

Infectious diseases of the kidney - spectrum of imaging findings

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Learning objectives

- To discuss the role of imaging in the evaluation of renal infections.
- To review the US and CT imaging findings of some common and not so common infectious diseases of the kidney, including acute pyelonephritis, pyonephrosis, emphysematous pyelonephritis, xanthogranulomatous pyelonephritis and tuberculosis.

Background

Urinary tract infections are the most common urologic disease. In the adult population they are typically diagnosed on the basis of clinical symptoms and laboratory findings.

Acute bacterial pyelonephritis is the most frequent renal infection but a variety of other infectious processes can be seen. Usually emergency radiological investigation is not required for diagnosis and treatment of uncomplicated cases in adults.

The role of imaging is:

- to assist in the diagnosis of acute pyelonephritis when the patient doesn't respond to appropriate therapy within the first 72 hours;
- to look for any complications that would need specific therapeutic management (obstruction of the collecting system; renal or perirenal abscess);
- to assess those patients at significant risk for more severe life-threatening complications (eg diabetic, elderly or immunocompromised patients);
- to look for previously occult structural or functional abnormalities;
- to identify rare forms of pyelonephritis in atypical clinical presentations or with atypical laboratory results.

Pyonephrosis is a suppurative infection that occurs in the setting of a hydronephrotic obstructed kidney and is considered a urologic emergency requiring urgent drainage. The obstruction may arise from calculi, tumor, complications from pyelonephritis (sloughed papilla) or strictures. Pyonephrosis should be suspected in any patient with a known urinary tract obstruction accompanied by fever and flank pain.

Emphysematous pyelonephritis is a life-threatening gas-forming infection resulting in necrosis of the renal parenchyma. The majority of patients have poorly controlled diabetes. No diabetic patients are typically immunocompromised or have associated urinary tract obstruction by stones, neoplasm or sloughed papilla.

Xanthogranulomatous pyelonephritis is an unusual form of chronic pyelonephritis in which the renal parenchyma is destroyed and replaced by lipid-laden foamy macrophages. It usually affects middle-aged women with a history of recurrent urinary tract infections, diabetes or kidney stones.

The urinary tract is the most common extrapulmonary site of **tuberculosis**, being affected in 4 to 8% of patients with evidence of pulmonary tuberculosis. Almost all cases result from hematogenous dissemination of *Mycobacterium tuberculosis* to the kidney after initial pulmonary inoculation. Despite this presumed route of spread from the lungs to the kidney, less than 50% of patients with urinary tract tuberculosis have abnormal chest radiography. Clinical diagnosis is usually delayed because of the insidious onset and nonspecific symptoms. Hematuria and culture-negative pyuria may be seen at urinalysis.

Findings and procedure details

Acute bacterial pyelonephritis

- In most patients with clinically suspected pyelonephritis **ultrasound** imaging shows a normal appearing kidney. When positive findings are found they can include renal enlargement (kidney length at least 1,5 cm longer than the unaffected side); loss of renal sinus fat due to edema; loss of corticomedullary differentiation; changes in renal echogenicity with either hypoechoic or hyperechoic areas; hydronephrosis and areas of hypoperfusion visible with Doppler evaluation ([Fig. 1](#) on page 23 and [Fig. 2](#) on page 24).

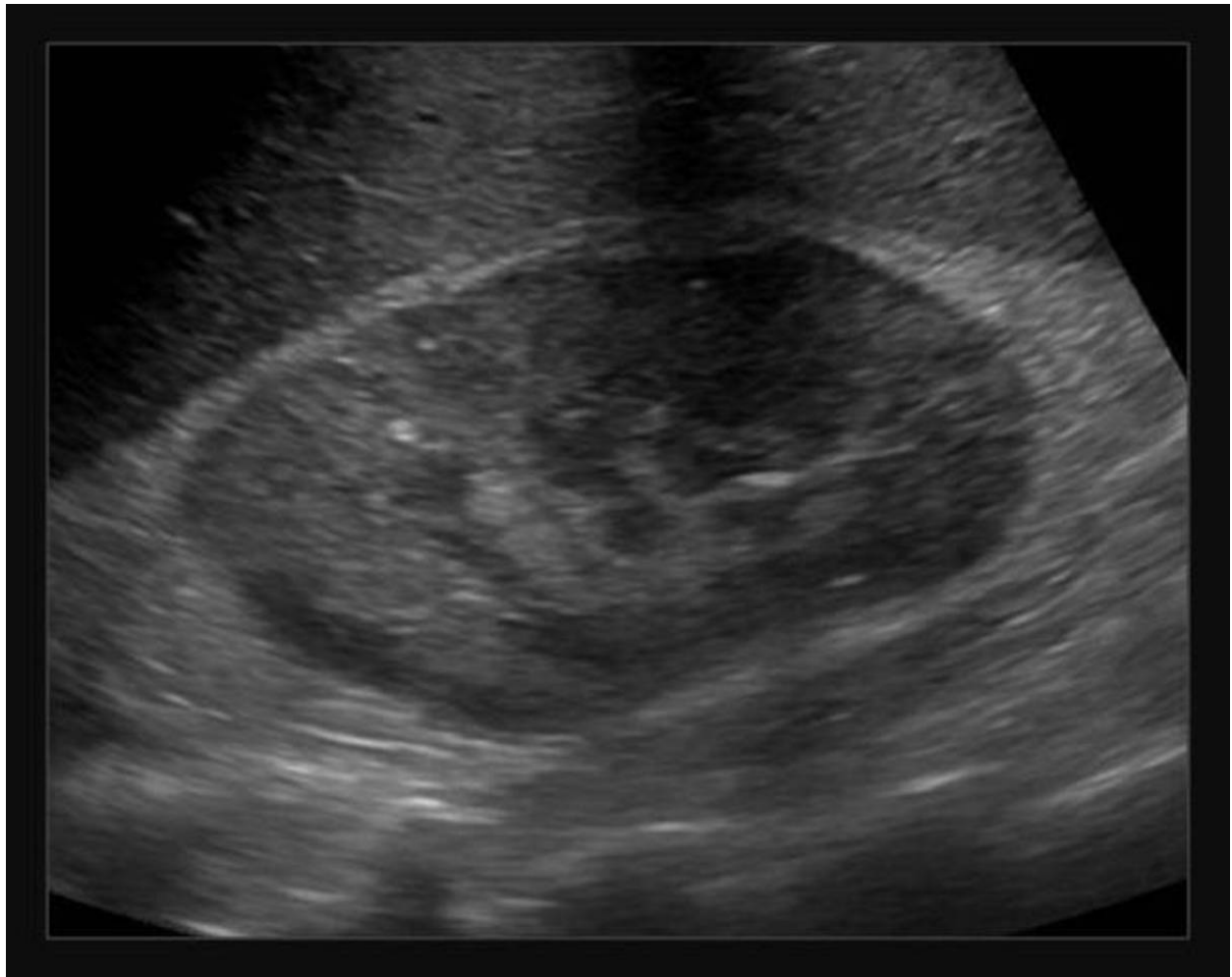


Fig. 1: Acute pyelonephritis. Ultrasound scan shows an enlarged right kidney with diffuse hyperechogenicity of the parenchyma and loss of differentiation.

