CT Findings in Urinary Diversion after Radical Cystectomy: Postsurgical Anatomy and Complications[1]

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LEARNING OBJECTIVES

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

- Describe the main surgical procedures used to create a urinary diversion after radical cystectomy.
- Discuss optimal multidetector CT technique for postsurgical evaluation.
- Identify normal anatomy, common and uncommon complications of urinary diversion, and potential diagnostic pitfalls.

Numerous surgical procedures have been developed for urinary diversion in patients who have undergone a radical cystectomy for bladder cancer or, less frequently, a benign condition. Because urinary diversion procedures are complex, early and late postsurgical complications frequently occur. Possible complications include alterations in bowel motility, anastomotic leaks, fluid collections (abscess, urinoma, lymphocele, and hematoma), fistulas, peristomal herniation, ureteral strictures, calculi, and tumor recurrence. Computed tomography (CT) is an accurate method for evaluating such events. Multiplanar reformatting and three-dimensional volume rendering of multidetector CT image data are particularly useful for achieving an accurate and prompt diagnosis of complications and obtaining information that is essential for adequate surgical management. In addition, knowledge of urinary diversion procedures, normal postsurgical appearances, and optimal CT technique for postsurgical evaluations is essential for detecting complications and avoiding misdiagnosis.

TEACHING POINTS

See last page

Abbreviation: 3D = three-dimensional

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Introduction

The most frequent indication for radical cystectomy is a muscle-invasive (stage T2 or higher) bladder tumor or high-risk high-grade noninvasive muscle disease with no evidence of distant metastasis. Less frequently, radical cystectomy may be performed to treat benign conditions such as bladder neuropathy, damage from irradiation, or interstitial cystitis. Numerous surgical procedures have been developed for urinary diversion after radical cystectomy. The type of surgical procedure to be used is decided after the patient is informed about the possible advantages and disadvantages of each surgical technique. Relevant criteria for selecting the most appropriate technique include the patient's age, overall physical condition, and intestinal, hepatic, and renal function; the tumor stage; and whether the patient previously underwent abdominal radiation therapy.

More than 50 surgical procedures for urinary diversion have been described. Because these procedures are complex, early and late postsurgical complications are frequent. Computed tomography (CT) is an accurate method for detecting these complications. The diversity of the surgical procedures and of the resultant postoperative anatomic changes makes image interpretation difficult. Familiarity with the normal postoperative anatomy and with optimal CT technique is essential to achieve correct diagnosis.

In this article, we review various surgical techniques used for urinary diversion after radical cystectomy, discuss optimal CT technique for postsurgical evaluation, and describe the imaging appearances of normal postoperative anatomic changes as well as early and late complications.

Surgical Techniques

The principal methods of urinary diversion entail fashioning a segment of intestine into a conduit or reservoir to which the ureters are anastomosed. Methods of urinary diversion are commonly differentiated according to whether the functional result is urinary incontinence or continence: Either incontinent cutaneous diversion or continent diversion may be performed, with the latter method involving either orthotopic bladder replacement with attachment to the intact native urethra or creation of a reservoir with cutaneous diversion. The procedures most frequently performed are described in Table 1 (1–6).

Table 1
Description of Surgical Procedures Most Commonly Used for Urinary Diversion

Incontinent cutaneous diversion

- Cutaneous ureterostomy: Both ureters are anastomosed directly to the anterior abdominal wall.
- Ileal conduit creation: An ileal segment of 15–20 cm is isolated, and both ureters are anastomosed to its proximal end. The distal end provides urinary drainage to a cutaneous stoma (Fig 1).

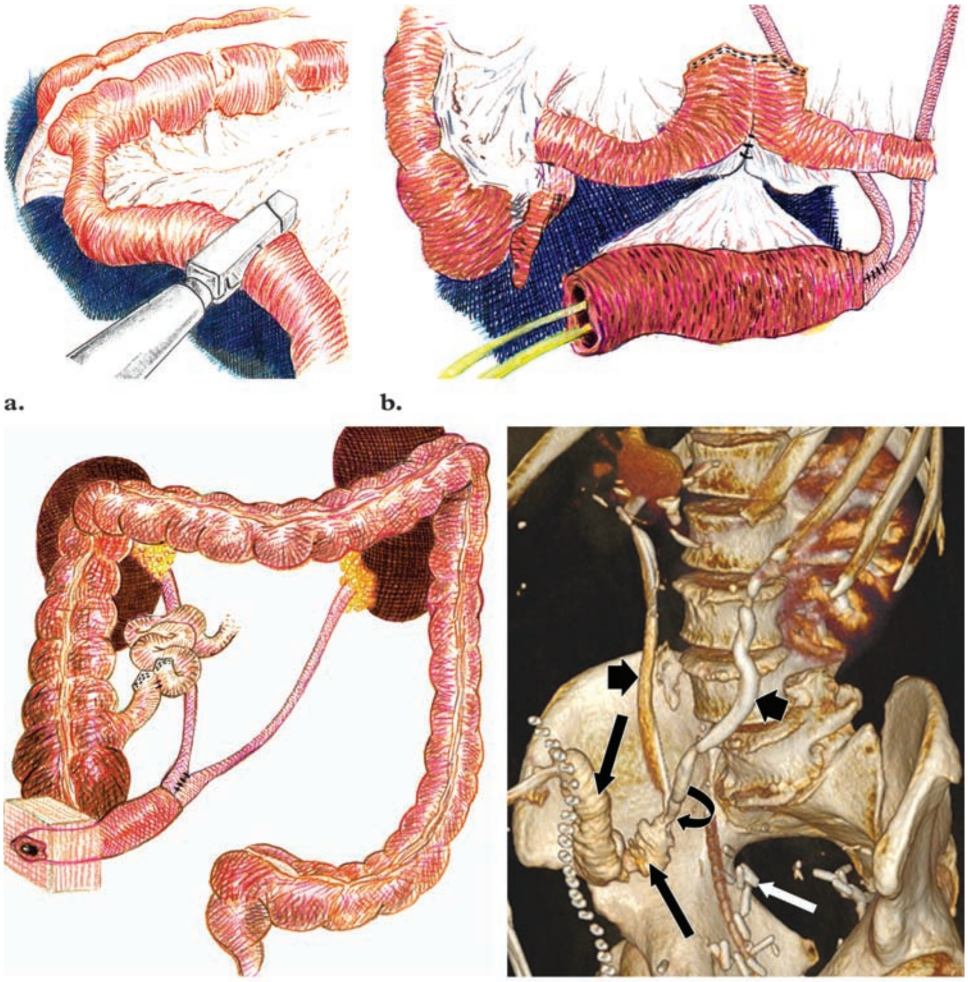
Continent diversion

- Cutaneous diversion with Kock technique (1): A 70–80-cm length of ileum is used. With the central 50-cm segment, a reservoir is created. The remaining proximal and distal segments are used to create two valves in an antireflux system: One valve provides cutaneous egress, and the other is anastomosed to the ureters. This procedure is technically more difficult than others, and complications often occur in relation to the antireflux mechanism.
- Cutaneous diversion with colonic reservoir creation: A segment of colon is detubularized and folded to form the reservoir (Fig 2). Continence is provided by a catheterizable tunnel and stoma created from the appendix with a cuff of cecum. The mesentery is preserved.
- Orthotopic bladder replacement (neobladder construction) with Studer (2) (Fig 3), Hautmann (3), and Padovan (4) techniques: In all three procedures, a 40–60-cm ileal segment is used to construct a neobladder. The techniques differ in the configuration of the neobladder and ureteral anastomoses. All three are widely performed with very good functional results.
- Orthotopic bladder replacement with Mainz technique (5): A 15-cm length of cecum and ascendant colon and 30-cm segment of the distal ileum are detubularized to construct the reservoir. Disadvantages of using the ileocecal valve and distal ileum include diarrhea and decreased intestinal absorption of bile acid and vitamin B_{12}.
- Orthotopic bladder replacement with Mayo technique (6): The entire right colon is opened lengthwise to the cecum, folded over on itself, and anastomosed to the urethra. This procedure is not performed in Europe.

