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Adult Ureteral Reconstruction

Editor:
Bernard Fallon, MD
Professor of Urology
Department of Urology
University of Iowa
Iowa City, IA

Contributor:
Darlene M. Gaynor-Krupnick, DO
Fellow, Female and Reconstructive Surgery
Department of Urology
University of Iowa
Iowa City, IA

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INTRODUCTION

Many approaches are available for the management of ureteral strictures. Open surgical techniques for ureteral repair include ureteroneocystostomy, psoas hitch, Boari flap, ureteroureterostomy, transureteroureterostomy, ileal ureter substitution, and renal autotransplantation. Before deciding on definitive management of a stricture, the urologist must carefully consider the indications, contraindications, risks, and benefits of the various types of repair. A thorough workup will aid in properly diagnosing the cause of the defect and provide important information to guide therapy decisions. The length and location of the ureteral injury or stricture are key factors in decision making, as are prior medical history (eg, radiation exposure), pathology involving the contralateral collecting system, and the performance status of the patient. Knowledge of the anatomy surrounding the ureter at the upper, middle, and lower portions is critical. Although selecting the most appropriate approach is essential to achieving optimal outcomes, urologists should have a variety of treatment options within their surgical armamentarium, as the intraoperative course may require the urologist to perform alternative forms of surgical treatment.

This manual reviews forms of open surgical repair of ureteral injuries with a focus on indications, contraindications, surgical technique, success rates, and possible complications.

SURGICAL CONSIDERATIONS

ANATOMY

From a surgical perspective, the ureter is divided into the abdominal and pelvic portions. The renal pelvis is the upper border of the abdominal ureter, and the iliac vessels are the inferior border. The pelvic ureter extends from the iliac vessels to the bladder. Radiologically, the ureter is divided into 3 portions: the upper, middle, and lower ureter. The upper ureter is the length between the renal pelvis and the upper border of the sacrum; this segment overlies the psoas muscle. The upper ureter receives its blood supply medially from branches of the renal artery, gonadal artery, abdominal aorta, and common iliac artery. The midureter extends from the upper border to the inferior border of the sacrum at the level of the iliac vessels and is located posterior to the gonadal artery and vein. It receives its blood supply from the gonadal artery, internal iliac artery, and the superior vesical artery. The lower section of the midureter crosses anterior to the common iliac vessels, a key landmark in identifying the ureter intraoperatively. This portion of the left ureter runs posterior to the sigmoid and descending colon, and the right ureter runs under the cecum. The lower ureter extends from the inferior border of the sacrum to the ureteral orifice and receives its blood supply laterally from the superior and inferior vesical arteries and the uterine, middle rectal, and vaginal arteries. An adventitial network of anastomosing vessels allows the ureter to be extensively mobilized without ischemia if the adventitia is preserved.1

ETIOLOGY

Ureteral calculi, instrumentation, external malignancy, infection, fibrosis, radiation, and trauma are the major causes of ureteral strictures. Rare causes include schistosomiasis, tuberculosis, and endometriosis. Ureteral stricture is a complication in 4.5% of ureteroscopic procedures and in 1.1% of hysterectomies.2 External violence is responsible for 6% of traumatic ureteral injuries.2 Intrinsic ureteral malignancy is another potential cause of ureteral narrowing. Ureteroscopy, selective cytology, barbotage, and brush biopsies are important methods of evaluation for intrinsic ureteral malignancy that may lead to ureteral strictures.

