Multi-detecter CT urography of various ureteral disease

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Learning objectives

We review the normal anatomy and illustrate the imaging features of various ureteral diseases on MDCTU. The article is organized as follows: (1) normal anatomy of the ureter, (2) traumatic and iatrogenic injuries, (3) inflammatory diseases, (4) urolithiasis, (5) primary and metastatic tumors, (5) post-radiation and post-operative change of the ureter.

Background

Many imaging modalities have been used in the evaluation of patient with suspicious ureteral diseases. Currently, MDCT urography (MDCTU) is increasingly used in the diagnosis of ureteral diseases. MDCTU is useful in the diagnosis of urolithiasis and other conditions such as trauma, infection, or tumor. And also MDCTU is useful for evaluating periureteral structures.

Findings and procedure details

The ureters
- paired muscular ducts with narrow lumina that carry urine from the renal pelvis to the bladder
- roughly 25-30 cm long and courses down the retroperitoneum
- begins at the level of the renal vessels posterior to these structures (L2 vertebra)
- continues anteriorly on the psoas major muscle
- course medial to the sacroiliac joint and then curve laterally in the pelvis
- enters the pelvis, where it crosses anteriorly to the iliac vessels, which usually occurs at the bifurcation of the common iliac artery
- course out to the ischial spines before coursing medially to penetrate the base of the bladder

Proximal ureter - the portion of the ureter between the kidney and the bony pelvis

Middle Ureter - the portion of the ureter which overlies the bony pelvis (the sacroiliac joint)

Distal ureter - the portion of the ureter between the bony pelvis and the bladder. The narrowest portion of the ureter is found as the ureter enters the bladder

Iatrogenic injury
The ureters are at risk during open surgery because of their proximity to many abdominal and pelvic structures
- Associated with abdominopelvic surgery or ureteroscopy

Risk factors: previous operations, bulky tumors, retroperitoneal fibrosis, previous radiation, inflammatory processes, ureteral duplication, and ectopic kidneys
- Potential to alter the expected course of the ureter

The upper ureter (39%), the mid ureter (31%), and the distal ureter (30%)

**Traumatic injury**

Ureteral injuries due to external trauma are rare
- Well-protected in the retroperitoneum by the bony pelvis, psoas muscle, and vertebrae

Damage to the ureter usually results from a significant traumatic event
- Involved in less than 1% of all genitourinary injuries caused by external trauma
- Penetrating injuries (ie, gunshot wounds, stab wounds) or blunt trauma

Contrast-enhanced CT

- Delayed excretory phase images (at least 10-15 minutes after contrast injection)
  : Highly sensitive in detecting contrast extravasation from the ureteral injury
Rupture or tear of the ureter
- Proximal dilatation if the ureteral lumen is narrowed
- Intramural hematomas: wall thickening with stranding of the periureteral fat
- Also illustrate accompanying lesions, particularly involving the kidney

**Ureteritis**

Primary inflammation disease of the ureter is rare
- May be caused from the upper urinary tract via urine, hematogeneous spread, or direct extension from lesions in adjacent organs

Regardless of the origin of inflammation, ureteral responses include loss of peristalsis, dilatation and striation due to redundancy, gas formation, mural infiltration, ulceration, pseudo-diverticulation, edema, and/or fibrosis

- Bacteria itself or endotoxin can decrease ureteral peristalsis # Dilation
- Nonspecific granulomatous ureteritis, an intrinsic inflammatory disease of the ureter with no history of previous related disease # Focal ureteral stricture that can be multiple

**Tuberculosis**
About 30% of extrapulmonary TBc involve the genitourinary tract
Due to the downstream passage of infected urine (50% Renal TBc)
Most common in the distal third of the ureter

Radiologic findings
Dilatation and a ragged mucosal irregularity : the first signs of ureteral tuberculosis -
Mucocal nodules and ulceration and ureteral wall thickening
As the disease progress # stricture and eventually forms a straight, rigid tube
: the characteristic " beaded" "corkscrew", "pipe stem" appearance
The ureterovesical orifice may become gaping, leading to reflux from the bladder
Ureteral wall calcifications : infrequent finding

**Suburothelial Hemorrhage**

Usually secondary to trauma or excessive administration of anticoagulant Tx
Hemorrhage within ureteral wall

Radiological findings
- Focal wall thickening with high attenuation
- multiple smooth filling defects of ureter or renal pelvis projecting into lumen
- radiological abnormality disappears a few days after correction of coagulopathy

**Urolithiasis**

The most common disorder of the urinary tracts and a common cause of obstructive uropathy. The prevalence increased with age and is about 2-3 times more common in men than in women. Stone formation is related to predisposing nondietary (family history, systemic disorder; hyperparathyroidism, renal tubular acidosis), dietary (calcium, oxalate, sodium), and urinary factors (hypercalciuria and hyperoxaluria). About 80% of urinary stones are calcium stones. Determination of etiology and treatment modality is influenced by the mineral content of stones

**Tumor**

Various tumors can arise from the ureter. Any benign or malignant tumors can arise from urothelium and mesodermal tissue.

Urothelial carcinoma is the most common tumor arising from urothelium, followed by squamous cell carcinoma, adenocarcinoma. Papilloma and inverted papilloma are benign tumors arising from urothelium, but extremely rare.
Ureteral or periureteral metastasis can occur by hematogenous route, lymphangitic spread or direct invasion by adjacent malignant tumors.

Tumors arising from mesodermal tissues are less frequent than from urothelium. Mesodermal tumors arise from smooth muscles, neural tissues, vascular tissues, fibrous tissue, or lymphoid tissues. Fibroepithelial polyp is the most common tumor among them. They include hemangioma, leiomyoma, neurofibroma, fibroepithelial polyp, and lymphoma.

