Ureteral Injury and Laparoscopy

Prof. Dr. R. K. Mishra

URETERAL INJURIES

Ureteral injury is one of the most serious complications of gynecologic surgery. Ureteral injury during laparoscopic surgery has become more common as a result of the increased number of laparoscopic hysterectomies and retroperitoneal procedures that are being performed. Consequently, prevention of ureteral injuries should be a priority during laparoscopic gynecologic surgery. When a ureteral injury does occur, quick recognition of the problem and a working knowledge of its location and treatment are essential in providing patients with optimal medical care. Detailed anatomic knowledge of the retroperitoneum is necessary to prevent ureteral injuries.

The ureters are retroperitoneal tubular structures that extend from the renal pelvis, coursing medially and inferiorly to the bladder **(Fig. 1)**. Each ureter travels inferiorly along the psoas muscle and crosses the iliac vessels at approximately the level of the bifurcation of the common iliac arteries. In females, the ureter is crossed anteriorly by the ovarian vessels as they enter the pelvis. Inferiorly, they are crossed anteriorly by the uterine artery. At this point, they enter the cardinal ligament, approximately 1.5–2 cm lateral to the cervix before their insertion into the trigone of the bladder **(Fig. 1)**.

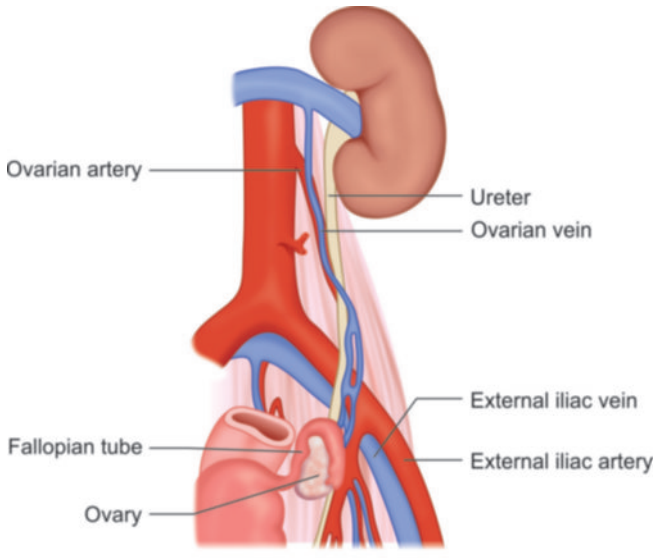


Fig. 1: Anatomy of ureter.

The ureters derive their blood supply from the renal artery, aorta, gonadal artery, and common iliac artery while they traverse intra-abdominally. These vessels approach the ureter from its medial side and course longitudinally within the periureteral adventitia. In the pelvis, the ureter derives its blood supply from the internal iliac artery or its branches. These vessels approach the ureter from its lateral side and also course longitudinally within the periureteral adventitia.

A significant ureteral injury is defined as any recognized or unrecognized iatrogenic trauma to the ureter that prevents it from functioning properly or effectively. The injury may lead to acute ureteral obstruction (e.g., a ureter that is inadvertently ligated) or discontinuity (i.e., inadvertent ureteral resection). If an injury to the ureter has occurred and is unrecognized, it may lead to chronic ureteral obstruction (i.e., crush injury, ischemia) or the formation of fistulas.

FREQUENCY OF URETERAL INJURY

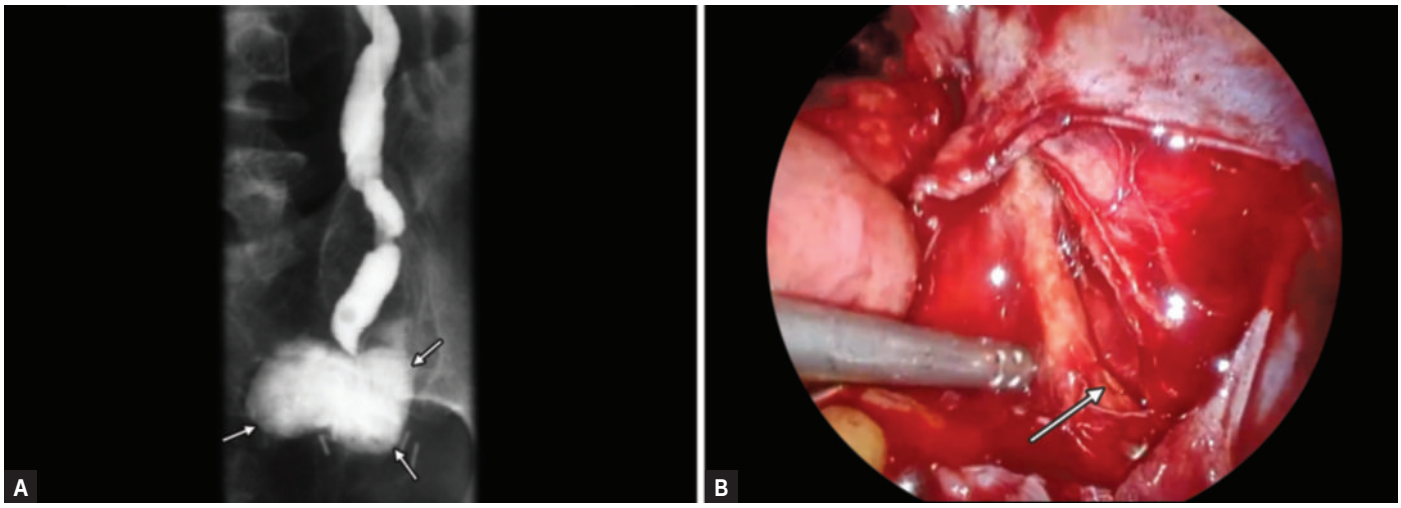
The frequency of ureteral injury following gynecologic surgery is approximately 1% with a higher percentage of injuries occurring during abdominal hysterectomies and partial vaginectomies. Patients who have received pelvic radiation or who have advanced pelvic cancers requiring extensive surgical procedures are more likely to experience a ureteral injury **(Figs. 2A and B)**.

The rate of ureteral injuries in laparoscopic procedures varies. While some physicians report that laparoscopic procedures have an equivalent rate of ureteral stricture formation secondary to ureteral injury, other authors argue that the rate of ureteral strictures is significantly higher. More research is necessary before a definitive statement can be made regarding the rates of ureteral injury during laparoscopy.

ETIOLOGY

The seven most common mechanisms of operative ureteral injury are as follows:

1. Crushing from misapplication of a clamp
2. Ligation with a suture
3. Transection (partial or complete)
4. Angulation of the ureter with secondary obstruction



Figs. 2A and B: Ureteric injury during laparoscopic hysterectomy (arrows).

5. Ischemia from ureteral stripping or electrocoagulation
6. Resection of a segment of ureter
7. Excessive use of monopolar, which creates remote injury of ureter

Any combinations of these injuries may occur.

Several predisposing factors have been identified in iatrogenic urologic injury. These factors include uterus size larger than 12 weeks of gestation, ovarian cysts 4 cm or larger, endometriosis, pelvic inflammatory disease, prior intra-abdominal operation, radiation therapy, advanced state of malignancy, and anatomical anomalies of the urinary tract. Ureteral injuries can be either expected or unexpected and they may be the result of carelessness or due to a technically challenging procedure.

LEVEL OF URETERAL INJURIES

Intraoperative ureteral injury may result from transection, ligation, angulation, crush, ischemia, or resection **(Fig. 1)**.

There are three specific anatomic locations for potential ureteral injury during gynecologic laparoscopy:

1. At the infundibulopelvic ligament
2. At the ovarian fossa
3. In the ureteral canal

Among all the ureteral injuries, 14.3% occurred at or above the level of the pelvic brim, 11.4% occurred at or above the uterine artery, and 8.6% occurred at the level of the bladder **(Fig. 3)**. The initial procedure in 20% of these cases was laparoscopic-assisted vaginal hysterectomy. Alterations to normal anatomy may also hinder identification of the ureters as in severe endometriosis, which may involve the ureter and also cause intraperitoneal adhesions.

PREVENTION OF URETERAL INJURY

Injury to the ureters can be prevented by meticulous surgical technique and adequate visualization.

Fig. 3: Intravenous pyelogram (IVP) showing ureteric injury.