Approximately 80% of ureteral injuries are iatrogenic,3 and 30% to 45% of these injuries are recognized intraoperatively. A study by Ghali et al emphasized that early diagnosis is the most critical aspect affecting outcome.4 Postoperative flank pain, fever, and evidence of possible adynamic ileus, such as nausea and vomiting, are highly suggestive of iatrogenic ureteric injury.
following a hysterectomy. Intraoperative recognition and repair is best, but when the injury is diagnosed postoperatively early repair within 3 months is recommended.³

Ureteral injuries occur in 0.4% to 2.5% of all gynecologic procedures.⁵ Abdominal hysterectomy is by far the most common setting for surgical ureteral injuries, with 2% to 3% of patients who undergo hysterectomy experiencing ureteral injury.⁶ Gynecologic-related malignancy increases the rate of ureteric injury to approximately 10%.⁷ Ureteral injuries are the leading cause of medicolegal issues following hysterectomy. Two thirds of all gynecologic-related injuries occur below the pelvic brim at the point where the ureter courses under the uterine vessels.⁸ Most injuries occur during attempts to obtain hemostasis while ligating the infundibulopelvic ligament. The success rate following definitive treatment for a pelvic ureteric complication due to gynecologic surgery is more than 90%.

PREOPERATIVE IMAGING STUDIES

An intravenous pyelogram (IVP) and retrograde pyelogram are useful in visualizing ureteral defects.³ The IVP will define the proximal border of the stricture area. A “goblet sign” on the IVP is characteristic of an intrinsic malignancy. A retrograde pyelogram will demonstrate the distal border of the stricture and may outline its length and severity. If a percutaneous nephrostomy tube is present, an antegrade nephrostogram may be obtained to demonstrate the upper border of the ureteral defect. A furosemide-stimulated renal scan with a Foley catheter in place can provide additional information regarding the presence, location, and degree of upper tract obstruction and overall renal function.

ENDOSCOPIC TREATMENT

Minimally invasive methods of treatment such as balloon dilation and endopyelotomy can be used to dilate short strictures. Endoscopic methods are best reserved for strictures less than 2 cm in length. For treating strictures 1 to 2 cm in length, better long-term success has been reported with endoureterotomy with stent placement as opposed to balloon dilatation.¹¹ Active infection is considered a contraindication for balloon dilatation or endopyelotomy. Typically, a lower ureteral stricture should be approached with an anterolateral incision with endopyelotomy; a midureter or upper ureter stricture should be approached with a lateral and sometimes a posterolateral incision away from the ureteral blood supply and the great vessels.¹² A computed tomography (CT) angiogram may demonstrate crossing vessels and aid in planning the best approach with endoureterotomy.

SURGICAL KEY POINTS

When mobilizing the ureter, care must be taken to preserve the adventitia and blood supply. Nondurable tissue must be débrided. Spatulation of the ureteric end to approximately 10%. Ureteral injuries are the leading cause of medicolegal issues following hysterectomy. Two thirds of all gynecologic-related injuries occur below the pelvic brim at the point where the ureter courses under the uterine vessels.⁸ The left ureter is at higher risk of injury because it is located 2 cm from the cervical cuff.⁹¹⁰ Most injuries occur during attempts to obtain hemostasis while ligating the infundibulopelvic ligament. The success rate following definitive treatment for a pelvic ureteric complication due to gynecologic surgery is more than 90%.

OPTIONS FOR URETERAL REPAIR

CASE PRESENTATION 1

A 56-year-old man with a 5-month history of diffuse abdominal pain and anorexia presents to the urology department. Past medical and social history is significant for coronary artery disease, a 32-pack-year smoking habit, and pulmonary embolism and Greenfield filter placement. Urinalysis reveals microscopic hematuria, and a full genitourinary workup is ordered, including cystoscopy with urine cytology. The results of the workup are normal. An abdominopelvic CT scan demonstrates a lower pelvic mass as well as moderate to severe hydronephrosis on the left and mild hydronephrosis on the right. No other pathology is noted on the CT scan.

An IVP is obtained, which reveals medial deviation of the left ureter. A furosemide-stimulated renal scan demonstrates 35% function on the left and 65% function on the right. Retrograde pyelogram demonstrates obstruction at the left midureter (Figure 1). There is no obstruction or medial deviation evident at the right ureter. It is not possible to place a left ureteral stent in a retrograde fashion; percutaneous placement of a nephrostomy tube is performed to decompress the affected left renal pelvis. (Another indication for percutaneous nephrostomy drainage, in general, is active infection. The nephrostomy tube also allows an approach for further treatment and radiography in stable patients.) An antegrade nephrostogram is obtained, which reveals complete ureteral obstruction at the upper portion of the proximal left ureter (Figure 2). Urine cytology specimens are collected and are negative for malignant cells.

