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Ureteral Injury

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Introduction

Overall, a ureteral injury is rare. The most common cause is iatrogenic trauma during open surgery, laparoscopic, or endoscopic procedures. Penetrating trauma accounts for most non-iatrogenic ureteral injuries. Ureteral injuries are often subtle, and clinicians must have a high index of suspicion for them. An unrecognized or mismanaged ureteral injury can lead to significant complications including urinoma, abscess, ureteral stricture, and potential loss of ipsilateral kidney or even death.[1][2][3]

Etiology

Iatrogenic trauma during open surgery, laparoscopy or endoscopic procedures is the most common cause of ureteral injury. Suture ligation of the ureter, sharp incision and transection, avulsion, devascularization, and heat energies can cause ureteral damage. Most iatrogenic ureteral injuries involve the pelvic ureter.[4][5][6][7]

Ureteral trauma is very rare and is thought to comprise less than 1% of blunt and penetrating genitourinary trauma. It is most common with gunshot wounds, with the proximal ureter most commonly involved.

Ureteral injuries can be classified based on location:

- UPJ
- Abdominal ureter (UPJ to iliac vessels)
- Pelvic ureter (inferior to iliac vessels)

Ureteral injuries can be classified based on when the diagnosis is made:

- Immediate diagnosis (diagnosed shortly after injury)
- Delayed diagnosis (diagnosed long after surgery)

The American Association for the Surgery of Trauma (AAST) classifies ureteral injuries as follows:

- Grade I – hematoma; contusion or hematoma without devascularization
- Grade II – laceration; less than 50% transection
- Grade III – laceration; 50% or greater transection
- Grade IV – laceration; complete transection with less than 2 cm of devascularization
- Grade V – laceration; avulsion with greater than 2 cm of devascularization

Epidemiology

Ureter damage after external trauma is rare, occurring in less than 4% of penetrating trauma and less than 1% of all cases of blunt trauma. A patient with ureteral injury from a gunshot wound often has significant concomitant injuries and a large risk for mortality.

The overall incidence of iatrogenic ureteral injuries caused during operative procedures varies from 0.5 to 10%. Analysis of 13 published studies concluded the following procedures contribute to iatrogenic ureteral injuries: hysterectomy (54%), colorectal surgery (14%), pelvic procedures such as ovarian tumor removal (8%), transabdominal urethropexy (8%), and abdominal vascular surgery (6%). Another retrospective review identified 55 patients with iatrogenic ureteral injuries during a 16 year period and noted the majority of ureteral injuries occurred during gynecologic procedures (55%). The remainder of procedures were urologic (25%), colorectal (15%), and vascular (5%).

The incidence of injury to the ureter may be lower for laparoscopic versus open surgical approaches. A review looking at over 90,000 colectomies showed the incidence of ureteral injury in laparoscopic approach to be 0.54% compared with 0.66% with open surgery.

Pathophysiology

A basic understanding of the anatomy of the ureters is essential to further discuss the pathophysiology of ureteral injury. The ureters are peristaltic tubular structures that are located in the retroperitoneum and transport urine from the kidneys to the bladder. They are divided into three segments. The proximal ureter is the segment that extends from the ureteropelvic junction (UPJ) to the area where the ureter crosses the sacroiliac joint. The middle ureter courses along the bony pelvis and iliac vessels. The pelvic or distal ureter extends from the iliac vessels to the bladder.

The ureter is close to numerous abdominal and pelvic structures, which puts it at risk during surgical procedures. The left UPJ is just posterior to the pancreas and duodenal-jejunal junction. The right UPJ is posterior to the duodenum and lateral to the inferior vena cava. As they course downward, the ureters lie on the psoas muscle and pass medially to the sacroiliac joints. They swing laterally near the ischial spines before passing medially to penetrate the base of the bladder. The left ureter is crossed anteriorly by the inferior mesenteric artery and sigmoid vessels. The right ureter is crossed by the right colic and ileocolic vessels. When the ureters descend into the pelvis they course anterior to the iliac vessels and posterior to the gonadal vessels. In females, the ureter courses posterior to the ovary, lateral to the infundibulopelvic ligament and medial to the anterior vessels. It passes posterior to the broad ligament and lateral to the uterus. The uterine arteries pass just anterior to the ureter at the ureterovesical junction. In males, the ureter is crossed anteriorly by the medial umbilical ligament and passes under the vas deferens before entering the bladder.

