CT Technique

CT was performed with 16-MDCT or 64-MDCT scanners. For patients referred for routine follow-up, CT was performed with oral and IV contrast administration at the venous and excretory phases. When complications or recurrence of tumor of the urinary tract were suspected after urinary diversion, CT was performed using a CT urography protocol, which typically included unenhanced, corticomedullary, nephrographic, and excretory phases. Multiplanar reformation images were created routinely, and 3D images were created when requested by the referring physician.

Normal Postoperative Appearance After Urinary Diversion

The anatomy of the urinary diversion may vary depending on the types of urinary diversions. In ileal conduit urinary diversion, ureters extend to the ureteroileal anastomosis,
with ileal conduit extending to the urostomy (Figs. 1 and 2). In orthotopic neobladder urinary diversion, neobladder is seen extending to the midline lower pelvis and anastomosed to the urethra (Figs. 3 and 4). The ureters may be anastomosed to a segment of the bowel in a separate (Bricker procedure) or conjoined (Wallace procedure) fashion (Figs. 1 and 3). In the classic Bricker procedure, each ureter is sutured to the lateral aspect of the ileal conduit. In the Wallace procedure, both ureters are conjoined and sutured to the ileum. In right colonic urinary diversion, the colonic pouch is seen in the right lower quadrant. Intrarenal collecting systems are typically slightly wide after urinary diversion, either due to prior obstruction or to reflux.

**Urinary Leakage and Rupture**

Urinary leakage from anastomosis is an uncommon early complication and previous studies reported incidence of up to 1.1% [5]. On CT, intraperitoneal urinary leak from ileal conduit or neobladder may be detected as extravasation of contrast material into the peritoneal space. Ascites may contain radiodense fluid, reflecting extravasated contrast material (Fig. 5). Associated ileus may also be seen. If excretory images are not obtained, extravasation may not be seen. The leakage may also emanate from the anterior portion of the conduit that may not be entirely distended with contrast material.

**Postsurgical Fluid Collection/Hematoma**

Postsurgical fluid collections such as urinoma, abscess, hematoma, and lymphocele may be seen as early postoperative complications. On CT, hematoma is seen as a dense fluid collection (Fig. 6) that typically decreases in attenuation over time. The use of IV contrast enhancement helps to differentiate fluid collection, such as hematoma, from vascular complications, such as pseudoaneurysm (Fig. 6).

**Obstruction/Stricture at Anastomosis or Reservoir**

The incidence of ureteral stricture after radical cystectomy with urinary diversion is reported with rates varying from 3% to 10% in the literature [6]. Ureteral ischemia is the most common cause of ureteroenteric anastomotic stricture. Ureteroenteric obstruction often is silent clinically and is detected by increased serum creatinine or on follow-up imaging studies [7]. Most cases of ureteroenteric anastomotic strictures occur within the first 1–2 years postoperatively but can occur several years after surgery [7]. On CT, ureteral stricture is usually associated with hydronephrosis and delayed contrast excretion (Figs. 7 and 8). The involved ureteral wall may be thickened, and it may be difficult to differentiate a stricture with fibrosis from recurrent tumor.

Urinary diversion–enteric fistula is an uncommon complication after radical cystectomy and urinary diversion (Fig. 9) and reportedly occurred in 12 (2.2%) of 553 patients with a mean follow-up of 28.4 months [6].

**Stone Formation**

Patients who undergo urinary tract diversion procedures have an increased risk of developing urolithiasis, particularly patients with an ileal conduit. In patients after urinary diversion, the underlying cause of urinary stone formation is multifactorial and includes metabolic, structural, infectious, and idioopathic factors. Most stones are primarily of struvite and are thus thought to be secondary to infection by urea-splitting organisms [8]. Stones may be seen within the kidney, ureter, or ileal conduit or in multiple locations (Fig. 10). The incidence of upper tract stones after ileal conduit diversion as reported in the literature varies from 2.6% to 13.4% [8].

**Urinary Tract Infection**

Normal urothelium has several defense mechanisms against bacteria, such as voiding function to wash out bacteria and inhibitory action against bacterial adherence [7]. After urinary diversion, some of the normal defense mechanisms are impaired and patients are susceptible to bacterial infection [7]. Madersbacher et al. [9] reported that clinically evident urinary tract infection occurred in 30 (23%) of 131 patients with ileal conduit who were followed for more than 5 years, and urosepsis occurred in five patients (3.8%). CT findings of upper urinary tract infection include pyelonephritis and renal or perirenal abscess (Fig. 11).

Deterioration of renal function may occur because of recurrent urinary tract infection, stone formation, and obstruction or reflux. Madersbacher et al. [9] found that radiographic (shrunken kidney or hydronephrosis) or functional (increased serum creatinine greater than 130 μmol/L [1.7 mg/dL]) deterioration was observed in 27% of patients at minimum follow-up of 5 years after ileal conduit urinary diversion.

