>
Total abdominal hysterectomy	Myoma uteri	Fever, chills, C-V pain; palpable right kidney	3 weeks	Rt. hydroureter and hydronephrosis Catheter obstructed at 7 cm.	Rt. ureteroneocystostomy
	Myoma uteri	Left ureteral obstruction Cortical abscess of left kidney	3 weeks Following second operation	Hydroureter	Cervical stumpectomy and exposure of ligated left ureter Left ureterostomy into skin, second operation Left nephrectomy
	Myoma uteri	Left ureterovaginal fistula; left parametric abscess	30 days	Left hydroureter and hydronephrosis with poor kidney function; ureteral obstruction at 4 cm.	Left nephrectomy
	Myoma uteri	Ureterovaginal fistula; rt. hydroureter	30 days	Rt. hydroureter with poor kidney function; ureteral obstruction at 3 cm.	Right ureteroneocystostomy
	Myoma uteri	Ureterovaginal fistula	10 days	Fistula healed spontaneously	
		Left ureteral stricture	2 months	Left ureteral stricture at 3 cm.; ureter 2.5 cm. wide; poor kidney function	Left ureteroneocystostomy

Total abdominal hysterectomy	Myoma uteri	Left ureterovaginal fistula, chills, and fever	13 days	Left hydroureter and hydronephrosis with no kidney function	Left ureteroneocystostomy Pyelogram showed good function in left kidney 1 mo. later
	Myoma uteri	Ureterovaginal fistula	19 days	Obstruction at 1.5 cm.; hydroureter and hydronephrosis. Chills and fever 5 weeks later	Ureteroneocystostomy
	Cervical myoma <sup>a</sup> under bladder	Myomectomy, 1936; Vaginoplastic, 1937; D & C, 1951; total hysterectomy, bilateral salpingo-oophorectomy this admission (1952); recognized injury to left ureter at time of operation	Cut left ureter at time of ligation of left uterine artery (all in same ligature)		Left ureteroneocystostomy at time of total hysterectomy; I-V pyelogram 2 wks. p.o. showed mild hydro-ureter
Supracervical hysterectomy	Bilateral <sup>a</sup> carcinoma of ovaries End-to-end anastomosis of severed left ureter at time of injury	1. Left periureteral abscess 2. Ureterocervical fistula 3. Pelvic abscess and generalized peritonitis—died	3 days 7 days 9 months later	Pyelogram showed left hydronephrosis and urinary drainage into cavity which communicated with cervical canal Ureteral obstruction at 3 cm. Autopsy showed cut end of left ureter entering pelvic abscess	X-ray therapy to left kidney in attempt to destroy kidney function

<sup>a</sup> Authors' own cases.

TABLE 2. RECOGNIZED CASES OF URETERAL INJURIES. FIVE FROM BETH ISRAEL HOSPITAL AND 7 REFERRED FOR MANAGEMENT—(Concluded)

<i>Operative procedure</i>	<i>Preoperative diagnosis</i>	<i>Postoperative complications</i>	<i>Time of clinical appearance (post-op.)</i>	<i>Diagnostic findings</i>	<i>Method of treatment</i>
Salpingo-oophorectomy	Left tubo-ovarian abscess <sup>a</sup> ; right pyosalpinx; right cornual resection	Obstructed left ureter with fever, C-V pain	11 days	Ureteral obstruction at 5 cm.; nonfunctioning left kidney	Extraperitoneal exploration of left ureter; obstruction due to adhesion to ligature; plastic repair of ureter over catheter; normal function in kidney 21 days later
Vaginal hysterectomy	Prolapse <sup>a</sup> of uterus; uterus bicornis unicollis	Ligation of both ureters	10 hours	No urine in bladder; cystoscopy revealed bilateral ureteral obstruction; 5 wks. later nephrostomies closed spontaneously and I-V pyelograms showed good kidney function	Bilateral nephrostomy 11 hr. postoperatively; bilateral vaginal deligation of all sutures; followed by bilateral ureteral catheterization at time of operation
Cystocele, <sup>a</sup> rectocele Prolapse of uterus		Ligation of both ureters Bilateral hydronephrosis, marked Rt. ureterovaginal fistula	10 hours 3 weeks 9 weeks	No urine in bladder; both ureters obstructed at attempted catheterization; obstructing rt. ligature dissolved 19 days later and urine appeared rt. side	Left nephrostomy 24 hr. later; rt. nephrostomy 6 wks. later because of marked hydronephrosis

<sup>a</sup> Author's own cases.

## URETERAL INJURIES

Others feel that, early, after ligation, there is no azotemia and that late films (60 to 90 minutes) may show the point of obstruction.

Deligation after operation is difficult and dangerous and should not be done. Whether the surgery was abdominal or vaginal, one finds that the secondary operation superimposes further morbidity and a second anesthesia, the wound is filled with blood and plastic exudate, and removing the ligature is invariably fraught with the danger of partially severing the ureter. Caulk and Fisher state that even in animals it is difficult to secondarily untie ligatures without cutting the ureter.

The procedure of choice is prompt bilateral nephrostomy, ureterostomy, or pyelostomy. In the very sick patient, even a unilateral procedure will suffice. It is not too traumatic, can be done under local anesthesia, preserves renal parenchyma, and overcomes the immediate azotemia. The patient may now be allowed to convalesce to a point where some reparative procedure may be undertaken. In many cases the sutures around the ureters may become digested after several weeks and the ureteral obstruction relieved spontaneously. Other complications recognized postoperatively, such as ureterovaginal and ureteroabdominal fistula, belong to the urologist. These occasionally appear within 2–3 days of operation.

During the past 15 years we have had 5 instances of ureteral injury of our own and 7 cases referred to us for management. Table 2 shows the type of operation, the complication, and the method of management.

### SUMMARY

1. A brief summary of the American literature pertaining to ureteral injuries sustained during gynecologic surgery is presented.

2. The essential anatomic points of the pelvic ureter are reviewed. The relationship of this portion of the ureter to the pelvic peritoneum is emphasized.

3. The usual type of displacement of the ureter in the presence of various pathologic processes is described. A method for the avoidance of ureteral injury in each situation is described.

4. A tabulation of the 6309 gynecologic operations at Beth Israel Hospital has been made. Five recognized ureteral injuries are reported.

5. The necessity for immediate recognition of ureteral injury created during gynecologic surgery is emphasized.

6. Methods for handling the usual types of injury are described.

7. A simple technic for performing a ureterovesical or ureteroureteral anastomosis is described in detail.

8. Postoperative ureteral deligation is not recommended. The alternative management by nephrostomy is mentioned and relegated to the realm of the urologist.

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*Fit the Crime*

"I'd place him in a pillory  
 And shoot him with artillery—  
 The editor who cruelly clipped  
 And scarred my virgin manuscript!"

—ARTHUR FREDERIC OTIS,  
*Chicago Tribune*, November 20, 1952.