Laparoscopic biopsy of the pelvic mass is performed.
A pathologic diagnosis of idiopathic retroperitoneal fibrosis (IRF) is made. The final diagnosis is left ureteral stricture extending 15 cm from the upper ureter to the lower midureter.

- **What are the surgical options for treating the left ureteral stricture?**

  Typically, ureterolysis with an omental flap is the procedure of choice to treat ureteral obstruction caused by IRF. However, because an extensive length of the ureter is obliterated, another form of therapy should be considered in this patient. Left ileal ureter substitution may be safely performed in the setting of benign IRF. The risks associated with this procedure include bacteriuria and increased mucus production, which can lead to obstruction. It is unlikely that a Boari flap would reach the upper ureter tension-free. A renal autotransplant may be a viable option, but the risk of ischemia to the kidney may outweigh the risks associated with ileal ureter substitution. Surgical intervention is not required on the right side, as there was no evidence of significant obstruction or deviation to the right ureter.

The best tissue for ureteral reconstruction is urothelium, which may be obtained from the bladder or from tissue harvested from a hydroureter. The benefits of urothelium are difficult to match. It is resistant to inflammatory and carcinogenic effects of urine, and, most important, it does not reabsorb toxins or solutes, which in excess may be harmful. Nonetheless, ureter substitution with an ileal segment has been reported as an effective form of ureteral reconstruction. The benefit of using an ileal segment to replace a large ureteral defect is that it is readily available and not as scarce in supply as urothelium. Other forms of replacement have been described, including tubularized collagen-based porcine small intestine submucosa and polytetrafluoroethylene conduits. However, anastomotic leakage and stenosis have been reported with various techniques for ureteral substitution, including in-situ prosthetic ureters.

**ILEAL URETER SUBSTITUTION Contraindications**

There are 4 major contraindications for ureteral ileal substitution. 1) A serum creatinine level greater than 2 mg/dL is associated with an increased risk for hyperchloremic metabolic acidosis when ileum is used. This occurs when chloride and hydrogen ions are absorbed within the bowel segment in greater amounts than sodium and ammonium ions, resulting in a net loss of bicarbonate through the ileal segment. Renal insufficiency precipitates this action and further increases the acid load. Normal preoperative renal function indicated by a serum creatinine level below 2 mg/dL helps to avoid hyperchloremic metabolic acidosis in the majority of cases. 2) Bladder outlet obstruction or a neurogenic bladder may increase intravesical pressures and pressures to the ileal segment, resulting in an increased frequency of complications. 3) Inflammatory bowel disease

**Figure 1.** Left retrograde pyelogram with midureteral obstruction.

**Figure 2.** Supine view of left antegrade nephrostogram.
may affect the ileal tissue and peristalsis. 4) Radiation enteritis increases the risk for strictures and poorly vascularized bowel.

Technique

Preoperatively, the patient receives a mechanical and antibiotic bowel preparation. A transperitoneal incision typically is used to provide sufficient exposure. The ureter is mobilized and the defect area is excised, if possible; a frozen section may be sent for evaluation. The method for creating an ileal ureter is similar to the method for creating an ileal conduit, with mobilization of the ileal segment under the sigmoid colon. The bowel segment is isolated in standard fashion. The segment chosen should be at least 15 cm from the ileocecal valve in order to avoid vitamin B₁₂ malabsorption. It is important to properly identify and mark the distal and the proximal ends of the segment, so the segment can be placed in an isoperistaltic fashion. For a bilateral ureteral ileal substitution, one longer segment may be anastomosed to each collecting system and then to the bladder. Alternatively, 2 separate ileal segments can be used. The segment is then anastomosed to the proximal end of the ureter with 4-0 polydioxanone sutures and at the distal end to a cystotomy incision with 3-0 Vicryl sutures (Figures 3–5). It is imperative to position and anastomose the isolated ileal segment in an isoperistaltic fashion in order to avoid functional obstruction. Tapering the ileal segment has not been found to provide benefit and may increase the risk for strictures at the level of the anastomosis.23,24 Although ileal ureters do reflux, segments greater than 15 cm have not been found to reflux into the renal pelvis.25 A laparoscopic approach may be performed, although it is associated with a longer intraoperative time.26