References: Serviço de Radiologia, Centro Hospitalar Tondela-Viseu, Portugal

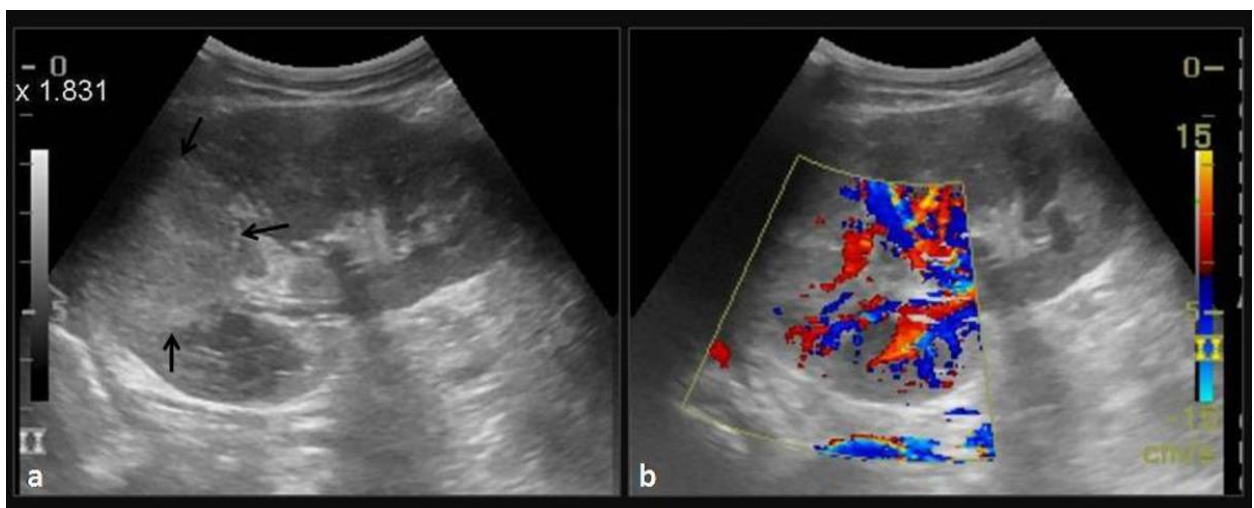


Fig. 2: Acute bacterial pyelonephritis. (a) US scan shows a wedge-shaped hyperechoic focus (arrows) in the upper pole of the right kidney related to acute bacterial pyelonephritis. (b) Color flow US image demonstrates diminished flow through the involved area.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

- **CT** is the modality of choice for evaluating acute bacterial pyelonephritis. The classic CT finding on contrast-enhanced studies is the so-called striated nephrogram which appears as a wedge-shaped area of hypoattenuation extending from the papilla to the renal cortex. Additional CT findings include focal or global renal enlargement, thickening of Gerota fascia, perinephric stranding and urothelial thickening (Fig. 3 on page 25 and Fig. 4 on page 25) .

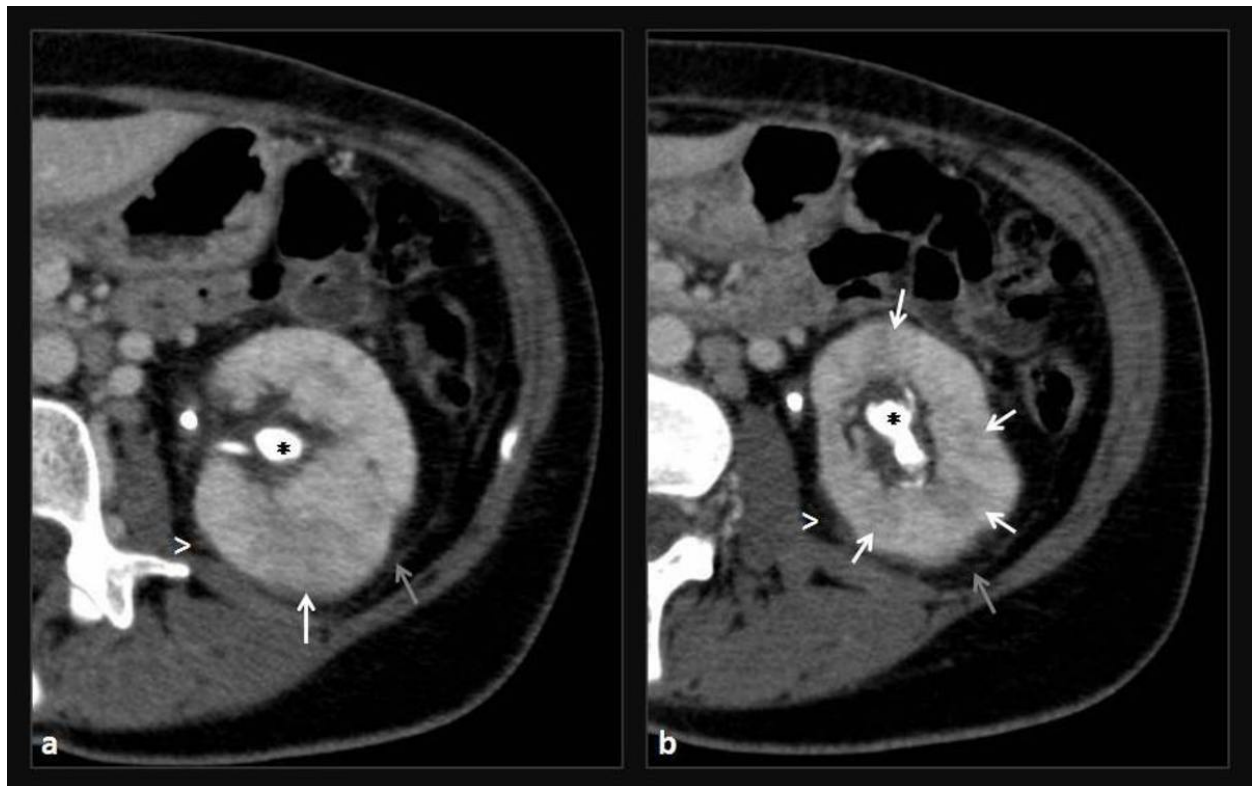


Fig. 3: Acute pyelonephritis. Contrast-enhanced axial CT images show several wedged-shape areas of decreased enhancement consistent with a striated nephrogram (white arrows). They also demonstrate a large stone in the renal pelvis (*), perinephric stranding (arrowheads) and thickening of Gerota fascia (grey arrow).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