Techniques to enhance visualization include:

- *Ureteral catheterization with lighted stent*: Ureteral catheterization with lighted stents has been used to assist in identifying the location of the ureters during laparoscopic surgery to help prevent iatrogenic injury. If the lighted stents are not visible during laparoscopic surgery, four options are available as follows:
  1. Change the intensity of the laparoscopic lighting. By dimming the lights, the light from the stent may become visible
  2. Change the camera to a different port
  3. Identify the ureter where it is visible and follow it down to the surgical field
  4. Convert to an open procedure, so that the ureter can be palpated and identified

  Although ureteral catheterization helps to identify the ureters; however, in a large review of major gynecologic surgeries, Kuno et al. found that ureteral catheterization did not substantially reduce the

risk of ureteral injury. The surgeon must practice meticulous surgical technique and have intimate knowledge of the ureter's course to prevent ureteral injury.

- *Hydrodissection*: By making a small opening in the peritoneum and injecting 50–100 mL of lactated Ringer's or normal saline solution along the course of the ureter, one can displace the ureter laterally and create a safe plane within which to operate.
- *Preoperative intravenous pyelogram (IVP)*: IVP has been used to locate the ureters in high-risk patients with potentially distorted anatomy; however, this did not decrease the risk of ureteral injury.

USE OF INFRARED URETERIC CATHETER

Several studies have been done to examine the advantages of the use of infrared or lighted ureteral stents in various procedures, including laparoscopic procedures. For instance, a study was conducted on the implications of the use of lighted ureteral stents on laparoscopic colectomy. The study was conducted between April 1996 and January 2000, where a total of 66 patients had infrared ureteral stents placed before laparoscopic colectomy was done. Among the total 66 patients, 32 of them were males and 34 of them were females. They had an average age of about 62.27 years.

A lot was discovered after the surgery and was reported. The researchers also identified the complications that were related to the use of the lighted ureteral stents. In the results, it was established that in spite of the use of the lighted ureteral stents, one man still suffered from an incomplete left ureteral injury during a sigmoid colectomy. However, the injury was managed by use of the conservative approach where the left ureteral stent was reinserted.

The value of the use of the infrared or lighted ureteral stents in laparoscopic colectomy was studied and several things were discovered. In some instances, there were ureteral injuries during the laparoscopic colectomy that were reported. Also, the injuries were reported in the laparoscopic hysterectomy.

Infrared Ureteral Stent

There are four types of ureteral injuries, including laceration, ligation, crush, and devascularization. All these types of injuries can be detected either intraoperatively or postoperatively. When the infrared ureteral stents are placed before laparoscopic surgery, they can help in detecting and identification of the ureteral injuries intraoperatively. This, therefore, helped the surgeon to take adequate and immediate action before the problem would become fatal.

In the same study, it was discovered that there was one patient who suffered from an incomplete ureteral injury during a sigmoid colectomy. For this to be detected, the diagnosis was done with retrograde cystourethrogram.

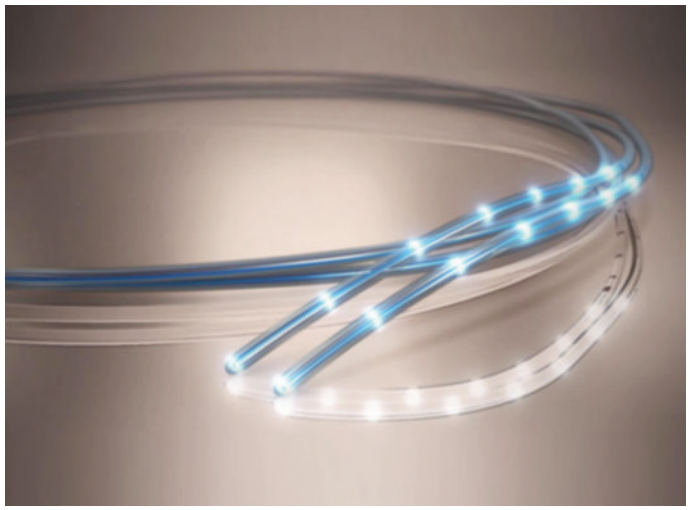
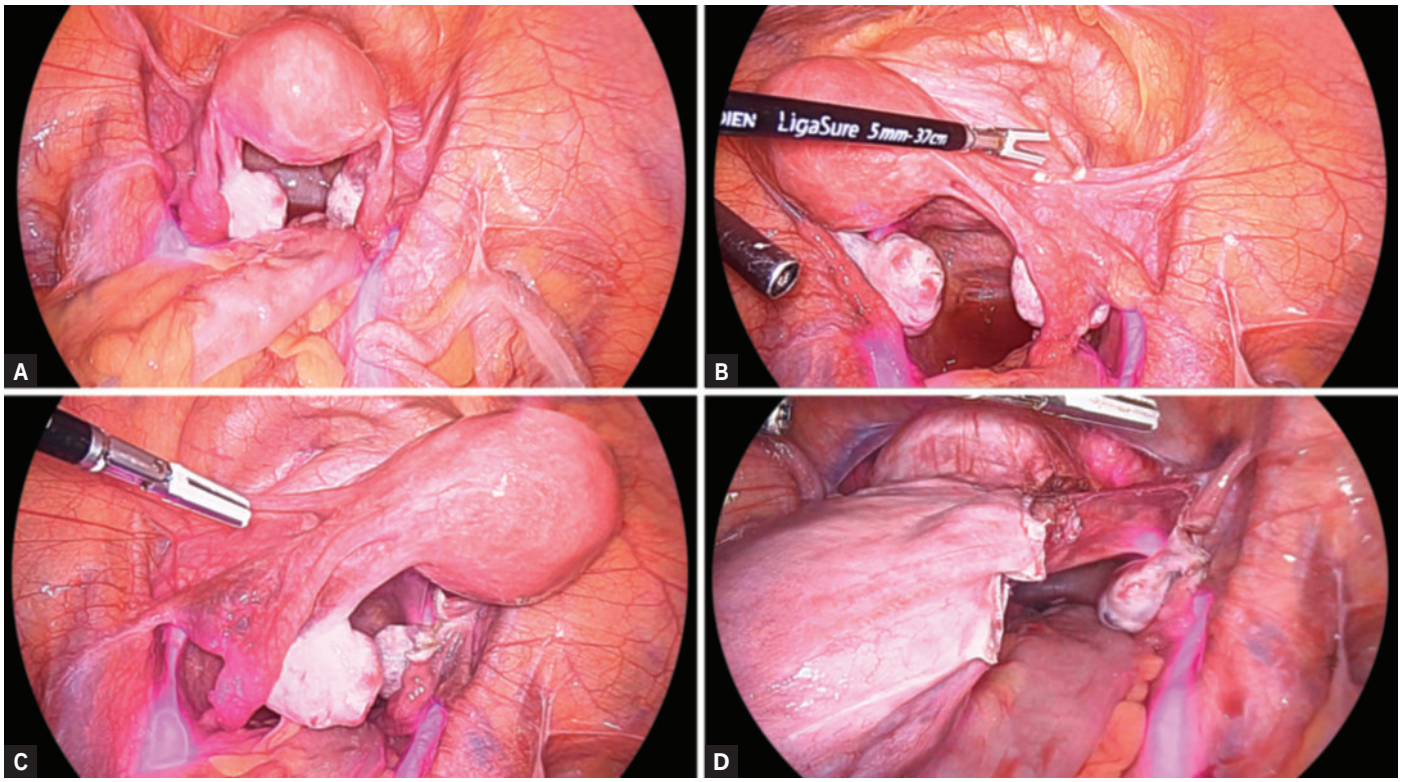


Fig. 4: Infrared ureteric catheter to prevent ureteric injury.

In fact, the injury was detected on postoperative 2 days after the procedure. The injury had some urinary ascites. The ureteral injury together with urinary ascites was managed by the reinsertion of the left ureteral stent temporarily. The temporary lighted ureteral stents were removed on the 11th day after the operation and the patient discharged. It is evident that use of the lighted ureteral stents in the laparoscopic colectomy led to a decrease in the number of patients with ureteral damage. The significant decrease in the number of patients who suffered from ureteral damage shows that the placement of infrared ureteral stents before laparoscopic surgery is done to reduce the risk of having the ureter damaged **(Fig. 4)**. In fact, in this study, out of the 66 patients, only one patient suffered from ureter damage. In addition, the placement of the lighted ureteral stent helped in the detection of the ureteral damage, which aided in the taking of immediate action to correct the problem. Actually, the problem could be solved postoperatively and even the patient got discharged after postoperative day 11. Therefore, the placement of the lighted ureteral stent during total laparoscopic hysterectomy does not only helps in the detection of damage to the ureter but also it helps in the taking of immediate action to correct the injury **(Figs. 5A to D)**.

