Imaging findings in renal infections

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Learning objectives

The objectives are to identify and describe the radiologic findings of kidney infections and their possible complications, imaging characterization of different forms of pyelonephritis and highlight the role of urography, ultrasonography and CT in adult patient evaluation with suspected urinary tract infection.

Background

Urinary tract infections are the most common urologic disease. Diagnosis is based on typical clinical symptoms and laboratory findings. In general, imaging is not necessary for diagnosis and treatment of uncomplicated urinary tract infections in adult patients. However, diagnostic imaging demonstrates the extent and nature of the urologic infections and their potential complications.

Imaging findings OR Procedure details

Acute bacterial pyelonephritis

Abdominal radiography is often performed as initial screening study for suspected pyelonephritis. It detects gas and calcifications in the urinary tract.

The findings on excretory urography include renal enlargement, a delayed nephrogram and possible dilatation of the collecting system. Currently, however, it is a technique in disuse due to limitations such as the inability to characterize renal masses and renal parenchyma or its renal function dependency, so that the TC has largely displaced this exploration.

In ultrasonography, most pyelonephritis don´t show any abnormality. In other cases, it shows renal enlargement, hydronephrosis, loss of renal corticomedullary differentiation, changes in renal parenchymal echogenicity due to hemorrhage (hyperechoic) or edema (hypoechoic) and areas of hypoperfusion visible with color Doppler or power Doppler. Sometimes pyelonephritis areas may have a masslike appearance.

CT is the technique of choice for the evaluation of pyelonephritis. Unenhanced CT is excellent for identifying gas in the urinary tract, calculi, bleeding and dilatation of the urinary tract. After intravenous contrast material administration, pyelonephritis manifests as "wedge shaped" areas of lesser enhancement that extend from the sinus to the renal cortex. The excretory phase, obtained between 3 and 5 minutes after the administration of the contrast material, should be performed in suspected urinary obstruction.
CT is also the best modality to evaluate the secondary signs of renal inflammation and its complications, including trabeculation of perinephric fat, thickening of Gerota’s fascia and abscess formation.

In TC, abscesses appear as low attenuation collections, with no central enhancement but an enhancement ring. In US, abscesses appear as hypoechoic masses with posterior acoustic transmission, that lack internal flow with color Doppler.

**Chronic pyelonephritis**
The characteristic radiologic findings are the existence of renal scarring with cortical thinning, hypertrophy of the respected parenchyma and calyceal dilatation with renal asymmetry.

**Pyonephrosis**
It is an excretory system which is infected and, usually, obstructed and dilated.

Ultrasound can show pelvicalyceal dilatation occupied by echogenic material and fluid-fluid levels.

In TC we can identify renal pelvis wall thickening, more than 2 mm, parenchymal and perinephric inflammatory changes or excretory tract dilatation containing greater attenuation content than usually.

**Emphysematous Pyelonephritis**
It is a necrotizing infection of the kidneys characterized by the formation of gas within or surrounding the kidneys.

Conventional radiography may show gas collections or bubbles overlying the renal fossa.

Ultrasound shows enlarged kidneys and echogenic foci within the renal parenchyma or collecting system. These echogenic foci have low-level posterior dirty acoustic shadowing.

The CT findings include enlargement and destruction of the renal parenchyma, air bubbles and, often, fluid collections. Emphysematous pyelonephritis can be divided into two types, with different prognoses:

- **Type I** is characterized by renal parenchymal destruction with gas, without fluid collections
- **Type II** with renal or perirrenal fluid collections, associated with air bubbles

The type I has a more aggressive clinical course with greater morbidity and mortality than type II.
**Emphysematous pyelitis** is a less aggressive form of emphysematous infection is diagnosed by the presence of gas in the renal collecting system.

**Xantogranulomatous pyelonephritis**

It is a chronic and destructive granulomatous disease, induced by recurrent urinary tract infections.

The characteristic finding in **radiography** is the presence of a large kidney staghorn calculus, associated with increased kidney size and psoas contour blurring.

In **excretory urography** there is a decrease in renal function with no excretion of intravenous contrast.

**Ultrasound** shows an enlarged kidney with a large amorphous calculus with acoustic shadowing amorphous in the renal pelvis, involving loss of renal echotexture and calyceal dilatation.