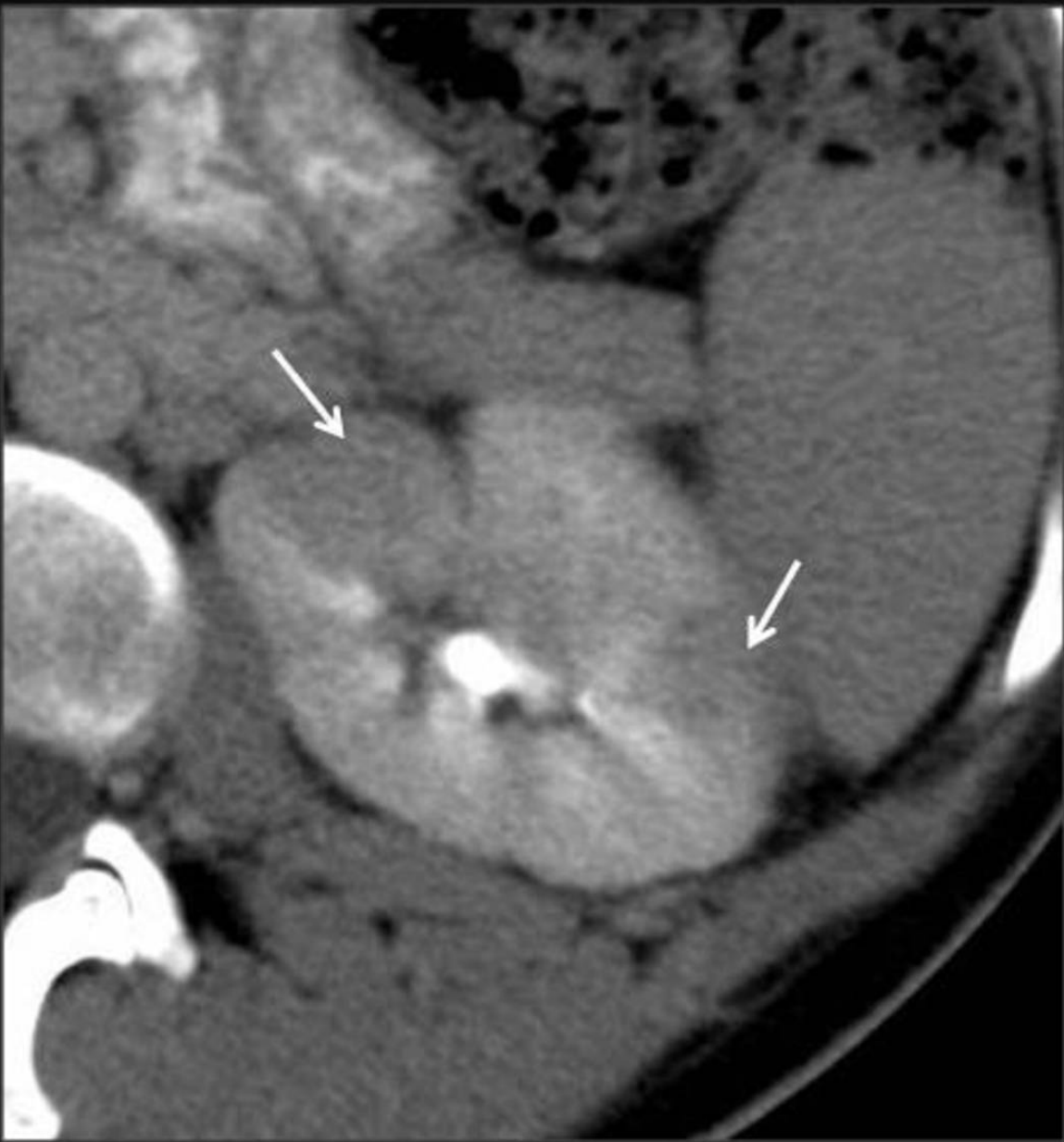


Fig. 4: Acute pyelonephritis. Contrast-enhanced axial CT image (excretory phase) shows several wedged-shape areas of decreased enhancement consistent with a striated nephrogram (arrows).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

- Acute pyelonephritis can also present as a focal alteration with a masslike appearance mimicking a neoplasm. Clinical history is fundamental in suggesting the diagnosis of focal pyelonephritis and follow-up imaging after appropriate therapy may be necessary to exclude a renal mass ([Fig. 5](#) on page 26, [Fig. 6](#) on page 27 and [Fig. 7](#) on page 28).

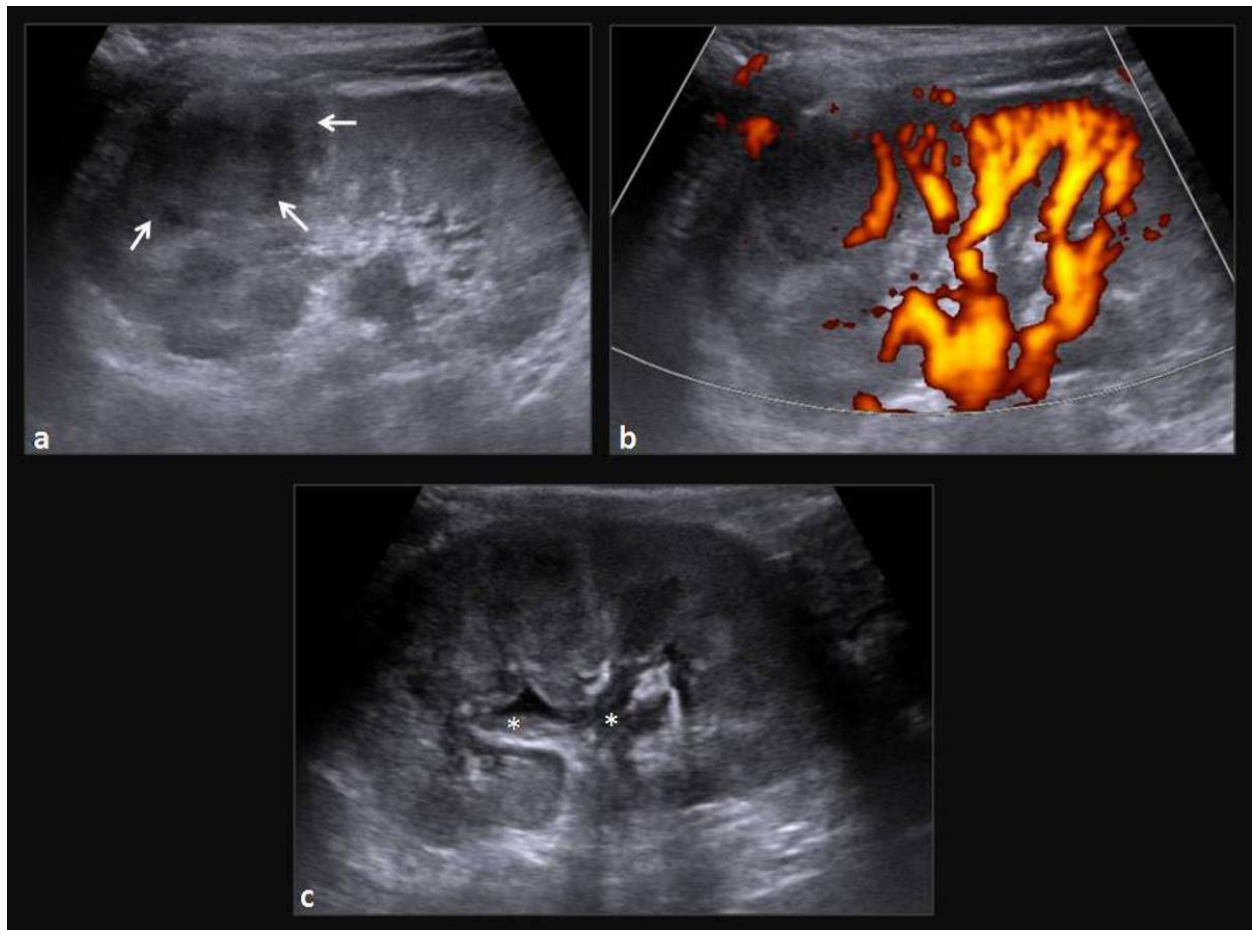


Fig. 5: Focal acute pyelonephritis. (a) US scan demonstrates a hypoechoic "mass" (arrows) in the upper pole of the right kidney, a finding that is worrisome for a solid tumor. (b) Power Doppler image demonstrates diminished flow through the involved area. (c) There is also thickening of the walls of the collecting system (*).
References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