Incontinent Cutaneous Diversion

Cutaneous Ureterostomy.—Cutaneous ureterostomy is performed only in patients who undergo total cystectomy and only when the use of

Figure 1. Incontinent cutaneous diversion (Bricker procedure). **(a–c)** Schematics show the surgical technique **(a, b)** and the resultant anatomic configuration **(c)**. First, an ileal segment approximately 15–20 cm long, proximal to the ileocecal valve, is isolated for construction of the ileal conduit **(a)**. Next, the ileal segment with its mesentery is positioned below the ileo-ileal anastomosis **(b)**. Both ureters are anastomosed together to the proximal end of the ileal conduit (refluxing Wallace-type anastomosis), and two stents are placed through the uretero-intestinal anastomosis. **(d)** Volume-rendered CT image shows normal postoperative changes in a patient after radical cystectomy and ileal conduit construction. The ureters (short black arrows), uretero-ileal anastomosis (curved arrow), ileal conduit (long black arrows), and surgical clips from lymphadenectomy (white arrow) are clearly depicted.

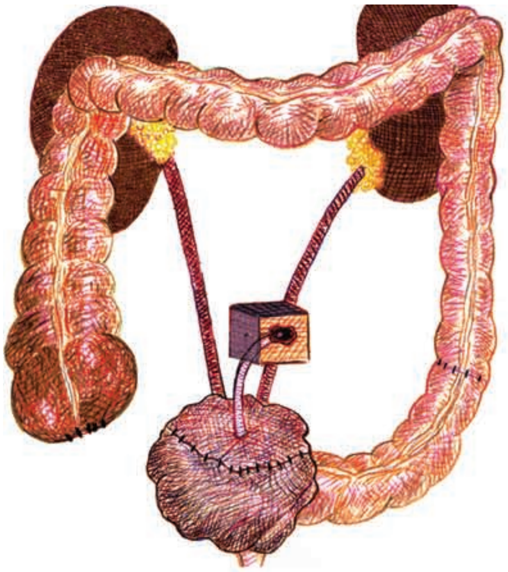


a. b. c. d.

intestinal segments is not possible (commonly, in patients with bowel disease or a serious coexisting medical condition). The procedure is performed by anastomosing the ureters directly to the anterior abdominal wall. Stomal stenosis, subsequent urinary tract infection, and compromise of renal function are the most frequent complications and limit the use of this technique (7).

Multidetector CT allows the accurate and complete depiction of both ureters and their surgical anastomoses to the anterior abdominal wall.

Ileal Conduit Creation (Bricker procedure).—In this commonly performed procedure, a 15- to 20-cm-long ileal segment is isolated, and the ureters are implanted at its proximal end. A 10- to 15-cm-long ileal segment proximal to the ileocecal junction is preserved to maintain adequate absorption of bile salts, vitamin B_{12}, and fat-soluble vitamins. The ileal stoma is usually located in the right flank (Fig 1). This procedure



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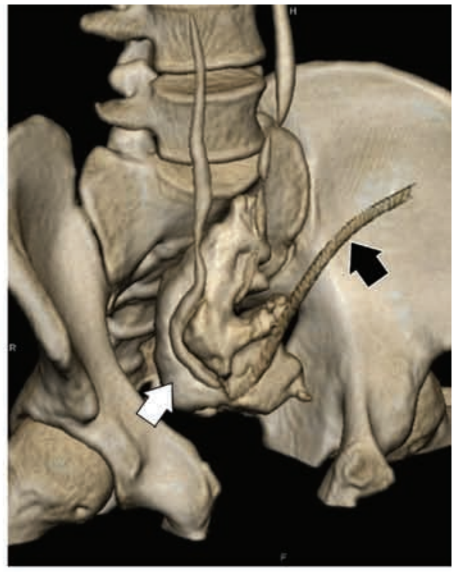

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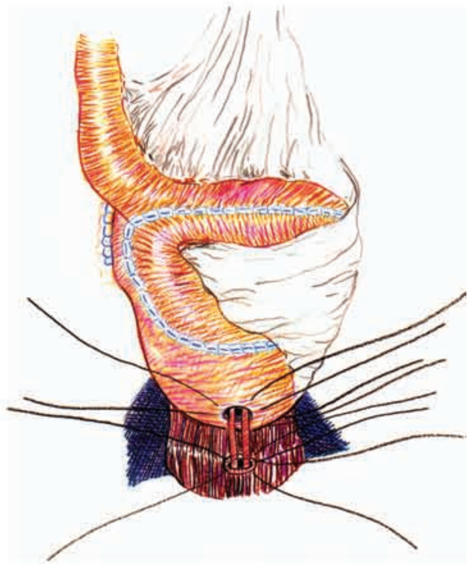

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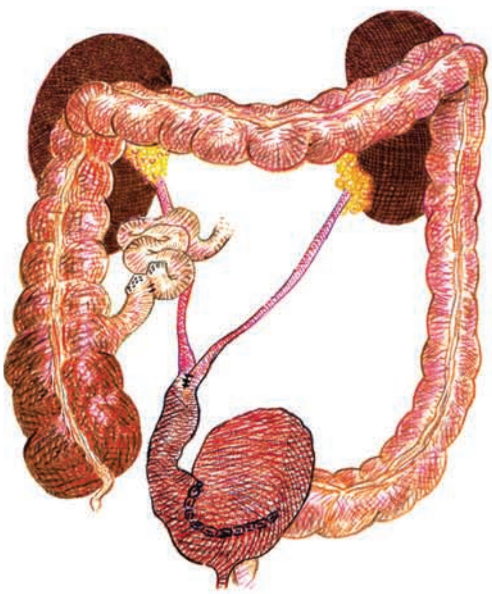

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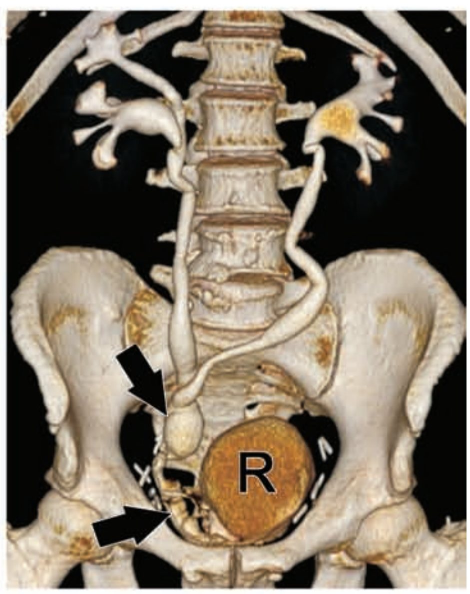


3d.