The mechanism by which bullets or other penetrating trauma injures the ureter is thought to not be by direct transection but most likely by disruption of the delicate intramural blood supply to the ureter. Patients with blunt trauma with a ureteral injury are subject to the extreme force applied over the entire body or larger surface area.

History and Physical

The prompt identification of ureteral injury is often difficult; therefore, whenever a patient undergoes a procedure with a higher risk for ureteral manipulation/injury, there should be a high index of suspicion for ureteral injury. Likewise, several trauma scenarios should raise suspicion for ureteral injury including penetrating wounds in proximity to ureter or sudden deceleration injuries. UPJ avulsion is more common in children because their spine is more mobile which allows spine hyperextension that can cause UPJ avulsion.

Delayed diagnosis can present as persistent flank or abdominal pain, flank mass, prolonged ileus, urinary tract infection, or hydronephrosis and elevated creatinine and BUN. If a patient has an abdominal drain after surgery and has prolonged high output, this can be another potential indicator of ureteral injury. Hematuria may be present, but the absence of hematuria does not exclude ureteral injury, and in fact, hematuria is not a reliable finding in ureteral injuries.

Evaluation

If a surgical drain is present, the fluid can be sent for spot creatinine. Spot creatinine will usually be 25-450 mg/dL when the fluid is urine, but it will be similar to the serum creatinine when it is not urine. A basic metabolic panel should be ordered to evaluate kidney function. Elevated BUN/creatinine would raise suspicion for some disruption to the collecting system, preventing drainage of urine.[8][9]

Imaging studies are the most important diagnostic tools available to evaluate for ureteral injury. A retrograde pyelogram (RPG) is the most accurate imaging test to evaluate the location and extent of the ureteral injury. Antegrade pyelogram also can be performed if the patient has antegrade access. A CT urogram (CT abdomen and

pelvis with IV contrast and delayed images) can accurately identify ureteral injury. Other findings on CT imaging studies that may raise suspicion for ureteral or renal pelvis injury include perinephric standing, low-density fluid around the kidney and ureters, perinephric hematoma, ureteral dilation or deviation, and incomplete visualization of the entire ureter. When a CT or intravenous urogram is inconclusive, and ureteral injury is suspected, an RPG must be obtained.

Surgical exploration of the retroperitoneum and direct visualization of the ureter is the most accurate method to identify ureteral injury. Inspection of the ureter should involve mobilization of the ureter and visualization of the entire wall for evidence of contusion, hemorrhage or disruption. Extravasation of urine confirms the presence of ureteral injury. The viability of the ureter may be compromised when the ureter is murky, discolored, or without capillary refill. A dye study using indigo carmine or methylene blue can be administered by intravenous infusion and aid in direct visualization of ureteral injury. This can be performed by directly injecting into the renal pelvis or by retrograde injection during cystoscopic ureteral catheterization.

Treatment / Management

Prevention

Prophylactic ureteral stents/catheters can be placed prior to surgery to assist in intraoperative identification of ureters. This is often performed in surgeries that occur in close proximity to the ureter, such as gynecologic, rectosigmoid, and aortoiliac surgeries and particularly important if the operative field is scarred from previous dissection. It is debated whether stents actually prevent ureteral injury. In one review of 5729 colectomies, there was no difference seen for those who did versus did not undergo prophylactic ureteral stent placement.[10][11]

Treatment

Several important principles are necessary for successful ureteral repair. It is important to debride all devitalized tissue. There must be sufficient ureteral mobilization to permit a tension free anastomosis. It is important to preserve the ureteral adventitia and vasculature to ensure adequate ureteral blood supply. The ureteral ends should be spatulated. A water-tight, tension-free, mucosa-to-mucosa anastomosis should be created over a ureteral stent using absorbable suture.