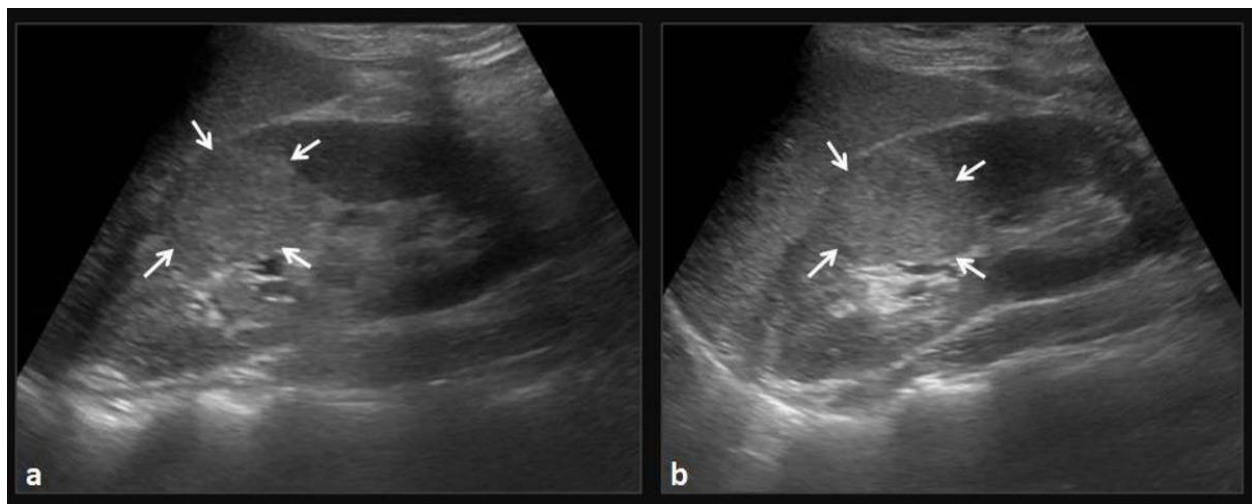


Fig. 6: Masslike appearance of acute bacterial pyelonephritis. US scan demonstrates a geographic, slightly lobulated, hyperechoic "mass" (arrows) in the mid pole of the right kidney, a finding that is worrisome for a solid tumor.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

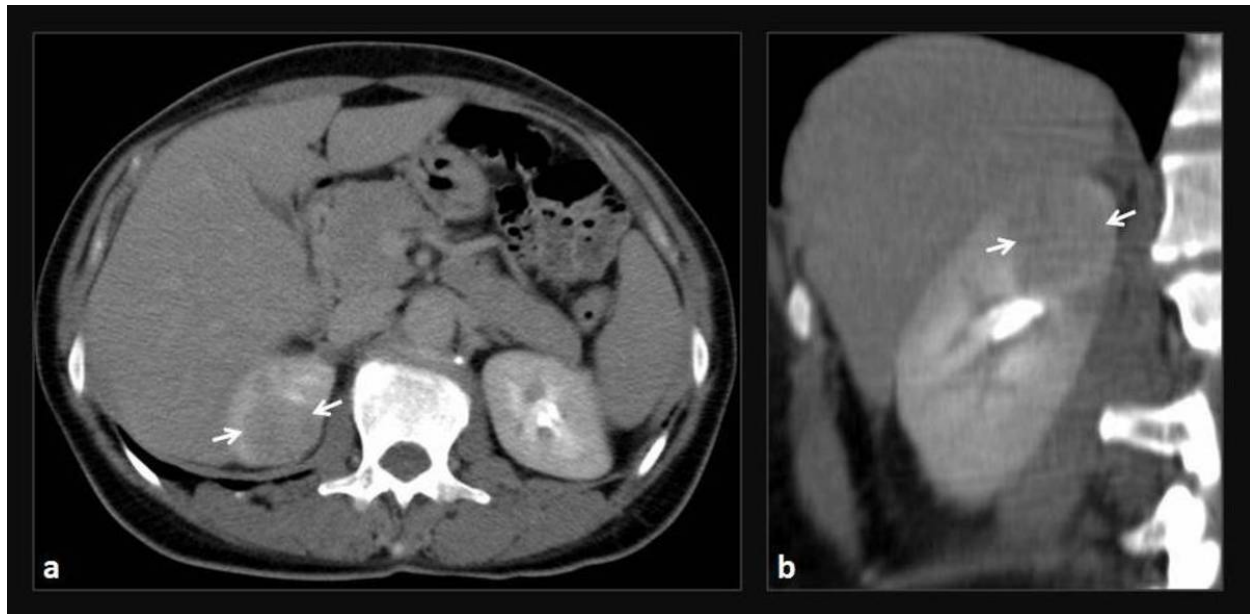


Fig. 7: Focal acute pyelonephritis. Axial (a) and coronal (b) contrast-enhanced CT images (excretory phase) show a nodular hypodense area in the upper pole of the right kidney, representing a focus of pyelonephritis.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

- In cases of untreated or inadequately treated pyelonephritis, tissue necrosis and liquefaction can occur resulting in **abscess** formation.

- **Ultrasonography** is less sensitive than CT in evaluating for the presence of an abscess, and small microabscesses, which are common in early acute infection, are frequently missed by this technique (Fig. 8 on page 28). When positive imaging findings are found, US demonstrates a fluid-filled mass with distinct walls, sometimes with internal echoes (Fig. 9 on page 29).



Fig. 8: Acute pyelonephritis with microabscesses. Axial (a and b) and coronal (c) contrast-enhanced CT images show several wedged-shape areas of decreased enhancement (*) and small collections representing microabscesses (arrows) which were not seen on ultrasound scan.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

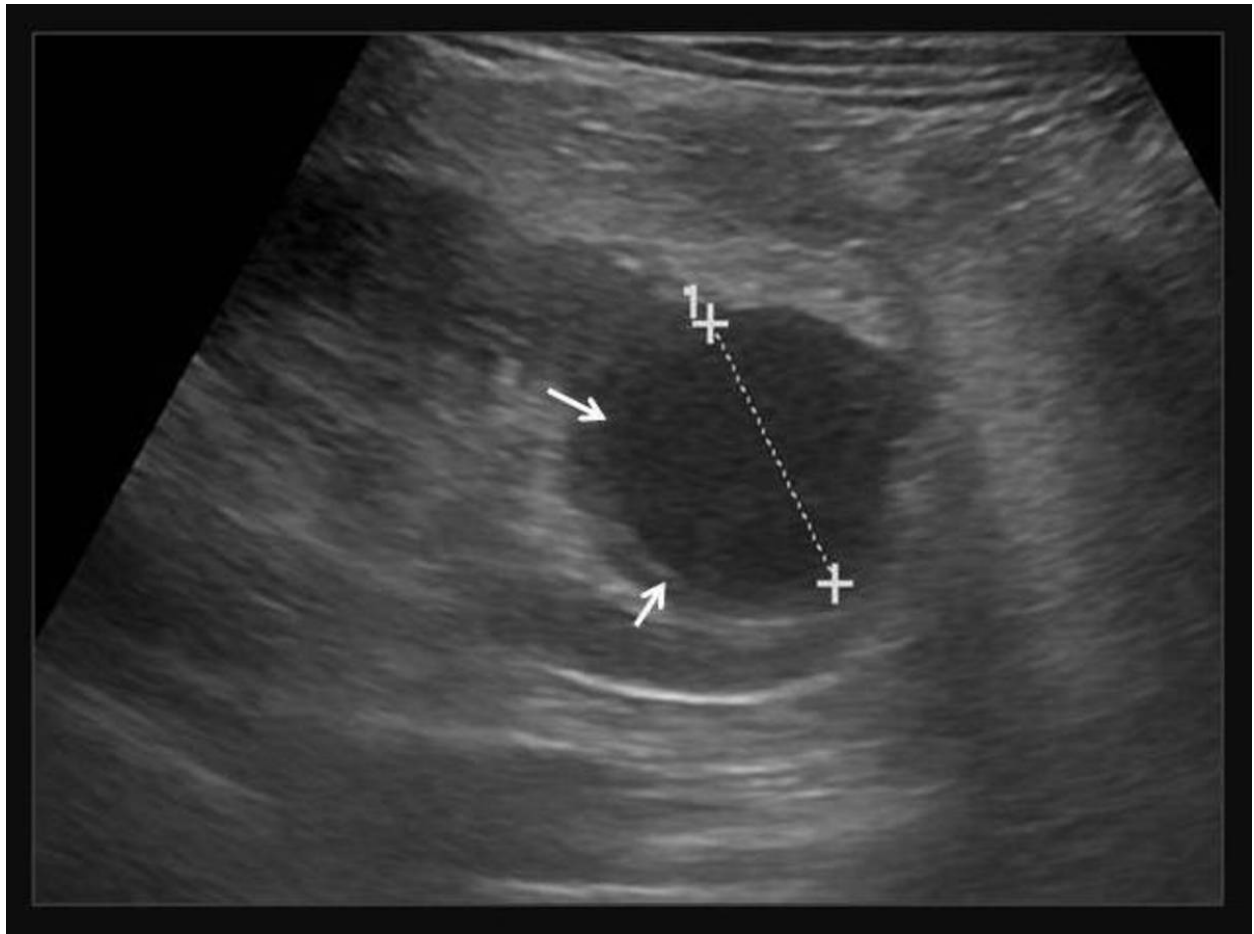


Fig. 9: Renal abscess. US scan of the left kidney shows a well-defined hypoechoic lesion near the lower pole, with a visible pseudocapsule (arrows).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

