ELSEVIER

Seminars in
ULTRASOUND
CT and MRI

Multimodality Imaging Findings Postcystectomy: Postoperative Anatomy, Surgical Complications, and Surveillance Imaging

Aishah Azam, and Giles Rottenberg

Various surgical techniques exist for urinary diversion post cystectomy and each have different imaging features. This diverse range of surgical procedures can make imaging interpretation difficult and so familiarity with the postoperative anatomy is essential. Multiple imaging modalities and techniques are available for the radiologist's assessment including fluoroscopic studies, computed tomography, magnetic resonance, and radionuclide imaging. Knowledge of when each of these modalities is indicated and the typical imaging appearances is essential for early identification of postoperative complications and detection of tumor recurrence. This information enables the radiologist to make an accurate and early diagnosis and subsequently guide the management pathway for these patients.
Semin Ultrasound CT MRI 41:392-401

Introduction

Radical cystectomy is most commonly performed for muscle invasive bladder cancer, or high risk non-muscle invasive disease which may be recurrent or resistant to local treatment.

Other indications include pelvic exenteration for other pelvic malignancies, but less commonly include benign conditions such as neurogenic disorders of the bladder.

There are various surgical options for urinary diversion postcystectomy, and these depend on multiple factors including tumor site, stage, and patient factors including age and comorbidities.[1]

The surgical methods of urinary diversion can be divided into whether the functional result is urinary continence or incontinence. Continent urinary diversions allow the patient to void through the native urethra or use self-catheterization. Incontinent urinary diversions are where a cutaneous stoma is formed and used for passive urinary drainage. This surgery is more straight-forward and is therefore more frequently performed of the two, although this may depend upon the experience of the surgical center. Recent advances include the development of robotic surgery over the past few years. Evidence has shown that robotic cystectomy is associated with a reduced blood loss, fewer complications, and a shorter length of hospital stay despite overall a longer operative time.[2]

Knowledge of the expected postoperative imaging appearances after the various methods of urinary diversions and potential postoperative complications is crucial to facilitate early diagnosis and management of any complications that may arise.

In this article, we review the various surgical techniques used for urinary diversion and the expected postoperative imaging appearances. We will also assess the imaging features of early and late complications and the variety of imaging modalities available for the radiologists' assessment.

Incontinent Diversion

These procedures are commonly performed and involve the urine draining via a cutaneous stoma. They are a straightforward, safe, and reliable method of urinary diversion.

Department of Radiology, Guy's and St Thomas' NHS Trust, London, United Kingdom.
Address reprint requests to GilesRottenberg, Department of Radiology, Guy's and St Thomas' NHS Trust , London SE1 7EH United Kingdom. E-mail: gilesrott@aol.com

 https://doi.org/10.1053/j.sult.2020.04.008
0887-2171/

Ileal Conduit Formation

The gold standard for incontinent urinary diversion is the formation of an ileal conduit, and this is the most common urinary diversion procedure performed worldwide.[3] A segment of ileum acts as a conduit for urine storage, and it is usually sited within the right iliac fossa. A 15-20 cm long segment of ileum, approximately 20-30 cm proximal to the terminal ileum, is harvested to form the conduit. The ureters are isolated and anastomosed into the proximal part of this ileal segment. The distal part of the ileum is then exteriorized as a stoma where it serves as a passive conduit for urine to drain to a stoma bag. An ileal-ileal anastomosis is performed. On imaging, the ileal conduit will be found in the right iliac fossa and will be seen as a fluid-filled loop of bowel with evidence of small bowel folds and extend to the skin surface as a stoma (Fig. 1).

Cutaneous Ureterostomy

Patients who suffer from inflammatory bowel disease or who have a serious comorbidity which prevents utilisation of bowel as a reservoir can undergo a cutaneous ureterostomy.[4] The ureters are anastomosed directly to the anterior abdominal wall either singly or anastomosed together to form a continuously draining stomas. This procedure is associated with a risk of stomal stenosis, and recurrent UTI, although avoids the complications associated with any form of bowel anastomosis.[5]

Continent Diversion

These procedures are surgically more complex with a higher complication rates, and are therefore reserved for younger and medically fit patients with better compliance.

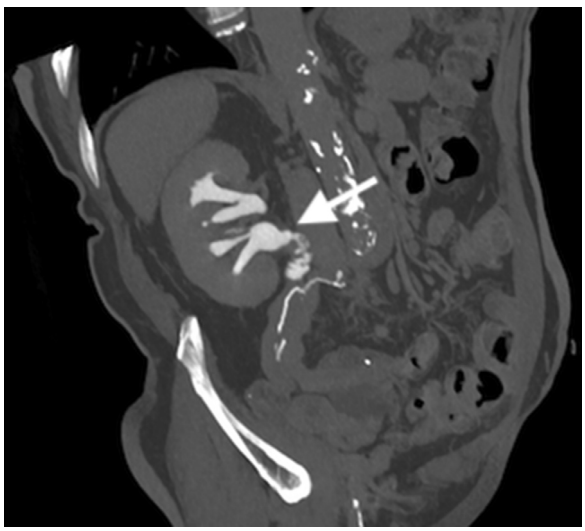

Figure 1 Coronal oblique MIP reconstruction of a CT Urogram. The patient underwent cystectomy, left sided nephroureterectomy and right ureterectomy for upper tract TCC. Due to the ureteric involvement the surgeons have directly anastomosed the ileal conduit to the right renal pelvis as indicated by the arrow.

