RadioGraphics

Urine Leaks and Urinomas: Diagnosis and Imaging-guided Intervention[1]

Ross L. Titton, MD • Debra A. Gervais, MD • Peter F. Hahn, PhD, MD Mukesh G. Harisinghani, MD • Ronald S. Arellano, MD • Peter R. Mueller, MD

CME FEATURE

See accompanying test at http://www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES FOR TEST 5

After reading this article and taking the test, the reader will be able to:

- Describe the underlying causes of urine leaks and urinoma formation.
- Recognize the imaging features of urine leaks.
- Select the appropriate interventional procedure for treating various types of urine leaks and urinomas.

Urine leaks from the kidney, ureter, bladder, and urethra most commonly result from trauma. Urinomas may be occult initially and may lead to complications such as abscess formation and electrolyte imbalances if not promptly diagnosed and appropriately managed. Radiologists play a key role in diagnosing urine leaks and determining their cause and extent. Contrast material–enhanced computed tomography (CT) with delayed imaging, CT cystography, and retrograde urethrography are the diagnostic imaging studies of choice. Studies such as intravenous pyelography, antegrade and retrograde pyelography, renal scintigraphy, and imaging-guided needle aspiration may play complementary diagnostic roles. In some instances, the role of the radiologist ends with the diagnosis of urine leaks, after which patients are treated conservatively or perhaps surgically. Uncomplicated renal urine leaks, extraperitoneal urinary bladder rupture, and type 1 urethral injuries are generally managed conservatively. Urine leaks that require more extensive, imaging-guided treatment can usually be managed safely and effectively with a combination of percutaneous urinoma drainage catheters, percutaneous nephrostomy catheters, ureteral stents, and bladder drainage. In the appropriate setting, use of these management options may reduce urinoma-related complications and limit or totally eliminate the need for urologic surgery.

Index terms: Genitourinary system, infection, 84.21, 85.21 • Genitourinary system, injuries, 80.43 • Surgery, complications, 82.458, 83.458 • Ureter, stenosis or obstruction, 82.844 • Urine, extravasation • Urinoma, 80.43

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[1]From the Department of Radiology, Massachusetts General Hospital, 55 Fruit St, White 270, Boston, MA 02114. Recipient of a Certificate of Merit award for an education exhibit at the 2002 RSNA scientific assembly. Received February 11, 2003; revision requested March 17 and received March 27; accepted March 31. **Address correspondence to** D.A.G. (e-mail: *dgervais@partners.org*).

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Figure 1. Renal urine leak and urinoma in a 24-year-old man who sustained left renal trauma in a motor vehicle accident. **(a)** Contrast material–enhanced CT scan shows a fracture of the left kidney and a surrounding perinephric urinoma. Faint high attenuation is seen within the urinoma laterally (arrow), a finding that represents a leak of enhanced urine from the renal collecting system. **(b)** Delayed phase CT scan obtained slightly caudad to the left kidney 10 minutes later shows increased attenuation of the urinoma. Note the contrast material in the dependent portion of the urinoma collection (arrow). **(c)** Contrast-enhanced CT scan obtained after 3 months of conservative therapy demonstrates an interval decrease in the size of the urinoma, with a small amount of contrast material in the dependent portion of the urinoma (arrow). Note that the anterior renal fracture fragment (arrowheads) is surrounded by a smaller urinoma and is now closer to the remainder of the kidney.

Introduction

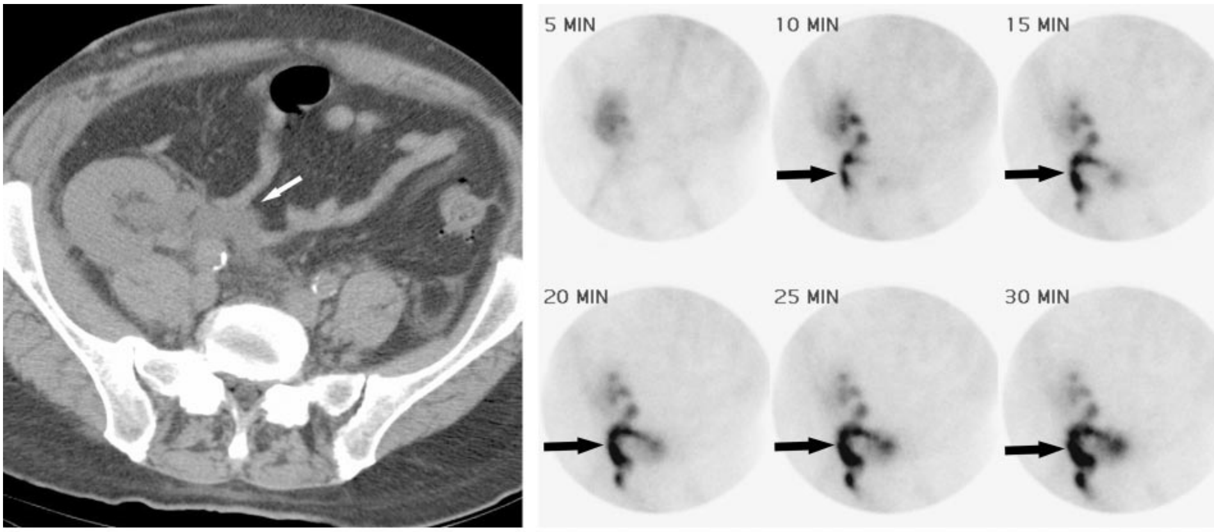
Urine leaks and urinomas result from disruption of the urinary collecting system at any level from the calix to the urethra. Persistent urine leakage is common following injury. Urinomas may initially be clinically occult and may manifest with delayed complications such as hydronephrosis, paralytic ileus, electrolyte imbalances (1), and abscess formation. Urine leaks and urinomas have a variety of appearances and may be misdiagnosed as ordinary ascites, abdominal or pelvic abscesses or hematomas, cystic masses, or pancreatic pseudocysts (2). Diagnostic imaging plays a crucial role in promptly identifying these leaks and determining their cause and extent. In some cases, the role of the radiologist ends with the diagnosis, after which patients are treated conservatively or, alternatively, surgically. In many other cases, imaging-guided interventions play a crucial role in the management of these leaks.

In this article, we discuss and illustrate urine leaks and urinomas of the kidney, ureter, urinary bladder, and urethra with respect to their causes, diagnosis and imaging features, and treatment.

Renal Leaks and Urinomas

Causes

Renal urine leaks result from disruption of the calices, infundibula, or renal pelvis. Most commonly, renal urine leaks result from blunt or penetrating renal trauma. They may accompany any form of renal trauma, ranging from a simple renal laceration to a renal vascular pedicle injury. Renal urine leaks may also be the result of transmitted back pressure caused by obstruction of the genitourinary system (3) due to a ureteral stone or pelvic mass, pregnancy, retroperitoneal fibrosis, posterior urethral valves, or bladder outlet obstruction. Iatrogenic injury during surgical or percutaneous procedures is an uncommon cause of renal injury.



a. b.