- Contrast-enhanced **CT** shows round or geographic low-attenuation collections with enhancing walls. Abscess cavities may be single or multiple and either intra or extraparenchymal. Gas within the collections may or may not be present ([Fig. 10](#) on page 30, [Fig. 11](#) on page 31, [Fig. 12](#) on page 31 and [Fig. 13](#) on page 32)



Fig. 10: Renal abscess (same case as in fig.9). Coronal (a) and axial (b) contrast-enhanced CT images show a round low-attenuation collection (*) with enhancing walls (arrows), in the mid pole of the left kidney.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

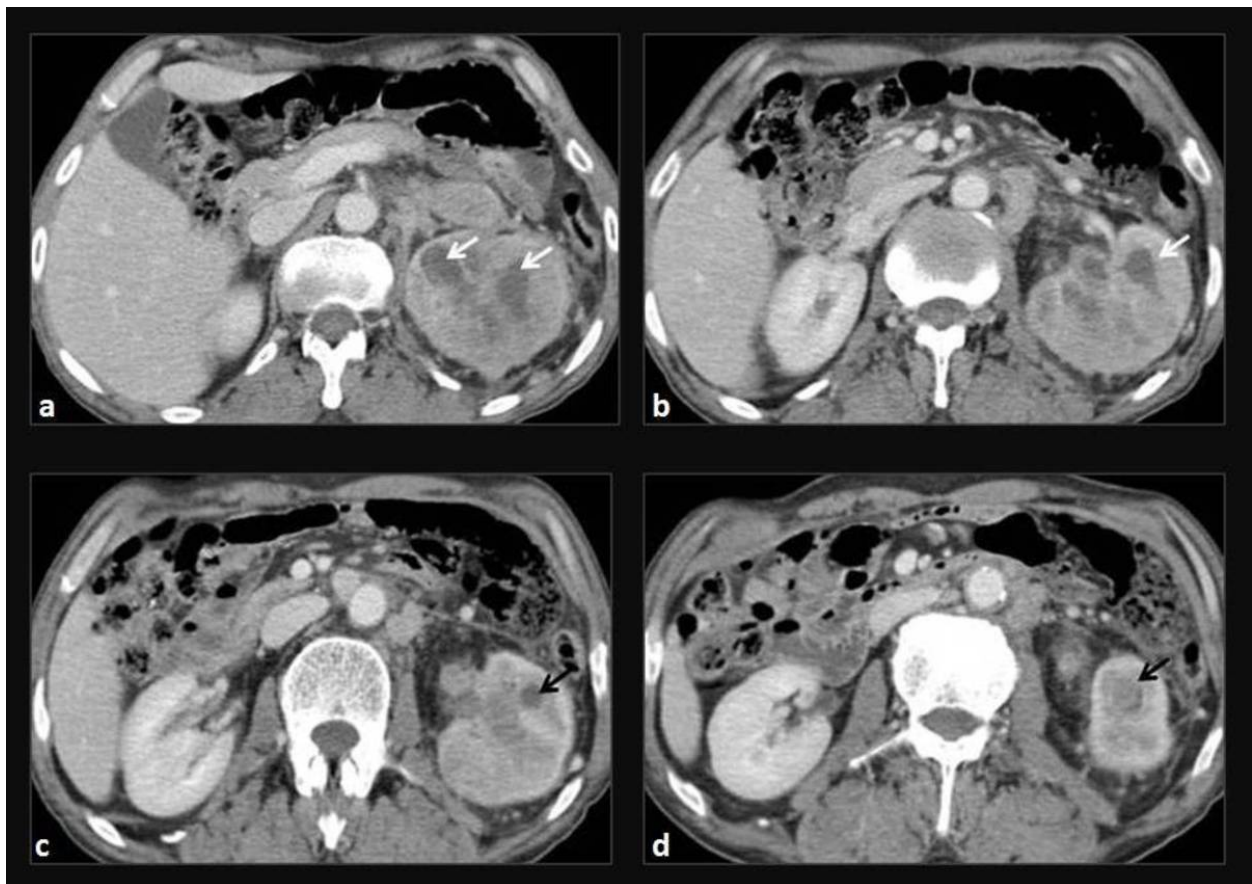


Fig. 11: Multiple renal abscesses. Axial contrast-enhanced CT images show an enlarged and heterogeneous left kidney, with multiple hypodense collections representing abscesses (white arrows). There is also dilatation of several calyces in the lower pole, which are filled with dense material (pyonephrosis) (black arrows).
References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

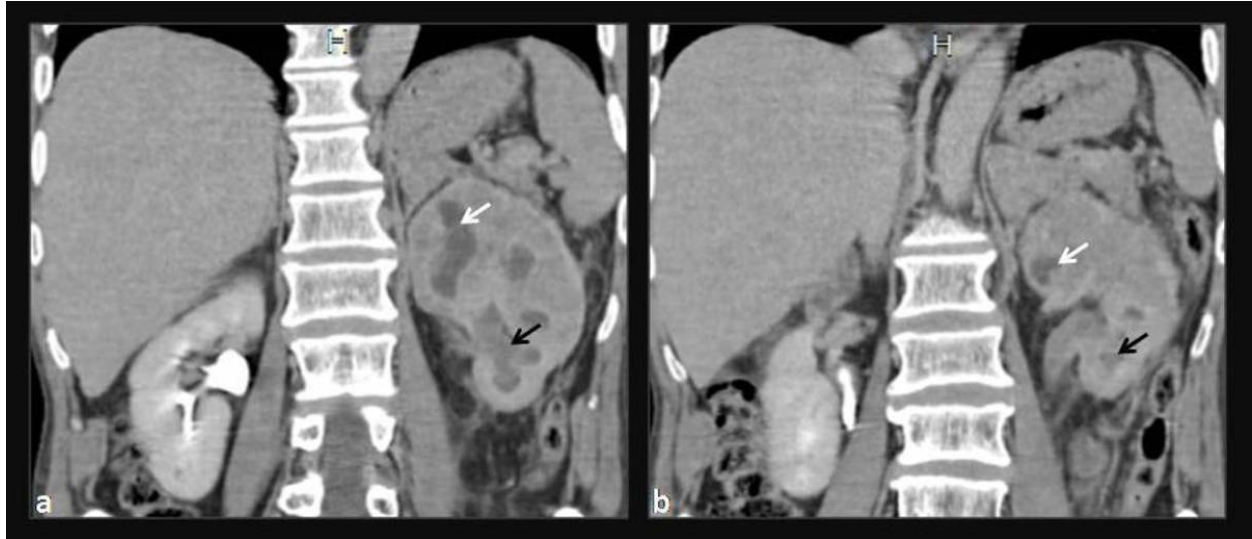


Fig. 12: Multiple renal abscesses (same case as in fig. 11). Coronal contrast-enhanced CT images show an enlarged and heterogeneous left kidney, with multiple hypodense collections representing abscesses (white arrows). There is also dilatation of several calyces in the lower pole, which are filled with dense material (pyonephrosis) (black arrows).
References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