This involves resection of a segment of bowel which is subsequently fashioned into a low-pressure pouch, to which the ureters are anastomosed. The most common surgical technique is an Indiana pouch where the ascending colon and caecum act as the urine reservoir.[6] This segment of large bowel is detubularized to reduce peristalsis. The pouch/reservoir that is fashioned, is then connected to the abdominal wall to open as a stoma via a segment of the terminal ileum. The stoma can then be intermittently self-catheterized by the patient to drain the urine. Other surgical techniques have been described using gastric and sigmoid pouches. On imaging, the pouch will be seen as a fluid-filled loop of bowel with evidence of haustral folds often in the right lower quadrant of the abdomen. On excretory phase, imaging contrast will opacify this bowel assisting its recognition.

Neobladder Construction

This is commonly performed in a younger cohort of patients and allows patent to void through the native urethra without the need for a stoma which achieves a more aesthetically pleasing result.[7] Patients may be required to perform self-catheterization as well dependent upon pouch function.

Approximately 60 cm segment of ileum is resected and is subsequently folded on itself to create the "neobladder." The "neobladder" is then placed into the cystectomy bed and anastomosed to the native ureters and urethra. Voiding is initiated by increasing intra-abdominal pressure. A Studer ileal orthotopic neobladder is the method most frequently used worldwide[8](Fig. 2), however, antireflux mechanisms can be incorporated at the site of the ureterointestinal anastomosis, for example, as in a T-pouch neobladder formation. Good

Figure 2 Loopogram demonstrating the normal configuration of a Studer Pouch which is a type of neobladder formed from a segment of ileum – note the presence of valvulae conniventes (arrow). There is incomplete reflux into the left kidney but there was no evidence of obstruction. There is also a post-operative surgical drain in situ.

Figure 3 Coronal MIP reconstruction of a CT urogram. The neobladder is opacified well and seen as a tubular structure within the pelvis (arrow). Numerous surgical clips are seen along the pelvic side wall.

patient knowledge and compliance regarding voiding is required to minimize complication postneobladder formation. On cross-sectional imaging the "neobladder" will demonstrate a mucosal fold pattern, often have a round or tubular shape and be sited in the cystectomy bed (Fig. 3). Identifying the uretoneobladder and urethra-neobladder anastomoses can assist in assessment of this.

Ureterocolonic Diversion

Ureterocolonic diversion is the oldest form of urinary diversion and involves anastomosis of the ureters to the sigmoid colon. The technique is infrequently performed due to the risk of urinary tract infection, and the risk of colonic malignancy from contact between the urine and the colonic mucosa.[9] Modifications to the technique can include an antirefluxing technique, as well as an interposed loop of small bowel between the ureters and colon to augment the capacity.[10]

Multiple Imaging Modalities Available

Postoperatively imaging is used to assess for surgical complications and to monitor patients for recurrence. Interventional radiology plays an important role in managing both the early and late complications of cystectomy.

Computed Tomography

Computed tomography (CT) is the predominant imaging modality used in the early postsurgical period and in the long term assessment of postoperative collections and tumor recurrence.[11] CT imaging protocols vary between institutions but in principle the CT protocol should be tailored to the complication being evaluated.

Noncontrast CT can be helpful for baseline imaging of any surgical material and also for assessment of urolithiasis. Dual energy source scanner can allow simultaneous acquisition of a postcontrast and virtual noncontrast CT.[12] Careful assessment of drainage catheters and stents should be made in the early postoperative period. Most patients have ureteric stents which may pass through the abdominal wall, as well as an abdominal drain adjacent to the gastrointestinal anastomosis and balloon catheters in the conduit or neobladder. Migration of these catheters can be associated with catastrophic complications such as rupture of a neobladder (Fig. 4).

Contrast-enhanced CT enables assessment of any collections outside the urinary tracts for example abscesses or lymphoceles and other associated complications such as hernias. A careful review of the abdominal wall should be performed following laparoscopic or robotic surgery to evaluate local complications such as an obstructed bowel loop, or vascular injury related to port insertion. CT also enabled evaluation of visceral and lymph node metastases.

Urographic phase imaging can assess the integrity of the urinary diversion system.[13] CT urography can often replace a loopogram without the risk of sepsis from catheterization of the stoma (Fig. 5). Split bolus techniques can provide

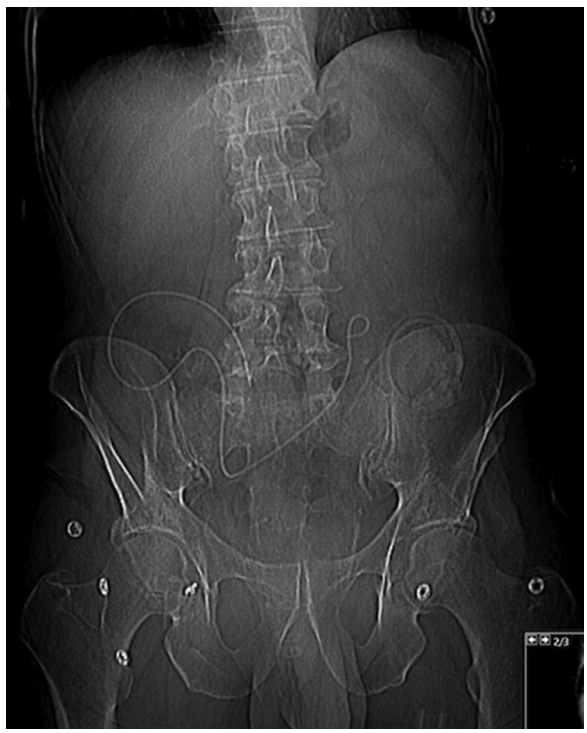

Figure 4 Scout imaging shows migration of a ureteric Bander stent inferiorly in a patient with an ileal conduit. The CT following this showed the patient had hydronephrosis.