Figure 2. Renal urine leak in a 57-year-old man with oliguria and renal insufficiency. The patient had undergone renal transplantation 1 week earlier. **(a)** CT scan of the right lower quadrant of the transplanted kidney demonstrates a fluid collection medial to the right ureteropelvic junction (arrow). **(b)** Sequential dynamic images obtained at renal scintigraphy with technetium-99m dimercaptosuccinic acid help confirm an anastomotic leak at the level of the transplant ureteropelvic junction, with progressive accumulation of radiotracer outside the collecting system over time (arrows).

Diagnosis and Imaging Features

Computed tomography (CT) is the study of choice in the diagnosis of renal urine leaks and urinomas. CT protocols in patients with a suspected urine leak involve scanning the abdomen and pelvis prior to and following the intravenous administration of 100–150 mL of contrast material. Delayed phase images (obtained 5–20 minutes after contrast material injection) are the key for demonstrating a urine leak because iodinated urine increases the attenuation of the urinoma over time (Fig 1). Coronal and sagittal three-dimensional reformatted CT images can help further define the extent of injuries to the collecting system.

Even if a renal urine leak or urinoma is not suspected at the time the CT protocol is prescribed, it may still be diagnosed following CT if the location and pattern of spread of the fluid collection is recognized. Urinomas may be confined, encapsulated fluid collections or may manifest as free fluid (4). However, most urinomas leak into a subcapsular location or into the perirenal space within the Gerota fascia (5). If extensive, a urine leak may cross the midline within the perirenal space anterior to the aorta and inferior vena cava and extend into the contralateral perirenal space (6). A urine leak may extend superiorly through the aortic hiatus into the mediastinum and through the diaphragm into the pleural space. Urine may also travel through lymphatic vessels from a urinoma to the pleural and mediastinal space (6), or it may extend inferiorly along the iliopsoas compartment below the inguinal ligament to the soft tissues of the thigh, pelvis, buttocks, or scrotum or into the perineum. A urine leak may extend into the intraperitoneal cavity and surround bowel loops, causing urinary ascites. Intraperitoneal urine leaks are usually a result of penetrating or iatrogenic injury (6).

Excreted radiotracer outside the genitourinary tract at either bone scintigraphy or renal scintigraphy may also allow a diagnosis of a urine leak (Fig 2). In patients who *(a)* cannot receive intravenous contrast material due to elevated creatinine levels, *(b)* are allergic to the contrast material, or *(c)* have received a renal transplant, scintigraphy plays a vital role in the diagnosis of urine leaks. Intravenous pyelography is relatively insensitive in the diagnosis of renal injuries and urine leaks and may demonstrate normal findings in over 30% of cases of significant renal injury (7).

If the diagnosis of urinoma remains uncertain following diagnostic imaging, the fluid in question may be percutaneously aspirated. Urinomas demonstrate significant elevation of creatinine levels and decreased glucose levels relative to serum levels.

Treatment

In most instances, small urinomas will reabsorb spontaneously, and drainage is not necessary (6). However, if urinomas are larger or persist over

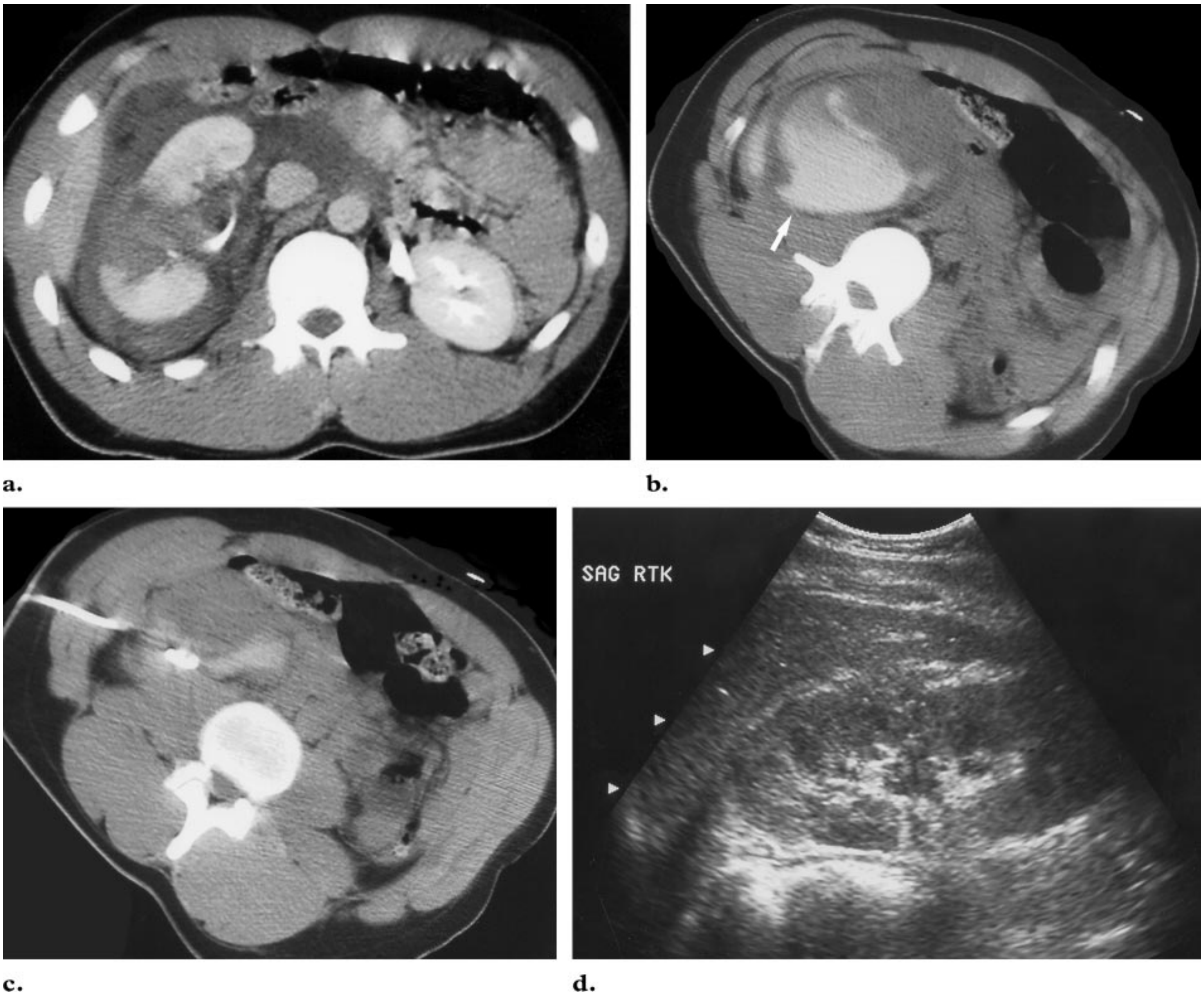


Figure 3. Renal urine leak and urinoma in a 20-year-old man who sustained right renal trauma in a motor vehicle accident. **(a)** Contrast-enhanced CT scan shows a fracture of the right kidney and a surrounding perinephric urinoma. **(b)** Delayed phase CT scan obtained 1 week later shows a persistent large perinephric urinoma. Note the high-attenuation contrast material in the dependent portion of the collection (arrow), a finding that indicates active leakage of enhanced urine. The patient developed progressive abdominal pain with initial conservative treatment, and a percutaneous urinoma drainage catheter was placed under US guidance. **(c)** CT scan obtained after percutaneous drainage of the perinephric urinoma helps confirm optimal placement of the drainage catheter. **(d)** Sagittal US image obtained 4 weeks after urinoma drainage catheter placement demonstrates complete resolution of the perinephric urinoma and continued healing of the right renal fracture.