The use of the ureteral stents is associated with an adverse effect, which is that it leads to postoperative gross hematuria in almost every patient that was in the study. Hematuria is normally known to last for an average of 3 days after the surgery; however, the placement of the bilateral ureteral stents led to a significant increase in the duration of the hematuria. Fortunately, hematuria is not associated with any clinical significance because it does not require a blood transfusion. In order to reduce the hematuria, there is one major thing that the surgeon would adopt and that is the use of unilateral stents rather than the bilateral stents. The unilateral stents can help to reduce the operative time as well as reduce the postoperative hematuria.



Figs. 5A to D: Use of infrared ureteric catheter during total laparoscopic hysterectomy.

Another adverse effect that was discovered in the study is that the use of lighted ureteral stent led to reflux anuria, which can be serious and even lead to an acute renal failure. Anuria is mostly linked to the result of neurogenic factors that are brought about by the manipulation of the ureter and mediated through the autonomic nervous system.

According to various studies, it was established that anuria that resulted after the placement of the ureteral stents was due to edema that is known to cause mechanical obstruction at the ureterovesical junction. The detection of this symptom is very important in order to take action immediately. Detection or recognition of such symptom would require repeated ureteral stents.

The role of infrared or lighted ureteral stent in laparoscopic colectomy can easily be seen. As it tries to improve vision for the identification of the ureter and, thus, reducing and preventing ureteral damage, the technique aims to make laparoscopic colectomy safe. Without the placement of the lighted ureteral stents, the risk of ureteral injury was high. Ureteral damage can lead to many problems to a patient that can also be very expensive to deal with, especially if it is not detected and recognized at an early stage. The best thing about the placement of the ureteral stents is that the surgeon can easily identify whether or not there is any ureteral damage. This allows the doctor to detect the injury early enough before it becomes fatal or difficult to deal with. When an injury is detected, immediate action is taken to correct the problem either intraoperatively or postoperatively.

The placement of the lighted ureteral stent requires special skills, which can actually be acquired through practice, in order to ensure that the stents are well placed so that it can effectively aid the surgeon during laparoscopic surgery. The use of infrared ureteral stents is a safe and cost-effective procedure that can aid in laparoscopic surgery, especially laparoscopic colectomy. The placement of the ureteral stents helps improve the vision, which, thus, helps avoid intraoperative ureteral injury. The ability to detect any ureteral injury using the procedure facilitates immediate action to be taken. Unilateral stent placement should always be the procedure to use rather than the bilateral procedure. Unilateral stent placement is associated with lower postoperative hematuria and can reduce operative time.

RECOGNITION OF URETERAL INJURY

Once a ureteral injury is suspected, the ureter must be identified to assess the severity of the injury. Ureteral injury should be suspected with the presence of hematuria or urinary extravasation. Intravenous indigo carmine may be given to aid in the diagnosis and localization of the site of injury. Unfortunately, the majority of ureteral injuries are diagnosed in the postoperative period. Patients who present with postoperative fever, flank pain, and leukocytosis should undergo evaluation for ureteral injury.

PATHOPHYSIOLOGY

The pathophysiology of ureteral injury depends on many factors, including the type of injury and the time when the

injury is identified. Numerous consequences may occur after ureteral injury, including spontaneous resolution and healing of the injured ureter, hydronephrosis, ureteral necrosis with urinary extravasation, ureteral stricture formation, and uremia.

Spontaneous Resolution and Healing

If the injury to the ureter is minor, easily reversible, and noticed immediately, the ureter may heal completely and without consequence. Inadvertent ligation of the ureter is an example of such an injury. If this injury is noticed in a timely fashion, the suture can be cutoff the ureter without significant damage.

Hydronephrosis

If complete ligation of the ureter occurs, the urine from the ipsilateral kidney is prevented from draining into the bladder, leading to hydronephrosis and progressive deterioration of ipsilateral renal function. These events may occur with or without symptoms. If the urine in this obstructed system becomes infected, the patient will almost certainly become septic with pyonephrosis.

Ureteral Necrosis with Urinary Extravasation

In complete unrecognized ligation of the ureter, a section of the ureteral wall necrosis occurs because of pressure-induced ischemia. The ischemic segment of the ureter eventually weakens, leading to urinary extravasation into the periureteral tissues. If the urinary extravasation drains into the adjacent peritoneum, urinary ascites may develop. If the urinary ascites gets infected, peritonitis may ensue. If the peritoneum has remained intact, a urinoma may form in the retroperitoneum.

Ureteral Stricture

Ureteral stricture may occur when the adventitial layer of the ureter is stripped or electrocoagulated. When the adventitia, the outer layer of the ureter that contains the ureteral blood supply, is disturbed by either stripping or electrocoagulation, ischemia to a particular segment of ureter may result. Ischemic strictures of the ureter may then develop, leading to obstruction and hydronephrosis of the ipsilateral kidney.

Uremia

Uremia results when ureteral injury causes total urinary obstruction. This may result from a bilateral ureteral injury or from a unilateral ureteral injury occurring in a solitarily functioning kidney. Anuria is the only immediate sign of imminent uremia. These cases require immediate intervention to preserve renal function.

MANAGEMENT

Depending on the type, duration, and location of the ureteral injury, surgical treatment may range from simple removal of a ligature to ureteroneocystostomy **(Flowchart 1)**. The most common surgical treatments for ureteral injury are simple removal of a ligature, ureteral stenting, ureteral resection and ureteroureterostomy, transureteroureterostomy (TUU), and ureteroneocystostomy.

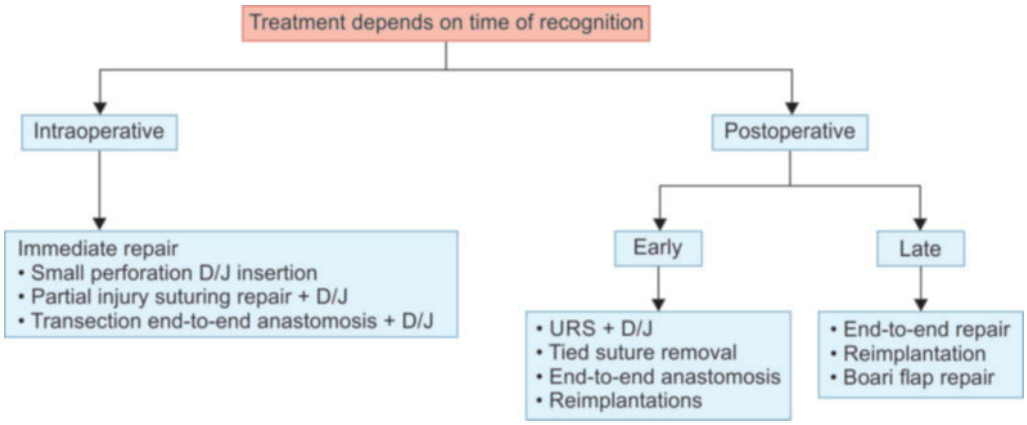
Observation

If a clamp or ligature constricting the ureter is discovered, the clamp or ligature should be removed immediately and the ureter should be examined. If ureteral peristalsis is preserved and it is believed that minimal damage has occurred, the ureter injury may be managed with observation.

Ureteral Stenting with or without Ureterotomy

If tissue ischemia or a partial transection of the ureteral wall is suspected, a ureteral stent should be placed. The purpose of the stent, which is typically placed cystoscopically, is to act as a structural backbone onto which the healing ureter may mold. It also guarantees drainage of urine from the renal pelvis directly to the urinary bladder. It also can work

Flowchart 1: Treatment logarithm of ureteric injuries.



as a gentle dilator since it moves slightly in an up-and-down motion, associated with breathing, as the kidney unit moves. The use of the stent is thought to minimize the rate of obstruction of a ureteral stricture in the injured area.

Alternatively, a ureterotomy may be made along the length of the injured or strictured section of ureter before placement of a stent. Davis described this technique in 1943 (the Davis intubated ureterotomy) in which an ureterotomy is made and left open over the stent. The ureter eventually heals to form a watertight closure over the stent. The stent is withdrawn 6 weeks after it is placed, as it is estimated that all ureteral healing has occurred by that time.

The principles of the Davis intubated ureterotomy have been extended to endoscopic treatments of ureteral strictures. Ureteroscopic endoureterotomy and Acucise endoureterotomy are two modalities that are used to attempt to treat the segment of strictured ureter endoscopically by a longitudinal full-thickness ureteral incision, followed by a stent placement. The success of these procedures closely resembles the success of the open Davis intubated ureterotomy, which approaches 80% patency at 3 years.