**TC** identifies a renal enlargement with a central staghorn calculus with calyceal dilatation, replacement of renal parenchyma by fluid collections and inflammatory changes in the perirrenal fat.

Complications may occur such as psoas abscesses or cutaneous or colonic fistulas.

**Renal Tuberculosis**

The urinary tract is the most common site of extrapulmonary tuberculosis and results from hematogenous dissemination.

The collector system shows thickening, ulceration and fibrosis with stenosis. Stricture formation in the urinary tract can result in focal non-excretion, "phantom calix" and can associate caliectasia.

Characteristically cavities are formed by papillary necrosis in the renal parenchyma, which may communicate with the collecting system. Parenchymal lesions lead to cortico-medullary scarring and renal contour irregularities.

It is frequent the presence of calcifications in the renal parenchyma, which may be granular, amorphous or curvilinear, and, typically, coming to replace part of the renal parenchyma.

Ureteral involvement is manifested by extensive stenosis and irregularity with a "corkscrew" shape.
Radiographic findings include pelvic and infundibular strictures, papillary necrosis, cortical masses with low attenuation, renal scarring and calcifications. The combination of three or more findings are highly suggestive of renal tuberculosis.

Images for this section:

**Fig. 1:** Hydronefrosis. Dilated collecting system in US imaging, which is produced by a lithiasis in renal pelvis.
Fig. 2: (a) US shows a round shaped hyperechoic focus in the inferior pole of the right kidney related to acute bacterial pyelonephritis. (b) US also shows mild dilatation of the collecting system in the right kidney.
**Fig. 3:** Hipovascular area in the upper pole with power Doppler, due to acute pyelonephritis.
Fig. 4: Acute bacterial pyelonephritis. US demonstrates a lobulated hypoechoic masslike area in the upper pole of the right kidney.
Fig. 5: Contrast-enhanced CT demonstrates an area of decreased enhancement with a "wedge shaped" that extends to the periphery of the kidney in the midpole of the right kidney.
Fig. 6: CT without contrast material shows focal hyperattenuation areas in the upper pole of the right kidney which does not present enhancement with contrast administration, findings suggestive of hemorrhagic acute bacterial pyelonephritis.

Fig. 7: (a) US shows a renal abscess as an hypoechoic lesion with internal echoes in the midpole of the right kidney.
Fig. 9: Enhanced CT scan demonstrates an abscess with peripheral inflammatory changes and stranding throughout the perinephric space and thickening of Gerota fascia. Simple cyst in the left kidney.
Fig. 10: (a) CT scan demonstrates an abscess cavity with peripheral enhancing rim in the left kidney. (b) We also see stranding throughout the perinephric space and thickening of Gerota fascia.
**Fig. 11:** CT scan shows a small, deformed left kidney with deep scars and dystrophic calcifications in a chronic pyelonephritis.

**Fig. 12:** Pyonephrosis. US image shows a dilated collecting system with a fluid-fluid level with echogenic debris.
**Fig. 13**: Pyonephrosis. Dilatation and enhancing walls of the collecting system and higher than usual attenuation values of the fluid within the renal collecting system.
**Fig. 14:** CT demonstrates intraparenchymal air within the left kidney related to enphysematous pyelonephritis.
**Fig. 15:** Abdominal radiograph shows a classic staghorn calculus secondary to xanthogranulomatous pyelonephritis in the right kidney.

**Fig. 16:** US scan shows a large shadowing calculus corresponding to a staghorn calculus and a fluid collection in the perinephric space related to a xanthogranulomatous pyelonephritis.
Fig. 17: Contrast-enhanced CT scan demonstrates a fragmented staghorn calculi with distension of the right collecting system secondary to inflammatory debris in a xantogranulomatous pyelonephritis.
Fig. 18: Xantogranulomatous pyelonephritis. Fluid collections with rim enhancement in the perirenal and pararenal spaces that extent to the lumbar region in a 72 years female who consulted for a lumbar mass.
Fig. 19: Renal tuberculosis. Contrast enhanced nephrographic phase CT shows dilated calices and thinning of the renal cortex with thin calcifications.
Conclusion

The diagnosis of urinary tract infections in adults is based on clinical symptoms and laboratory findings. However, in an appropriate clinical context, imaging findings suggest the correct diagnosis and accurate assessment of the extent of the infection and its complications, essential for planning medical or surgical treatment of the disease.

References


Personal Information