several days, or if the patient develops fevers or sepsis irrespective of urinoma size, imaging-guided drainage is clinically warranted. Under ultrasonographic (US) or CT guidance, a urinoma drainage catheter may be placed into the most dependent portion of a urinoma with either the Seldinger or trocar technique. After catheter placement, a culture of the urinoma is taken and the patient begins empiric antibiotic therapy (8). Drainage of urinomas that separate renal fragments has been shown to accelerate renal healing and ultimately aids in preserving renal function (Fig 3) (9).

Although there is no absolute quantity of output from a urinoma drainage catheter that is indicative of a continuous urine leak, diminishing daily outputs are expected. In cases in which urinoma outputs do not decrease despite placement of an optimally positioned percutaneous drainage catheter, a percutaneous nephrostomy catheter may be placed in addition to the percutaneous urinoma drainage catheter to decompress the collecting system and facilitate urinary drainage (Fig 4). Placement of a nephrostomy catheter alone may not divert enough urine to allow a urine leak to heal spontaneously. Therefore, in cases of persistent leakage from the collecting system, placement of a nephrostomy catheter, usually in combination with placement of a ureteral stent or

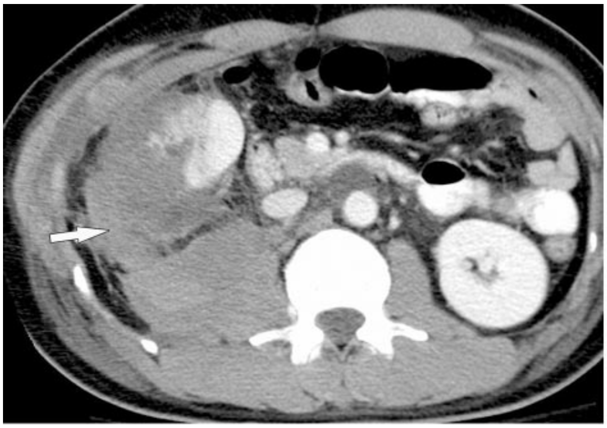


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Figure 4. Renal urinoma in a 39-year-old man who sustained right renal trauma from a stab wound. **(a)** Contrast-enhanced CT scan shows a fracture of the right kidney and a surrounding perinephric fluid collection (arrow). **(b)** On a contrast-enhanced CT scan obtained 7 days later, the perinephric fluid collection has increased in size and now demonstrates a high-attenuation rim. Percutaneous drainage of the presumed liquefied and infected hematoma was performed. **(c)** Sagittal US image obtained on the same day as **b** shows a fluid collection inferior to the right kidney. An 8-F drainage catheter was placed under US guidance. **(d)** Contrast-enhanced CT scan obtained 7 days after **c** shows a smaller but persistent perinephric fluid collection. High-volume catheter outputs persisted. Evaluation of the creatinine level of the fluid collection confirmed the diagnosis of urinoma. Antegrade ureteral stent placement was performed. Contrast material was injected through the percutaneous drainage catheter 5 days later due to decreased catheter output. **(e)** Pyelogram shows that the size of the urinoma cavity has decreased (arrow), but that communication between the percutaneous urinoma drainage catheter and the renal collecting system persists (arrowheads). **(f)** Contrast-enhanced CT scan obtained 10 days after **e** shows interval resolution of the perinephric urinoma. The combined use of the urinoma drainage catheter and ureteral stent promoted healing of the collecting system.

nephroureterostomy catheter, is warranted. The combined use of a percutaneous drainage catheter with either a nephrostomy catheter and a ureteral stent or with a nephroureteral catheter diverts the urine away from the area of the leak and promotes primary healing of the collecting system.

Ureteral Leaks and Urinomas

Causes

Like renal urine leaks, ureteral urine leaks may result from blunt or penetrating trauma, iatrogenic injury, or transmitted back pressure caused by downstream obstruction due to a ureteral stone, surgical ligature, or abdominal or pelvic mass. Unlike renal urine leaks, ureteral urine leaks most commonly occur as a result of iatrogenic injury following genitourinary, retroperitoneal, pelvic, or gynecologic surgery (4,10). Ureteral perforations resulting in urine leakage may also occur following ureteral antegrade or retrograde manipulation during endourologic procedures. Ureteral anastomotic dehiscence may occur following renal transplantation or ureteral diversion procedures.

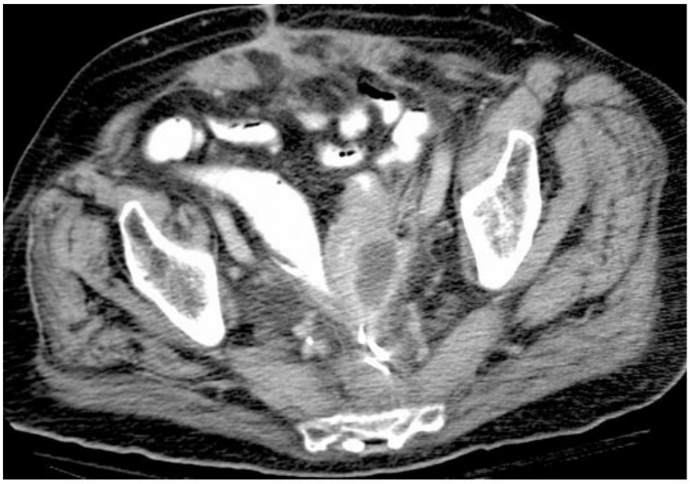
Diagnosis and Imaging Features

The diagnosis of ureteral injuries may readily be accomplished with retrograde or antegrade pyelography or with CT that includes unenhanced, corticomedullary, and delayed imaging. CT with delayed imaging is the least invasive and most readily available of these three options. Delayed phase CT scans (obtained 5–20 minutes after contrast material injection) are optimal for demonstrating ureteral urine leaks. Coronal and sagittal three-dimensional reformatted CT images can help further define the extent of injury to the ureter. In patients who are not candidates for imaging with intravenous contrast material, scintigraphy plays a vital role in the diagnosis of ureteral urine leaks. The reported sensitivity of intravenous pyelography in the diagnosis of ureteral injury is 33% (10).