Ureteral Resection and Ureteroureterostomy

The establishment of an anastomosis between two different ureters or between two segments of the same ureter may be required. This end-to-end anastomosis between two portions of a transected ureter can be done by open as well as laparoscopic surgery. If extensive ischemia or necrosis is the result of an injury, the ureter injury is best treated by excising the injured segment of the ureter and re-establishing continuity with the urinary system. If the ureteral injury occurred above the pelvic brim, the simplest reconstruction is a ureteroureterostomy, a procedure that is indicated for injuries to short segments of the ureter (i.e.,<2 cm), in which an anastomosis is performed between the two cut edges of the ureter.

Transureteroureterostomy

Transureteroureterostomy is a urinary reconstruction technique that is used to join one ureter to the other across the midline. It offers patients with distal ureteral obstruction, an option to live without external urostomy appliances or internal urinary stents. TUU is also used in undiversion procedures when the surgeon wants to avoid the pelvis because of previous trauma, surgery, or radiation therapy.

If ureteroureterostomy cannot be performed technically and the defect is too proximal in the ureter for ureteroneocystostomy, TUU may be performed. Absolute contraindications to TUU include urothelial cancer, contralateral reflux, pelvic irradiation, retroperitoneal fibrosis, or chronic pyelonephritis. Stone disease, which was once considered an absolute contraindication, is now considered a relative contraindication by some urologists, based on the current ability to prevent stone formation in over 90% of patients with medical therapy.

Ureteroneocystostomy

Ureteroneocystostomy is the operation to implant the upper end of a transected ureter into the bladder. If the ureteral injury occurred below the pelvic brim, where visualization of the ureter is difficult and where the vesical pedicles overlie the ureter, ureteroureterostomy is often too difficult to perform. In these cases, two types of ureteroneocystostomy procedures are indicated, either a psoas hitch or a Boari flap, in which the bladder is mobilized to reach the easily identifiable ureter proximal to the injury. Boari flaps are contraindicated in patients with prior pelvic radiation, a history of bladder cancer, or any condition with a thick, hypertrophied bladder wall.

Preoperative Details

If consultation with an urologist is indicated intraoperatively, the urologist dictates no specific preoperative preparation. If a ureteral injury is identified after the patient is stabilized following the initial gynecologic operation, a discussion is conducted regarding the possible treatment options. Preoperative antibiotics that target urinary organisms should be administered. If patients are persistently febrile secondary to a potentially infected and obstructed renal unit, percutaneous nephrostomy on the affected side may be indicated. Pertinent radiographic studies [e.g., intravenous urogram (IVU), CT scan] may be used to help define the location of ureteral injury preoperatively.

Intraoperative Details

Ureteral Stent Placement with or without Ureterotomy

The perineum of patient should be prepared and draped in the standard sterile manner and while the patient sedated adequately or anesthetized, a cystoscope should be inserted into the bladder.

After the bladder is examined and the ureteral orifices are identified, the ureteral orifice on the side of the injury should be cannulated with a ureteral catheter. A dilute cystografin-gentamicin mixture should be injected slowly through the ureteral catheter under fluoroscopy. Fluoroscopy should reveal the course of the ureter and identifying potential sites of injury.

A Teflon-coated guidewire should be placed under fluoroscopic guidance through the ureteral catheter and up the ureter into the renal pelvis. A double-J stent should be placed over the wire and pushed, so that its proximal J-hook is placed within the renal pelvis and its distal J-hook is within the bladder. Then, the wire is pulled and the stent position is reaffirmed fluoroscopically. Proper length of the

stent can be estimated from the measured length of the ureter on retrograde pyelography from the ureteral orifice to the ureteropelvic junction. Allowing for roughly 10% magnification from the radiograph, subtract 2–3 cm and select that length of the ureteral stent. If, after placement, the stent is not well positioned because of inadequate or surplus length, it is best to replace it with a stent of proper dimensions **(Fig. 6)**.

If an endoscopic ureterotomy is to be made, prior to placing the stent, retrograde pyelography should be performed to delineate the ureteral anatomy and a Teflon-coated guidewire, acting as a safety wire, is positioned into the renal pelvis and out through the urethra.

With ureteroscopic endoureterotomy, a rigid ureteroscope should be placed through the ureteral orifice and into the ureter lumen until the ureteral lesion can be visualized. The ureteral stricture is then cut with a probe from a number of cutting modalities, including holmium laser or electrocautery. A full-thickness incision through the ureteral wall should be made until periureteral fat is visualized. Retrograde pyelography should be performed; extravasation of contrast outside the ureter should be seen. A wide-caliber ureteral stent should be then placed (usually 8F) in the fashion described above.

If Acucise endoureterotomy is performed, the Acucise device should be placed over the safety wire. Once position is confirmed via fluoroscopic guidance and the orientation of the cut is set, the Acucise balloon is inflated and electrocautery is instituted. The Acucise device should be withdrawn, retrograde pyelography should be performed to confirm extravasation, and a wide-caliber ureteral stent should be placed in the fashion described above.

The formal Davis intubated ureterotomy is typically performed intraoperatively only when consultation with an urologist is called for while the patient is open. In this case, the injured ureter is cut sharply in a longitudinal fashion.

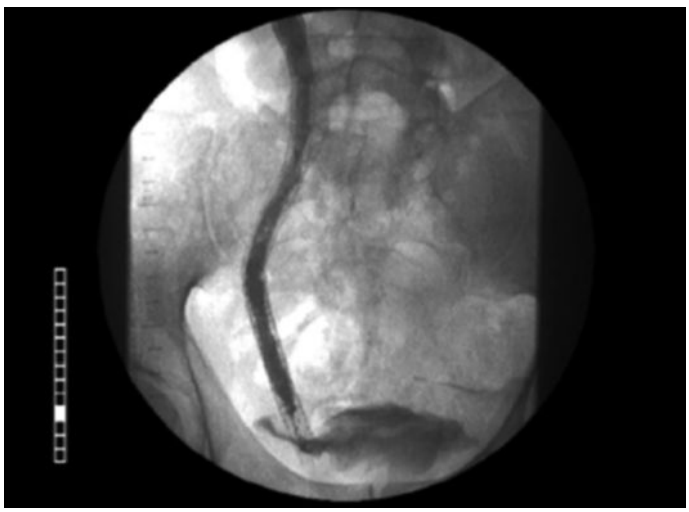


Fig. 6: Stent in the ureter.

A stent then can be placed to the kidney and bladder through the ureteral incision.

Ureteroureterostomy

It is end-to-end anastomosis of the two portions of a transected ureter. If the urologist is asked to evaluate the ureteral lesion intraoperatively, further dissection of the existing exposure is often necessary because the lack of exposure is the most likely contributor to the injury. Additional blunt and sharp dissection is often necessary to adequately identify the ureter and its course.

If the ureteral injury is discovered after the initial gynecologic procedure, the urologist must decide whether to enter through the original incision and approach the ureter transperitoneally or to make a new incision and approach the ureter using a retroperitoneal approach. Either approach is acceptable and each has distinct advantages and disadvantages.

If one decides to enter through a previous midline incision, intraperitoneal adhesions may complicate the dissection; however, this approach spares the patient an additional incision.

In contrast, if a modified Gibson incision is made to approach the ureter retroperitoneally, the dissection may be less challenging technically because it avoids the adhesions of the peritoneal cavity, but the patient is left with an additional incision.

Regardless of the approach, a Foley catheter is placed and the patient is prepared and draped in a sterile manner.

In the transperitoneal approach, an incision is made though the scar of the old incision. The dissection is extended down to the peritoneal cavity and once the small bowel and colon are identified, a vertical incision is made along the left side of the small bowel mesentery. Blunt dissection is performed in the retroperitoneum until the desired ureter is identified. If the inferior mesenteric artery (IMA) limits the exposure, it can be divided without consequence. If the left lower ureter is the area of the injury, the sigmoid can be mobilized medially to gain adequate exposure.

In the retroperitoneal approach, after the incision is made, the external oblique, internal oblique, and transversus abdominus muscles are dissected in a muscle-splitting manner. Once the transversalis fascia is incised, take care not to enter the peritoneal cavity. The peritoneum and its contents are retracted medially and the ureter is located in its extraperitoneal position.

The ureter is most consistently found at the bifurcation of the common iliac artery, but it is often difficult to identify, especially when dilated. Steps that can differentiate the ureter from a blood vessel with a similar appearance include pinching the structure with forceps and watching for peristalsis. If peristalsis occurs, the ureter has been identified. Additionally, a fine needle can be placed into

the lumen of the questionable structure. If urine is retrieved through aspiration, the ureter has been identified; if blood is aspirated, then the structure is a blood vessel.

