INTRODUCTION

The ureter serves as the sole source of urinary transport from the kidney. Any injury to this delicate tubular structure poses a potential risk to the ipsilateral renal unit. Ureteral injuries may be classified etiologically as surgical or external. Surgical injuries are the most common. During abdominal surgery, the ureter is vulnerable to inadvertent injury because of its inconspicuous retroperitoneal location, adjacent to the iliac vessels, colon, and uterus. In addition, various abdominal disease processes can affect the normal ureteral course, causing it to deviate and making it more difficult to identify.

Factors that predispose to surgical ureteral trauma are listed in Table 1. In the past, the majority of surgical ureteral injuries occurred during gynecological procedures, most frequently during abdominal hysterectomies (1–6). The most common site was at the pelvic brim where the ovarian vessels cross the ureter in the infundibular pelvic ligament. With the advent of ureteroscopic surgery, however, urological procedures now cause most ureteral injuries; fortunately, the majority of these are minor injuries and can be safely treated nonsurgically (7,8). Other surgical procedures that may injure the ureter include aortoiliac and aortofemoral arterial bypass surgery, low anterior bowel resection, and, rarely, lumbar laminectomy (Table 2). Mechanisms of injury include kinking, crushing, electrocoagulation, devascularization, ligation, perforation, transection, and excision.
Table 1
Factors That Predispose to Surgical Ureteral Trauma

- Prior surgery
- Infection or Inflammation (e.g., diverticulitis, pelvic inflammatory disease, endometriosis)
- Radiation therapy
- Malignancy
- Uterine size >12-wk gestation
- Ovarian mass >4 cm
- Obesity
- Massive bleeding

Table 2
Causes of Surgical Ureteral Trauma, by Procedure

<table>
<thead>
<tr>
<th>Reference</th>
<th>Gynecologic</th>
<th>Urological</th>
<th>Colon</th>
<th>Vascular</th>
<th>Spinal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higgins (1967) (1)</td>
<td>60</td>
<td>5</td>
<td>12</td>
<td>7</td>
<td>2</td>
<td>86</td>
</tr>
<tr>
<td>Ihse (1975) (2)</td>
<td>23</td>
<td>13</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td>Dowling (1986) (4)</td>
<td>14</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>Gangai (1986) (3)</td>
<td>9</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Assimos (1984) (7)</td>
<td>11</td>
<td>12</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Seltzman (1996) (8)</td>
<td>56</td>
<td>70</td>
<td>28</td>
<td>10</td>
<td>1</td>
<td>165</td>
</tr>
<tr>
<td>Total</td>
<td>173</td>
<td>118</td>
<td>56</td>
<td>18</td>
<td>6</td>
<td>371</td>
</tr>
<tr>
<td></td>
<td>(46.6%)</td>
<td>(31.8%)</td>
<td>(15.1%)</td>
<td>(4.9%)</td>
<td>(1.6%)</td>
<td></td>
</tr>
</tbody>
</table>

Ureteral injuries constitute up to 3% of all genitourinary injuries from external trauma (9). The ureter’s mobility and anatomic characteristics protect it from trauma; its narrow diameter and retroperitoneal location between major muscle groups and the spine make it an unlikely target. Most external ureteral injuries occur from gunshot wounds; stab wounds are infrequent (Table 3) (10–15). The bullet does not need to transect the ureter; if its path is simply near the ureter, the temporary cavitation created by the missile can cause significant tissue destruction and delayed necrosis. These injuries can be very difficult to identify and often present with delayed sequelae. Penetrating ureteral injuries are almost always associated with multiple organ injuries. The most common sites, in order of decreasing frequency, include the small bowel, colon, liver, and iliac vessels (14–22). The location of ureteral injuries is fairly evenly distributed, with the upper ureter slightly more prone to trauma (Table 4) (11,15–18,22–25).

Ureteral injuries from blunt trauma are rare. They usually occur in children or young adults during rapid deceleration, which causes excessive hyperextension of the vertebral column and disruption at the ureteropelvic junction (UPJ). They also are associated with multiple organ injuries, most commonly to the liver, spleen, and skeletal system (26–31). In general, UPJ disruptions occur almost exclusively in polytraumatized patients, with most presenting in shock.
Table 3

<table>
<thead>
<tr>
<th>Injury mechanism</th>
<th>No. patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunshot wounds</td>
<td>227 (81.9)</td>
</tr>
<tr>
<td>Stab wounds</td>
<td>14 (5.1)</td>
</tr>
<tr>
<td>Blunt</td>
<td>36 (13.0)</td>
</tr>
<tr>
<td>Total</td>
<td>277</td>
</tr>
</tbody>
</table>

*Results of combined series from refs. 10, 11, 15–19, 23–25, 28–30, and 32.