Figures 2, 3. **(2)** Continent cutaneous diversion. **(a)** Schematic shows the construction of a pouch from a segment of the left colon by using the Mitrofanoff technique. Continence is provided by a narrow catheter port constructed from the excised and repositioned appendix and a generous cuff of cecal tissue, which serves as the stoma. **(b)** Volume-rendered CT image shows the expected postoperative anatomic configuration in a patient who underwent this type of diversion after cystectomy for treatment of bladder exstrophy (note the associated wide pubic symphysis). The white arrow indicates the colonic reservoir, and the black arrow indicates the catheter port–appendix. **(3)** Orthotopic bladder replacement (neobladder construction). **(a–c)** Schematics show the construction of a neobladder from the ileum by using the Studer technique. First, an ileal segment approximately 55–65 cm long is selected and isolated at a point approximately 20 cm proximal to the ileocecal valve. The distal part (a length of approximately 40 cm) is detubularized by cutting the antimesenteric border and is then folded into a *U* shape **(a)**. After the medial edges are sewn together, the *U*-shaped ileal pouch is folded in the longitudinal direction to give it a spherical shape and is anastomosed to the urethra by making a small opening in the distal part of the pouch **(b)**. An isoperistaltic afferent limb is created by using the proximal segment (10–15 cm) of the ileum, to which the ureters are then anastomosed **(c)**. **(d)** Volume-rendered CT image shows normal postoperative changes in a patient after the creation of a Studer-type reservoir *(R)*. Arrows indicate the afferent limb.

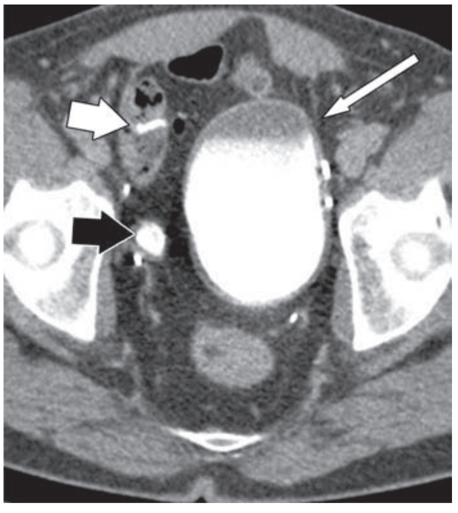


Figure 4. Axial CT image shows normal postoperative changes in a patient after radical cystectomy and orthotopic bladder replacement with a Studer pouch. The use of mechanical suturing allows good postoperative depiction of the ileo-ileal anastomosis (short white arrow) along with the reservoir (long white arrow) and afferent limb (black arrow).

is technically easier to perform than continent reconstruction (Figs 2, 3). However, continence and voluntary voiding are not possible afterward, and the body image is not preserved (7,8).

Multidetector CT allows visualization of the ureters up to the point of anastomosis to the ileal conduit, which is usually placed to the right. It is important to evaluate the enteroenteric anastomosis, which is also placed to the right side and is most often visible because mechanical suturing is usually performed (Fig 4).

Continent Diversion

Continent diversion (continent cutaneous diversion or, preferentially, orthotopic bladder replacement) is the method most often used in young oncologic patients with a good prognosis because it allows preservation of a positive body image and a greater quality of life.

The goal of all continent urinary diversion techniques is to create a reservoir capable of storing a proper volume of urine by using the shortest possible segment of bowel while allowing low filling pressure, low residue after micturition or catheterization, and an acceptable level of continence. Continent urinary diversion methods rely on principles of physics and geometry in the construction of a spherical reservoir from the normally tubular bowel segment. The cutting of the antimesenteric edge of the bowel impairs intrinsic intestinal contractility and prevents peristaltic motion that would lead to increased filling pressure and, therefore, leakage of urine. The spherical reshaping of the bowel provides a higher holding capacity without requiring the use of a longer segment.

Several factors must be considered when selecting the bowel segment to be used for reservoir creation. Contact of urine with the mucosa in the ileum and colon causes metabolic acidosis because of the resorption of urea and ammonia. The kidneys may compensate if sufficient renal function (creatinine clearance of more than 60 mL/min) is preserved. With an ileal reservoir, metabolic acidosis has less impact than with a colonic reservoir.

Ileal reservoirs can accumulate higher volumes of urine with lower pressures than colonic ones. The use of the sigmoid colon for reservoir creation has the advantage of easy access, but filling pressure in a sigmoid reservoir is higher than that in reservoirs created from other intestinal segments. When a colonic segment is used to create the reservoir, the postsurgical complications are graver and more difficult to resolve than those encountered with the use of other intestinal segments (7,8).

In summary, the advantages and disadvantages of each surgical technique, the specific experience of the surgeon, and the physical condition of the patient determine the choice of intestinal segment.

Continent Cutaneous Diversion.—At present, continent cutaneous diversion is not frequently performed. The aim of this procedure is to create a low-pressure reservoir that protects the upper urinary tract and provides socially acceptable elimination of urine. Several methods have been developed that differ in the segment of bowel used and the means of elimination. A segment of the large or small bowel may be used to construct the reservoir. The ureters are anastomosed to this segment. A cutaneous stoma is created, and urine is eliminated during self-catheterization performed by the patient (Fig 2). Although the body image is preserved, voluntary voiding is not possible (1).

At our institution, the Mitrofanoff technique is used whenever possible (7). With this technique, the cecal appendix, which is anastomosed to the reservoir at one end and to the navel at the other, is used as a mechanism of catheterization (Fig 2). At multidetector CT, the reservoir usually appears to be partially filled by hypoattenuating material, a feature that represents mucous secretions from the bowel.

Orthotopic Bladder Replacement.—A recent review of the literature about the current status of urinary diversion after cystectomy for bladder cancer showed that orthotopic bladder replacement (neobladder construction) is the most frequently used technique (47%), followed by ileal conduit creation (33%) (7). The aim of neobladder construction is to create a low-pressure, high-compliance reservoir. The neobladder is anastomosed to the native urethra, and voluntary voiding is thereby preserved.

Compared with other techniques, orthotopic bladder replacement leads to an improved quality of life without a stoma and external collecting devices and with full retention of the patient's body image. Disadvantages include longer surgical time, the need for a longer bowel segment for neobladder construction, the need for negative findings in the urethral margin at frozen section analysis performed at the time of urethral anastomosis, and the delay before optimal neobladder function is achieved (4–7).

Orthotopic bladder replacement with an ileal neobladder, as described by Studer et al (2) (Fig 3), is becoming the preferred procedure in many centers, including ours. The Studer procedure begins with cystectomy, lymphadenectomy, and preparation of the urethra. Next, an ileal segment approximately 50 cm long is selected, from which an intestinal reservoir is created by completing the following steps: First, an ileal segment 40 cm long is detubularized, and an intestinal reservoir or pouch is formed. A small opening is made in the distal part of the pouch, which is then anastomosed to the native urethra. An isoperistaltic afferent limb is created by using a proximal ileal segment with a length of approximately 10 cm. Bowel continuity is restored by performing a side-to-side or end-to-end ileal anastomosis. Finally, the ureters are anastomosed to the afferent limb.

Multidetector CT allows the identification of a bowel loop in anatomic continuity with the reservoir, a finding that corresponds to the isoperistaltic afferent limb. This afferent limb normally is located to the right of the reservoir. The radiologic imaging appearance of the ureters and enteroenteric anastomosis after ileal neobladder construction is the same as that after ileal conduit creation.

Postoperative Imaging Features

Normally, when urinary diversion is performed, ureteral stents are positioned to extend from both renal pelves through the ureteral–urinary reservoir anastomoses to the distal end of the reservoir (Fig 1). The use of ureteral stents is beneficial for avoiding urinary leakage. Other potential advantages are less-frequent early postoperative dilatation of the excretory system, earlier resumption of bowel activity, and reduced incidence of metabolic acidosis (9). The surgeons at our institution prefer to leave ureteral stents in place for 7–10 days after urinary diversion. Likewise, hypogastric drainage catheters are left in place for 3–5 postoperative days to avoid postsurgical fluid collections. In addition, a urethral catheter is positioned in the reservoir for 2 weeks and then removed if warranted by findings at cystography.