Treatment

Interventional radiologists may treat ureteral injuries with percutaneous urinoma drainage along with diversionary percutaneous nephrostomy with or without ureteral stent placement. Alternatively, they may place nephroureteral catheters across the site of ureteral injury. Ureteral stent placement across sites of ureteral transection may be performed either retrograde through the bladder or antegrade through a percutaneous nephrostomy catheter. To facilitate passage of an antegrade or retrograde stent across a dehiscent or partially dehiscent ureter, any existing urinoma should be aspirated to reduce tension that may splay partially severed ureteral segments (Fig 5) (6). In cases of difficult ureteral stent deployment, radiologists and urologists may work in tandem to successfully place the stent. The urologist can cystoscopically advance a guide wire retrograde into the urinoma, after which the radiologist may insert a wire loop snare antegrade to capture the guide wire and advance it through the proximal ureter for subsequent stent passage (11). When placed for ureteral injury, ureteral stents are generally left in place for 4–8 weeks, allowing uroepithelium to cover the site of ureteral injury, which in turn allows the ureter to heal (Fig 6) (6). In these instances, a percutaneous nephrostomy catheter is usually left in place to maintain access to the collecting system so that contrast material can be injected to confirm that the ureteral injury has healed. Alternatively, a nephroureteral catheter may be placed across the site of ureteral injury for the 4–8-week period following ureteral injury, thereby maintaining access to the collecting system without the need for a second percutaneous nephrostomy catheter.

Figure 5. Ureteral urine leak and urinoma in a 73-year-old man who had undergone abdominoperineal resection for rectal cancer. **(a)** Contrast-enhanced CT scan demonstrates a fluid collection in the left sigmoid mesentery. **(b)** CT scan obtained 1 day later during CT-guided needle aspiration demonstrates delayed attenuation of the fluid collection. Results of needle aspiration confirmed that the collection represented a urinoma. Postaspiration evaluation revealed that the cavity had completely resolved, and no percutaneous drainage catheter was placed. The patient underwent left percutaneous nephrostomy to divert urine flow. Attempts at antegrade ureteral stent placement were unsuccessful. **(c)** Prone antegrade pyelogram obtained following nephrostomy and unsuccessful stent placement demonstrates enhancement and a guide wire within the left ureter. A focal outpouching of extraluminal contrast material (arrow) is seen at the level of complete ureteral transection. **(d)** Photograph of the 10-F, 20-cm ureteral stent (Boston Scientific, Watertown, Mass) demonstrates that the stent has two pigtails with multiple side holes. This stent may be placed across the level of a ureteral injury, with side holes above and below the level of the urine leak. It is completely internal and is usually removed through the urinary bladder. Ureteral stents come in variable lengths and are typically 8–10 F in diameter. **(e)** Abdominal radiograph obtained following left retrograde ureteral stent placement demonstrates the stent in satisfactory position.



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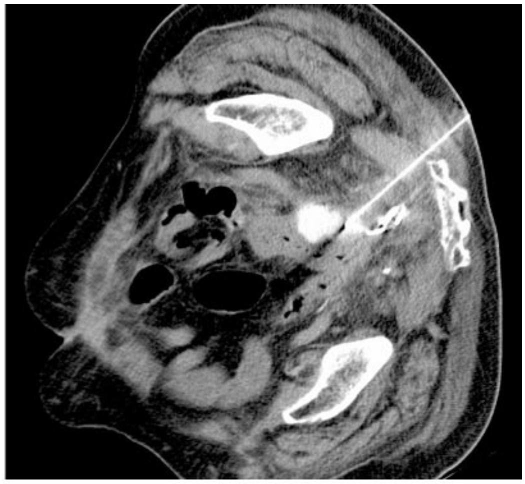

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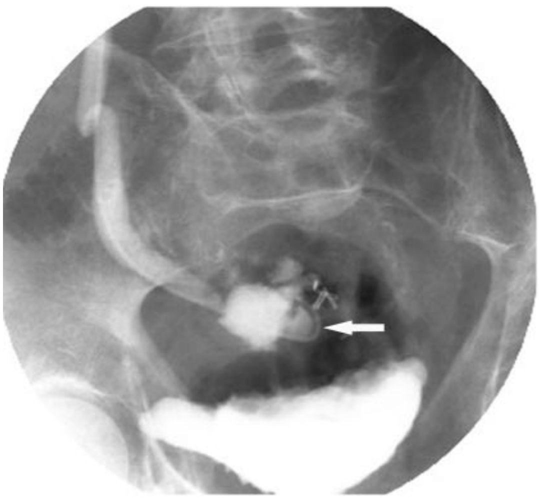

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Figure 6. Ureteral urinoma in a 40-year-old man with recurrent fevers following pelvic exenteration and ileal loop diversion. **(a)** Contrast-enhanced delayed phase CT scan demonstrates a presacral urine collection with high attenuation. A percutaneous urinoma drainage catheter (not shown) was placed. **(b)** Pyelogram obtained after injection of contrast material through the urinoma drainage catheter shows communication of the urinoma with the ileal loop (arrow). Both kidneys were obstructed, and bilateral percutaneous nephrostomy was performed. Management options included ureteral stent placement (if technically possible) and, as a last resort, surgical revision. Stent deployment was attempted. **(c)** Spot radiograph obtained during stent placement demonstrates a guide wire that has been placed antegrade via the right kidney through the ureteral anastomosis and out the ileal loop. After percutaneous access to the ileal loop via the kidney was established, an exchange-length guide wire (arrows) was inserted to help place a retrograde catheter. A percutaneous nephrostomy catheter (not shown) was left in place. Arrowheads indicate the percutaneous urinoma drainage catheter. **(d)** Photograph of an 8-F, 30-cm biliary urinary drainage catheter (Boston Scientific) demonstrates that the catheter is long with a single pigtail. The catheter is suitable for ureteral stent placement in patients with ileal loops. In such patients, the distal portion of the stent is external to the patient and is confined within the ileostomy drainage bag. This particular design with a Luer-lock hub facilitates over-the-wire exchanges. These catheters come in lengths of 30 or 45 cm and are typically 8–10 F in diameter. **(e)** Lateral radiograph shows a right percutaneous nephrostomy catheter (arrow) and a right biliary urinary drainage catheter (arrowheads) placed across a right ureteral–ileal loop anastomotic injury.