Table 4

<table>
<thead>
<tr>
<th>Ureteral sites</th>
<th>Injuries (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>126 (38.9)</td>
</tr>
<tr>
<td>Middle</td>
<td>107 (33.1)</td>
</tr>
<tr>
<td>Lower</td>
<td>91 (28.0)</td>
</tr>
<tr>
<td>Total</td>
<td>324</td>
</tr>
</tbody>
</table>

*Results of combined series from refs. 11, 15–18, and 22–25.

**DIAGNOSIS**

**Clinical**

Prompt diagnosis is the first step toward a successful outcome. With external ureteral trauma, this is complicated by the presence of multiple organ injuries and the absence of early clinical and laboratory findings specific for ureteral trauma. Indeed, hematuria, which is a reliable indicator of renal trauma, is absent in approx 30% of ureteral injuries (10–15,19,21,22,25,28,29,31). Early clinical indicators of ureteral trauma are vague or nonexistent.

To avoid the additional morbidity associated with a delay in diagnosis, it is imperative that the evaluating physician maintains a high index of suspicion based on injury mechanism and location. Whether from an external or surgical cause, delayed signs or symptoms of a ureteral injury include prolonged ileus, urinary obstruction, urinary leakage, azoospermia, fever, persistent flank pain, fistula formation, and eventually sepsis. After abdominal or pelvic surgery, any patient presenting with these signs or symptoms that suggest the possibility of a ureteral injury should be thoroughly evaluated. In addition, all patients with penetrating abdominal or flank trauma should be suspected of having a ureteral injury and appropriately assessed. Similarly, children and young adults with significant blunt abdominal trauma and multiple associated injuries, especially from a mechanism of rapid deceleration, should undergo radiographic ureteral assessment regardless of the findings on urinalysis.
Overall, more than 90% of ureteral injuries from external trauma are identified immediately (defined as during the first 24-h period) (11,15,16,18,24,25,32), whereas less than half of surgical ureteral injuries are identified immediately (Tables 5 and 6) (4,5,8). Laparoscopic injuries result in the highest incidence of delay (33,34). This can be ascribed to the mechanism of these injuries, usually by electrocoagulation or ligation, which can lead to delayed tissue necrosis and consequent delayed recognition.

**Radiographic**

Initial urinary tract imaging can be obtained in the resuscitation suite with computed tomography (CT) of the abdomen and pelvis or a complete high-dose (2-mL contrast/kg body weight) intravenous urogram (IVU). Contrast extravasation is the *sine qua non* of any ureteral injury. On IVU, the findings are often subtle, including delayed function or mild ureteral dilation or deviation. The most consistent CT finding in an upper ureteral transection or UPJ avulsion is extravasation of contrast confined predominantly to the medial perirenal space; urinary ascites is a less-frequent presentation (35,36).
In addition, on delayed CT images, with a complete ureteral injury there is absence of distal ureteral opacification. When rapid-sequence spiral CT is used, this lack of distal ureteral filling cannot be accurately evaluated unless delayed films are explicitly requested. Typically, a repeat CT scan should be performed 15 to 20 min after the initial study to assess ureteral filling. If the results of the CT and IVU are inconclusive, a retrograde ureterogram may be performed. Although it is the most accurate ureteral imaging study, it is often impractical in the acute trauma setting. A one-shot IVU is unreliable and nondiagnostic for ureteral injuries. The role of ultrasonography is limited in the acute setting, with insufficient data available.

**Intraoperative**

Direct visual inspection is the most reliable method of assessing ureteral integrity. The bowel should be reflected sufficiently to expose the ureter(s) and an attempt made at tracing the missile’s path. Urinary extravasation, ureteral discoloration or bruising, and lack of bleeding are indicative of ureteral trauma; decreased peristalsis is a more subtle finding. Intraoperative recognition can be facilitated by the intravenous or intraureteral injection of indigo carmine or methylene blue. This should be used as a last step in the intraoperative evaluation of the ureter as the bluish dye somewhat obscures the surgical field.