**Upper urinary tract urothelial cell carcinoma**

Incidence is highest in the 50~70-year-old group, in men than in women
Hallmark: multiplicity and recurrence
Multicentric nature makes assessment of entire urothelium essential before Tx.
Bladder > Pelvocalyceal system > Ureter
Ureter: distal (73%) > mid (24%) > proximal (3%)

**Adenocarcinoma**

Rarer than UCC and squamous cell carcinoma
Like squamous cell carcinoma, caused by malignant transformation of metaplastic mucosa
Commonly associated with stone or chronic inflammatory disease
Dystrophic calcification : rather common, especially in mucin-producing adenoca
Difficult to differentiate adenocarcinoma from UCC radiologically

**Fibroepithelial Polyp**

Benign mesodermal tumors of the ureter composed of a fibrovascular core lined by normal urothelium
Age: 20-40 yrs
Intermittent abdominal pain, flank pain, gross hematuria (rare)
Commonly solitary and in the proximal ureter

Radiologic findings
- elongated cylindrical filling defect c smooth margin mobile on thin pedicle (1~13cm)
- not be easily differentiated from urothelial malignancy

**Post-operative change**

Depending on the type, duration, and location of the ureteral injury, and the histologic type, grade, stage, location of the ureteral tumor, and fistula, operative treatment may range from simple removal of a ligature to ureteroneocystostomy.
The type of operative treatments: simple removal of a ligature, ureteral stenting, ureteral resection and ureteroureterostomy, transureteroureterostomy, and ureteroneocystostomy, nephroureterectomy.

Ureteroneocystostomy
- Reimplantation of the ureter into the bladder for disease or trauma involving the distal ureter that results in obstruction or fistula (close proximity to the bladder: 3-5 cm) and VUR.

Vesicopsoas hitch
- The treatment of choice for lower ureteral injuries that cannot be successfully repaired with ureteroneocystostomy alone. This procedure involves mobilizing the bladder and pulling it superiorly and laterally by fixing it to the psoas tendon with an absorbable suture. This technique can be used to bridge a 6-8cm defect.

Boari bladder flap
- It provide an additional 12-15 cm of length. In this procedure, a pedicle of bladder is swung cephalad and tubularized to bridge the gap to the injured ureter.

Images for this section:

Fig. 1: Ureteral perforation due to URS with laser lithotripsy for stone in a 52-year-old man. (a) CT shows a lower ureteral wall thickening with mild enhancement. (b) CT shows multiple extraluminal air bubble and urine collections. (c,d) Excretory phase CT images show contrast extravasation at the rupture site.
Fig. 2: Ureteral injury due to incar TA in a 46-year-old man. (a,b) CT shows a hydroureter and perirenal and retroperitoneal urinomas. (c) CT shows contrast extravasation at the rupture site (arrow). (d) CT shows large amount of contrast extravasation.

Fig. 3: Ureteral injury due to stab wound in a 40-year-old man. (a,b) CT shows a hydroureteronephrosis with mild mucosal enhancement. (c) CT shows a abrupt luminal narrowing at injury site and adjacent extraluminal hematoma. (d) CT shows a large hematoma in the anterior abdominal wall (stab wound).
**Fig. 4:** Bacterial ureteritis. CT images show various ureteral wall thickenings with enhancement and stranding of the periureteral fat and dilatation and narrowing.

**Fig. 5:** Tuberculosis of the left urinary tract and kidney in a 45-year-old woman. (a) CT shows mid ureteral wall thickening and mild dilatation. (b) CT shows multifocal uneven caliectasis and a cyst. (c) CT at lower level shows a hydroureter.

**Fig. 6:** Suburothelial hemorrhage due to anticoagulant in a 54-year-old woman with MDS. Axial multi-phase CT images show diffuse wall thickening with high attenuation
and hydroureteronephrosis in the renal pelvis and upper ureter. CT images also show minimal mucosal enhancement and stranding of the periureteral fat.

**Fig. 7:** Direct signs of ureteral stone. (a,b,c) CT shows a high attenuated stone within ureteral lumen (Soft tissue rim sign) and proximal ureteral dilatation. (d) CT shows the comet tail sign created by an eccentric tapering soft-tissue area adjacent to a phlebolith.

**Fig. 8:** Secondary signs of ureteral stone. (a,b,c) CT images show the hydronephrosis and unilateral renal enlargement, hydroureter, perinephric strading

**Fig. 9:** Various types of ureteral urothelial carcinomas. Axial CT image shows a circumferential focal wall thickening - type cancer (a) and an intraluminal polypoid mass - type cancer (b) and a large infiltrative mass - type cancer (c).
Fig. 10: Ureteric adenocarcinoma in a 55-year-old man. (a,b) CT images show a circumferential focal wall thickening with hydroureter in the distal ureter. (c) CT image 2 years ago shows a ureteral stone and marked ureteral wall thickening.

Fig. 11: Fibroepithelial polyp in a 39-year-old man. Excretory CT images show an elongated filling defect with hydroureter in the mid and distal ureter.

Fig. 12: Ureteral resection and ureteroureterostomy in a 23-year-old man with benign ureteral stricture.
Conclusion

Imaging of the ureter based on CT urography is valuable for the evaluation of patients with various ureteral diseases. Because the ureter has a very thin wall and small diameter, we could miss important ureteral abnormalities if we don't take a close look at them. Although some imaging findings overlap between various diseases, each ureteral disease have specific clinical history and symptoms and imaging characteristics in location, shape, enhancement and relationship with adjacent organ, which leads to correct diagnosis.

Personal information

References