Postoperative care includes an antegrade nephrostogram and removal of the indwelling stent within 3 to 4 weeks. An IVP should be obtained 3 months postoperatively. The patient should be followed with annual evaluations alternating between measurement of creatinine level and renal ultrasonography unless there are changes in clinical status.

Complications

Early extravasation leading to a possible urinoma or fistula may occur postoperatively. Obstruction from edema, a mucus plug, or a kink in the ileal segment must be considered when flank pain, signs associated with ileus, or a rise in the creatinine level are present. Long ileal segments increase the risk of mucus obstruction, and these obstructions may need to be treated endoscopically if they do not resolve spontaneously. Long-term complications include ureterointestinal stricture, reflux, hyperchloremic metabolic acidosis, mucosal obstruction, chronic bacteriuria, and renal insufficiency. Ureterointestinal stricture may be treated initially with laser endopyelotomy or open revision, which is considered the gold standard.27

Pyelonephritis remains a concern following ileal substitution, although the risk of damage to renal function due to pyelonephritis is extremely low. The risk for pyelonephritis may be diminished with an antireflux anastomosis; however, this issue is controversial because reflux may occur in an antirefluxing vesicoureteral anastomosis as well. In studies of ileal replacement of the ureter, Vatandaslar25,24 and Verduyckt28 concluded that there was no difference in renal function with either refluxing or antirefluxing ileal ureters. However, in a report on ileal ureteric replacement in 43 patients, Bonfig and colleagues concluded that although ascending bacteriuria is inevitable, pyelonephritis and potential renal damage may be prevented by an antireflux anastomosis.29 A procedure such as Leadbetter-Politano ureteral reimplantation may be considered. If pyelonephritis does occur, prophylactic antibiotics may aid in preventing further episodes. If a patient has preexisting renal insufficiency, an antireflux anastomosis may help to decrease the risk for hyperchloremic metabolic acidosis.

When utilizing bowel within the genitourinary system, the risk for malignancy must be considered as well. In a study by Ali-El-Dein et al, tumor was discovered in 2 of 258 (0.8%) patients with ileal ureters.30 Although the risk for malignancy is low, close surveillance is highly recommended with monitoring of creatinine levels and upper tract studies as well as with urine cytology studies. Despite the risks and complications associated with an ileal ureter, the overall success rate has ranged from 81% to 100%.31,39

CASE PRESENTATION 2

A 39-year-old gravida 4 para 3 woman undergoes a laparoscopic abdominal hysterectomy for severe endometriosis. The patient describes symptoms of right flank pain and mild nausea 4 days postoperatively. She denies any urinary storage or emptying complaints.

The patient has a low-grade fever of 100.1°F (37.2°C). Her abdomen is soft, with good bowel sounds. There is no rebound, rigidity, or guarding and no masses are appreciated. Physical examination reveals right-sided costovertebral angle tenderness. Her bimanual examination is unremarkable. Past medical history is significant for fibromyalgia, endometriosis, and chronic back pain. There is no history of smoking, drug use, or allergies.
Figure 3. Positioning for ileovesical anastomosis during single J stent placement.

Figure 4. Ileovesical anastomosis with interrupted suture placement.