**INJURY CLASSIFICATION**

Ureteral injuries are classified according to the organ injury scaling system of the committee of the American Association for the Surgery of Trauma (Table 7) (39).

**ANATOMIC CONSIDERATIONS**

The ureter is a thick-walled, narrow tube measuring approx 25 to 30 cm long and varying in diameter from 1 to 10 mm. It has three distinct layers: an outer adventitial sheath, through which the vessels course; a medial layer made of longitudinal and circular smooth muscle fibers; and an inner mucosal lining consisting of transitional epithelium. The ureter derives its blood supply from an anastomotic network, within the adventitia, arising from multiple vessels. The upper ureter receives its blood supply mainly from the renal arteries, its midportion receives it from the aorta and iliac arteries, and the lower segment receives it from the superior and inferior vesical, middle hemorrhoidal, and uterine arteries.

<table>
<thead>
<tr>
<th>AAST grade</th>
<th>Ureteral injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusion or hematoma without devascularization</td>
</tr>
<tr>
<td>II</td>
<td>&lt;50% transection</td>
</tr>
<tr>
<td>III</td>
<td>≥50% transection</td>
</tr>
<tr>
<td>IV</td>
<td>Complete transection with &gt;2 cm devascularization</td>
</tr>
<tr>
<td>V</td>
<td>Avulsion with &gt;2 cm devascularization</td>
</tr>
</tbody>
</table>

AAST, American Association for the Surgery of Trauma. (From ref. 38.)

\[
\text{Table 7}
\]

**Organ Injury Scale for Ureteral Injuries**

<table>
<thead>
<tr>
<th>AAST grade</th>
<th>Ureteral injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusion or hematoma without devascularization</td>
</tr>
<tr>
<td>II</td>
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<td>≥50% transection</td>
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<td>Complete transection with &gt;2 cm devascularization</td>
</tr>
<tr>
<td>V</td>
<td>Avulsion with &gt;2 cm devascularization</td>
</tr>
</tbody>
</table>

AAST, American Association for the Surgery of Trauma. (From ref. 38.)
The vessels to the upper two-thirds and lower third of the ureter emanate medially and laterally, respectively. Because these vascular sources can be variable, ureteral dissection always should be performed cautiously to avoid inadvertent devascularization. Additional obstacles that need to be recognized include ureteral anomalies, which may alter its course (retrocaval, ectopic), size (me gaureter, diverticulum), or number (duplication).

In the female, the pelvic portion of the ureter courses posterior to the infundibular pelvic ligament and then passes anteromedially at the base of broad ligament, lateral to the uterosacral ligament. At this level, it is crossed anterosuperiorly by the uterine artery; this occurs 1.5 cm lateral to the uterus, but can vary markedly when pathological conditions have distorted the anatomic relationships. The uterine artery then runs medially to ascend alongside the uterus. The ureter continues distally, coursing medially and then passing anterior to the vagina prior to traversing the bladder wall obliquely (Fig. 1) (40).

**Fig. 1.** Female pelvic ureteral anatomy.

**MANAGEMENT CONSIDERATIONS**

**Selection**

Selection of the appropriate management depends on the patient’s condition (including the associated organ injuries), promptness in injury recognition, and location and grade of the ureteral injury. Most patients with external ureteral injuries require prompt operative exploration for management of their associated abdominal injuries. If suspected intraoperatively, the injured ureter should be carefully inspected for evidence of ischemia. Concomitant intraabdominal organ or vascular injuries should not preclude ureteral reconstruction in an otherwise stable patient (15,41,42). In these cases, the appropriate reconstructive procedure can be safely performed and an omental flap interposed to protect the repair.
Temporary Urinary Diversion

Ureteral injuries with a significant delay in diagnosis or in an unstable patient are best managed initially by percutaneous nephrostomy drainage or endoscopic ureteral stenting. Percutaneous nephrostomy placement is safer and more universally applicable, whereas retrograde ureteral stenting should be attempted only for certain low-grade injuries. For select grade I–III surgical injuries, these minimally invasive techniques alone may be therapeutic (7,8,43). Similarly, grade I external ureteral injuries can be successfully managed in this way.