Multidetector CT Technique

Intravenous urography and fluoroscopic retrograde urography with contrast material injections (ie, fluoroscopic loopography or pouchography) have been the main imaging methods used to evaluate patients for potential complications after urinary diversion (10–12). However, these imaging techniques have significant limitations. Multidetector CT urography is a relatively new imaging technique that allows more rapid evaluation of the urinary system (9). The image data can be transferred to a workstation, allowing multiplanar reformatting and three-dimensional (3D) reconstruction. Advantages of multidetector CT urography over intravenous urography and fluoroscopic loopography include the ability to detect and characterize extraurinary findings (eg, common fluid collections, intestinal complications, tumor recurrence) and to better identify uroepithelial lesions. In addition, multidetector CT is not limited by the body habitus or the presence of abundant stool or intestinal gas, which may hinder evaluation with intravenous urography.

Currently, in our radiology department, studies are performed by using a 16-channel multidetector CT scanner (Somatom Emotion 16; Siemens Medical Solutions, Erlangen, Germany). After fasting for at least 4 hours, the patient ingests 500–750 mL of water over 20–30 minutes to improve hydration for the excretory phase of scanning. Oral contrast material is administered only if there is a suspicion that an intestinal leak is present, because positive oral contrast interferes with volume rendering and maximum intensity projection reconstruction procedures. The patient is placed on the scanner table in the supine position, and a 20-gauge intravenous catheter is inserted into an appropriate upper extremity vein. Scanning is performed in three phases, from the costovertebral angles through the floor of the pelvis, with 1.2-mm collimation and an overlap of 50%. In the first scanning phase, unenhanced images are acquired. These initial images are reviewed to determine whether urinary calculi or nonurinary calcifications are present and to characterize renal lesions. The second, nephrographic phase of scanning is performed 80 seconds after the initial injection of 125 mL of intravenous contrast material with a power injector at a rate of 3 mL/sec. Images from this phase are evaluated to characterize fluid collections and renal and urothelial lesions. Extrinsic mass lesions that affect the kidneys, ureters, or urinary diversion are noted, and extraurinary abnormalities are recorded. In the last scanning phase, the excretory phase, image data are acquired with a delay of at least 10 minutes after contrast material injection. A longer delay may be necessary in patients with a urinary tract obstruction. If ureteral stents are in place, it is not usually necessary to close them during scanning; however, it is important to close nephrostomy catheters to perform an accurate evaluation for urinary leaks. The excretory phase images are reviewed for evidence of urinary leaks and other postoperative fluid collections. A review of images from this scanning phase also is necessary for the accurate evaluation of urothelial lesions.

Teaching Point

After scanning, the image data are transferred to a workstation (Leonardo; Siemens). For each CT examination, readers use both two-dimensional and 3D postprocessing techniques, including multiplanar reformatting, maximum intensity projection, and volume rendering, according to their preferences. Each reader subjectively adjusts the 3D display parameters, including width, level, opacity, and brightness.

Complications of Urinary Diversion

Because urinary diversion procedures are complex, early and late postsurgical complications are common, with the frequency of their occurrence varying according to the type of procedure

Table 2
Complications of Urinary Diversion

Early complications (<1 month after surgery)
Alterations of bowel transit
Adynamic ileus
Mechanical obstruction
Urinary leakage from anastomosis of ureter and conduit or reservoir
Fluid collections
Urinoma
Abscess
Lymphocele
Hematoma
Wound infection
Sepsis
Fistula
Urinary obstruction
Late complications (≥1 month after surgery)
Urinary infection
Ureteral stenosis
Parastomal herniation
Lithiasis
Tumor recurrence

performed. The potential complications of urinary diversion are summarized in Table 2. Some complications (eg, wound infection) are easily diagnosed at physical examination, and imaging in such cases is unnecessary. However, CT is necessary for accurate diagnosis of most complications.

Early Complications

Early complications (complications that occur less than 30 days after surgery) include alterations of bowel motility, small-bowel obstruction, urinary leaks, collections, infections, and fistulas.

Alterations in Bowel Function.—Normal bowel function is commonly seen within 5 days after surgery. If normal function is not restored, the most likely cause is either adynamic ileus or mechanical obstruction. Multidetector CT with multiplanar reformatting has high accuracy in depicting the cause of bowel obstruction (13). The use of oral contrast material is usually unnecessary in patients with this complication because gas and fluid in the bowel provide sufficient contrast. However, intravenous contrast material is useful because the enhancement patterns of the intestinal wall may allow the diagnosis of bowel ischemia associated with obstruction (14).

Adynamic ileus is the most common bowel complication after urinary diversion surgery,

Figure 5. Intestinal subobstruction (partial obstruction) after ileal conduit construction in a patient with bladder exstrophy. Coronal CT image shows dilated fluid-filled small-bowel loops (white arrow) with a moderately collapsed distal ileum (long black arrow) and colon but does not depict the cause of obstruction. The presence of contrast material in the colon (short black arrow) is indicative of incomplete obstruction. Adhesions were found at surgery.

and it affects 18%–23% of patients (15,16). It is characterized by uniformly dilated loops of small and large bowel with gas-fluid levels and by the absence of a visible cause of obstruction (Fig 5).

In the presence of a mechanical obstruction, by contrast, bowel loops with gas-fluid levels are visible in locations proximal to the site of obstruction, where an abrupt change in intestinal caliber is seen (17). Adhesive small-bowel obstruction near the enteroenteric anastomosis is the type of mechanical obstruction most frequently seen after surgery for urinary diversion (Fig 5). A CT-based diagnosis of adhesive small-bowel obstruction may be made in the presence of an abrupt change in bowel caliber and the absence of another cause of obstruction. Mucosal edema is probably a transitory factor in mechanical obstruction (18). If acute and complete or high-grade obstruction is suspected (it occurs in only approximately 3% of cases),

Teaching Point

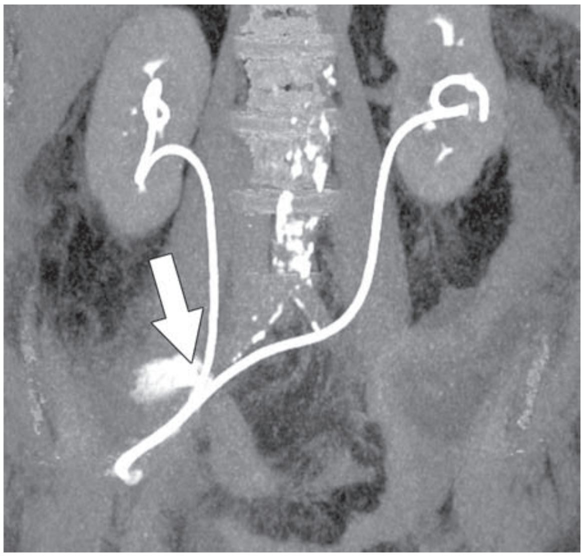
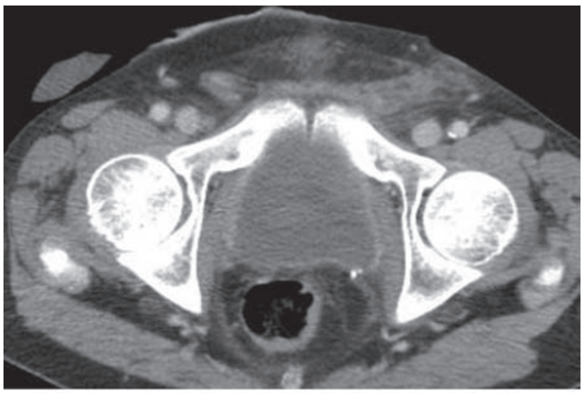


Figure 6. Urinary leak. Pyelographic phase maximum intensity projection CT image obtained in a 70-year-old man 5 days after urinary diversion with the Bricker procedure shows urinary extravasation (arrow) near the uretero-ileal anastomoses despite correct placement of both ureteral stents from the renal pelves through the anastomoses.