Once the ureter is identified and dissected from its surrounding tissues, the diseased segment is excised. Take particular care not to disrupt the adventitia of the ureter because its blood supply is contained within this layer. If difficulty is encountered in identifying the diseased segment, retrograde ureteropyelography can be performed to aid in localizing the lesion. Another option is to place a ureteral catheter cystoscopically up to the lesion; the ureteral catheter can then be palpated during the ureteral dissection.

Stay sutures are placed in each end of the ureter and the ureter is mobilized enough, so that tension-free anastomosis can be performed. Simple ureteroureterostomy is typically performed for ureteral lesions shorter than 2 cm. If the lesion is longer than 2 cm or if it appears that the ureteral ends will not come together without tension, seek an alternative surgical approach. Options include further mobilization of the ureter, mobilization of the ipsilateral kidney, TUU, ureteroneocystostomy, ileal ureter interposition, or a combination of the above.

Once the ureter appears to have enough length to be anastomosed without tension, both ureteral ends are spatulated. Two 5-0 absorbable sutures are placed in through the apex of the spatulated side of one ureter and out through the nonspatulated side of the opposite ureter. Each suture is tied and a running stitch is performed on one-half of the ureter. The same steps are performed to complete the anastomosis on the opposite half of the anastomosis.

Before completion of the second half, a double-J ureteral stent is placed by first placing a 0.038 cm Teflon-coated guidewire caudally and passing a standard 7F double-J stent over the wire. The wire is pulled after the position of the distal portion of the stent is confirmed within the bladder. Next, a small hole is made within the stent such that the wire can be passed cephalad, placed into the proximal tip of the stent, and comes out of the created hole in the side of the stent. Once the position of the cephalad tip in the renal pelvis is confirmed, the wire is pulled, leaving a well-positioned stent.

After the anastomosis is completed, a Penrose drain or a Jackson–Pratt (JP) drain is placed in the retroperitoneum and is brought out through the skin. Omentum may be retrieved from a small incision in the posterior peritoneum and can be used to wrap the repair. Adjacent retroperitoneal fat may be used. The anterior abdominal fascia and skin are closed.

Transureteroureterostomy

Transureteroureterostomy is a urinary reconstruction technique that is used to join one ureter to the other across the midline. It offers patients with distal ureteral obstruction, an option to live without external urostomy appliances or internal urinary stents. TUU is also used in undiversion procedures when the surgeon wants to avoid the pelvis because of previous trauma, surgery, or radiation therapy. A TUU is approached best via a midline incision and can be performed using both intraperitoneal and extraperitoneal approaches. A left-to-right intraperitoneal TUU is described.

After a Foley catheter is placed and the patient is prepared and draped in a sterile manner, a midline incision is made and the peritoneal cavity is opened. The small bowel is packed medially and the posterior peritoneum lateral to the sigmoid and descending colon is incised to expose the ureter. The ureter is dissected, preserving its adventitia. The diseased portion of the ureter is identified and a clamp is placed on the ureter proximal to the diseased portion. The diseased portion of ureter is excised, a stay stitch is placed on the proximal segment of the ureter, and the distal stump is ligated. The proximal ureter is dissected for a length of approximately 9–12 cm, while the adventitial vessels are preserved.

Attention is then turned to exposing the right ureter. The ascending colon is retracted medially, while an incision is made through the posterior peritoneum lateral to the colon. Blunt dissection aids in the identification of the ureter. Approximately 4–6 cm above the level of transection of the left ureter, the right ureter is exposed to make room for an anastomosis.

A retroperitoneal tunnel is created via blunt dissection and the left ureter is pulled through the tunnel by the stay suture. When the left ureter is pulled through, taking care not to wedge the ureter between the IMA and the aorta is important because obstruction may result. Instead, the ureter should be passed either over or under the IMA and should not be angulated or be under any tension. If the ureter is too short and a tension-free anastomosis can only be performed with the ureter firmly wedged between the IMA and the aorta, it is appropriate to consider ligation of the IMA. If this maneuver is not performed and the ureter is left firmly between the IMA and the aorta, a fibrous reaction of the ureter typically occurs, which causes an obstruction that must be treated later again with a surgical procedure.

The tip of the left ureter is spatulated and the medial wall of the right ureter is incised using a hook blade for a distance just longer than the diameter of the lumen of the left ureter. Using 4-0 or 5-0 absorbable suture material, a suture is placed at each end of the ureteral incision from the outside in. Each stitch is run over the course of one-half of the anastomosis. Before finishing the second side of the anastomosis, a stent is placed along the entire right ureter using the technique described in ureteral stent placement. The two stitches are tied to each other.

After the anastomosis is completed, a Penrose drain or a JP drain is placed in the retroperitoneum and is brought out through the skin. Omentum or any adjacent retroperitoneal fat may be used to wrap the repair. The anterior abdominal fascia and skin are closed.

Psoas Hitch

The psoas hitch ureteral reimplantation technique has been used with great success to bridge defects in ureteral length due to injury or planned resection. Several surgical principles have been historically stressed when performing this procedure, including adequate mobilization of the bladder, fixation of the bladder to the psoas tendon before reimplantation, the use of a submucosal nonrefluxing-type ureteral anastomosis, and a 6-week delay before attempting repair after a surgical injury.

After a Foley catheter is placed and the patient is prepared and draped in a sterile manner, various incisions are acceptable, including a midline, a Pfannenstiel, or a suprapubic V-shaped incision. A midline incision is preferred if the patient has a preexisting midline scar from a previous gynecologic operation. If entering the peritoneal cavity can be avoided, this incision is preferred.

The peritoneal reflection is dissected off the bladder. Some advocates saline installation in the subperitoneal connective tissue as a way of facilitating this portion of the dissection. If a peritoneal defect is encountered, it can be closed with a running chromic suture. Once the peritoneum is dissected off the bladder, the peritoneum can be reflected medially.

Attention is then turned to dissection and excision of the diseased ureteral segment. The diseased portion of the ureter is identified and a clamp is placed on the ureter proximal to it. The diseased portion of ureter is excised, a stay stitch is placed on the proximal segment of the ureter, and the distal stump is ligated.

The superior pedicle of the bladder is ligated on the ipsilateral side and the bladder wall is incised transversely, a little more than halfway around the bladder, in an oblique manner across the middle of its anterior wall at the level of its maximum diameter. When this horizontal incision is closed vertically, the effect of the incision is the elongation of the anterior wall of the bladder so that the apex of the bladder can be positioned and fixed above the iliac vessels.

After the bladder incision is made, two fingers are placed into the bladder to elevate it to the level of the proximal end of the ureter. If the bladder does not reach the proximal ureter, several steps can be performed for additional length. These steps include extending the bladder wall incision laterally to obtain further length or the peritoneum and connective tissue from the pelvic and lateral walls may be dissected from the contralateral side of the bladder. This dissection may require ligation and division of the superior vesical pedicle on the contralateral side too.

Once adequate mobilization of the bladder has occurred, the bladder is held against the tendinous portion of the psoas minor muscle without tension. Prolene sutures (2-0) are sutured into the bladder wall and to the tendon to fix the bladder in place.

With the bladder open, attention is turned to the ureteral reimplant. An incision is made in the bladder mucosa at the proposed site of the new ureteral orifice. A submucosal dissection occurs approximately 3 cm from the incision site, so that a tunnel is created. Lahey scissors may be used to facilitate this dissection. After achieving a 3-cm tunnel length, the scissors are inverted and the tips are pushed through the bladder wall. An 8F feeding tube is passed over the scissor blades and the stay suture on the proximal tip of the ureter is tied to the other end of the catheter, so that traction on the catheter draws the ureter into the bladder. The ureteral tip is trimmed obliquely and 4-6 absorbable sutures (4-0) are used to fix the ureter to the bladder mucosa. The ureteral adventitia is tacked to the extravesical bladder wall with several 4-0 absorbable sutures. A double-J ureteral stent may be placed at this time.

A nontunneled reimplant is also an acceptable choice in most adults, if ureteral length is insufficient. The end of the ureter can be reflected back after making a small longitudinal incision from the tip proximally about 1.5 cm. This will make the end of the ureter into a nonrefluxing nipple, which is useful when there is inadequate length for an antirefluxing submucosal tunnel.

After completing the reimplant, two fingers are placed within the bladder while five or six absorbable sutures (2-0) are placed within the bladder muscle, the psoas muscle, and the psoas minor tendon, paying specific attention not to suture the genitofemoral nerve. Alternatively, sutures may also take deep bites in the muscle itself. The bladder is closed with a 3-0 running absorbable suture on the mucosa and a running 2-0 suture incorporating the bladder muscle and adventitial layers. A Penrose drain or a JP drain is placed in the retroperitoneum next to the bladder closure. The anterior abdominal fascia and the skin then are closed.