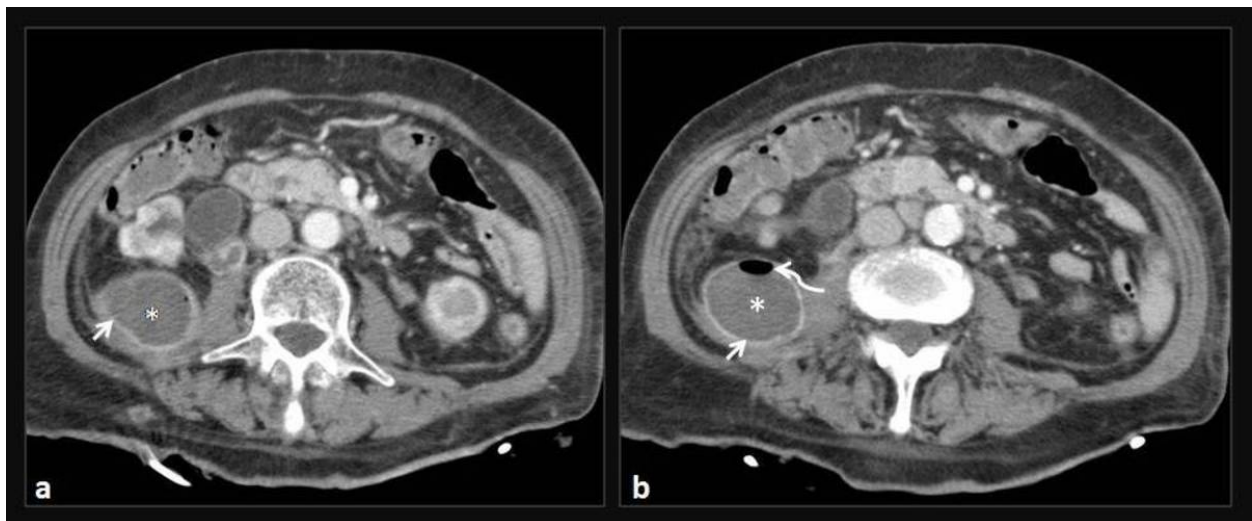


Fig. 13: Extraparenchymal abscess. Axial CT images show a well-defined low-attenuation collection (*), with enhancing walls (arrows) and gas (curved arrow), in the right retroperitoneal region.

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

Pyonephrosis

- **Ultrasonography** demonstrates echogenic debris in dependent portions of a dilated collecting system. If air is present in collecting system, echogenic foci with dirty shadowing may be present (Fig. 14 on page 32).

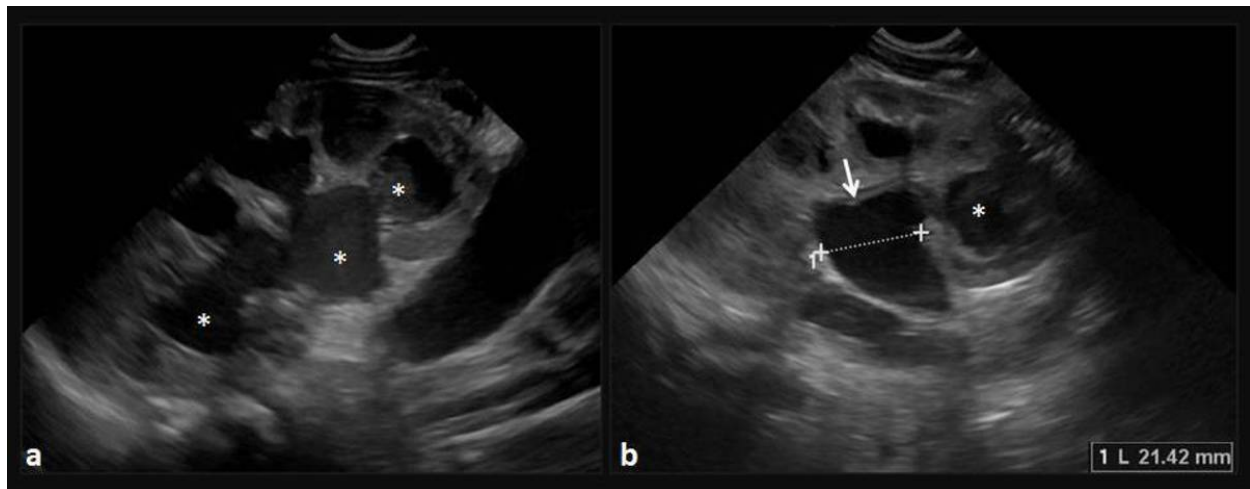


Fig. 14: Pyonephrosis. US scan images show a dilated collecting system that is partially filled with echogenic debris (*). There is also thickening of the collecting system walls (arrow).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

- **CT** shows dilatation of the collecting system (usually demonstrating the cause of obstruction); higher than usual attenuation values of the fluid within the renal collecting system; thickening of renal pelvis wall (> 2 mm) and parenchymal or perinephric inflammatory changes (Fig. 15 on page 33). A caveat to CT evaluation is that it is often difficult to distinguish simple hydronephrosis from pyonephrosis on the basis of fluid attenuation measurements.