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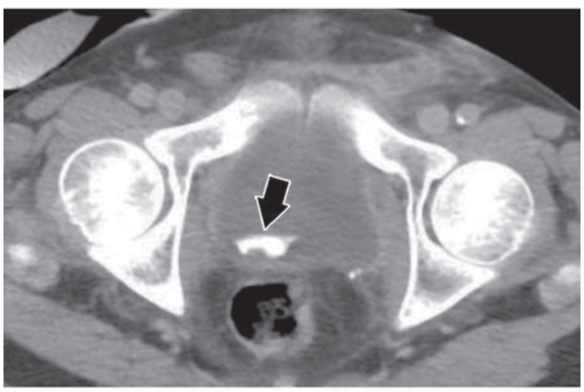


b.

Figure 7. Urinoma in a 61-year-old man 18 days after cystectomy and urinary diversion with the Bricker procedure. **(a)** Nephrographic phase pelvic CT image shows a fluid collection with the morphologic structure of the absent bladder. **(b)** Delayed phase CT image obtained at the same level as **a**, 10 minutes later, shows an influx of contrast material into the collection (arrow), a finding indicative of communication with the urinary tract.

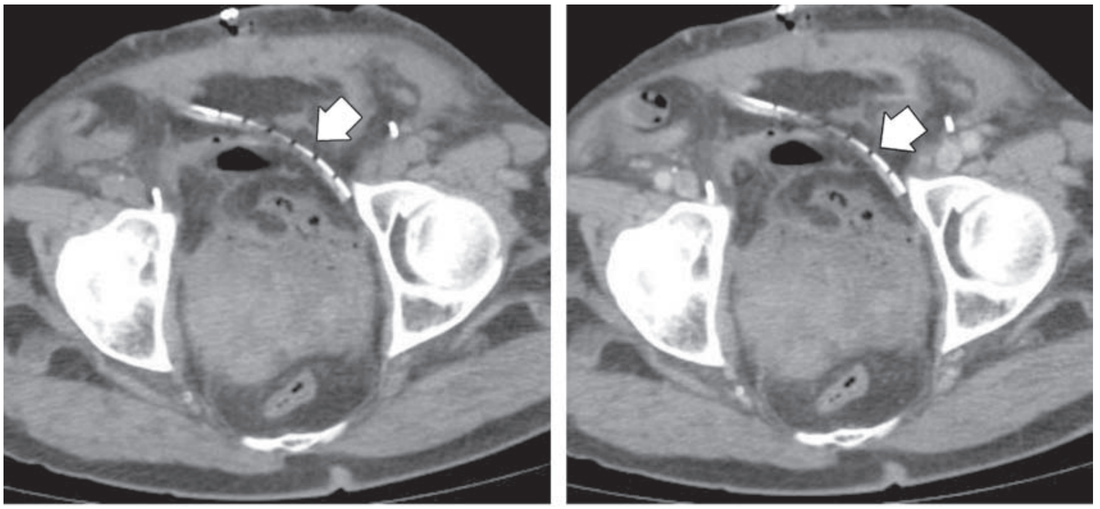
immediate surgery is required. Partial obstruction and adynamic ileus usually can be managed conservatively.

Urinary Leakage.—Urinary leakage occurs in approximately 4% of patients after urinary diversion (19). The most frequent site of leakage is the ureteral–reservoir anastomosis (Fig 6). Urinary leakage must be suspected when there is increased output from a drainage catheter or urinary drainage from the wound. An evaluation of excretory phase images is important for the diagnosis of this complication (Fig 6). Commonly, urinary leakage is treated by placing a stent over the leakage site in the appropriate urinary segment to encourage healing of the abnormal communication. Surgical repair is rarely necessary.

Urinary leakage from a reservoir–urethral anastomosis often is difficult to detect at multidetector CT.

Fluid Collections.—The differential diagnosis of postsurgical fluid collections includes urinoma, abscess, lymphocele, and hematoma. Such collections frequently are found in the location of the excised bladder and may mimic its morphologic structure. Awareness of this possibility is important to avoid misdiagnosis (Fig 7).

A urinoma occurs when leaked urine is not collected by the postoperative hypogastric drainage catheter. Patients with a urinoma commonly present with abdominal pain, signs of peritoneal irritation, and fever. Accurately timed excretory



a. b.

Figure 8. Hematoma in a 66-year-old man 7 days after cystectomy and urinary diversion with creation of an ileal conduit. Unenhanced **(a)** and nephrographic phase **(b)** pelvic CT images show a nonenhancing heterogeneous fluid collection. Note the presence of a pelvic drainage catheter (arrow) in this early postoperative study.

phase imaging (10–20 minutes after the contrast material injection) is crucial for distinguishing a urinoma from other types of postoperative fluid collections. On excretory phase images, a urinoma appears markedly enhanced because of contrast material accumulation (Fig 7) (20). If the diagnosis of urinoma remains uncertain, the fluid may be percutaneously aspirated and analyzed. The fluid in a urinoma contains a significantly decreased level of glucose and an increased level of creatinine. Percutaneous drainage of a urinoma is usually required. If urinary leakage persists after drainage, a stent must be placed in the appropriate urinary segment.

A noninfected hematoma is commonly seen as a heterogeneous, nonenhancing collection in or near the surgical area (Fig 8).

Lymphoceles may be seen in patients who have undergone lymphadenectomy in conjunction with radical cystectomy for the treatment of a malignant bladder condition. The CT finding of a homogeneous fluid collection with a very thin wall, in a location near the surgical clips, is suggestive of the diagnosis of lymphocele (Fig 9). Lymphoceles commonly resolve spontaneously, but those that are large or symptomatic may require percutaneous drainage.

A fluid collection such as a urinoma, hematoma, or lymphocele may become infected, resulting in an abscess. It may be difficult to differentiate an infected collection from an uninfected one. Air bubbles in a fluid collection with a thickened and enhancing wall are helpful findings for making a correct diagnosis; however, air bubbles also may be secondary to the placement of an intra-abdominal drainage catheter in the surgical bed (Figs 10, 11). If an abscess is suspected, percutaneous or surgical drainage is usually necessary.

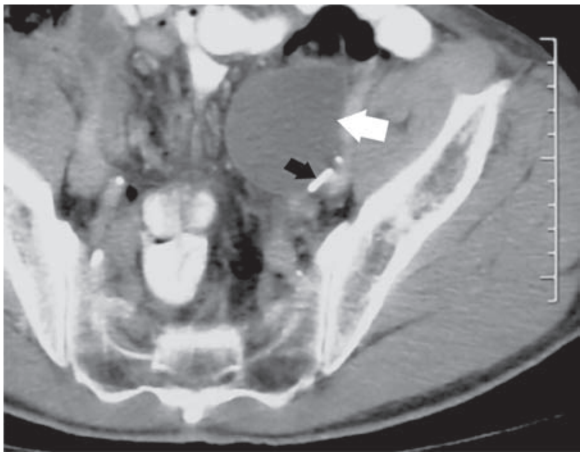
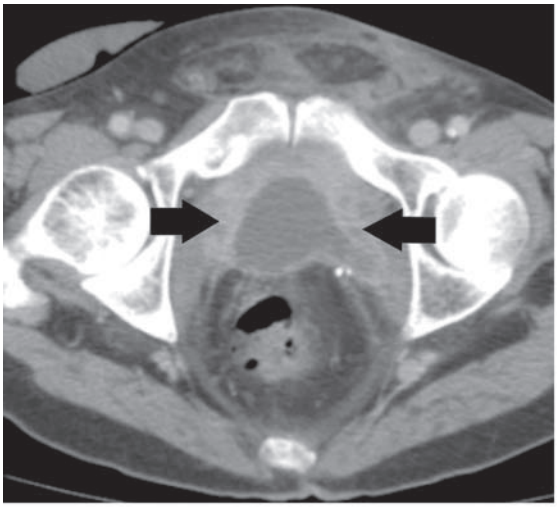
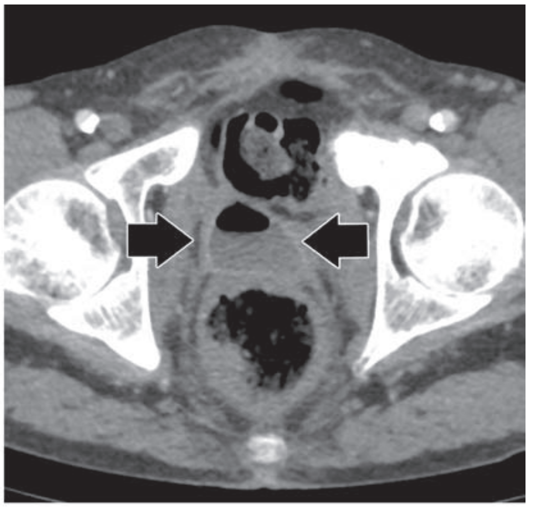