Figure 5. Posterior side of proximal ileoureteral anastomosis.
Right ureteral injury during the recent surgery is suspected. Both the serum creatinine level and urinalysis results are normal. IVP is obtained, which reveals decreased function of the right side and hydronephrosis of the right collecting system to the level of the pelvic brim. Retrograde stent placement is not possible. A percutaneous nephrostomy tube is placed and an antegrade nephrostogram shows obstruction of the right ureter at the pelvic brim (Figure 6).

- Which other studies should be considered to further evaluate the right-sided obstruction?

A CT scan of the abdomen and pelvis with and without contrast likely would give no new information beyond that obtained by IVP. It would, however, illustrate the extent of urinoma formation. A renal scan would assess function of the obstructed kidney. Retrograde ureteroscopy should be done to evaluate the ureter below the site of injury, while combined antegrade and retrograde pyelogram would illustrate the length of the defect.

CASE 2 CONTINUED

An antegrade nephrostogram combined with a retrograde study demonstrates a 3-cm ureteral defect at the middle to lower ureter. An attempt to place a double-J stent is unsuccessful, and surgical correction of the ureteral defect is planned.

- What are the surgical options?

The surgical options for this patient from worst to best choices are ureteroureterostomy, transureteroureterostomy, right renal autotransplantation, ureteral ileal substitution, right psoas hitch with a neoureterocystostomy, and right Boari flap and psoas hitch with ureteral reimplantation. A ureteroureterostomy would not be the best choice because a segment of the lower ureter is devascularized and the blood supply at this level may be tenuous. Because it is difficult to salvage a sufficient amount of healthy, well-vascularized ureteral tissue at the lower level, a direct anastomosis to the bladder would be more successful. Transureteroureterostomy may be an option, but it should be low on the list because it places the normal contralateral collecting system at risk for intraoperative damage or postoperative complications. Renal autotransplantation places the kidney at risk for ischemia during the harvesting process and vascular reanastomoses, and with a normal functioning contralateral kidney with no pathology, it is not mandatory. Also, because the defect is low and not excessive in length, autotransplantation is not necessary in this case. Ureteral ileal substitution may be a viable option, although its possible complications (eg, mucosal obstruction, urinary tract infection, and reflux) must be considered.

A ureteroneocystostomy is indicated for injury or obstruction of the lower 3 to 4 cm of ureter. If greater length must be traversed, then a Boari flap and/or psoas hitch may be necessary to avoid tension on the anastomosis. A direct, nontunneled anastomosis may be created if there is no prior history of reflux. If there is a concern of reflux, then a tunneled ureteral reimplant may be necessary. A retrospective study by Stefanovic et al determined that there was no difference in renal function or risk of stenosis in adult patients who underwent tunneled or nontunneled ureteral reimplant procedures. A contraindication for ureteroneocystostomy, Boari flap, or psoas hitch is a small, contracted bladder. Such a bladder is not only difficult to mobilize, but it also increases pressure in the upper collecting system. Consequently, a urodynamics study may be needed preoperatively.

Ureteral reimplantation is considered the procedure of choice for treating gynecologic-related ureteral injuries located between 4 and 6 cm from the ureterovesical junction. However, Boari flap along with a psoas hitch is most commonly utilized when the defect is longer, when midureteral defects or lower ureteral defects have questionable blood supply, or when it is not possible to obtain a tension-free anastomosis with a psoas hitch. Laparoscopic procedures have been described for most types of ureteral stricture repair, but experience with these procedures is not yet extensive.
BOARI FLAP WITH URETERONEOCYSTOSTOMY AND PSOAS HITCH

Psosas Hitch

A psoas hitch may provide an additional 5 cm of length and facilitates the creation of a tension-free anastomosis of the distal ureter to the bladder. The psoas hitch procedure is best suited to strictures that do not extend above the pelvic brim. The key to performing a successful tension-free hitch is sufficient mobilization of the bladder. Occasionally, the contralateral superior vesical artery may be ligated and divided to gain additional length. The psoas minor tendon typically is used for the hitch, but the psoas major muscle or even the peritoneum may be used as well. It is important to keep in mind that the genitofemoral nerve courses along the psoas muscle and should be avoided. After a cystotomy, typically placed at the cephalad ipsilateral side of the bladder dome, a ureterovesical anastomosis is created. As discussed above, tunneling is not necessary if there is no prior history of vesicoureteral reflux. The ipsilateral dome of the bladder posterior to the anastomosis is sutured to the psoas minor tendon, if present, or to the psoas major muscle. Stents are recommended, but some suggest that they may not be necessary.1