In an intraoperative situation in which a high-grade ureteral injury is identified but the patient’s precarious condition does not permit immediate ureteral reconstruction, ureteral ligation with placement of a percutaneous nephrostomy tube serves as an expedient "bail-out" procedure. Open nephrostomy should not be used because this is more invasive and consumes precious operating time, further jeopardizing patient outcome. The goal in this setting is to ensure hemodynamic and metabolic homeostasis prior to addressing the ureteral injury.

Most high-grade injuries will eventually require reconstruction. This should be deferred until the patient has healed from any associated injuries and the acute periureteral inflammatory response has resolved. The appropriate procedure should be planned only after compiling the necessary functional and anatomic radiographic information. Besides antegrade or retrograde ureteral imaging, a cystogram should always be obtained when the bladder is under consideration for the reconstructive procedure.

Incisions

With external trauma, the ureter is explored through a midline transperitoneal incision as part of the laparotomy. Surgical injuries identified intraoperatively can be repaired through the original incision, which may be extended as needed to optimize exposure. With planned ureteral reconstruction, the incision can be tailored to the specific procedure. In general, a midline abdominal incision allows complete exposure of the ureter and bladder. Alternatively, select proximal or distal ureteral injuries can be exposed through a subcostal or a Gibson incision, respectively.

Surgical Techniques

General principles of ureteral reconstruction (44) include careful debridement, creation of a watertight, tension-free, spatulated anastomosis; isolation of the anastomosis from associated injuries; and adequate ureteral and retroperitoneal drainage. Minimal handling of the adventitia and careful perireteral dissection are paramount in preserving ureteral vasculature. The appropriate reconstructive procedure should be performed based on the location and grade of the ureteral injury (Fig. 2). A description of the various techniques follows.

Disligation

Select surgical injuries that are identified intraoperatively and felt to be simply caused by inadvertent ureteral ligation can be managed by disligation. Once this is done, the ureter must be observed carefully for any signs of devascularization and, at least, stented. If there is any suggestion of irreversible ischemia, the appropriate reconstructive procedure should be performed.
Primary Closure

This technique has limited use for external ureteral injuries. Occasionally, it can be considered in the management of grade II stab wounds. It should never be used for gunshot wounds as these injuries require careful debridement to avoid delayed tissue breakdown as a consequence of the underestimated thermal damage created by the missile’s cavitation. Select grade II or III clean surgical ureteral lacerations, when identified promptly, can be managed by primary closure.

Interrupted fine absorbable sutures are used to reapproximate the ureter carefully, and a ureteral stent is placed to protect the repair. Care is taken to avoid inadvertent narrowing of the suture line.

Reimplantation

Injuries to the distal lower third of the ureter are best managed by submucosal bladder reimplantation. This is done using a combined intra- and extravesical approach, bringing the ureter through the posterior bladder wall just medial to the original hiatus. A submucosal tunnel is created based on the standard 3:1 ratio (tunnel length:ureteral diameter). The distal ureter is then spatulated and secured to the bladder wall with interrupted fine absorbable sutures. The repair is stented, and the bladder closed in two layers. Attention to adequate

Fig. 2. Reconstructive techniques by injury location.
ureteral mobilization without excessive adventitial dissection or ureteral kinking will limit potential postoperative problems, including reflux, obstruction, and extravasation.

**Psoas Hitch**

Injuries involving the entire lower third of the ureter are best managed by a psoas hitch in conjunction with ureteral reimplantation. Preoperative cystography is helpful in ensuring normal bladder capacity.

The proximal ureteral end is debrided, and a traction suture is placed distally to facilitate handling. The bladder fundus is mobilized by dissecting it away from the peritoneal reflection. The contralateral superior vesical pedicle is ligated; when needed, bilateral superior pedicle ligation affords improved bladder mobilization. An oblique anterior cystotomy is then made perpendicular to the involved ureter. Using the index and middle fingers, the bladder dome is guided over the ipsilateral iliac vessels toward the psoas tendon and anchored to this with three interrupted sutures. Care is taken to avoid entrapping the genitofemoral nerve. The ureter is then reimplanted, as previously described in the section on reimplantation, and the bladder wall is closed perpendicular to the cystotomy, in two layers, leaving a suprapubic tube for drainage. Occasionally, *de novo* detrusor instability can occur.