Boari Flap

A Boari flap may be required to bridge long defects of the middle and lower ureter to the bladder. Laparoscopic construction of a Boari flap was performed in a patient with a ureteral stricture secondary to iatrogenic injury. The salient steps performed were spatulation of the transected ureteral end, fashioning of a Boari flap from the bladder, end-to-side anastomosis of the ureter to the flap, placement of a stent with the aid of a suction cannula, and closure of the flap over the stent. A Boari flap can be accomplished even laparoscopically with minimal morbidity.

After preparing and draping the patient, in open method, a midline or Pfannenstiel incision is made. Once the transversalis fascia is incised, the ureter may be approached either transperitoneally or retroperitoneally. In the transperitoneal approach, the peritoneal cavity is entered, the sigmoid or cecum is reflected medially, the posterior peritoneum is incised, and the ureter is identified.

In the retroperitoneal approach, care is taken not to enter the peritoneal cavity, the peritoneum is mobilized medially, and the ureter is identified and exposed. A stay stitch is placed in healthy ureter tissue just proximal to the injury. The remaining end of the ureter is tied off.

The peritoneum is then dissected from the wall of the bladder. This dissection may be facilitated with hydrodissection, in which saline is injected subperitoneally, separating the peritoneal layer from the muscle layers of the bladder.

The necessary length of the bladder flap (i.e., the distance between the posterior wall of the bladder and the end of the healthy proximal ureter) is measured with umbilical tape, the bladder is one-half full of saline, and the length and shape of the bladder flap are planned. To measure accurately on the dome of the bladder, several stay stitches are placed at the base of the proposed bladder flap and at the apex. The bladder flap should be planned with a large base because the base contains all the blood supply necessary for the flap. The length of the bladder flap (i.e., the distance between the base and apex) should equal the distance between the posterior wall of the bladder and the end of the healthy proximal ureter. The width of the apex should be at least three times the diameter of the ureter to prevent constriction after the flap is tubularized. Avoid scarred areas of the bladder.

After proper planning, an outline of the flap is made in the bladder wall with coagulating current and the bladder flap is remeasured. If the measurements are satisfactory, the bladder flap is cut via cutting current and the concomitant bleeding vessels are coagulated.

After the bladder flap is turned superiorly, Lahey scissors are used to prepare a ureteral tunnel. The tunnel should be at least 3 cm long and is created by placing the Lahey scissors submucosally at the apex of the flap, tunneling the appropriate distance and coming out through the mucosa. Submucosal injection of saline may aid in this dissection. An 8F feeding tube is pulled through the tunnel by the scissors and the stay suture on the proximal ureter is tied to the feeding tube after the ureteral end is spatulated. The feeding tube is pulled toward the bladder, followed by the ureter. The stay suture is cut after the ureter has traveled completely through the tunnel.

The bladder flap is sutured to the psoas tendon of the psoas minor with a few 2-0 absorbable sutures. These sutures fix the flap in place to prevent tension on the ureteral anastomosis.

The ureter is anastomosed to the bladder mucosa with several 4-0 absorbable sutures. A few of the sutures should include the muscle layer of the bladder to fix the ureter into place. An 8F feeding tube is passed up the ureter into the renal pelvis and out through the bladder and body wall.

Before closing the bladder, a large suprapubic tube is placed, i.e., either a 22-24F Malecot or Foley. Then, the bladder is closed by approximating the bladder mucosa with a 3-0 absorbable running suture followed by a second row of running sutures, which approximate the muscularis and adventitial layers. A few absorbable sutures (5-0) can be placed to approximate the distal end of the flap to the adventitia of the ureter. If a transperitoneal approach is used, close the peritoneum and then place a Penrose or a JP drain retroperitoneally adjacent to the bladder closure. The anterior abdominal fascia and skin are closed.

Postoperative Details

Ureteral Stent

After the patient has recovered from anesthesia and is in suitable condition, the patient may be discharged with instructions to return to the clinic in 14–21 days, when the stent will be removed. The patient is discharged with 3 days of antibiotics and oral analgesics for potential bouts of discomfort from the stent.

Ureteroureterostomy, Transureteroureterostomy, Psoas Hitch, and Boari Flap

Patients who undergo a transperitoneal approach are kept on a regimen of nothing by mouth (NPO) for the first day after surgery. Subsequently, signs of bowel function are monitored routinely. Once bowel sounds are present, the diet is advanced to clear liquids and when the patient passes flatus, a regular diet is instituted.

Patients who undergo a retroperitoneal approach are started on clear liquids on the first day after surgery unless they are nauseous. Their diets are also advanced when they have passed flatus.

All patients receive a patient-controlled analgesia (PCA) pump postoperatively, unless they had an epidural catheter placed intraoperatively. The latter are then given an epidural pump. Oral analgesics are administered after patients tolerate a regular diet.

All patients receive a 24-hour course of intravenous antibiotics to prevent wound infections.

Patients are encouraged to ambulate on the first day after surgery. Once the pain is controlled with oral analgesics and patients are tolerating a regular diet, they are eligible for discharge, with or without their drains. If drains are not removed while in the hospital, appointments are set to assess patients and their drains in the clinic.

Follow-up

In patients who do not require a cystotomy, the Foley catheter or suprapubic tube is left to drain the bladder until the drain output from the Penrose or JP drain is <30 mL/day. If this is achieved, the Foley catheter can be removed or the suprapubic tube can be clamped and the output from the Penrose or JP drain is monitored. If no drainage