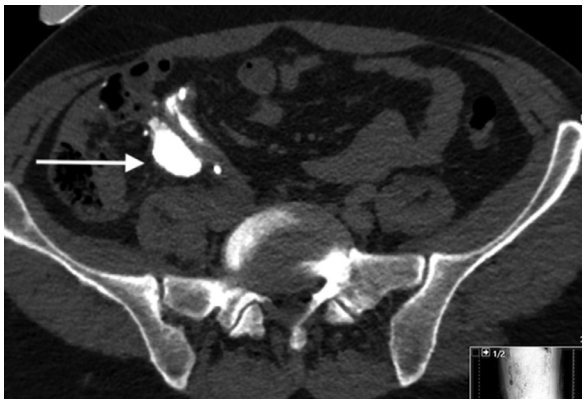

Figure 5 Urographic phase axial CT image demonstrates a contained leak of contrast at the site of the ileal conduit (arrow).

accurate evaluation of recurrence and urinary leaks simultaneously and can reduce radiation exposure.[14] An early postcontrast and delayed urographic CT is often more helpful than a standard split bolus examination especially in the presence of ureteric dilatation, or poorly draining systems where a delayed urogram may demonstrate a poorly opacified system. Most stones will still be identified on a postcontrast CT, and the urographic phase images following this examination may be better than a split bolus protocol due to the increased dose of contrast. Improved visualization of the ureters may be obtained with oral fluid load or a small dose of a diuretic. Careful evaluation of the ureter is recommended on different window settings, and in multiple planes to detect small areas of recurrence. MIP imaging may also help detection of lesions.[15]

Fluoroscopy

Loopograms are commonly used to evaluate postoperative leaks, or ureteric strictures.[16] They can be performed within the first few months of surgery to confirm patency of the conduit and ureteric anastomosis. A Foley catheter is inserted into the conduit via the stoma and the balloon is inflated to secure its position. Diluted water soluble contrast is hand injected via this catheter into the conduit. Contrast should reflux from the conduit into the ureters and collecting systems bilaterally. Spot images of the conduit, ureters, and kidneys are obtained with views of the ureteroileal anastomoses (Fig. 6). Failure of contrast to reflux may be due to a ureteric stricture, edema, mucosal flap, or recurrent upper tract tumor (Fig. 7). Some studies have suggested that routine studies are not mandatory as most cases will present symptomatically. Early diagnosis of a ureteric stricture can allow surgical or radiological management and prevent progressive renal damage. Loopograms can be used for long-term monitoring in patients with poor renal function who cannot have contrast-enhanced CT or in whom CT urography is indeterminate for upper tract disease or obstruction.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) can be used in patients with contraindications to CT contrast administration. Pelvic MRI can often be helpful in the assessment of local recurrence within the pelvis (Fig. 8). It may be prompted by an abnormal CT, or by the presence of pelvic symptoms which are a very strong indicator of recurrence. MRI has the advantage of better evaluation of the bony pelvis and soft tissue structures, and may be more sensitive for bone disease and local recurrence.[17] Contrast MRI urography can be considered for evaluation of the upper tracts, although noncontrast urography is most useful in the presence of ureteric dilatation.

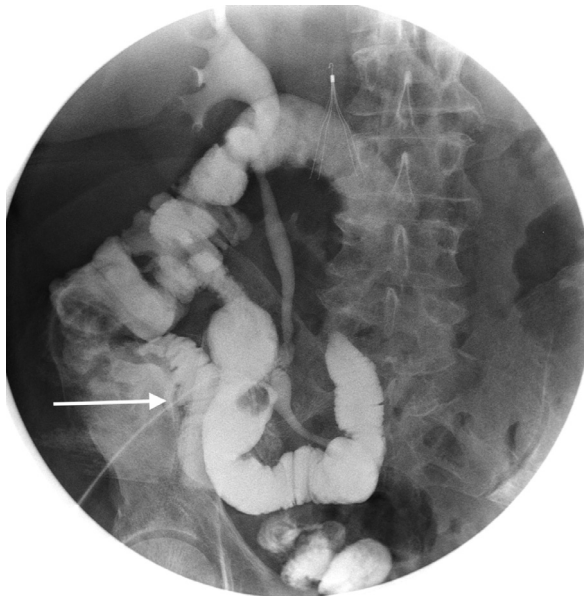

Figure 6 Urinary tract loopogram demonstrates free reflux of contrast into the conduit and ureter with subsequent filling of the terminal ileum (arrow) and proximal large bowel, indicative of the development of a fistula between the ileal conduit and terminal ileum.

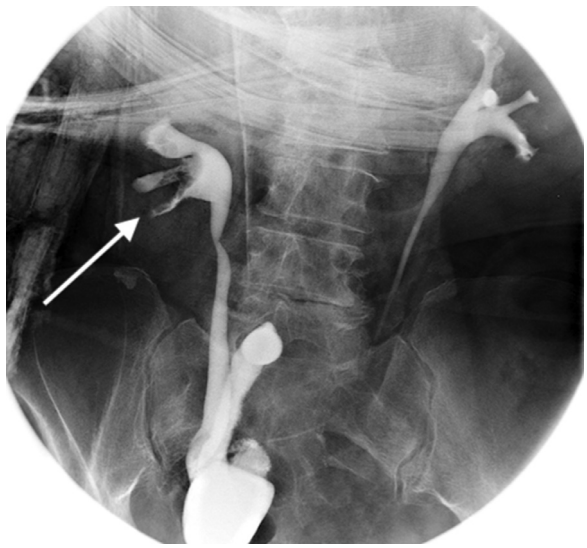

Figure 7 Patient presented 10 years postcystectomy with hematuria and poor renal function, therefore unable to have a contrast enhanced CT. A loopogram of the urinary tract was therefore performed and demonstrated patchy filling defects within the right renal calyces (arrow) which was proven to be upper tract transitional cell carcinoma.