**Anterior Bladder Wall Flap**

Injuries encompassing the entire lower two-thirds of the ureter are best managed with an anterior bladder wall flap in conjunction with a psoas hitch. This procedure should not be used in patients with prior pelvic irradiation or neurogenic bladder disease.

The bladder is mobilized as described in the section on psoas hitch, and a full-thickness U incision is made in its anterior wall; for longer defects, additional length can be obtained using an L configuration. The width of the flap should be approximately three to four times the ureteral diameter, maintaining a wider base to ensure an adequate blood supply. The flap is raised toward the involved ureter, and the bladder wall is hitched to the psoas tendon. The ureter is reimplanted submucosally into the flap, which is then closed in a tubular configuration. Bladder closure is completed as described in the section on psoas hitch. Accurate flap dissection with maintenance of a wide base can minimize flap complications and avoid significantly decreasing bladder capacity.

Using this technique, ureteral defects of up to 15 cm can be easily bridged. The ureteral defect can be further decreased by up to 3 to 4 cm by performing a reverse nephropexy. Dissecting the kidney away from Gerota’s fascia and fixing the renal capsule caudally to the underlying retroperitoneal muscles accomplishes this. Extensive dissection or tension can result in renal hemorrhage or vascular injury, respectively.

**Ureteroureterostomy**

Most grade II–IV lacerations involving the middle or upper third of the ureter can be best managed by primary ureteroureterostomy. The ureteral ends are carefully dissected and debrided to viable tissue. Each end is spatulated on opposite sides, and a watertight, tension-free anastomosis is fashioned over a ureteral stent using fine absorbable sutures. Optical loop magnification is helpful in achieving optimal suture placement. Maintaining ureteral vascularity minimizes postoperative stricture and fistula formation.

With concomitant intraabdominal organ injury, the greater omentum can be used to exclude the ureter and protect the repair. This is dissected from the greater curvature of the stomach and sustained on either the right or the left gastroepiploic vessels. The short
gastric vessels are then divided, and the flap is transferred retroperitoneally and wrapped around the ureteral anastomosis, isolating it from the abdominal contents.

**Transureteroureterostomy/Transureteropyelostomy**

Alternatively, injuries involving the distal two-thirds of the ureter with insufficient bladder capacity or severe pelvic scarring can be managed by transureteroureterostomy. The posterior peritoneum is incised, exposing both ureters. The diseased ureter is brought through a retroperitoneal window carefully, avoiding any angulation. A 1.5-cm longitudinal ureterotomy is made on the medial surface of the recipient ureter, and an end-to-side anastomosis is created with interrupted fine absorbable sutures. The donor ureter should course above the inferior mesenteric artery to avoid inadvertent ureteral impingement. For more extensive injuries, a transureteropyelostomy can be performed by anastomosing the involved ureter to the medial aspect of the contralateral renal pelvis.

These procedures can potentially jeopardize the integrity of the normal ureter or pelvis and should be used selectively. In addition, they are contraindicated in patients with upper tract transitional cell carcinoma or recurrent urolithiasis.

**Ureterocalycostomy**

An ureterocalycostomy can be used for extensive injuries to the ureteropelvic junction and proximal ureter. The lower pole of the involved kidney is amputated, exposing the infundibulum of the inferior calyx. The ureter is generously spatulated, allowing a direct end-to-end ureterocalyceal anastomosis over an internal stent.

This procedure should be used as a last resort because it involves excessive renal dissection and is fraught with a high incidence of anastomotic stricture.

**Ileal Interposition**

For complete ureteral avulsion, a segment of ileum may be interposed as a ureteral substitute. This cannot be done acutely because it requires a standard mechanical and antibiotic bowel preparation. Moreover, it should be used exclusively in patients with relatively normal renal function (serum creatinine <2.5 mg/dL).