**CT in Urinary Diversion**

CT has an important role in the evaluation and management of patients with urinary diversion. CT is useful in the detection and assessment of upper urinary tract tumors in patients who are suspected to have upper tract TCC after urinary diversion for bladder cancer. To detect upper urinary tract TCC, excretory phase CT should be included [14]. Using high-resolution images obtained with thin-section MDCT, detection of upper tract TCC may be improved. On CT, TCC of the upper urinary tract is often seen as a focal intraluminal mass (Fig. 13), urothelial wall thickening with luminal narrowing (Fig. 14), and infiltrating mass. However, flat or early-stage tumors may be difficult or impossible to detect at CT [15]. To evaluate TCC in the renal collecting system and ureter on excretory phase imaging in patients with bladder cancer, optimal opacification and distention are essential [14].

**Late Complications Not Directly Related to Urinary Diversion**

The most common late complications unrelated to neobladder reconstruction leading to open surgery were incisional hernia (1.5%) and small-bowel obstruction (1.6%) [16] (Fig. 15).

**Conclusion**

MDCT can detect potential early and late complications of the urinary tract, recurrent tumors, and complications not directly related to urinary diversion. CT has an important role in the follow-up of patients with urinary diversion.
role to identify tumor recurrence and correctable causes of urinary complications early to prevent deterioration in renal function.

References


Fig. 1—Illustration showing ileal conduit urinary diversion. Ureters are anastomosed to segment of ileum (arrows) in conjoined (Wallace) fashion.

Fig. 2—Normal CT urography after ileal conduit urinary diversion in patient who underwent cystoprostatectomy and ileal conduit urinary diversion for bladder cancer. Anterior volume-rendered image shows normal bilateral renal collecting systems and ureters anastomosed to ileal conduit.

Fig. 3—Illustration shows ileal neobladder urinary diversion. Ureters are anastomosed to segment of ileum (arrows) in conjoined (Wallace) fashion.
CT in Urinary Diversion

Fig. 4—Normal CT urography after ileal orthotopic neobladder reconstruction in patient who underwent cystoprostatectomy and urinary diversion for bladder cancer.
A, Anterior volume-rendered CT image shows neobladder in pelvis (asterisk).
B, Oblique anterior 3D CT urography image shows normal appearance of bilateral collecting systems and ureters anastomosed to neobladder. There is duplication of left collecting system.

Fig. 5—Leak from ileal orthotopic neobladder in patient who underwent recent cystoprostatectomy and ileal orthotopic neobladder reconstruction for bladder cancer. Patient had abdominal pain, distention, and nausea.
A, Axial contrast-enhanced CT image shows amorphous contrast material immediately superior to ileal neobladder (arrowheads).
B, Axial CT image inferior to A shows ileal neobladder containing contrast material (arrow). Small ascites (asterisk) is present, which is radiodense, suggestive of extravasated contrast material.
C, Sagittal reformation image shows amorphous contrast material (arrowheads) superior to neobladder (arrow), indicating leak.

Fig. 6—Pelvic hematoma and pseudoaneurysm 4 weeks after radical cystoprostatectomy and ileal conduit reconstruction for bladder cancer. There was drop in hemoglobin in early postsurgical period and recurrent fever. CT angiography was performed for suspected pseudoaneurysm found by previous CT for evaluation of hematoma or abscess.
A, Axial unenhanced CT image shows hematoma in pelvis.
B, Arterial phase sagittal image shows large pseudoaneurysm (arrow) surrounded by large hematoma. Angiography showed pseudoaneurysm with feeding branches from left and right internal pudendal arteries and left obturator artery, and patient was successfully treated with coil embolization.
**Fig. 7**—Benign ureteral stricture in patient 6 months after cystoprostatectomy and ileal conduit diversion for bladder cancer.  
**A,** Coronal multiplanar reformation (MPR) image shows moderate hydrenephrosis of left kidney.  
**B,** Axial image shows thickening and contrast enhancement of distal left ureter (arrow) near anastomosis to ileal conduit.  
**C,** Excretory phase coronal MPR image shows dilated left ureter (arrows) and thickening of distal left ureter near anastomosis to ileal conduit. Excreted contrast seen in normal caliber right ureter (arrowhead). Ureteroscopy showed left distal ureteral stricture, and biopsy was negative for malignancy.

**Fig. 8**—Worsening left pelvic pain and fever. Renal ultrasound showed left hydrenephrosis and left perinephric fluid collection. Patient underwent cystoprostatectomy and ileal conduit urinary diversion for bladder cancer 7 days previously.  
**A** and **B,** Excretory phase axial (**A**) and anterior volume-rendered (**B**) images show mild left hydrenephrosis and contrast extravasation into perinephric and periureteral regions. Left distal ureter is not opacified due to filling defect, which was thought to be clot.  
**C,** Patient had left percutaneous nephrostomy placement. Nephrostogram in prone position several months after surgery shows stricture of distal left ureter at anastomosis (arrow). Patient underwent ureteral reimplantation.