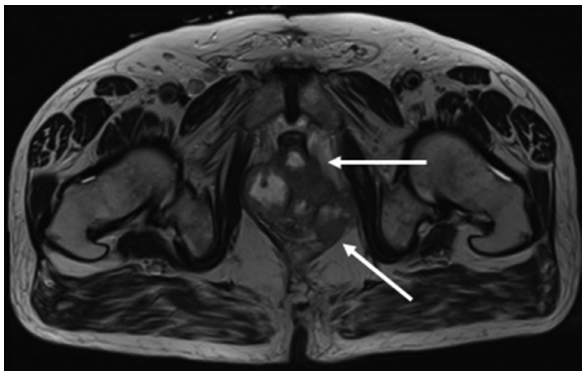

Figure 8 Axial T2W MRI sequence demonstrating local recurrence within the cystectomy bed. There is a lobulated soft tissue mass involving the left puborectalis muscle and extending deep to involve the urethra (arrows). The patient presented with perineal pain 6 months after cystectomy.

PET CT and PET MRI

There is evidence that FDG PET CT and PET MRI are more accurate in assessing the presence of local recurrence and metastatic disease postcystectomy than standard CT or MRI.[18-20] With the introduction of new treatments for metastatic bladder cancer (eg, Immunotherapy), the use of PET may increase in the search for early asymptomatic metastatic disease, as well as assessing the response of disease to treatment (Fig. 9 and Fig. 10A, B). There is some interest in the use of PET for a survival prediction score.[21]

Complications

Radical cystectomy is a highly complex procedure with a significant morbidity and mortality. Perioperative mortality is recorded as 1.2%-3.2% at 30 days and 2.3%-8% at 90 days.[22]

Morbidity and mortality is generally lower in hospitals with a large case load and therefore more experience. The patient population often have significant other comorbidities including respiratory and cardiovascular disease which may be related to both age and smoking related factors.

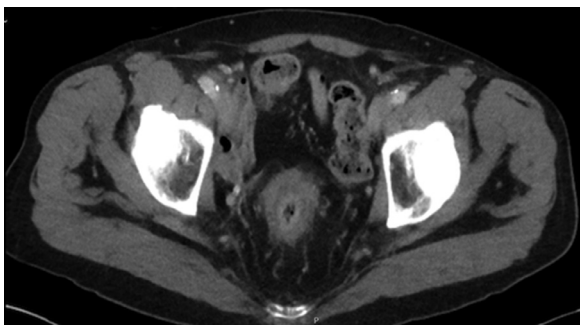

Figure 9 The patient attended for a routine surveillance re-staging scan 6-months postcystectomy for a plasmacytoid bladder cancer. CT scan demonstrated marked circumferential thickening of the rectal wall sparing the mucosa. Following this the patient underwent a colonoscopy which reported normal intraluminal appearances. However a subsequent PET scan confirmed high uptake in this region consistent with recurrent disease.

Complications vary in their nature and frequency depending on the type of urinary diversion procedure selected postcystectomy. Most complications arise from the urinary diversion complication of the procedure rather than the cystectomy component.

They can be divided into early (occurring within 30 days of the surgical procedure) and late.

Early

The incidence of early complications is up to 48% following conduit formation.[23]

Urinary leak postsurgery is fairly uncommon with an approximate rate of 2%-5%, however can lead to significant morbidity.[24] Urinary leak occurs secondary to dehiscence of the ureteral-reservoir anastomosis but can also occur at the rear end of the ileal conduit and lead to spillage of urine into the abdominal cavity. Leaks are clinically suspected if there is increased urinary output from the abdominal drain, or urine from the wound. Urinary leaks can be evaluated with a fluoroscopic urinary loopogram or urographic phase CT scan.

It is preferable to perform contrast-enhanced CT prior to a loopogram as the contrast from a Loopogram examination may degrade subsequent CT examination especially in the presence of a leak. An adequate delay between contrast injection and urographic phase scanning may be required to demonstrate a leak. Initial review of the images may be helpful with a further delayed pelvic examination if there is incomplete contrast density within the conduit.

Postoperative collections include hematoma formation, lymphocoeles, and abscesses. These are best assessed on cross-sectional imaging, and most commonly occur at the operative site. The imaging characteristics of the collection can determine its nature. A hematoma tends to be a heterogeneous hyperdense collection adjacent to the surgical bed. Arterial phase CT imaging can be used to assess for active hemorrhage if clinically suspected. Lymphoceles tend to occur in patients who have undergone lymph node dissection. They typically appear as a thin-walled homogenous collection of fluid density commonly along the pelvic side wall (Fig. 11). Abscesses can be differentiated from the others by presence of an enhancing wall, adjacent fat stranding, inflammatory change, and the presence of gas (Fig. 12).

The most common bowel-related complication postsurgery is postoperative paralytic ileus.[25] This may related to the surgery itself or metabolic imbalances. On imaging, multiple dilated loops of bowel with no discrete site of obstruction confirm the presence of an ileus. This is managed conservatively and commonly relieved with enteric decompression. Mechanical bowel obstruction postsurgery is rare and occurs as a late complication in comparison to ileus. It is most likely secondary to adhesions, strictures, hernias or bowel ischemia, and the transition point is best assessed on CT (Fig. 13). Bowel obstruction often requires surgical intervention.