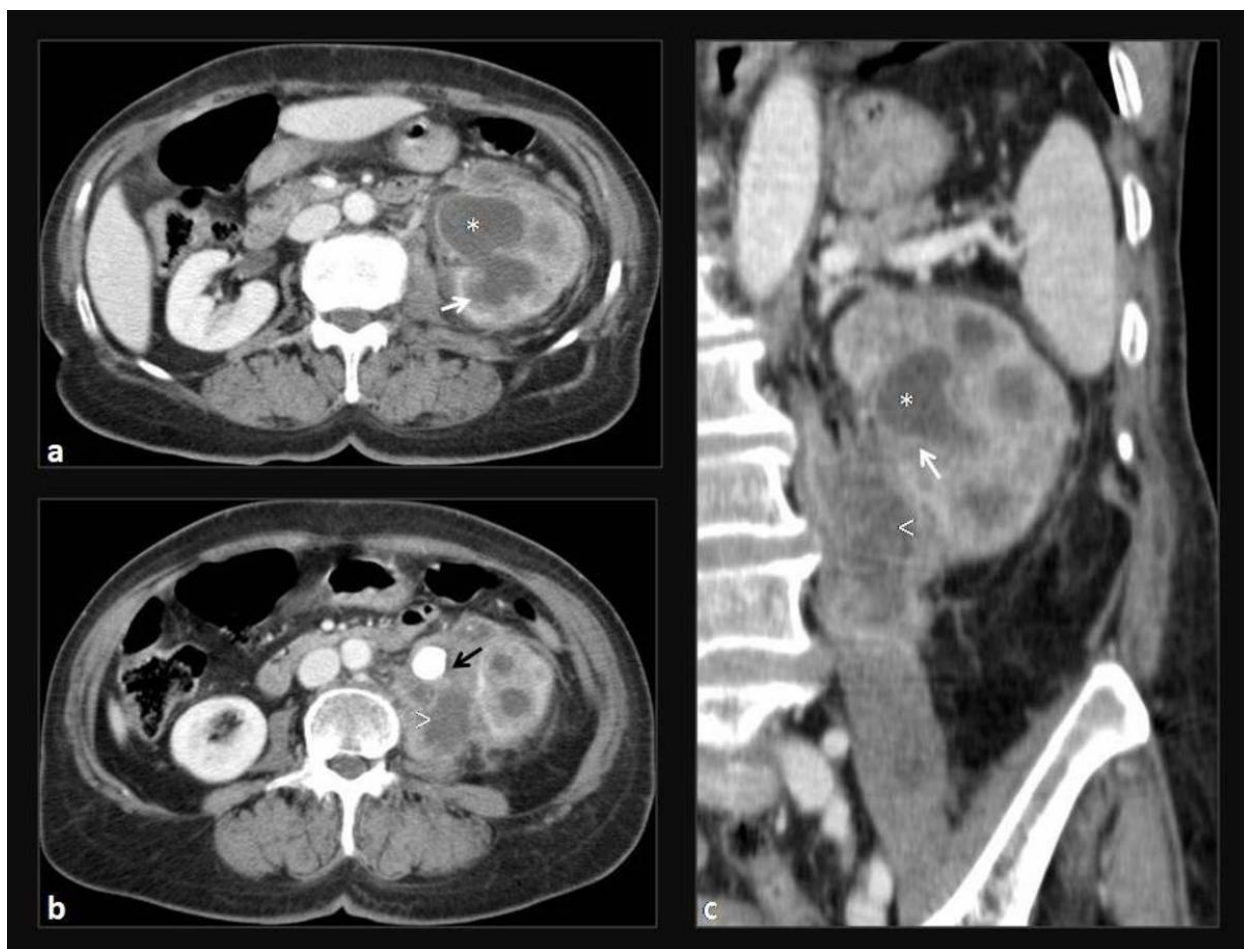


Fig. 15: Pyonephrosis. Axial (a and b) and coronal (c) CT images show a dilated collecting system (*) with thickening of its walls (white arrows). There is also a perinephric abscess with extension to psoas muscle (arrowhead), and a large stone in the proximal ureter (black arrow).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal

Emphysematous pyelonephritis

- **Ultrasonography** demonstrates an enlarged kidney with parenchymal high-amplitude echoes with posterior acoustic dirty shadowing, but it may underestimate the extent of parenchymal involvement ([Fig. 16](#) on page 34).

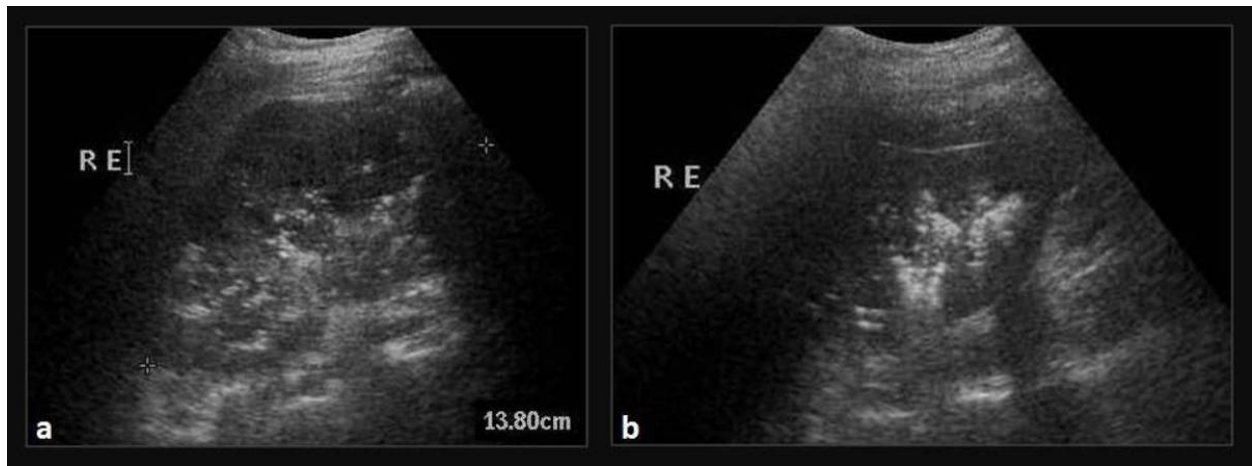


Fig. 16: Emphysematous pyelonephritis. US images show multiple hyperechoic foci with dirty shadowing consistent with gas, in the left kidney.

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

- **CT** is the modality of choice for evaluating patients with emphysematous pyelonephritis. Findings include renal enlargement and destruction, small bubbly or linear streaks of gas, fluid collections, gas-fluid levels and tissue necrosis, with or without abscess ([Fig. 17](#) on page 34 and [Fig. 18](#) on page 35).



Fig. 17: Emphysematous pyelonephritis (same case as in fig. 16). Axial contrast-enhanced CT images show multiple air bubbles within both the renal parenchyma and the collecting system, with associated fluid collections (*).

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

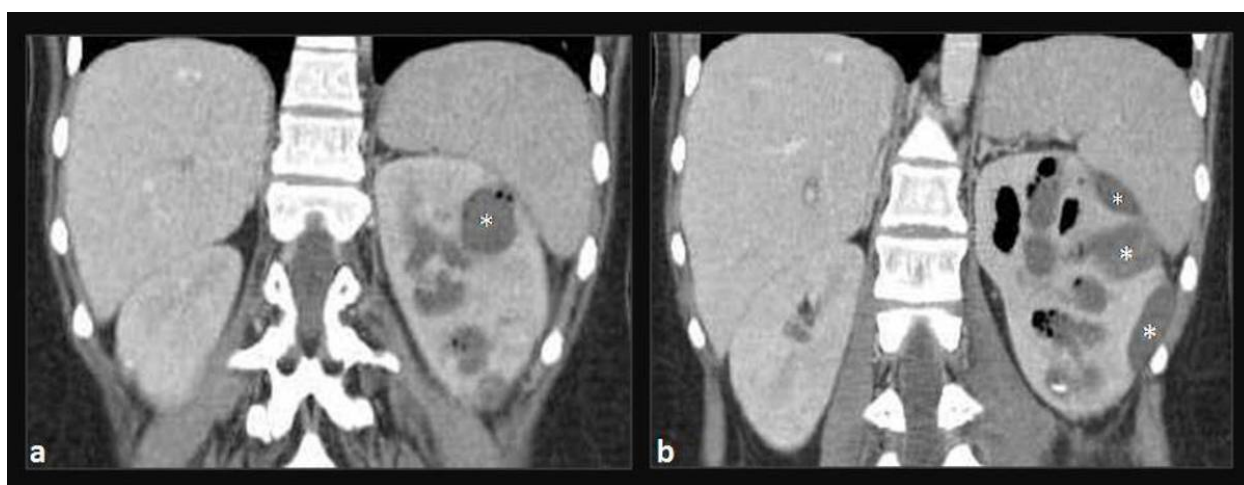


Fig. 18: Emphysematous pyelonephritis (same case as in figs. 16 and 17). Coronal contrast-enhanced CT images show multiple air bubbles within both the renal parenchyma and the collecting system, with associated fluid collections (*).

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

- It is important to distinguish emphysematous pyelonephritis from emphysematous pyelitis because the latter has a better prognosis. In **emphysematous pyelitis** gas is limited to the renal collecting system.

- **US** findings are typically nondependent high-amplitude echoes within the renal sinus or calices, representing foci of air.

- **CT** findings are a dilated collecting system, gas bubbles or gas-fluid levels within the collecting system, and the lack of parenchymal gas (Fig. 19 on page 35).