**Fig. 9**—Ureteroenteral fistula in patient 4 months after radical cystectomy and ileal orthotopic neobladder reconstruction for bladder cancer. Patient had recurrent abdominal pain and fever and recurrent urinary tract infections on right side. Nephrostomy was placed for right hydrenephrosis.  
**A,** Coronal reformation image shows mild right hydrourerater extending to right lower quadrant (arrowheads) and is closely related to adjacent distal small bowel (arrow). Ileal neobladder (asterisk) is seen in pelvis.  
**B,** Percutaneous right nephrostomy is in place. Nephrostogram in prone position shows fistula from distal right ureter to terminal ileum (arrows) and contrast material fills colon. At surgery, right ureteral stricture was found. Patient was treated with repair of ureteroenteric fistula. Pathologically, distal right ureter had fibrosis and chronic inflammation, but there was no evidence of tumor.
Fig. 10—Calculi in ileal conduit and in left kidney in patient who underwent ileal conduit urinary diversion for neurogenic bladder in childhood. Patient has recurrent urinary tract infections and stones. Arterial phase anterior volume-rendered image shows 7-mm calculus in lower pole of left kidney (arrow) with adjacent renal cortical scarring. There are also multiple calculi (arrowheads) within ileal conduit in right lower quadrant.

Fig. 11—Recurrent urinary tract infection with urinary conduit stomal stenosis and bilateral hydronephrosis in patient who underwent radical cystoprostatectomy and ileal conduit urinary diversion for bladder cancer more than 20 years previously. Patient had abdominal pain and positive urine cultures for Escherichia coli. Urine cytology showed acute inflammatory cells and candida species.

A, Excretory phase axial image shows bilateral hydronephrosis. Subtle filling defects (arrows) are seen within right renal pelvis.

B, Excretory phase coronal image with wide window setting shows filling defects (arrows) in left renal pelvis. Patient underwent stomal revision. Fluoroscopic gravity loopogram and ultrasound before and after surgery showed resolution of filling defects within left renal pelvis, and they were thought to represent clot, inflammatory debris, or fungus ball.

Fig. 12—Liver and bone metastases in patient who underwent radical cystectomy with ileal conduit urinary diversion and left nephrectomy for upper and lower tract transitional cell carcinoma with adenocarcinoma differentiation.

A, Axial CT image shows multiple hypodense masses in liver that developed during follow-up, compatible with metastases.

B, Anterior volume-rendered image shows interval development of mixed sclerotic and lytic lesion involving L3 vertebral body, representing bone metastasis.

Fig. 13—Multiple transitional cell carcinoma (TCC) in renal pelvis on both sides in patient 2 years after undergoing cystectomy and left ureterectomy with ileal interconnection with continent diversion for refractory bladder carcinoma in situ with distal left ureteral involvement.

A and B, Arterial (A) and excretory phase oblique axial (B) CT images show multiple masses (arrows) in bilateral renal pelvis. Excretory phase oblique axial CT image (B) shows multiple masses (arrows) in bilateral renal pelvis, seen as filling defect in left renal pelvis. There is delayed excretion of contrast material from right kidney due to hydronephrosis. Masses were high-grade papillary TCC with widespread involvement of ureter and renal pelvis on both sides. There was invasion through muscularis propria of ureter and into renal parenchyma bilaterally (stage pT3).
Fig. 14—Infiltrating high-grade transitional cell carcinoma (TCC) in renal pelvis in patient 4 months after undergoing radical cystoprostatectomy and segmental ureterectomy for bladder cancer and left distal ureteral involvement. Patient developed hematuria and positive urine cytologies with high-grade TCC. A–C, Arterial phase axial (A) and coronal (B) images and excretory phase coronal (C) image show diffuse thickening and stranding of left renal pelvis and proximal ureter (arrows) extending to calyces. Left kidney is atrophic, and there is mild left hydronephrosis. Pathologically, there was infiltrating high-grade TCC in renal pelvis invading renal parenchyma.

Fig. 15—Small-bowel obstruction with scrotal hernia in patient 3 years after undergoing cystoprostatectomy and urethrectomy with ileal conduit for squamous cell carcinoma of urethra. Patient has undergone neoadjuvant chemoradiation therapy. A and B, Axial images of pelvis (A) and scrotum (B) show multiple dilated small-bowel loops in abdomen and pelvis extending into scrotum. There are multiple areas of adhesions and nondistended bowel loops (arrowheads, A) near ileal conduit. Urostomy is seen in right lower quadrant (arrow, A). At surgery, there were multiple adhesions but no evidence of tumor recurrence.