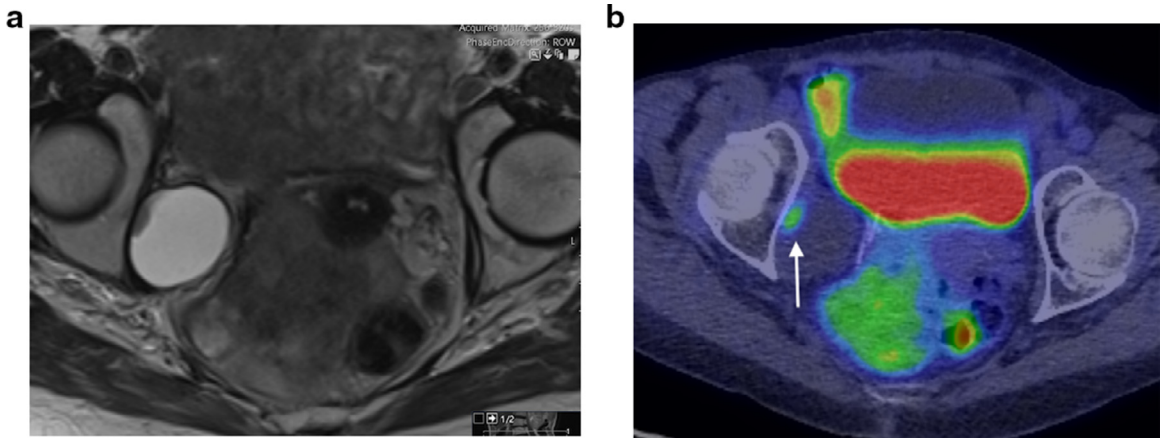

Figure 10 (A) Axial T2W MRI sequence showed a cystic collection along the right pelvic sidewall and this was reported as a likely post operative lymphocele. However, note was made of a discrete nodular component to this collection. (B) A follow up PET scan was performed which showed this nodule demonstrated high avidity consistent with recurrent disease.

Wound infection is common but usually evaluated clinically although CT may be helpful to assess the extent.

Late

Ureteric strictures are seen in 10%-14 % of patients postcystectomy, and are frequently ischemic in origin.[26] They usually present within the first postoperative year. The strictures are often asymptomatic and will be picked up on routine surveillance although can present with a change in the renal function. Strictures may be malignant in nature and related to local recurrence of tumor, or upper tract tumor. The initial management may involve insertion of a stent although surgical correction is often required.

Figure 11 Routine follow up surveillance CT on an asymptomatic patient showed a large homogenous collection extending from the pelvic sidewall into the left upper quadrant of the abdomen. This was proven to be a lymphocele.

Strictures may be demonstrated as a focal segment of ureteral narrowing, however, the most common finding is dilatation of the ureters up until a discrete transition point. The level of obstruction can be demonstrated on either a loopogram or CT imaging (Fig. 14). Malignant strictures can be distinguished from benign strictures by evidence of asymmetrical/polypoidal features and may demonstrate concentric mural enhancement. It is important to know the postsurgical histology as the presence of carcinoma in situ or a positive margin will make malignant obstruction much more likely.

Nonobstructed dilatation of the ureter secondary to the conduit needs to be distinguished from obstruction, and a Mag3 renogram or loopogram can be helpful to confirm the presence of obstruction (Fig. 15). A long-term ileal conduit is often associated with significant dilatation of the ureters and pelvicalyceal systems.

Parastomal hernias occur when the mesentery, or loops of bowel extrude through the abdominal wall defect adjacent to the site of the stoma. They commonly occur in patients with a high body mass index. These are often asymptomatic as often only involve omental fat, however, if a loop of bowel is involved this may result in acute obstruction. CT imaging is best for the assessment of the size of the defect and its contents (Fig. 16). Recurrent stomal hernias are common even after repair.

The development of urolithiasis postoperatively is related to urinary stasis, metabolic imbalances, and in some cases infection.[27] Calculi may be seen in the urinary reservoir or within the upper urinary tract, and early detection is important to limit potential obstruction. They can be solitary or multiple and have been reported in up to 10% of patients. Although these can be seen on radiography and ultrasound, they are best assessed on unenhanced CT imaging and are often managed with lithotripsy or endoscopic retrieval. Dual energy CT may be helpful in these patients.

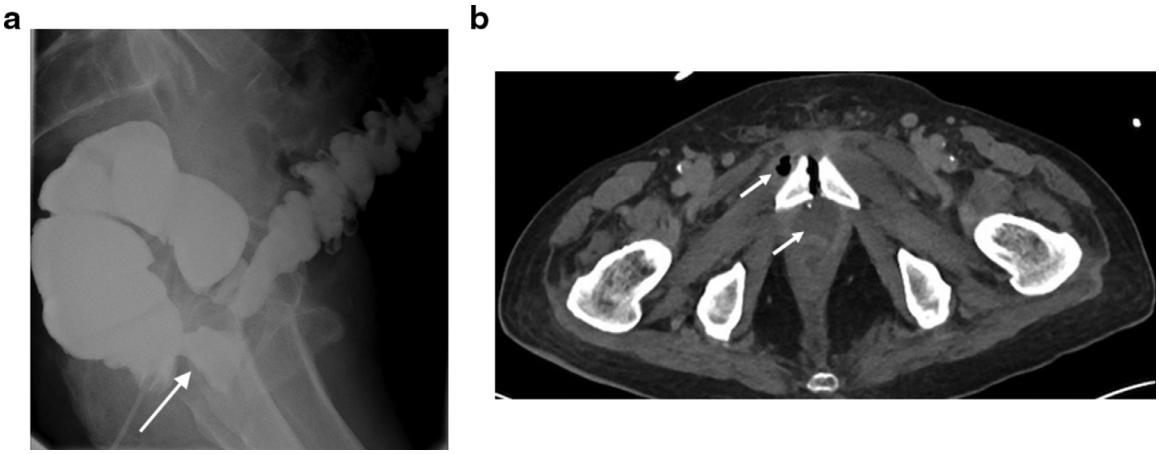

Figure 12. (a and b) A water soluble enema demonstrated extravasation of contrast anteriorly from the rectum consistent with a rectal leak from an injury sustained during surgery. The patient subsequently had a CT scan (12b) which demonstrated a pelvic collection (arrow) with locules of gas extending to and involving the pubic symphysis consistent with secondary osteitis pubis.