25. Fernandez H, Bourget P, Ville Y, Lelaidier C, Frydman R. Treatment of unruptured tubal pregnancy with methotrexate: pharmacokinetic analysis of local versus intramuscular administration. Fertil Steril. 1994;62:943-7.
26. Fernandez H, Pauthier S, Doumerc S, Lelaidier C, Olivennes F, Ville YY. Ultrasound-guided injection of methotrexate versus laparoscopic salpingotomy in ectopic pregnancy. Fertil Steril. 1995;63:25-9.
27. Fernandez H, Pauthier S, Sitbon D, Vincent Y, Doumerc S. Role of conservative therapy and medical treatment in ectopic pregnancy: literature review and clinical trial comparing medical treatment and conservative laparoscopic treatment. Contracept Fertil Sex. 1996;24:297-302.
28. Fernandez H, Yves VS, Pauthier S, Audibert F, Frydman R. Randomized trial of conservative laparoscopic treatment and methotrexate administration in ectopic pregnancy and subsequent fertility. Hum Reprod. 1998;13:3239-43.
29. Flamant DR, Lellouch J. Clinical Trials. London: Academic Press; 1980. pp. 214-23.
30. Foulot H, Chapron C, Morice P, Mouly M, Aubriot FX, Dubuisson JB. Failure of laparoscopic treatment for peritoneal trophoblastic implants. Hum Reprod. 1994;9:92-3.
31. Franklin EW, Zeiderman AM. Tubal ectopic pregnancy: etiology and obstetric and gynecologic sequelae. Am J Obstet Gynecol. 1973;117:220-5.
32. Fujishita A, Ishimaru T, Masuzaki H, Samejima T, Matsuwaki T, Chavez RO, et al. Local injection of methotrexate dissolved in saline versus methotrexate suspensions for the conservative treatment of ectopic pregnancy. Hum Reprod. 1995;10:3280-3.
33. Fujishita A, Masuzaki H, Newaz KK, Kitajima M, Hiraki K, Ishimaru T. Laparoscopic salpingotomy for tubal pregnancy: comparison of linear salpingotomy with and without suturing. Hum Reprod. 2004;19:1195-200.
34. Garbin O, de TR, de PL, Coiffic J, Lucot JP, Le-Goueff FF. Medical treatment of ectopic pregnancy; a randomized clinical trial comparing methotrexate mifepristone and methotrexate-placebo. J Gynecol Obstet Biol Reprod. 2004;33:391-400.
35. Gazvani MR, Baruah DN, Alfirevic Z, Emery SJ. Mifepristone in combination with methotrexate for the medical management of tubal pregnancy: a randomized controlled trial. Hum Reprod. 1998;13:1987-90.
36. Giana M. Tratamens chirurgico conservative in caza digraviden zatubarica. Minerva Gynecol. 1979;30:51-99.
37. Gjelland K, Hordnes K, Tjugum J, Augensen K, Bergsjø P. Treatment of ectopic pregnancy by local injection of hypertonic glucose: a randomized trial comparing administration guided by transvaginal ultrasound or laparoscopy. Acta Obstet Gynecol Scand. 1995;74:629-34.
38. Gracia CR, Brown HA, Barnhart KT. Prophylactic methotrexate after linear salpingostomy: a decision analysis. Fertil Steril. 2001;76:1191-5.
39. Graczykowski JW, Mishell DR. Methotrexate prophylaxis for persistent ectopic pregnancy after conservative treatment by salpingostomy. Obstet Gynecol. 1997;89:118-22.
40. Gray DT, Thorburn J, Lundorff P, Strandell A, Lindblom B. A cost-effectiveness study of a randomized trial of laparoscopy versus laparotomy for ectopic pregnancy. Lancet. 1995;345:1139-43.
41. Hajenius P, Mol F, Mol B, Bossuyt P, Ankum W, van der Veen F. Interventions for tubal ectopic pregnancy. Cochrane Database Syst Rev. 2007;1:CD000324.
42. Hajenius PJ, Engelsbel S, Mol BWJ, van der Veen F, Ankum WM, Bossuyt PMM. Randomized trial of systemic methotrexate versus laparoscopic salpingostomy in tubal pregnancy. Lancet. 1997;350:774-9.
43. Hallatt JG. Tubal conservation in ectopic pregnancy: a study of 200 cases. Am J Obstet Gynecol. 1986;154:1216-21.
44. Hordnes K. Reproductive outcome after treatment of ectopic pregnancy with local injection of hypertonic glucose. Acta Obstet Gynecol Scand. 1997;76:703-5.
45. Hu CX, Han LX. Mifepristone in combination with methotrexate for the medical treatment of unruptured ectopic pregnancy. Acta Acad Med. 2003;12:171-2.
46. Hugues GJ. Fertility and ectopic pregnancy. Eur J Obstet Gynecol Reprod Biol. 1980;10:361-5.
47. Intramuscular. Fertil Steril. 1996;65:206-7.
48. Judlin P, Leguin T, Zaccabri A, Landes P. Avenir genital des patientes apres GEU: a proposd'une sine continue de 330 cas. J Gynecol Obstet Biol Reprod. 1988;17:58-9.
49. Kaya H, Babar Y, Ozmen S, Ozkaya O, Karci M, Aydin AR. Intratubal methotrexate for prevention of persistent ectopic pregnancy after salpingostomy. J Am Assoc Gynecol Laparosc. 2002;9:464-7.
50. Klauser CK, May WL, Johnson VK, Cowan BD, Hines RS. Methotrexate for ectopic pregnancy: a randomized single dose compared with multiple doses. Obstet Gynaecol. 2005;105:64S.
51. Koninckx PR, Witters K, Brosens J, Stemers N, Oosterlynck D, Meuleman C. Conservative laparoscopic treatment of ectopic pregnancies using the CO_2 laser. Br J Obstet Gynaecol. 1991;98:1254-9.
52. Korhonen J, Stenman U, Ylostalo P. Low-dose oral methotrexate with expectant management of ectopic pregnancy. Obstet Gynecol. 1996;88:775-8.
53. Laatikainen T, Tuomivaara L, Kaar K. Comparison of a local injection of hyperosmolar glucose solution with salpingostomy for the conservative treatment of tubal pregnancy. Fertil Steril. 1993;60:80-4.
54. Landstrom G, Bryman I, Ekstrom P, Engman M, Gunnarsson J, Hjersing MM. Ectopic pregnancy: local medical treatment versus oral methotrexate therapy—a multicentre pilot study. Hum Reprod. 1998;13:38.
55. Lang PF, Weiss PA, Mayer HO, Haas JG, Honigl W. Conservative treatment of ectopic pregnancy with local injection of hyperosmolar glucose solution or prostaglandin F2a: a prospective randomised study. Lancet. 1990;336:78-81.
56. Langebrekke A, Somes T, Umes A. Fertility after treatment of tubal pregnancy by laparoscopic laser surgery. Acta Obstet Gynecol Scand. 1993;72:547-9.
57. Langer R, Raziel A, Ron-El R, Golan A, Bukovsky I, Caspi E. Reproductive outcome after conservative surgery for unruptured tubal pregnancy—a 15-year experience. Fertil Steril. 1990;53:227-31.
58. Lund J. Early ectopic pregnancy; comments on conservative treatment. J Obstet Gynecol Br Emp. 1955;62:70-6.
59. Lundorff P, Hahlin M, Sjöblom P, Lindblom B. Persistent trophoblast after conservative treatment of tubal pregnancy: prediction and detection. Obstet Gynecol. 1991;77:129-33.
60. Lundorff P, Thorburn J, Hahlin M, Kallfelt B, Lindblom B. Laparoscopic surgery in ectopic pregnancy: a randomized trial versus laparotomy. Acta Obstet Gynecol Scand. 1991;70:343-8.
61. Lundorff P, Thorburn J, Lindblom B. Fertility after conservative surgical treatment of ectopic pregnancy evaluated in a randomized trial. Ugeskr Laeger. 1993;155:3282-6.
62. Lundorff P, Thorburn J, Lindblom B. Fertility outcome after conservative surgical treatment of ectopic pregnancy evaluated in a randomized trial. Fertil Steril. 1992;57:998-1002.
63. Lundorff P, Thorburn J, Lindbloom B. Second-look laparoscopy after ectopic pregnancy. Fertil Steril. 1990;53:604-9.
64. Lundorff P. Laparoscopic surgery in ectopic pregnancy. Acta Obstet Gynecol Scand. 1997;164:81-4.
65. Lundorff P. Treatment of ectopics and subsequent adhesion formation. Prog Clin Biol Res. 1993;381:139-47.
66. Makinen JI, Salmi TU, Nikkanen VPJ, Koskinen EYJ. Encouraging rates of fertility after ectopic pregnancy. Int J Fertil. 1989;34:46-51.