Choice of repair depends on the site of ureteral injury and timing of identification. If the injury is Grade I-III, consider placing a ureteral stent and allowing ureter to heal over stent. If the injury is to the upper or middle ureter, consider direct ureteroureterostomy (UU) or transureteroureterostomy (TUU). If the injury is to the lower ureter, consider ureteral reimplantation (ureteroneocystostomy), psoas hitch, or Boari flap.

Surgical Repair

UU is primary anastomosis of the injured ureter. This repair is most appropriate for short ureteral defects and is the preferred repair for the abdominal ureter when a tension free anastomosis can be created.

TUU involves anastomosing the injured ureter to the contralateral ureter in an end-to-end fashion. The ureter is brought through a window in the colonic mesentery, cephalad to the inferior mesenteric artery. This method is useful when a psoas hitch or Boari flap cannot be performed. It is very useful if there is extensive damage to the proximal ureter or the bladder is small or radiated.

Ureteral reimplantation (ureteroneocystostomy) involves reimplanting the ureter directly to the bladder and is useful for pelvic ureteral injuries. Psoas hitch and/or Boari flap are sometimes required to aid in reimplantation. A psoas hitch is a maneuver in which the bladder dome is pulled cephalad and sutured to the ipsilateral psoas tendon. The ureter is then reimplanted into the dome of the bladder. This may be required if there is injury to the distal ureter and the distance is too far to create a tension-free reimplantation of the ureter into the bladder. A Boari flap is a maneuver in which a flap of bladder is rotated cephalad and tubularized and the ureter is reimplanted into the tubularized flap. Again, this is useful if there is injury to the distal ureter, creating too great of a distance between the viable ureter and the bladder.

Ureteropyelostomy is a procedure in which the ureter is anastomosed to the renal pelvis.

Ureterocalycostomy is a procedure in which the lower pole of the kidney is amputated to expose the infundibulum and the ureter is anastomosed to the infundibulum.

Ileal ureter is a procedure in which a segment of ileum is used as ureter replacement. This is useful when there is a long segment of ureter that is destroyed.

Immediate Diagnosis

If ureteral perforation occurs during endoscopy, it can usually be managed with placement of ureteral stent for 4 to 6 weeks. If there is an intra-operative crush injury or ureteral contusion that is immediately identified, such as clamping the ureter, suturing the ureter, stapling the ureter, or applying a clip to the ureter, it can be managed based on the extent of injury. If it appears the injury is minimal and the ureter is viable, place a ureteral stent. If the injury is large or the ureter does not appear viable, the section of injury can be debrided, and ureter primarily repaired over a stent. If a partial laceration is identified, it can be debrided and primarily repaired over a stent.

A major pelvic ureteral injury is managed with distal ureter ligation and reimplantation into the bladder. This may require psoas hitch and/or Boari flap. Generally, psoas hitch combined with Boari flap is necessary if length of injury is greater than 15 centimeters. Major abdominal ureteral injury can be repaired with UU, TUU, or ureteral reimplantation with/without psoas hitch or Boari flap.

If the patient is unstable and has a significant ureteral injury, he/she may not be stable enough to undergo formal repair. If this is the case, ligate the ureter with a non-absorbable suture just above the injury and place a percutaneous nephrostomy tube.

Delayed Diagnosis

When a ureteral injury diagnosis is delayed, a ureteral stricture often develops. Experts suggest that postoperatively discovered ureteral injuries should be immediately repaired when detected within 72 hours. Injuries that are identified after 3 days should be drained with a ureteral stent, percutaneous nephrostomy tube, or both and definitive repair should be delayed until 6 weeks after injury. If a urinoma is present, a drain should be placed. Complete imaging of the ureteral defect should be obtained. If possible, obtain an RPG and APG to identify the location and extent of the injury. A pelvic ureteral injury should be repaired with ureteral reimplantation with/without psoas hitch and/or Boari flap. Abdominal ureter injury can be repaired by UU, TUU, or ureteral reimplantation. UPJ injury can be repaired with ureteropyelostomy or ureterocalycostomy. These repairs can be performed with an open surgical approach, laparoscopically or robotically.