It is important to ensure that surgical material is not mistaken for calculi and comparison with previous imaging is necessary.

Tumor recurrence postcystectomy most commonly occurs within the first 2-3 years.[28] Local recurrence may present as a mass lesion, focal wall thickening, filling defect, or stricture within the urinary diversion system. Metastatic disease is frequently symptomatic, and the onset of new symptoms should prompt repeat imaging with a modality dependent on the site of the symptoms (Fig. 17).

Figure 13 This patient presented to the emergency department 1 year post cystectomy with acute abdominal pain and vomiting. CT scan demonstrated acute small bowel obstruction with small bowel feces sign. The small bowel loops were tethered to the right iliac fossa where there was extensive peritoneal disease (arrow).

Figure 14 Left-sided hydronephrosis was detected on surveillance, and obstruction was confirmed on MAG3 renogram. Nephrostogram demonstrates focal narrowing at the distal ureter proximal to the site of the uretoileal anastomoses (arrow). This was benign in etiology and the patient subsequently underwent successful reimplantation of the ureter.

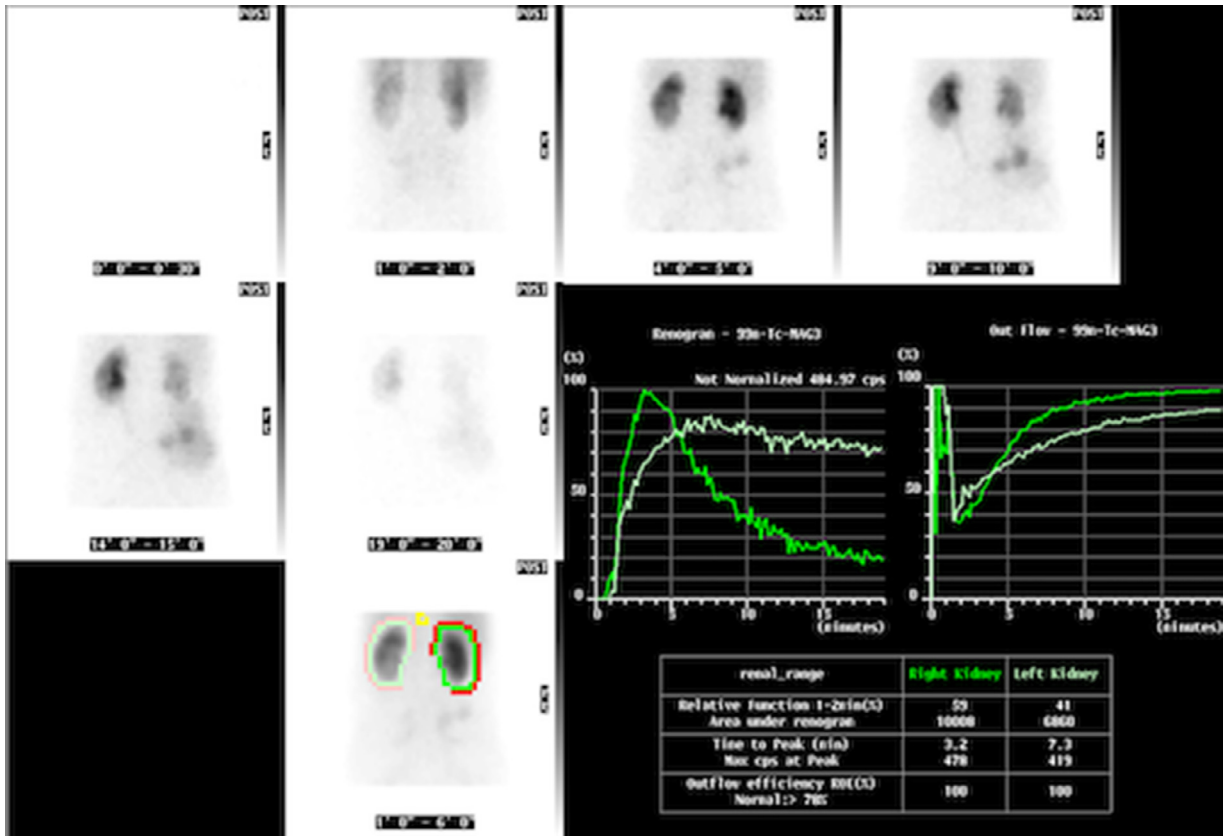

Figure 15 Postcystectomy the patient was found to have deteriorating renal function. 99mTc MAG3 renogram was performed to evaluate dynamic renal function by measuring uptake and excretion of the radio-isotope. This study confirms reduced uptake in the left kidney and reduced excretion of contrast.

Upper tract recurrence is a common site of late recurrence and is seen in 2%-6% of patients.[29] The incidence of this is increased in patients with CIS, noninvasive bladder tumor at the time of surgery, and the presence of a positive ureteric margin. Radiological detection of upper tract disease is important as a majority of these patients will not have metastatic disease, so that treatment has been shown to reduce mortality.

Figure 16 A patient with ileal conduit presented 1 year postoperatively with severe abdominal pain and clinically unwell. CT showed a necrotic loop of small bowel which had herniated through the site of the ileal conduit which was confirmed at surgery.