A 20- to 25-cm segment of ileum is chosen 15 cm proximal to the ileocecal junction. The bowel mesentery is divided, maintaining vascular integrity, and the appropriate segment of ileum is resected using a linear anastomotic stapler. Bowel continuity is resumed by creating a stapled functional end-to-end enteric anastomosis; the mesenteric window is closed to prevent internal visceral herniation. The ileal neoureter is then positioned posteriorly in an isoperistaltic fashion. An end-to-end pyeloileal anastomosis is completed using a nephrostomy to maintain a low-pressure system during healing. Distally, the ileal segment is anastomosed to the bladder dome without tunneling. This can be accomplished by opening the bladder anteriorly in the midline and completing the end-to-side ileovesical anastomosis using a combined intra- and extravesical approach. Although bacteruria and vesicoileal reflux are common, they have not been shown to have a deleterious effect on renal function (45–47). In addition, the ileum can be tapered to decrease its absorptive surface area, potentially limiting the incidence of metabolic derangements arising from urinary absorption. Because it is an infrequent occurrence, this maneuver may be superfluous.

For extensive bilateral ureteral injuries, a segment of ileum can be tailored as a conduit for both kidneys. This can be used alone or in conjunction with a psoas hitch or anterior
bladder wall flap to minimize the segment of ileum used. Alternatively, in select grade V ureteral injuries for which the urinary tract cannot be used for reconstruction, partial ureteral replacement can be achieved using a shorter segment of ileum.

Potential long-term complications of ileal interposition include hyperabsorption of electrolytes, which is manifested by hyperchloremic metabolic acidosis. Patients who are symptomatic should be treated with oral alkalizing agents. Other postoperative problems include anastomotic leaks, obstruction, prolonged mucus formation, recurrent infection, and ischemic ileal necrosis.

Renal Autotransplantation

In patients with a solitary kidney or compromised renal function, complete ureteral avulsions can be managed by renal autotransplantation. The affected kidney is transplanted into the iliac fossa with vascular anastomoses of the renal and iliac vessels; urinary continuity is restored with a pyelovesicostomy. Although this is a more formidable surgical procedure that requires comfort with vascular techniques, it can achieve excellent long-term preservation of renal function (48).

DRAINAGE ISSUES

All ureteral injuries should be stented to maximize urinary diversion. An internal double-J or exteriorized pediatric feeding or single-J tube can be used for this purpose. A retroperitoneal drain should be placed at the site of reconstruction to limit urinoma formation. A passive drain (e.g., penrose) is preferable because suction drains can prolong leakage by exerting negative pressure on the suture line. The bladder should be decompressed using a transurethral Foley catheter or a suprapubic Malecot tube, alone or in combination. Both tubes are usually used when the bladder has been opened, although in female patients, the suprapubic tube may be foregone. The retroperitoneal drain is maintained for at least 48 h or until urinary extravasation subsides. The bladder catheter is removed in 2 to 7 d, depending on the type of ureteral repair and the extent of bladder dissection. The ureteral stent usually is maintained for 4 to 6 wk.

POSTOPERATIVE EVALUATION

Once the patient is tube free, ureteral patency and renal function are evaluated using CT, IVU, or radionuclide scanning. This should be repeated at 3 and 6 mo to ensure proper healing. In addition, after ileal interposition periodic assessment of blood chemistries is essential to identify any potential metabolic complications.

COMPLICATIONS

Complications of ureteral injuries include prolonged urinary extravasation, infection, urinoma, fistula, and stricture. Progressive renal failure with acidosis and upper urinary tract decompensation can complicate a failed repair. Complications specific to each reconstructive procedure are discussed in the Surgical Techniques section.

SUMMARY

With surgical ureteral injuries, prevention is the goal. An understanding of ureteral anatomy and location at all times during abdominal or pelvic surgery is paramount to
avoid inadvertent injury to the ureter. When a ureteral injury is suspected, vigilant intraoperative inspection and immediate implementation of corrective measures will minimize complications. With all ureteral injuries, the clinical and radiographic evaluations are often indeterminate; consequently, maintaining a high index of suspicion is paramount in making the diagnosis promptly. A delay in diagnosis is the most important contributory factor in morbidity related to ureteral injury. The decision when to repair the ureteral injury is based on the patient’s overall condition and associated organ injuries, promptness of injury recognition, and type of ureteral injury. In an unstable patient, restoring hemodynamic and metabolic stability takes precedence over definitive ureteral repair. Successful surgical management, whether performed immediately or in a delayed fashion, requires familiarity with the broad reconstructive armamentarium, as well as meticulous attention to the specific details of each procedure. Adhering to these diagnostic and therapeutic principles will serve to minimize complications and maximize renal preservation in patients who sustain ureteral injuries.

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