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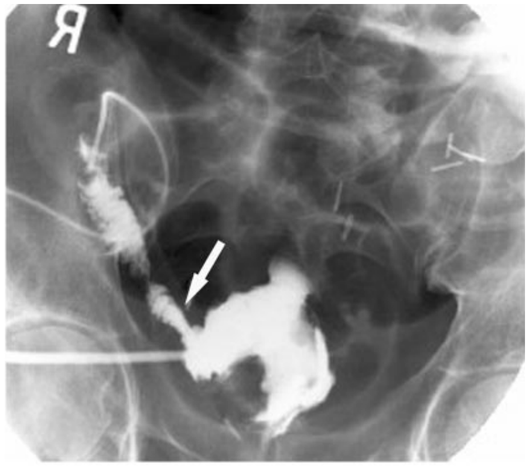

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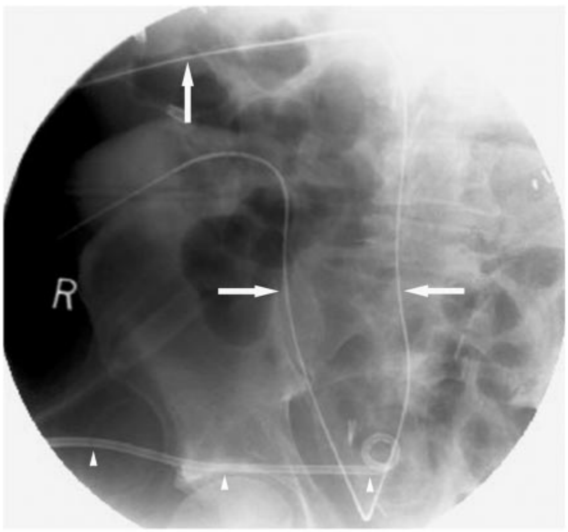

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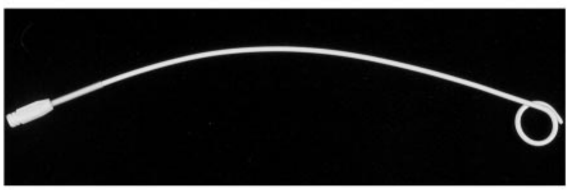

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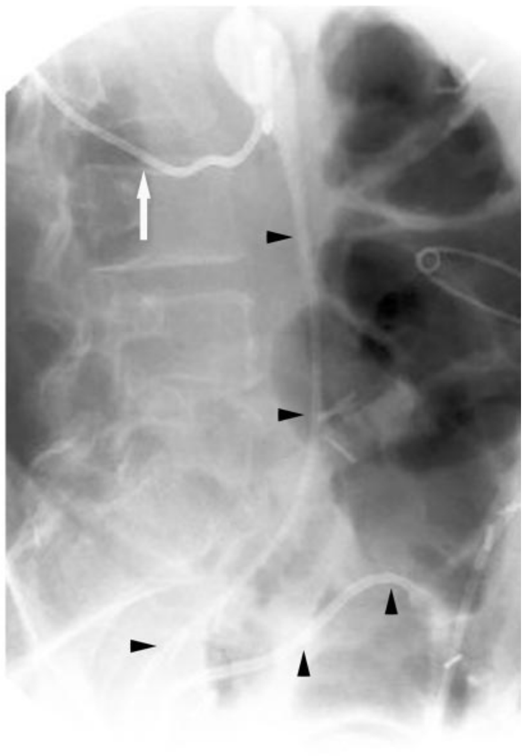

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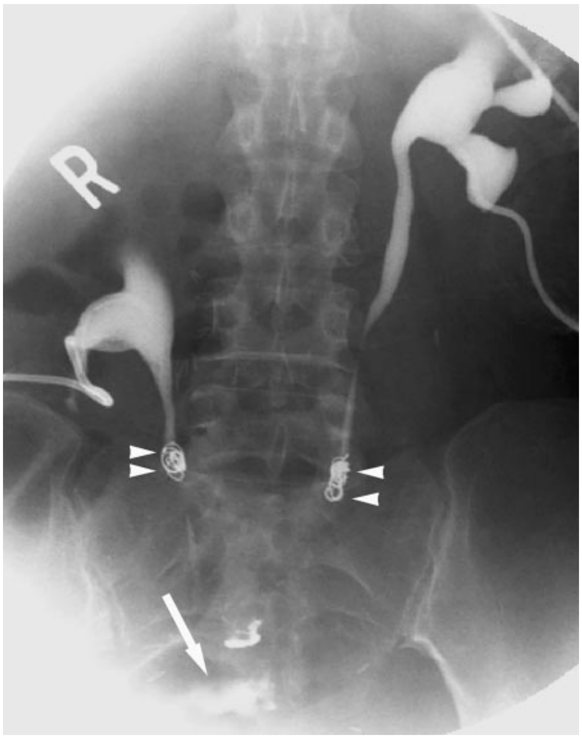

Figure 7. Ureteral urine leak in a 46-year-old woman with bilateral ureteral fistulas to the vagina. The patient had undergone total abdominal hysterectomy and pelvic irradiation for cervical cancer. Bilateral antegrade stent deployment was unsuccessful. Bilateral antegrade pyelogram, obtained following bilateral ureteral occlusion with stainless steel coils (arrowheads) and placement of an absorbable gelatin sponge slurry, demonstrates complete ureteral occlusion on the left side and nearly complete occlusion on the right side. Some leakage of previously administered contrast material into the right side of the pelvis (arrow) is seen. The patient will have bilateral percutaneous nephrostomy catheters for the rest of her life.

In some cases of complete ureteral transection, ureteral stents cannot be placed with retrograde, antegrade, or combined approaches. If ureteral stents cannot be deployed or a nephroureteral catheter cannot be placed across the region of ureteral injury, percutaneous urinoma drainage and percutaneous nephrostomy may be combined with delayed open surgical repair of the ureter. The transected portion may be resected with ureteroureterostomy formation, or a portion of the damaged ureter may be resected, followed by bladder-psoas "hitch" with ureteroneocystostomy.

In patients with advanced inoperable gynecologic or pelvic tumor, external drainage with a percutaneous nephrostomy catheter and a urinoma drainage catheter may not provide adequate urinary diversion from a ureteral leak or fistula. In these patients, surgical repair is often precluded by tumor and by scarring from prior radiation or surgery. Stainless steel or platinum coils can be deployed antegrade in the ureter above the level of the ureteral leak to achieve complete ureteral occlusion from resultant uroepithelial hyperplasia and fibrosis. This fibrotic reaction forces all urine to drain through a percutaneous nephrostomy catheter (12,13). Because this reaction takes time following ureteral coil placement, an absorbable gelatin sponge slurry is often placed proximal to the ureteral coils to diminish the antegrade flow of urine in the early postembolization period. The major drawback is the permanent nature of the ureteral occlusion and the lifelong need for percutaneous nephrostomy drainage (Fig 7). Some patients who may ultimately be eligible for surgical ureteral revision may undergo ureteral coil placement as a temporizing measure while acute medical conditions are treated. For example, in the post–myocardial infarction period, a patient may need to wait 6 months before undergoing definitive surgical therapy (Fig 8). In these patients, options for future surgical repair may be limited due to loss of ureteral length from resultant fibrosis.