The most common complications of a psoas hitch are urinary fistulae and ureteral obstruction. The adult and pediatric success rate is greater than 95%.33 Success rates for psoas hitch with neoureterocystostomy are typically 90% to 95%.19

Boari Flap

A psoas hitch alone may be insufficient to allow for a tension-free anastomosis if the distal ureteral defect is longer than 8 to 10 cm. A Boari flap can be used to repair defects as long as 15 cm. Spiral flaps that reach longer than 8 to 10 cm. A Boari flap can be used to tension-free anastomosis if the distal ureteral defect is

The most common complication following Boari flap and psoas hitch with ureteral reimplantation is recurrent stricture formation due to ischemia or a non-tension-free anastomosis. Anastomotic stricture rates for Boari flaps range from 0% to 17%, and success rates for long ureteral defects range from 81% to 100%.19

CASE PRESENTATION 3

A 27-year-old man is status post-exploratory laparotomy for 2 gunshot wounds to the left abdomen. Intraoperatively, a splenic laceration was repaired, and there were no other findings of injury following exploration. On postoperative day 3, the patient has notable abdominal distention with a rising blood urea nitrogen level (36 mg/dL) and a slightly elevated creatinine level (1.2 mg/dL).

A CT scan with intravenous contrast shows evidence of extravasated contrast at the level of the left midureter. The contralateral side is normal. An IVP demonstrates a diffuse “ground glass” appearance overlying the abdomen as a result of extravasation of contrast within the abdominal cavity. The patient is reexplored because it is likely that transection of the ureter occurred from one of the bullets. Intraoperatively, the ureter is found to be transected at the junction of the upper and middle portions, and débridement of the ends is performed until healthy tissue is encountered.

- What are the surgical options?

IPSILATERAL URETEROURETEROSTOMY

A ureteroureterostomy is most commonly performed by a urologist during an intraoperative consult relating to transection of a ureter. The ideal setting for this procedure is a benign transection or stricture caused by iatrogenic injury or penetrating trauma. Ureteroureterostomy may be performed safely for short defects and is best performed on the midureter and upper (abdominal) ureter, which can be mobilized more easily than the lower ureter. However, due to the wide débridement necessary following a gunshot wound, ureteroureterostomy would not be recommended.35 As discussed earlier, defects in the lower third of the ureter can be repaired with a ureteroneocystostomy, with or without a Boari flap.
Technique

Mobilization of the ureter at each end must be carefully performed with attention to maintaining the periureteral adventitia. Mobilization must be sufficient to allow for spatulation of both ends and a water-tight, tension-free anastomosis. The first 5 to 6 mm of each fresh end are spatulated 180° apart. If possible, the anastomosis is wrapped with omentum or retroperitoneal fat for added protection. A Foley catheter and closed-suction drain are placed and may be removed within a few days following the procedure depending on the postoperative course. A ureteral stent should be maintained for approximately 4 weeks. Complications include ureteral strictures and urinary leak.

TRANSURETEROURETEROSTOMY

A transureteroureterostomy is commonly performed when the injury is located above the level of the pelvic brim, the distal ureter is not viable, and a Boari flap with ureteroneocystostomy may not be possible.1,36 As the maximum tension-free length for a Boari flap is 12 to 15 cm in theory, longer defects may require treatment by transureteroureterostomy. Preoperatively, it is important to rule out reflux with a voiding cystourethrogram if the situation is nonemergent. A baseline IVP or CT urogram to rule out reflux with a voiding cystourethrogram if the situation is nonemergent. A baseline IVP or CT urogram and retrograde pyelogram also should be obtained.