67. Manhes H, Mage G, Pouly JL. Treatment, coelioscopique de la grossesse tubaire: ameliorations techniques. Presse Med. 1983;12:1431.
68. Mathieu J, Soulerin A. Le pronostic obstetrical après grossesse extra uterine. Rev Fr Gynecol Obstet. 1957;52:167-76.
69. Mol BW, Hajenius PJ, Ankum WM, van der Veen F, Bossuyt PM. Conservative versus radical surgery for tubal pregnancy. Acta Obstet Gynecol Scand. 1996;75:866-7.
70. Mol BW, Hajenius PJ, Engelsbel S, Ankum WM, Hemrika DJ, van der Veen F. The treatment of tubal pregnancy in the Netherlands: an economic evaluation of systemic methotrexate and laparoscopic salpingostomy. Am J Obstet Gynecol. 1999;181:945-51.
71. Mol BW, Hajenius PJ, Engelsbel S, Ankum WM, van der Veen F, Hemrika DJ, et al. Serum human chorionic gonadotropin measurement in the diagnosis of ectopic pregnancy when transvaginal sonography is inconclusive. Fertil Steril. 1998; 70:972-81.
72. Mol BW, Matthijsse HM, Tinga DJ, Huynh VT, Hajenius PJ, Ankum WM, et al. Fertility after conservative and radical surgery for tubal pregnancy. Hum Reprod. 1998;13:1804-9.
73. Mol BW, van der Veen F, Bossuyt PM. Implementation of probabilistic decision rules improves the predictive values of algorithms in the diagnostic management of ectopic pregnancy. Hum Reprod. 1999;14:2855-62.
74. Mottla GL, Rulin MC, Guzick DS. Lack of resolution of ectopic pregnancy by intratubal injection of methotrexate. Fertil Steril. 1992;57:685-7.
75. Murphy AA, Nager CW, Wujek JJ, Kettel LM, Torp VA, Chin HG. Operative laparoscopy versus laparotomy for the management of ectopic pregnancy: a prospective trial. Fertil Steril. 1992;57:1180-5.
76. Murphy AA. Operative laparoscopy. Fertil Steril. 1987;47:1-18.
77. Nagamani M, London S, St Amand P. Factors influencing fertility after ectopic pregnancy. Am J Obstet Gynecol. 1984;149:533-5.
78. Nieuwkerk PT, Hajenius PJ, Ankum WM, van der Veen F, Wijker W, Bossuyt PM. Systemic methotrexate therapy versus laparoscopic salpingostomy in patients with tubal pregnancy. Part I. Impact on patients' health-related quality of life. Fertil Steril. 1998;70:511-7.
79. Nieuwkerk PT, Hajenius PJ, van der Veen F, Ankum WM, Wijker W, Bossuyt PM. Systemic methotrexate therapy versus laparoscopic salpingostomy in tubal pregnancy. Part II. Patient preferences for systemic methotrexate. Fertil Steril. 1998;7:518-22.
80. Oelsner G, Goldenberg M, Admon D, Pansky M, Tur-Kaspa I, Rabinovitch O, et al. Salpingectomy by operative laparoscopy and subsequent reproductive performance. Hum Reprod. 1994;9:83-6.
81. Paavonen J, Varjonen-Toivonen M, Komulainen M, Heinonen PK. Diagnosis and management of tubal pregnancy: effect on fertility outcome Int J Gynecol Obstet. 1985;23:123-33.
82. Palmer R. Resultats et indications de la chirurgie conservatrice au cours de la grossesse extra utirine. CR Soc Fr Gynecol. 1972;42:317-20.
83. Peng LX. The comparison of three conservative treatments for ectopic pregnancy; analysis of 97 cases. Guangxi Med J. 1997;19:752-4.
84. Pereira GD, Hajenius PJ, Mol BW, Ankum WM, Hemrika DJ, Bossuyt PM, et al. Fertility outcome after systemic methotrexate and laparoscopic salpingostomy for tubal pregnancy. Lancet. 1999;353:724-5.
85. Ploman L, Wicksell F. Fertility after conservative surgery in tubal pregnancy. Acta Obstet Gynecol Scand. 1960;39:143-52.
86. Porpora MG, Oliva MM, De CA, Montanino G, Cosmi EV. Comparison of local methotrexate and linear salpingostomy in the conservative laparoscopic treatment of ectopic pregnancy. J Am Assoc Gynecol Laparosc. 1996;3:271-6.
87. Pouly JL, Chapron C, Manhes H, Canis M, Wattiez A, Bruhat MA. Multifactorial analysis of fertility after conservative laparoscopic treatment of ectopic pregnancy in a series of 223 patients. Fertil Steril. 1991;56:453-60.
88. Pusey J, Taylor PJ, Leader A, Pattinson HA. Outcome and effect on medical intervention in women experiencing infertility following removal of an ectopic pregnancy. Am J Obstet Gynecol. 1984;148:524-7.
89. Querleu D, Lenain F, Hennion A. Feconditi apres grossesse extrauterine. Contracept Fertil Sex. 1988;16:131-5.
90. Reich H, Jones DA, De Caprio J. Laparoscopic treatment of 109 consecutive ectopic pregnancies. J Reprod Med. 1988;33:885-90.
91. Rozenberg P, Chevret S, Camus E, de TR, Garbin O, Poncheville LL. Medical treatment of ectopic pregnancies: a randomized clinical trial comparing methotrexate-mifepristone and methotrexate-placebo. Hum Reprod. 2003;18:1802-8.
92. Sadan O, Ginath S, Debby A, Rotmensch S, Golan A, Zakut HH. Methotrexate versus hyperosmolar glucose in the treatment of extrauterine pregnancy. Arch Gynecol Obstet. 2001;265:82-4.
93. Saraj AJ, Wilcox JG, Najmabadi S, Stein SM, Johnson MB, Paulson RJ. Resolution of hormonal markers of ectopic gestation: a randomized trial comparing single-dose intramuscular methotrexate with salpingostomy. Obstet Gynecol. 1998;92:989-94.
94. Seifer DB, Gutmann JN, Grant WD, Kamps CA, DeCherney AH. Comparison of persistent ectopic pregnancy after laparoscopic salpingostomy versus salpingostomy at laparotomy for ectopic pregnancy. Obstet Gynecol. 1993;81:378-82.
95. Sharma JB, Gupta S, Malhotra M, Arora R. A randomized controlled comparison of minilaparotomy and laparotomy in ectopic pregnancy cases. Indian J Med Sci. 2003;57:493-500.
96. Shea RT, Thompson GR, Harding A. Intra-amniotic methotrexate versus CO_2 laser laparoscopic salpingotomy in the management of tubal ectopic pregnancy: a prospective randomized trial. Fertil Steril. 1994;62:876-8.
97. Sherman A, Langer R, Sadovsky G, Bukovsky I, Caspi E. Improved fertility following ectopic pregnancy. Fertil Steril. 1982;37:497-502.
98. Shulman A, Maymon R, Zmira N, Lotan M, Holtzinger M, Bahary C. Conservative treatment of ectopic pregnancy and its effect on corpus luteum activity. Gynecol Obstet Invest. 1992;33:161-4.
99. Silva PD, Schaper AM, Rooney B. Reproductive outcome after 143 laparoscopic procedures for ectopic pregnancy. Obstet Gynecol. 1993;81:710-15.
100. Skulj V, Pavlic Z, Stoilkovic C, Bacic G, Drazancic A. Conservative operative treatment of tubal pregnancy. Fertil Steril. 1964;15:634-9.
101. Sowter MC, Farquhar CM, Gudex G. An economic evaluation of single-dose systemic methotrexate and laparoscopic surgery for the treatment of unruptured ectopic pregnancy. Br J Obstet Gynaecol. 2001;108:204-12.
102. Sowter MC, Farquhar CM, Petrie KJ, Gudex G. A randomized trial comparing single-dose systemic methotrexate and laparoscopic surgery for the treatment of unruptured ectopic pregnancy. Br J Obstet Gynaecol. 2001;108:192-203.
103. Stovall TG, Ling FW, Gray LA, Carson SA, Buster JE. Methotrexate treatment of unruptured ectopic pregnancy: a report of 100 cases. Obstet Gynecol. 1991;77:749-53.
104. Su Y, Sun Y, Ma L. Observation on treatment of ecotopic pregnancy by combination therapy of Chinese herbal medicine with mifepristone or methotrexate. Zhongguo Zhong Xi Yi Jie He Za Zhi. 2002;22:417-9.
105. Sultana CJ, Easley K, Collins RL. Outcome of laparoscopic versus traditional surgery for ectopic pregnancies. Fertil Steril. 1992;57:285-9.
106. Thorburn J, Philipson M, Lindblom B. Fertility after ectopic pregnancy in relation to background factors and surgical treatment. Fertil Steril. 1988;49:595-601.
107. Timonen S, Nieminen U. Tubal pregnancy: choice of operative method of treatment. Acta Obstet Gynecol Scand. 1967;46:327-39.

108. Tulandi T, Guralnick M. Treatment of tubal ectopic pregnancy by salpingotomy with or without tubal suturing and salpingectomy. Fertil Steril. 1991;55:53-5.
109. Tuomivaara L, Kaupilla A. Radical or conservative surgery for ectopic pregnancy? A follow-up study of fertility of 323 patients. Fertil Steril. 1988;50:580-3.
110. Tzafettas J, Anapliotis S, Zournatzi V, Boucklis A, Oxouzoglou N, Bondis J. Transvaginal intra-amniotic injection of methotrexate in early ectopic pregnancy: advantages over the laparoscopic approach. Early Hum Dev. 1994;39:101-7.
111. Ugur M, Yesilyurt H, Soysal S, Gokmen O. Prophylactic vasopressin during laparoscopic salpingotomy for ectopic pregnancy. J Am Assoc Gynecol Laparosc. 1996;3:365-8.
112. Vehaskari A. The operation of choice for ectopic pregnancy to subsequent fertility. Acta Obstet Gynecol Scand. 1960; 39:1-7.
113. Vermesh M, Presser SC. Reproductive outcome after linear salpingostomy for ectopic gestation: a prospective 3-year follow-up. Fertil Steril. 1992;57:682-4.
114. Vermesh M, Silva PD, Rosen GF, Stein AL, Fossum GT, Sauer MV. Management of unruptured ectopic gestation by linear salpingostomy: a prospective, randomized clinical trial of laparoscopy versus laparotomy. Obstet Gynecol. 1989;73:400-4.
115. Wang J, Yang Q, Yu Z. Clinical study of tubal pregnancy treated with integrated traditional Chinese and Western medicine. Zhongguo Zhong Xi Yi Jie He Za Zhi. 1998;18:531-3.
116. Wei FY, Chen HF. Clinical analysis of 82 cases of ectopic pregnancy treated by methotrexate combined with traditional Chinese recipe. Zhong Xi Yi Jie He Xue Bao. 2003;1:267-92.
117. Weinstein M, Morris MB, Dutters D. Ectopic pregnancy: a new surgical epidemic. Obstet Gynecol. 1983;61:698-701.
118. Yalcinkaya TM, Brown SE, Mertz HL, Thomas DW. A comparison of 25 mg/m^2 vs. 50 mg/m^2 dose of methotrexate (MTX) for the treatment of ectopic pregnancy (EP). J Soc Gynecol Invest. 2000;7:179A.
119. Zilber U, Pansky M, Bukovsky I, Golan A. Laparoscopic salpingostomy versus laparoscopic local methotrexate injection in the management of unruptured ectopic gestation. Am J Obstet Gynecol. 1996;175:600-2.