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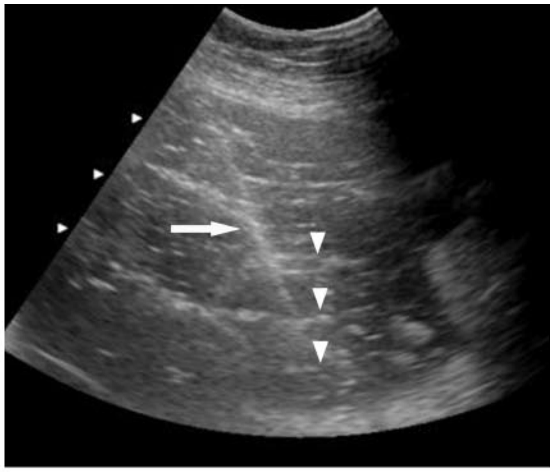

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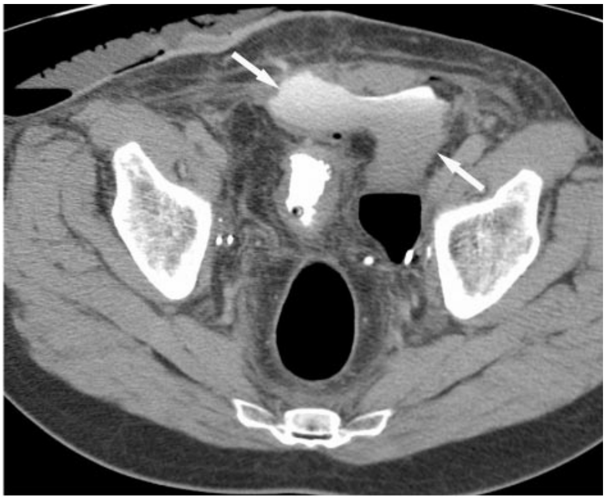

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Figures 9, 10. **(9)** Extraperitoneal bladder injury in an 88-year-old man who had undergone transurethral resection of the prostate gland. Gross hematuria was seen postoperatively. CT cystogram demonstrates extraperitoneal contrast material leakage from the right side of the urinary bladder (arrow). The contrast material extends posteriorly along the medial aspect of the right levator ani muscle. The patient was successfully treated conservatively with a transurethral bladder catheter. **(10)** Extraperitoneal bladder injury in a 58-year-old man who had undergone radical retropubic prostatectomy and bilateral pelvic lymph node dissection. Continuous high outputs from the surgical drains were seen postoperatively. CT cystogram demonstrates extraperitoneal urine and contrast material leakage into the prevesical space of Retzius (arrows). The patient was successfully treated conservatively with a transurethral bladder catheter.

Urinary Bladder Leaks and Urinomas

Causes

Bladder injuries most frequently occur due to blunt or penetrating trauma and are most commonly associated with pelvic fractures. Bladder injuries may also be iatrogenic. The likelihood of bladder injury and urine leakage is increased when the bladder is fully distended at the time of injury. There are two types of bladder injury: extraperitoneal (65% of cases) and intraperitoneal (35%) (14). Extraperitoneal bladder injuries (Figs 9, 10) most often occur due to shearing or direct laceration of the bladder from pelvic fractures. Intraperitoneal bladder injuries (Figs 11, 12) generally result from blunt trauma, which leads to a rapid rise in intraperitoneal pressure, causing the bladder dome to burst.

◀ **Figure 8.** Ureteral urine leak and urinoma in a 73-year-old man who presented with abdominal pain 2 weeks after undergoing low anterior resection. **(a)** CT scan demonstrates an extensive intraperitoneal fluid collection in the left side of the pelvis. The fluid collection extended superiorly into the lesser sac (not shown). Because of the extensive nature of the collection, a percutaneous drainage catheter was placed under US guidance. **(b)** Sagittal US image demonstrates the percutaneous drainage catheter (arrow), which has been advanced into the complicated intraperitoneal fluid collection. The collection completely collapsed following drainage despite the appearance of multiple septa within the collection (arrowheads). **(c)** Intravenous pyelogram obtained 3 days after **b** and 10 minutes after contrast material injection demonstrates persistent extravasation of contrast material in the left side of the pelvis (arrow), a finding that helped confirm the diagnosis of urinoma. A left percutaneous nephrostomy catheter (not shown) was placed. **(d)** Antegrade pyelogram obtained following left percutaneous nephrostomy demonstrates a distal contrast material leak (arrow). Despite combination treatment with percutaneous nephrostomy and a urinoma drainage catheter (arrowheads), outputs from the latter remained high. Neither antegrade nor retrograde ureteral stent placement was successful. The urologist wanted to defer definitive surgical treatment for 3–6 months due to a perioperative myocardial infarction. Ureteral embolization was offered as a temporizing measure to divert urine flow from the ureteral leak. **(e)** Antegrade pyelogram demonstrates two Gianturco coils (arrowheads) in the distalmost portion of the left ureter above the transection. Contrast material from prior injections is seen inferiorly (arrow). **(f)** CT scan obtained 2 weeks after **e** demonstrates an interval decrease in the size of the pelvic urinoma due to urinary diversion from the site of the ureteral leak.

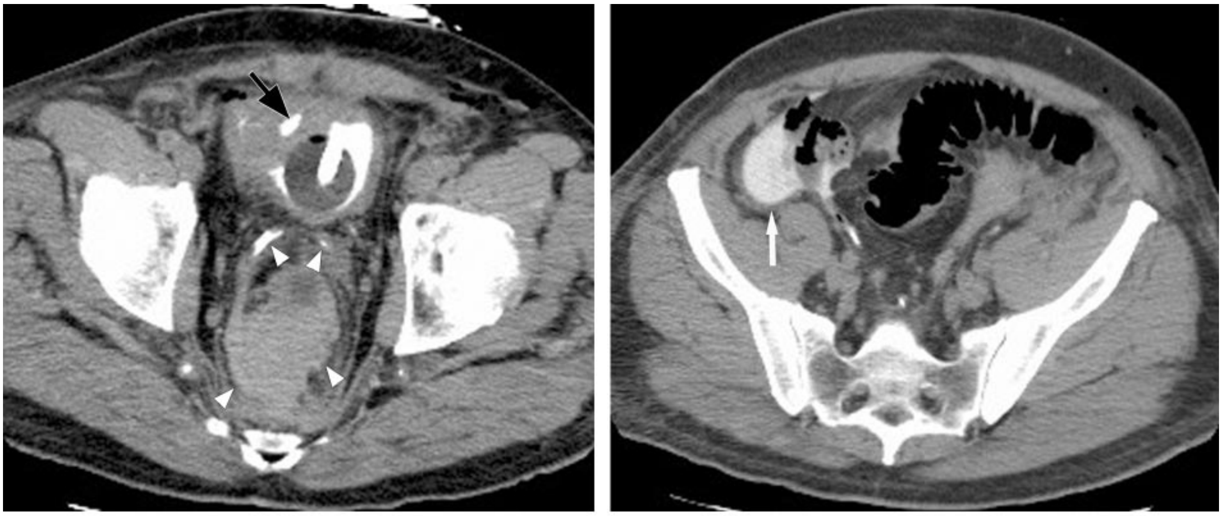

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Figure 11. Intraperitoneal bladder injury in a 65-year-old man who had undergone laparoscopic low anterior resection. Continuous high outputs from the surgical drains were seen postoperatively. **(a)** CT cystogram demonstrates a bladder catheter and contrast material within the urinary bladder. Note the contrast material posterior to the bladder (arrowheads) and the surgical drain traversing the urinary bladder dome (arrow). **(b)** CT cystogram obtained cephalad to **a** demonstrates intraperitoneal leakage of contrast material into the right paracolic gutter and adjacent to the cecum (arrow). The surgical drain was removed, and the patient was successfully treated with prolonged bladder catheter drainage alone. Although most intraperitoneal bladder injuries require surgical intervention, many iatrogenic injuries to the bladder are minor and can be managed conservatively.