Figure 9. Typical lymphocele in a 59-year-old man 1 month after cystectomy with lymphadenectomy and ileal conduit creation for treatment of bladder carcinoma. Delayed phase pelvic CT image shows a fluid collection with a very thin wall (white arrow), located near several surgical clips (black arrow) in the left side. Note the absence of contrast material in this collection.



10.



11.

Figures 10, 11. Postoperative abscesses. **(10)** Nephrographic phase CT image, obtained 7 days after cystectomy and urinary diversion (Bricker procedure) for bladder carcinoma, shows a fluid collection surrounded by fatty tissue. The periphery of the collection is enhanced and appears thickened (inflammatory sign). Delayed phase images did not show any contrast material influx into the collection. **(11)** CT image obtained 5 days after radical cystectomy and urinary diversion (ileal conduit creation) shows an air- and fluid-filled collection (arrows) that echoes the morphologic structure of the bowel (colon). Analysis of fluid drained from the collection helped confirm that it was an abscess.

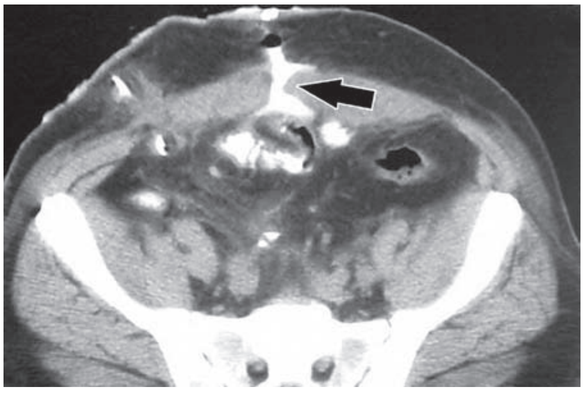


Figure 12. Enterocutaneous fistula. CT image obtained at the level of the lower abdomen after oral contrast material administration in a 77-year-old patient with an ileal conduit depicts intestinal extravasation and an enterocutaneous fistula (arrow).

Fistulas.—The fistulas typically seen after urinary diversion surgery are entero-urinary, enterogenital, or enterocutaneous (Figure 12). In a retrospective study of 553 patients who had undergone radical cystectomy and urinary diversion for bladder cancer, Msezane et al found that 12 (2.2%) of the patients had a urinary-enteric fistula (21). Previous pelvic radiation therapy is a predisposing factor. Such fistulas usually are located in the intestinal anastomosis. If the presence of a fistula is suspected, a detailed medical history may be very helpful for determining the anatomic origin of a leak. Fistulas may resolve with conservative management if there is good drainage and no sepsis; otherwise, surgical revision is required (21).

Urinary Obstruction.—Urinary obstruction is not frequently seen in the first 30 days after surgery. An error in surgical technique at the uretero-intestinal anastomosis is the usual cause of this complication in the early postoperative period. If a moderate or severe obstruction is detected, surgical revision (construction of a new uretero-intestinal anastomosis) is required. However, other possible causes of urinary obstruction, such as extrinsic compression by a fluid collection, should be excluded before surgery.

Late Complications

Late complications of urinary diversion (complications that occur 1 month or more after surgery) include urinary tract infection, ureteral stenosis, herniation, lithiasis, and tumor recurrence.

Urinary Infection.—Infection may occur as either an early or a late complication of urinary diversion. The normal urinary tract and urothelium

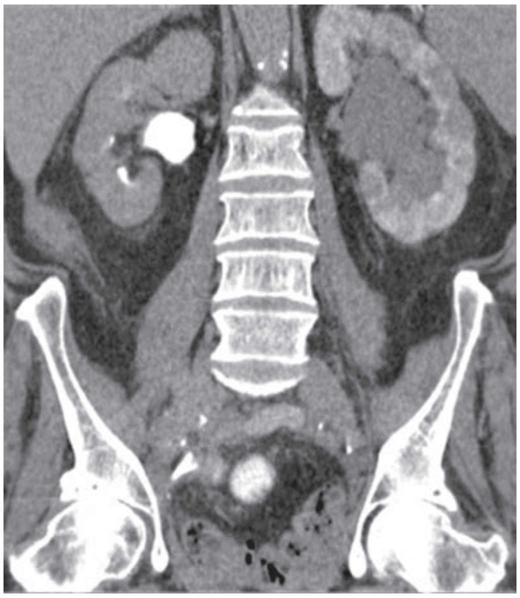


Figure 13. Urinary obstruction and acute left pyelonephritis after cystectomy and urinary diversion with ileal conduit creation. Pyelographic phase coronal CT image shows persistent parenchymal enhancement of the enlarged left kidney, a finding indicative of delayed excretion of contrast material.

have defense mechanisms against bacteria; for example, the voiding function allows them to be washed out. In patients with a urinary diversion, some of these mechanisms are impaired and there is greater susceptibility to bacterial infections. Among patients with an ileal conduit, bacteriuria was found in approximately 85%, and clinical evidence of pyelonephritis was seen in 15% (22). Pyelonephritis occurs more frequently in patients with a history of ureteral obstruction or urinary reflux. When a clinically relevant urinary tract infection is present, a postvoiding urinary residue and calculi must be ruled out. The diagnosis of pyelonephritis is commonly based on clinical and laboratory findings, but the typical features of pyelonephritis also may be observed at CT (Fig 13).