Differential Diagnosis

- Unrecognized bladder injury will result in urine leaking into the retroperitoneum which can mimic ureteral injury symptoms. Treatment is most often with the placement of a Foley catheter for 7 to 10 days. After this time, a cystogram should be obtained to ensure that the bladder is healed.
- Lymphocele can present with flank pain. Generally, no intervention is required, but on occasion, if very painful or it becomes infected, a drain may need to be placed by IR
- Hematoma can present with flank pain. It is managed conservatively.
- In a female, ureteral fistulae can present as a ureterovaginal fistula with continuous urinary incontinence. It is managed the same as ureteral injury.

Prognosis

If identified immediately, patients have an excellent prognosis as a urologic surgeon can immediately repair the ureter. Early diagnosis is considered the single most important prognostic factor. Patients with a delayed diagnosis of ureteral injury have a much higher rate of complications. One study found that delayed diagnosis resulted in complications in up to 40% of cases compared to 10% of cases with the immediate diagnosis.

Complications

Urine leak from a ureteral injury may lead to urinoma formation, which can eventually lead to infection and/or abscess. Extravasated urine can also irritate the intestines and peritoneum, resulting in pain and ileus. If the ureter stricture is down and there is no drainage of urine, this obstruction can lead to loss of renal function and, ultimately, loss of a kidney. A ureterovaginal fistula can form if not recognized.

Postoperative and Rehabilitation Care

Follow-up care is a matter of personal preference and will depend on the type of repair performed. If a distal ureteral injury is repaired with reimplantation into the bladder and a cystostomy is required, a Foley catheter should be left in place postoperatively for 7 to 10 days. Sources vary on the length of time a ureteral stent should be left in place. Some sources recommend keeping the stent in place for up to 6 weeks; others advocate removal after 14 days. This is up to the discretion of the practitioner. At the time of stent removal, an RPG can be obtained to document healing without leakage or stenosis. Continued follow up with renal ultrasounds to ensure no restenosis of the ureter occurs is recommended.

Pearls and Other Issues

Ureteral injuries are rare, but a high level of suspicion for these injuries is necessary when performing an operation with high risk for ureteral injury because immediate identification of the injury is the most important prognostic factor. If a ureteral injury is suspected, an RPG can be obtained at the time of the procedure. Another method to identify the injury involves direct inspection of the ureters using intravenous dyes such as methylene blue and indigo carmine to evaluate for dye leakage along the course of the ureter. Injury treatment will vary on the location and extent of the injury. Treatment can be as simple as ureteral stent placement and as complicated as using a portion of ileum as ureter replacement.

Enhancing Healthcare Team Outcomes

Ureteral injuries are usually managed by a urologist but the cause of ureteral injury can occur during a variety of surgical procedures. An iatrogenic ureteral injury most commonly occurs during gynecologic surgery (52% to 82%). Hysterectomy accounts for the majority of cases resulting in ureteral injury. Injury occurs in the distal ureter in the region of the infundibulopelvic ligament where the ureters cross inferior to the uterine artery. If an injury occurs during laparoscopic gynecologic surgery, it is usually caused by cauterization or clipping.

Ureteral injury also occurs in colorectal and vascular surgery cases. Low anterior resection (LAR) and abdominal perineal resection (APR) account for the majority of colorectal procedures resulting in ureteral injury. In these cases, the left ureter is most commonly injured as it may be elevated with the sigmoid mesentery and mistaken as a mesenteric vessel. Ureteral manipulation is common with aortoiliac and aortofemoral bypass surgery, and thus these surgeries also have a risk for ureteral injury.

It is vital to be aware of a ureteral injury and call the urologist when it occurs. The surgical nurse assistant or scrub nurse should try and remind the surgeons of a ureteral stent in high risk cases. The type of repair procedure depends on the site and extent of the injury. Untreated ureteral injuries have a very high morbidity. [12](Level V)

Questions

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