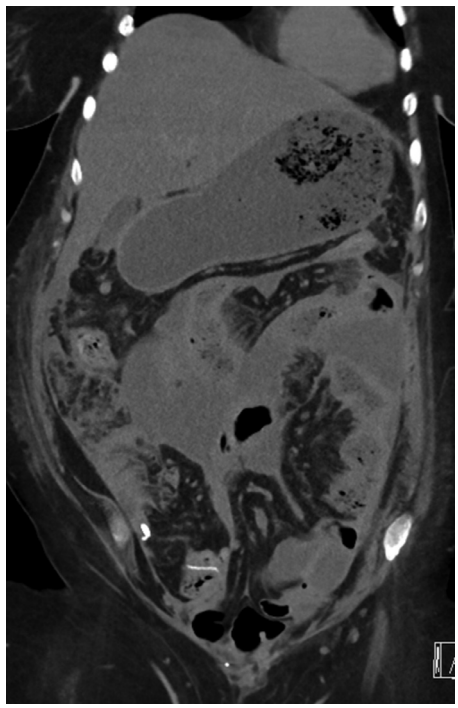

Figure 17 Patient had a slow recovery 6 weeks post cystectomy and presented with abdominal distension. CT showed diffuse peritoneal disease within the abdomen. Interestingly there was no evidence of peritoneal metastases on pre-operative imaging or at original surgery.

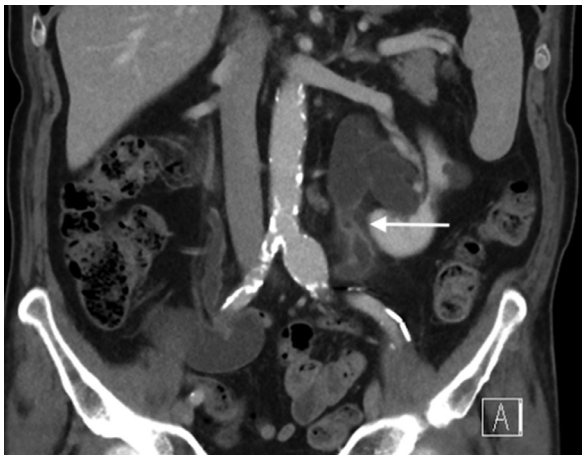

Figure 18 Portovenous phase CT imaging shows extensive mural enhancement of the ureters bilaterally (left worse than right) with subsequent stricturing and upstream hydronephrosis consistent with upper tract recurrence (arrow).

Guidelines suggest regular follow up with CT, although the frequency and duration of follow up is not known for sure. A risk adapted schedule of follow up appears to be a promising approach.[30] This can be assessed via a loopogram or urographic phase CT/MRI (Fig. 18). Cross-sectional imaging is perhaps more favorable as it enable assessment of nodal and distant metastatic disease simultaneously (Fig. 19).

Distant metastatic disease is usually detected on surveillance imaging which is commonly performed annually post-surgery. Nodal recurrence may occur along the pelvic sidewall, inguinal, and para-aortic sites and is best assessed on cross-sectional imaging. Distant metastases are also best assessed this way, ensuring appropriate windowing to assess for skeletal sites of disease (Fig. 20).

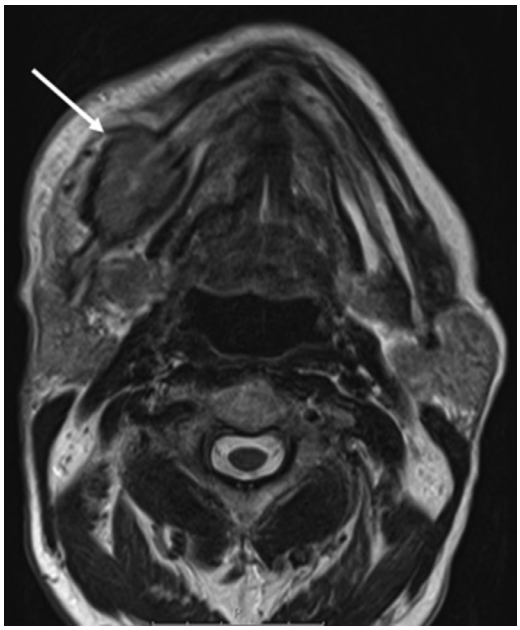

Figure 19 Nine months after radical cystectomy a patient presented with a lump on their mandible. MRI showed a destructive soft tissue mass centred on the body of the right mandible (arrow). PET confirmed a solitary site of disease, which was proven to be recurrence at biopsy. The patient responded well to chemotherapy.

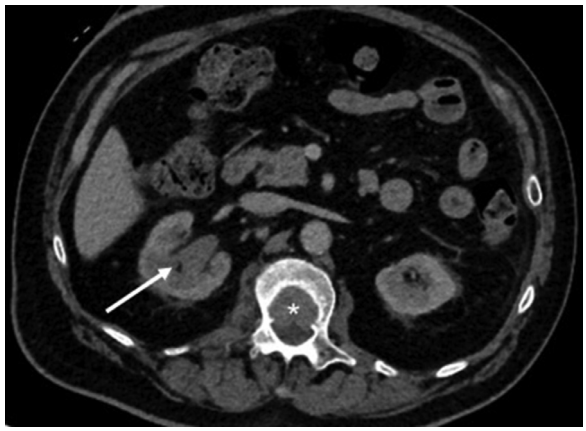

Figure 20 Portovenous phase CT showed abnormal soft tissue expanding the right renal pelvis (arrow). There is extensive bone destruction within the thoracic vertebral body at the same level with an extradural mass (*) causing imminent cord compression.