Calculi.—Calculi may be seen along the urinary reservoir or conduit (Figs 14, 15) or in the upper urinary tract (Fig 15) in approximately 10% of patients who have undergone urinary diversion (23). The timely detection of calculi is important because they may cause a complete or partial urinary tract obstruction in patients with a

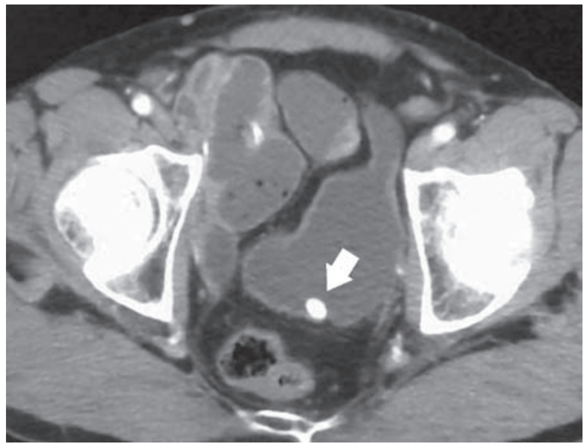
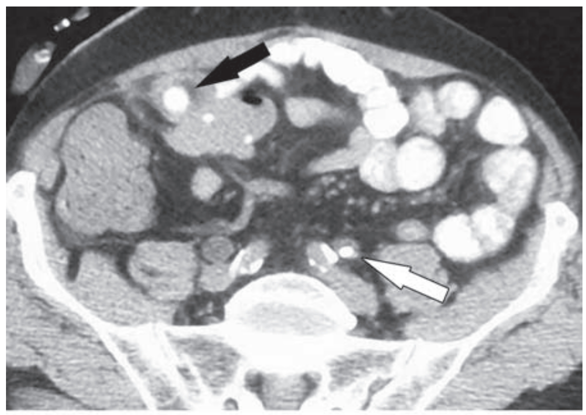
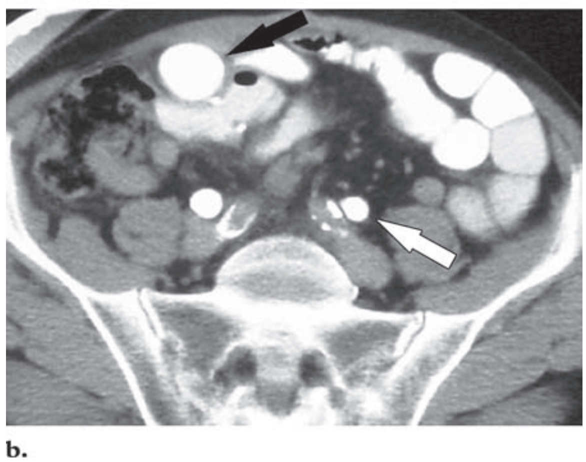


Figure 14. Unenhanced CT image obtained in a 59-year-old man 1 year after neobladder construction shows a calculus (arrow) in the reservoir.

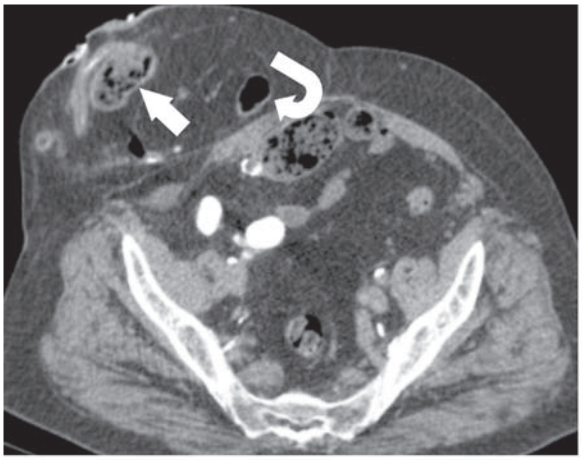


a.

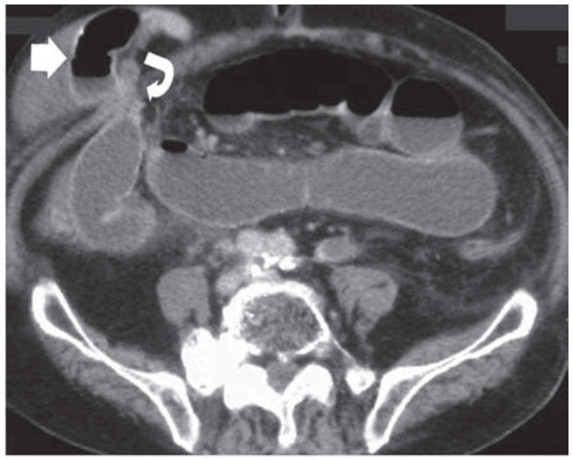


b.

Figure 15. Multiple calculi in a 78-year-old man 1 year after cystectomy and urinary diversion with ileal conduit creation. **(a)** Pelvic CT image obtained after oral administration of contrast material shows one calculus in the ileal conduit (black arrow) and another in the left ureter (white arrow). **(b)** Delayed phase image obtained at the same level as **a** shows neither calculus because the contrast material has been excreted.

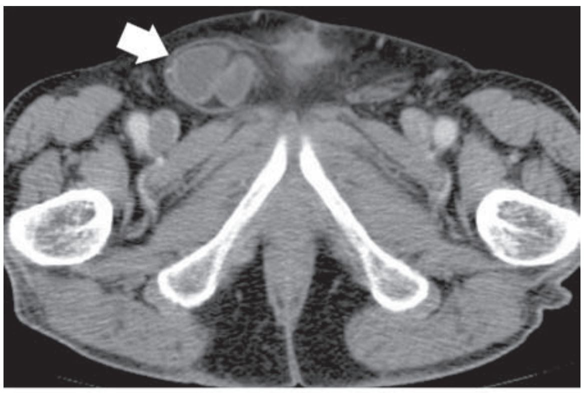


16.



17.

Figures 16, 17. **(16)** CT image shows normal small bowel (curved arrow) and colon (straight arrow) after parastomal herniation of an ileal conduit, with no other signs of complication. **(17)** CT image shows parastomal herniation and intestinal obstruction after the creation of an ileal conduit. Note the dilatation of the afferent loop (straight arrow) and collapse of the efferent loop (curved arrow).



a.

b.

Figure 18. CT images (**a** at a higher level than **b**) obtained in a 66-year-old man after orthotopic bladder replacement (Studer pouch creation) show inguinal herniation of the afferent limb (arrow), an uncommon complication. *R* = reservoir.

urinary diversion and thus affect renal function. To detect urinary tract calculi, a careful review of unenhanced CT images is necessary. Calculi may not be detectable on delayed phase CT images because of the excretion of intravenous contrast material (Fig 15). Once diagnosed, calculi are commonly managed with percutaneous or endoscopic methods.

Teaching Point

Herniation.—Parastomal intestinal hernias are frequently seen after ileal conduit creation; 10%–22% of patients who have undergone the procedure are affected. Obesity may be a contributing factor in the development of this type of hernia, particularly in the elderly (24). Although such hernias commonly are visible or palpable, CT is useful for detecting them in obese patients (Fig 16) and allows the demonstration of any associated complications (Fig 17). Although most patients are asymptomatic, about 10% of these hernias require surgical repair (25). Recurrence after surgical repair is not uncommon.

Other types of hernia associated with urinary diversion also may be seen but are less frequent (Fig 18).

Ureteral Stricture.—Ureteral stricture occurs more commonly at the ureteroenteric anastomosis. The frequency with which this type of complication occurs (1%–30%) is related to the specific technique employed for ureteroenteric anastomosis (26,27).

A large number of ureteroenteric anastomotic strictures occur within 1–2 years after surgery, regardless of the type of ureteral reimplantation procedure (8). Ischemia of the distal ureter with subsequent fibrosis (Fig 19), an improperly fashioned anastomosis, and a recurrent tumor in the ureter (Fig 20) are the principal causes of ureteral strictures, with ureteral ischemia being the most common. The left distal ureter is at a particularly high risk for strictures because of its angulation; this ureter is brought under or through the left colonic mesentery to reach the urinary conduit or reservoir (27). Ureteroenteric stricture is often clinically silent and is detected on the basis of an increase in the serum creatinine level or at follow-up imaging studies. Early diagnosis and prompt treatment are required to prevent renal parenchymal loss and infection.

Teaching Point

It is important to bear in mind that hydronephrosis is not necessarily indicative of a urinary tract obstruction. Some degree of hydronephrosis is relatively common in patients with urinary reflux at the ureteral anastomoses (Fig 21).

Obviously, it is imperative that a tumor recurrence be excluded. Malignant strictures, unlike benign ones, usually are associated with a CT finding of an enhancing soft-tissue mass. In addition to CT, endoscopic and cytologic evaluations may be necessary to achieve an accurate diagnosis.