Diagnosis and Imaging Features

Bladder injury should be suspected if a patient who has sustained pelvic trauma has gross hematuria or fails to void (14). Historically, cystography was the diagnostic test of choice in evaluating for the presence of a urinary bladder injury. In conventional cystography, 300–500 mL of contrast material is administered retrograde to completely fill the urinary bladder. Anteroposterior, bilateral oblique, and postvoiding views of the pelvis are then obtained. Extraperitoneal bladder ruptures demonstrate flame-shaped extravasation into perivesical soft tissues. Intraperitoneal bladder ruptures demonstrate leakage of contrast material and urine around bowel loops and into the paracolic gutters. Findings at bladder cystography may lead to underestimation of the extent of an intraperitoneal leak (14). Consequently, CT cystography is now performed at many institutions and is the study of choice when available. CT cystography aids in the detection of coexistent injuries to the pelvis and is more sensitive in determining the true extent of bladder injury. In this procedure, 300–500 mL of diluted contrast material is instilled retrograde into the urinary bladder, the bladder catheter is clamped for 10–20 minutes, and abdominopelvic imaging is performed.

Treatment

Intraperitoneal bladder ruptures require prompt open surgical exploration and two-layer closure (14) due to the risk of urinary peritonitis. Extraperitoneal bladder ruptures are generally managed with bladder catheter drainage alone. Combined treatment with a suprapubic catheter and a transurethral bladder catheter may be required in cases of extraperitoneal bladder rupture with gross hematuria, especially if clots obstruct the transurethral bladder catheter within 48 hours of initial injury (14).

Urethral Leaks and Urinomas

Causes

Urethral urine leaks most commonly occur due to trauma but may also occur as a sequela of chronic infection. In type 1 urethral injury, the urethra is narrowed and stretched by a periurethral hematoma but remains intact. In type 2 urethral injury (Fig 13), there is rupture of the posterior urethra proximal to the urogenital diaphragm, an injury that occurs most commonly as a result of motor vehicle accidents. Type 3 urethral injuries involve injury proximal and distal to the urogenital diaphragm and are most commonly iatrogenic or caused by blunt trauma (15). Coexistent bladder rupture may be seen in up to 17% of patients with urethral injuries (14).

Figure 12. Intraperitoneal bladder injury in a 70-year-old man who had undergone subtotal cystectomy with orthotopic neobladder formation from the cecum. Increased output from the surgical drains was seen 1 week after surgery. **(a)** CT cystogram shows contrast material within the neobladder. Note the intraperitoneal contrast material leak posteriorly (arrows). **(b)** CT scan demonstrates a second component of intraperitoneal leakage superiorly into the left lower abdomen adjacent to bowel loops. The posterior and anterior components of the urinoma were both drained under CT guidance with 10-F percutaneous drainage catheters. **(c)** CT scan demonstrates that the transgluteal urinoma drainage catheter has been advanced into the posterior collection shown in **a**. **(d)** CT scan shows that the percutaneous urinoma drainage catheter has been advanced into the anterior collection shown in **b**. Outputs from the collections diminished over a period of 1 week, and the drainage catheters were removed.

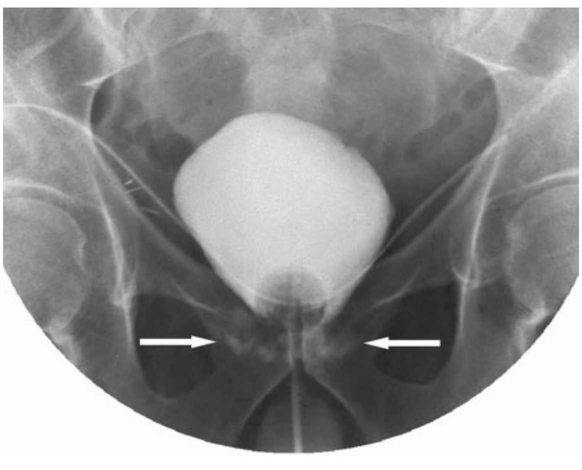
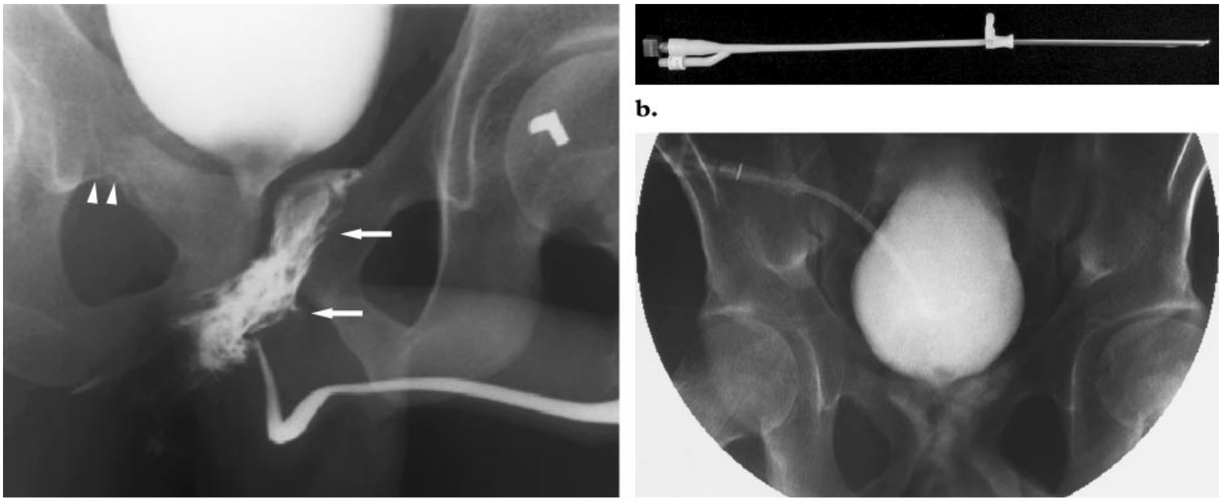


Figure 13. Type 2 urethral injury in a 62-year-old man who had undergone laparoscopic radical prostatectomy. Voiding cystourethrography with injection of contrast material through a bladder catheter was performed in anticipation of early postoperative removal of the catheter. Voiding cystourethrogram obtained during contrast material injection shows a small, contained posterior urethral leak (arrows). The bladder catheter was left in place in keeping with the usual postoperative protocol.



a. b. c.