Success rates with transureteroureterostomy for ureteral stricture repair have ranged from 90% to 97%.1,36 Absolute contraindications are a diseased contralateral ureter and inadequate length of the upper portion of the donor ureter. A length of at least 10 cm of upper ureter should be intact to allow it to reach the contralateral ureter. Relative contraindications include tumor, nephrolithiasis, pelvic or abdominal radiation, chronic pyelonephritis, retroperitoneal fibrosis, and reflux of the recipient ureter.

Technique

A transperitoneal midline incision allows exposure to both ureters. Typically, for either side, the sigmoid colon is mobilized and a peritoneal window is developed inferior to the inferior mesenteric artery to avoid kinking of the donor ureter. Mobilization of the ureter above the inferior mesenteric artery would prevent kinking for short upper ureters.37 The ureteral adventitia must be handled with care to maintain sufficient blood supply after mobilization. A recipient ureterotomy incision is made at the level of the midureter. A wide end-to-side spatulation is necessary for the donor and recipient ureters, respectively. A stent is maintained through the donor ureter and down to the distal recipient ureter. Closed-suction drainage is advisable.

Complications of transureteroureterostomy occur at rates ranging from 11% to 53% and include hematomas, infections, ureteral strictures, ureteral fistulae, recurrent urinary tract infections, and hydronephrosis.3 Stenosis of the ureteroureteral anastomosis and urinary leak also occur.38 Both complications may be a consequence of the failure to obtain a tension-free anastomosis.

CASE 3 RESOLUTION AND DISCUSSION

Due to the level of the injury and débridement that is necessary, a transureteroureterostomy is performed. Following ureteral injury due to gunshot wounds, wide débridement, possibly up to 2 cm from the point of injury, is necessary as microvascular injury may not be clearly evident.39,40 This procedure removes the risk of bacteriuria associated with an ileal substitution and allows the creation of a tension-free, water-tight anastomosis, which may not have been safely performed with a ureteroureterostomy.

CASE PRESENTATION 4

A 44-year-old man presents with sudden onset of right-sided flank pain. The pain radiates to the right groin region and is associated with nausea and vomiting. He denies fevers, chills, or gross hematuria. Past medical history is significant for eosinophilic interstitial pneumonitis. Urinalysis reveals microscopic hematuria. Serum creatinine and electrolytes are normal. An IVP demonstrates high-grade obstruction of the right kidney with nonvisualization of the ureter. The left kidney functions normally and promptly. Bilateral nephrolithiasis is evident on CT scan. Two calcifications are visualized in the right proximal ureter, and a crescent shaped, dysmorphic calcification is seen at the junction of the middle to upper segment. The left collecting system holds a 1-cm calculus in the upper pole.

Retrograde ureteroscopy with possible laser lithotripsy and biopsy of any suspicious lesions is planned. Resistance at the midureter is encountered intraoperatively when passing a guidewire. Flexible ureteroscopy reveals concentric calcifications. A retrograde pyelogram reveals irregular narrowing of the ureter from the junction of the middle and upper segments to the ureteropelvic junction. The upper ureter has a “moth-eaten” appearance associated with severe hydronephrosis (Figure 7). Urine cytology results are returned as negative for malignancy. Cultures from the right kidney urine are negative, and a tuberculosis skin test is negative as well. As the patient has a history of eosinophilic pneumonitis, it is theorized that the same process has affected his kidney.
Later, a right-sided nephrostomy tube is placed; repeat cytology studies of specimens extracted from the tube are persistently negative. Flexible nephroscopy reveals the same concentric calcifications at the upper ureter. Due to the severity of the ureteral strictures, it is not possible to incise the strictures percutaneously. Extracorporeal shock wave lithotripsy of the left-sided stone is performed at this time. Nuclear renal scan reveals 30% total renal function on the right side.