Strictures may be treated with minimally invasive procedures such as balloon dilation or endoscopic incision; however, the rate of stricture recurrence after such procedures is high. Open surgical revision, which has a higher long-term success rate (90%), is considered the definitive treatment method (27,28).

Tumor Recurrence.—The incidence of local tumor recurrence is 3%–16%, depending on the disease stage (29,30). Patients with a more advanced disease stage such as T3b or with lymph node involvement are at a higher risk for pelvic recurrence.

Local tumor recurrence may manifest with various patterns: It may appear as a pelvic soft-tissue mass (Fig 22), an obstructing ureteral stricture (commonly in association with a soft-tissue mass) (Fig 20), pelvic lymphadenopathy, or a stricture of the urethro-intestinal anastomosis in a patient with an orthotopic neobladder (31,32). In patients who have undergone pelvic lymphadenectomy for treatment of a bladder tumor, distant lymphatic nodes such as those in the inguinal and aortocaval regions should always be evaluated.

Teaching Point

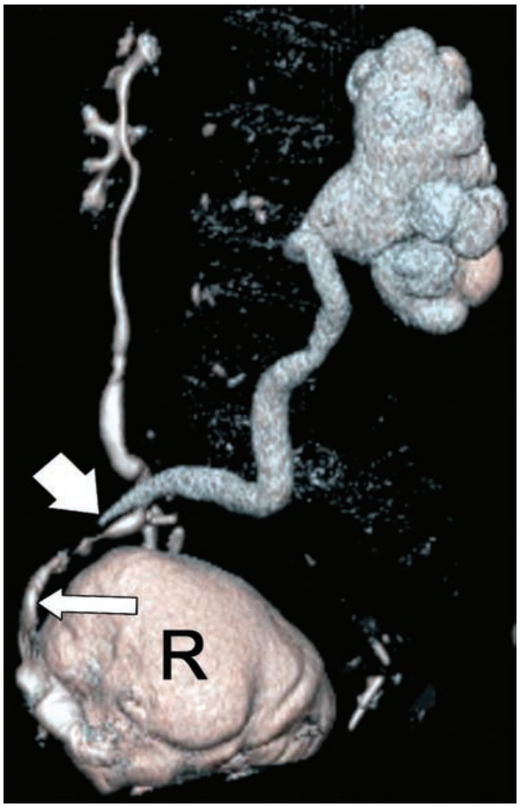
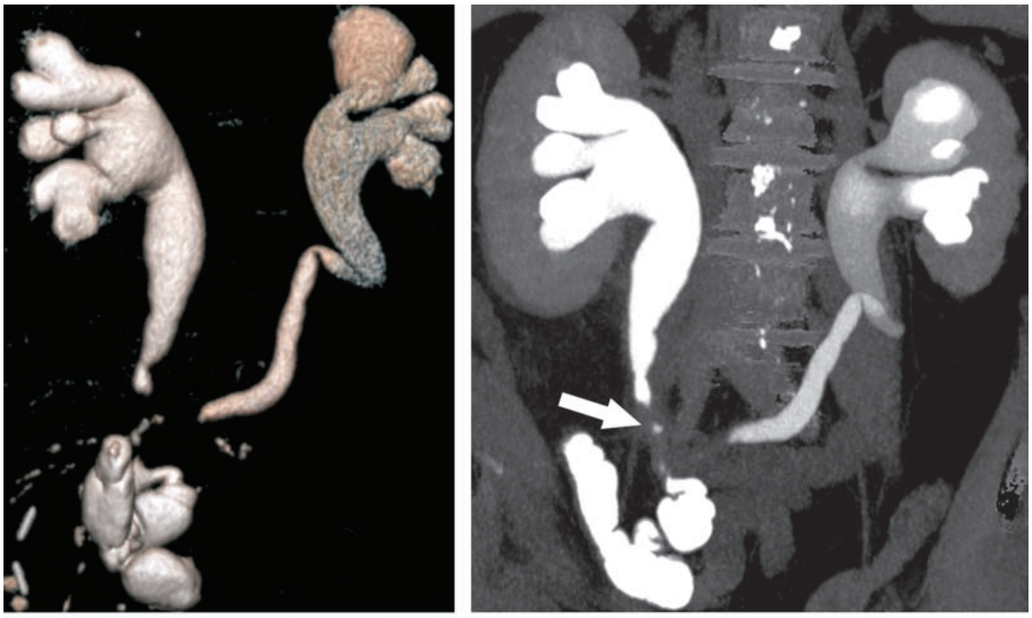


Figure 19. Benign ureteral stricture in a 54-year-old man after Studer-type neobladder construction. Volume-rendered CT image shows a short, smooth-walled stricture of the distal left ureter (short arrow) with moderate dilatation of the urinary tract above the stricture. The long arrow indicates the afferent limb. A benign cause of stricture was confirmed at surgical revision of the distal left ureter. *R* = reservoir.

Summary

Familiarity with the imaging appearances of expected postsurgical changes after radical cystectomy and urinary diversion is necessary to correctly diagnose complications and to avoid misdiagnoses. Multidetector CT, specially with 3D reconstruction techniques, provides excellent depiction of urinary and extraurinary anatomic structures and is therefore useful for the management of complications, including disease recurrence.



a. b.

Figure 20. Recurrent tumor in a patient who underwent cystectomy and urinary diversion with the Bricker procedure for treatment of bladder carcinoma. Volume-rendered **(a)** and maximum intensity projection **(b)** CT images show 3-cm-long distal strictures of both ureters with irregular ureteral walls and shelflike margins. In **b**, the cause of the stricture is readily identifiable as a solid lesion (arrow) that has engulfed the ureters.

Figure 21. Urinary reflux in a 21-year-old woman with a single (right) kidney after radical cystectomy and continent cutaneous urinary diversion with a colonic pouch. Volume-rendered CT image shows moderate dilatation of the entire excretory system, with no evidence of strictures at any level. Cystography showed evidence of long-standing reflux.

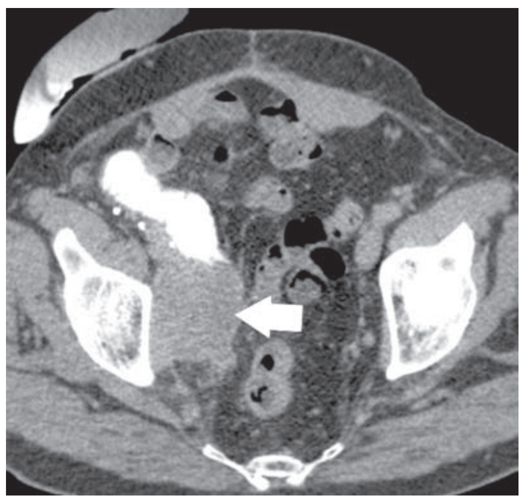


Figure 22. Local tumor recurrence in a patient 1 year after cystectomy and ileal conduit creation. Pyelographic phase pelvic CT image shows a soft-tissue mass (arrow) that surrounds the proximal end of the ileal conduit.

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CT Findings in Urinary Diversion after Radical Cystectomy: Postsurgical Anatomy and Complications

Violeta Catalá, MD, et al

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The excretory phase images are reviewed for evidence of urinary leaks and other postoperative fluid collections. A review of images from this scanning phase also is necessary for the accurate evaluation of urothelial lesions.

Page 468
Adhesive small-bowel obstruction near the enteroenteric anastomosis is the type of mechanical obstruction most frequently seen after surgery for urinary diversion.

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To detect urinary tract calculi, a careful review of unenhanced CT images is necessary. Calculi may not be detectable on delayed phase CT images because of the excretion of intravenous contrast material.

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