Figure 14. Type 3 urethral injury in an 18-year-old man who had sustained a crush injury to the pelvis. **(a)** Retrograde urethrogram shows contrast material extravasation above and below the urogenital diaphragm (arrows). Note the fracture of the right superior pubic ramus (arrowheads) and contrast material within the urinary bladder from prior contrast-enhanced CT. **(b)** Photograph demonstrates a regular Foley catheter (14-F suprapubic tube; Bard, Covington, Ga) loaded on a trocar-type introducing device for US-guided percutaneous placement. **(c)** Cystogram shows the suprapubic tube after US-guided placement.

Diagnosis and Imaging Features

A urethral injury should be suspected if there is blood at the urethral meatus, difficulty with urination, a palpable urinary bladder, inability to pass a transurethral bladder catheter, or a pelvic fracture. Retrograde urethrography should be performed to evaluate the caliber of the urethra. A 5–8-F urethral catheter is advanced through the meatus, and a retention balloon is insufflated with 1–2 mL of air once the catheter reaches the urethra approximately 2 cm distal to the meatus. With the urethra in an oblique position, contrast material is injected retrograde until the entire urethra is opacified.

Type 1 urethral injuries demonstrate urethral narrowing and elongation without contrast material leakage. In type 2 urethral injuries, extraperitoneal contrast material is seen above the urogenital diaphragm. In type 3 urethral injuries, contrast material is seen in the extraperitoneal space and within the perineum due to urethral disruption proximal and distal to the urogenital diaphragm (Fig 14).

Treatment

Type 1 urethral injuries are generally managed conservatively with transurethral bladder catheter placement. Types 2 and 3 urethral injuries are generally managed with suprapubic cystostomy to divert urine flow, possibly in combination with abdominal, perineal, or scrotal catheter drainage of a urine leak (Fig 15). Surgical reconstruction of the urethra is often indicated following type 3 urethral rupture to prevent long-term urinary complications such as urethral stricture formation, impotence, urethral fistulization, and incontinence.

Conclusions

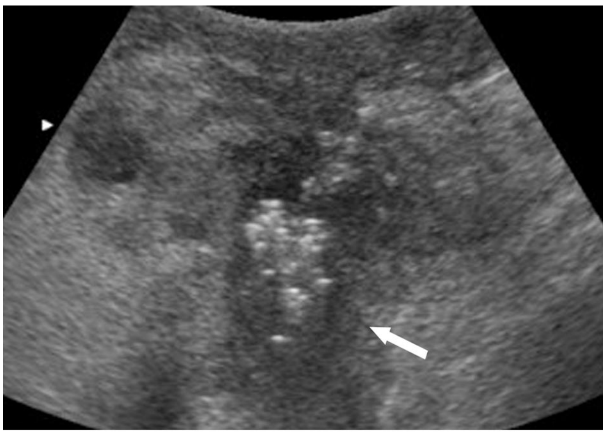
Radiologists play a key role in diagnosing urine leaks and determining their cause and extent. In some instances, the role of the radiologist ends with the diagnosis of urine leaks, after which patients are treated either conservatively or surgically. In many cases, imaging-guided interventions play a crucial role in the management of urine leaks. Percutaneous diversion of urine away from the site of the leak is often required to facilitate healing within the genitourinary system.

References

1. Lukacz ES, Nager CW. Ureteral injury presenting with hyponatremia. Obstet Gynecol 2001; 98: 974–976.
2. Sorgman JA, Langevin E, Banks PA. Urinoma masquerading as pancreatic pseudocyst. Int J Pancreatol 1992; 11:195–198.

a.

b.



c.

Figure 15. Type 3 urethral injury in a 56-year-old man with a history of urethritis. **(a)** Retrograde urethrogram shows a large periurethral collection of contrast material (arrow). **(b)** CT scan obtained following an unsuccessful attempt at transurethral bladder catheter placement shows the catheter and foci of air and contrast material within the periurethral space (arrow). Because a transurethral catheter could not be advanced into the urinary bladder, a suprapubic tube (not shown) was placed. **(c)** US image obtained 7 days after suprapubic tube placement demonstrates an abscess within the perineum due to urine leakage (arrow). An 8-F drainage catheter (not shown) was placed under US guidance. The abscess eventually resolved, permitting subsequent surgical reconstruction of the urethra.

3. Zunarelli E, Pollastri CA, Calo M, Migaldi M, Galizia G, Criscuolo M. Metastatic breast carcinoma presenting as urinoma. Pathologica 1995; 87:712–714.
4. Gayer G, Zissin R, Apter S, et al. Urinomas caused by ureteral injuries: CT appearance. Abdom Imaging 2002; 27:88–92.
5. Gore RM, Balfe DM, Aizenstein RI, Silverman PM. The great escape: interfascial decompression planes of the retroperitoneum. AJR Am J Roentgenol 2000; 175:363–370.
6. Lang EK, Glorioso L. Management of urinomas by percutaneous drainage procedures. Radiol Clin North Am 1986; 24:551–559.
7. McAlinden P, Vlahos I, Matson M, Chan O. Imaging of renal trauma. Imaging 2001; 13:44–58.
8. Titton RL, Gervais DA, Boland GW, Mueller PR. Renal trauma: radiologic evaluation and percutaneous treatment of nonvascular injuries. AJR Am J Roentgenol 2002; 178:1507–1511.
9. Wilkinson AG, Haddock G, Carachi R. Separation of renal fragments by a urinoma after renal trauma: percutaneous drainage accelerates healing. Pediatr Radiol 1999; 29:503–505.
10. Ghali AM, El Malik EM, Ibrahim AI, Ismail G, Rashid M. Ureteric injuries: diagnosis, management and outcome. J Trauma 1999; 46:150–158.
11. Gray RJ, Intriere L, Dolmatch BL, Edson M, Fischer J. Combined retrograde-antegrade ureteral stent passage: salvage procedure for a ureteral leak. J Vasc Intervent Radiol 1992; 3:557–558.
12. Gaylord GM, Johnstrude IS. Transrenal ureteral occlusion with Gianturco coils and gelatin sponge. Radiology 1989; 172:1047–1048.
13. Bing KT, Hicks ME, Picus D, Darcy MD. Percutaneous ureteral occlusion with use of Gianturco coils and gelatin sponge. Part II: clinical experience. J Vasc Intervent Radiol 1992; 3:319–321.
14. McAninch JW, Santucci RA. Genitourinary trauma. In: Walsh PC, ed. Campbell's urology. Philadelphia, Pa: Saunders, 2002; 3721–3727.
15. Dobrowolski ZF, Weglarz W, Jakubik P, Lipczynski W, Dobrowolska B. Treatment of posterior and anterior urethral trauma. BJU Int 2002; 89: 752–754.

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