Knowing that the upper half of the ureter is strictured, what are the most appropriate surgical options for this patient?

Nephrectomy is not indicated with 30% of total renal function present, especially considering the patient’s young age. Boari flap is not helpful for upper ureteral defects. Ileal substitution is an option, but there is an increased risk for infections with direct anastomosis to the renal pelvis. In addition, possible functional obstruction may occur at the anastomosis of ileal segment to the lower ureter with the smaller diameter. Transureteroureterostomy is not indicated in a patient with bilateral nephrolithiasis. Also, the right donor ureter would not reach the left side due to insufficient length. Autotransplant with pyelovesicostomy would create an anastomosis of the renal pelvis to the bladder with direct transmission of intravesical pressures. An advantage of this approach would be easy passage of stones into the bladder. Autotransplant with anastomosis to the lower ureter would avoid anastomosis directly to the bladder and, therefore, aid in preventing transmission of intravesical pressures and vesicoureteral reflux. A consult with a transplant surgeon is necessary if the urologist is not an expert with renal transplant.

RENSAL AUTOTRANSPLANT

Indications for an autotransplant include long ureteral stricture or injury, resectable upper ureteral malignancies, and branch renal artery disease. Autotransplant also could be considered in cases of severe, frequent nephrolithiasis, where pyelovesicostomy might allow for easier passage of stones. Autotransplant also has been performed in loin pain hematuria syndrome, with success rates of 70% in relieving the symptoms associated with this syndrome.

The kidney is “harvested”; maximum vessel length is obtained with anastomosis to the iliac vessels and bladder or lower ureter depending on the individual case. Two incisions may be necessary—a flank incision for harvesting the kidney and a Gibson incision for the transplant. Occasionally, one long Gibson or midline incision is used. Harvesting of the kidney may be done through a transperitoneal or retroperitoneal laparoscopic approach. A Gibson incision is then used for the transplant. Meng et al had success using ipsilateral transperitoneal laparoscopic nephrectomy with autotransplantation for severe proximal ureteral loss in 7 patients. All of these cases were associated with severe perinephric and perihilar fibrosis due to nephrolithiasis or trauma. In these 7 patients, all grafts functioned immediately. There were no intraoperative complications at 17 months follow-up and there was a mean decrease in creatinine level of 5%.

Advantages of autotransplant are that it avoids use of bowel and therefore reduces rates of intestinal complications such as mucus or electrolyte problems, avoids chronic bacteriuria associated with bowel substitutes, and allows easier access for endoscopic procedures. Disadvantages of autotransplant are that it requires 2 incisions, can lead to vascular injury, and increases the risk of reflux into the pelvis.

CASE 4 RESOLUTION

In this case, a renal autotransplant is performed with anastomosis of the renal pelvis to the lower ureter. The upper ureter is excised. Pathology reveals nondysplastic urothelium, chronic inflammation, extensive calcification, and focal ossification in addition to extensive stricture along the course of the ureter. The indwelling stent
is removed 4 weeks following the surgery. An IVP 3 months later reveals excellent function and drainage of the kidney.

**CONCLUSION**

Multiple options are available for treating ureteral defects. The best possible form of ureteral repair is determined based on the length and location of the ureteral defect, the patient’s prior medical history, pathology involving the contralateral collecting system, and the patient’s performance status. Repairs for strictures above the pelvic brim include transureteroureterostomy, ureteroureterostomy, ureteral ileal substitution, and renal autotransplant. Midureteral defects, if short, may be treated with ureteroureterostomy as well. For repairing injuries below the pelvic brim, a ureteral reimplant typically would be recommended with a psoas hitch or Boari flap to traverse a greater distance. In addition, an antireflux ureteroneocystostomy with a Leadbetter-Politano ureteral reimplant, for instance, may be preferred if necessary and feasible. The timing of repair should be judged on an individual case basis. It is important to keep in mind the mainstays of success: a watertight, tension-free anastomosis and preservation of the ureteral adventitia and blood supply.

**REFERENCES**

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