Conclusion

A variety of urinary diversion procedures exist postcystectomy, and knowledge of the imaging appearances is essential for the radiologist. Different imaging modalities can be used to characterize the anatomy and assist in the identification of early and late complications. This ultimately facilitates early diagnosis and management for patients.

References

1. Lee RK, Abol-Enein H, Artibani W, et al: Urinary diversion after radical cystectomy for bladder cancer: Options, patient selection, and outcomes. BJU Int 113:11-23, 2013
2. Bochner BH, Dalbagni G, Sjoberg D, et al: Comparing open radical cystectomy and robot-assisted laporoscopic radical cystectomy: A randomized clinical trial. Eur Orol 67:1042-1050, 2014
3. Hautmann RE, Abol-Enein H, et al: World Health Organization (WHO) Consensus Conference on bladder cancer. Urinary diversion. Urology 69(1 Suppl):17-49, 2007
4. Deliveliotis C, Papatsoris Chrisofos M, et al: Urinary diversion in high-risk elderly patients: Modifies cutaneous ureterostomy or ileal conduit? Adult Urol 66:299-304, 2005
5. Pycha A, Comploj E, Martini T, et al: Comparison of complications in three incontinent urinary diversions. Eur Urol 54:825-832, 2008
6. Rowland RG, Mitchell ME, Bihrle R, et al: Indiana continent urinary reservoir. J Urol 137:1136-1139, 1987
7. Singh V, Yadav R, Sinha RJ, et al: Prospective comparison of quality-of life outcomes between ileal conduit urinary diversion and orthotopic neobladder reconstruction after radical cystectomy: A statistical model. BJU Int 113:726-732, 2014
8. Studer UE, Zingg EJ: Ileal orthotopic bladder substitutes: What we have learned from 12 years' experience with 200 patients. Urol Clin North Am 24:781-793, 1997
9. Filner RB, Spencer JR: Malignancies in bladder audmentations and intestinal conduits. J Urol 143:671-678, 1990
10. Woodhouse CR, Christofides M: Modified ureterosigmoidostomy (Mainz II)-technique and early results. Br J Urol 81:247-252, 1998
11. Catala V, Sola M, Samaniego J, et al: CT findings in urinary diversion after radical cystectomy: Postsurgical anatomy and complications. Radiographics 29:461-476, 2009

12. Dual-energy CT with single-and dual-source scanners: Current applications in evaluating the genitourinary tract. Radiographics 32:353-369, 2012
13. McNicholas MM, Rptopoulous VD, Schwartz RK, et al: Excretory phase CT urography for opacification of the urinary collecting system. AJR AM J Roentgenol 170:1261-1267, 1998
14. Chow LC, Kwan SW, Olcott EW, et al: Split-bolus MDCT urography with synchronous nephrographic and excretory phase enhancement. AJR Am J Roentgenol 189:314-322, 2007
15. Raman SP, Horton KM, Fishman EK: MDCT evaluation of ureteral tumors: Advantages of 3D reconstruction and volume visualization. AJR Am J Roentgenol 201:1239-1247, 2013
16. Zagoria RJ: Genitourinary radiology. Requisites Series. St Louis, MO: Mosby, 2004
17. Hiorns MP: Imaging of the urinary tract: the role of CT and MRI. Paediatr Nephrol 26:59-68, 2011
18. Civelek AC, Apolo A, Agarwal P, et al: 18F-FDG PET-MRI in the management of muscle invasive bladder cancer: Challenges in imaging and solutions. J Nucl Med 57(suppl 2), 2016
19. Yang Z, Pan L, Cheng J, et al: Clinical value of whole body fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography in the detection of metastatic bladder cancer. Int J Urol 19:629-644, 2012
20. Goodfellow H, Viney Z, Hughes P, et al: Role of fluorodeoxyglucose positron emission tomography (FDG PET)-computed tomography (CT) in the staging of bladder cancer. BJU Int 114:389-395, 2014
21. Zattoni F, Incerti E, Dal Moro F, et al: 18F-FDG PET/CT and urothelial carcinoma: Impact on management and prognosis-a multicenter retrospective study. Cancers (Basel) 11:700, 2019
22. Nielsen ME, Mallin K, Weaver MA, et al: Association of hospital volume with conditional 90-day mortality after cystectomy: An analysis of the national cancer database. BJU Int 114:46-55, 2014
23. Nieuwenhuijzen JA, de Vries RR, Bex A, et al: Urinary diversions after cystectomy: The association of clinical factors, complications and functional results of four different diversions. Eur Urol 53:834-842, 2008
24. Kulkarni JN: Perioperative morbidity of radical cystectomy: A review. Indian J Urol 27:226-232, 2011
25. Farnham SB, Cookson MS: Surgical complications of urinary diversion. World J Urol 22:157-164, 2004
26. Tal R, Sivan B, Kedar D, et al: Management of benign ureteral strictures following radical cystectomy and urinary diversion for bladder cancer. J Urol 178:538-542, 2007
27. Turk TM, Koleski FC, Albala DM: Incidence of urolithiasis in cystectomy patients after intestinal conduit or continent urinary diversion. World J Urol 17:205-207, 1999
28. Gakis G, Black PC, Bochner BH: Systematic review on the fate of the remnant urothelium after radical cystectomy. Eur Urol 71:545-557, 2017
29. Tran W, Serio AM, Ra GV, et al: Longitudinal risk of upper tract recurrence following radical cystectomy for urothelial cancer and the potential implications for long-term surveillance. J Urol 179:96-100, 2008
30. Witjes JA, Comperat E, Cowan NC, et al: EAU guidelines on muscle invasive and metastatic bladder cancer: Summary of 2013 Guidelines. Eur Urol 65:778-792, 2014