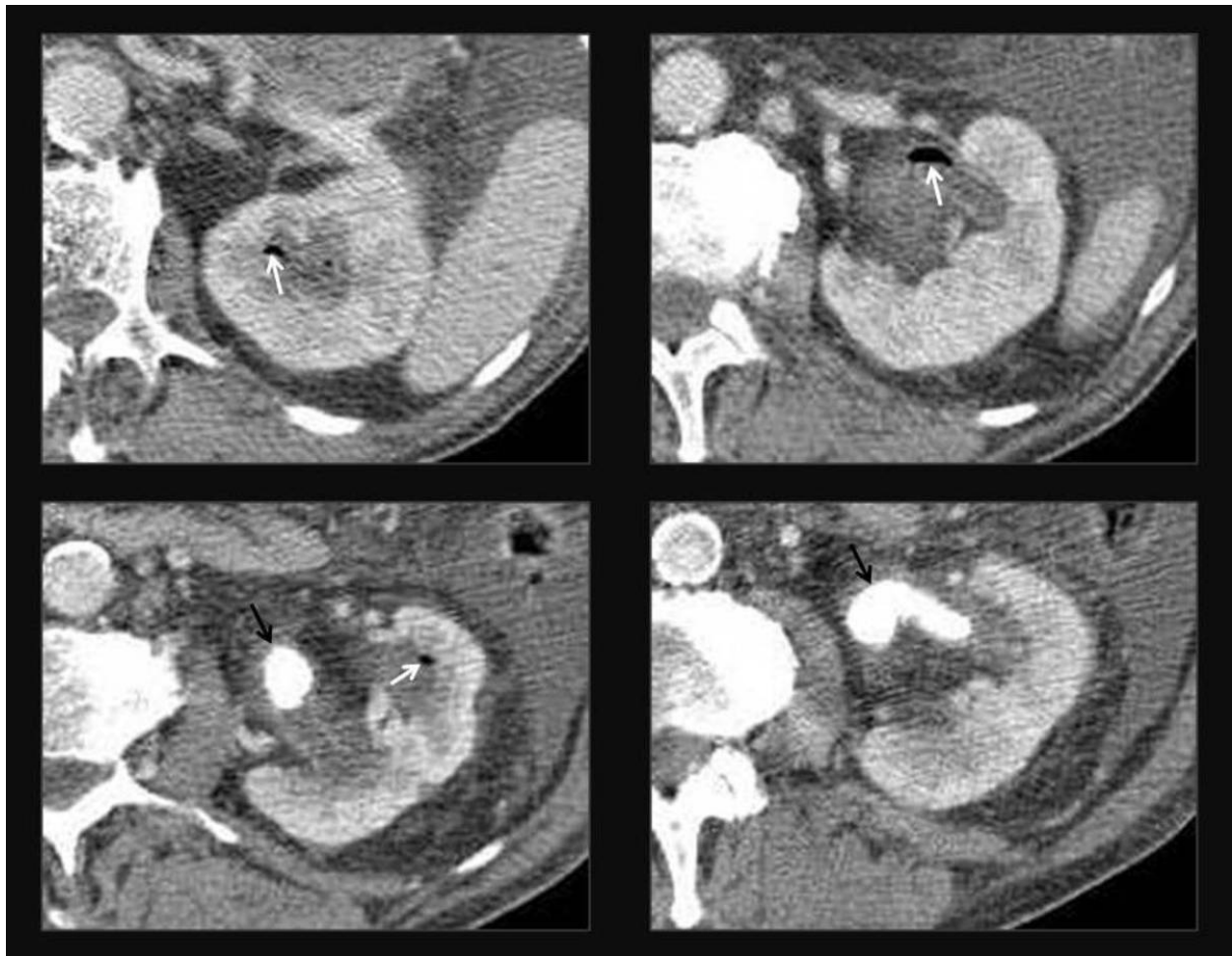


Fig. 19: Emphysematous pyelitis. Axial contrast-enhanced CT images show a dilated collecting system with multiple air bubbles (white arrows). Dilatation is caused by a large staghorn-shaped stone (black arrows). There is no evidence of gas collections in the renal parenchyma.

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

Xanthogranulomatous pyelonephritis

- **Ultrasonography** features of xanthogranulomatous pyelonephritis include multiple hypoechoic round masses in the affected kidney, which can demonstrate internal echoes. Global enlargement with relative preservation of the renal contour is usually seen with diffuse disease. In focal segmental xanthogranulomatous pyelonephritis a mass-like lesion may be demonstrated.

In addition, there is usually evidence of obstruction and renal calculus (Fig. 20 on page 36).

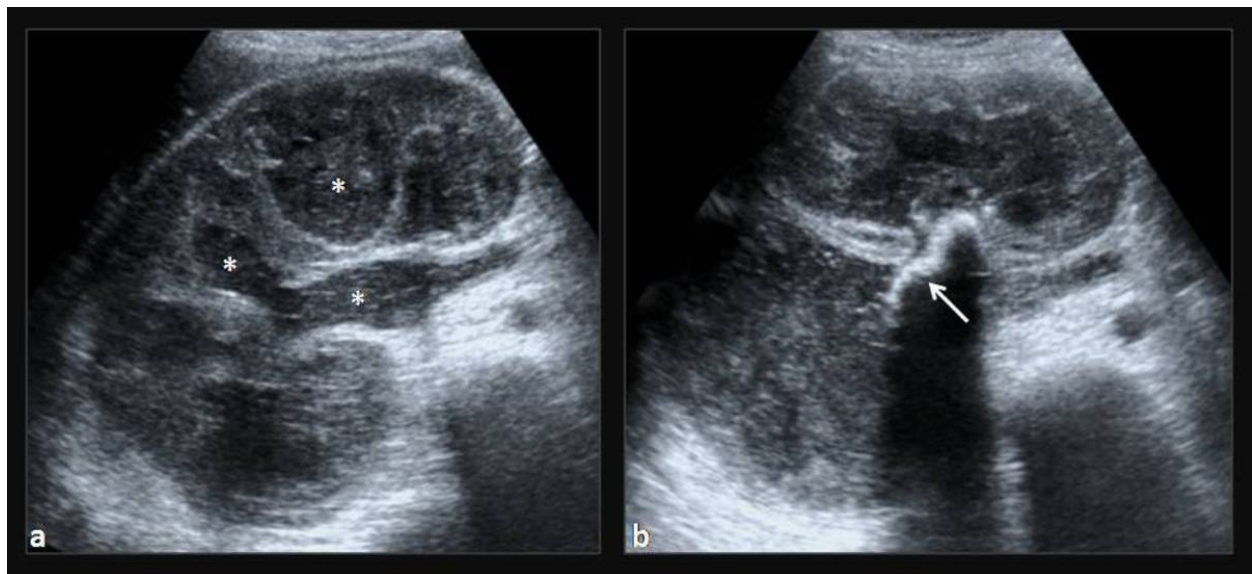


Fig. 20: Xanthogranulomatous pyelonephritis. (a) US scan shows an enlarged right kidney with distention of the collecting system secondary to inflammatory debris (*). (b) A central shadowing calculus is also seen (arrow).

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

- **CT** is the mainstay of diagnostic imaging for xanthogranulomatous pyelonephritis as it usually shows a high specific set of findings that allow a confidence diagnosis. It also accurately assesses the extent of extrarenal disease, if present, and aids in surgical planning.

- In the diffuse form of disease CT usually demonstrates renal enlargement, a central calculus (often staghorn-shaped) within a contracted renal pelvis and replacement of the renal parenchyma by multiple oval hypodense areas representing dilated calices and abscess cavities filled with pus and debris. Areas of fat attenuation can be present because of lipid rich xanthogranulomatous tissue. Renal function is rarely seen at the time of diagnosis ([Fig. 21](#) on page 37 and [Fig. 22](#) on page 37).

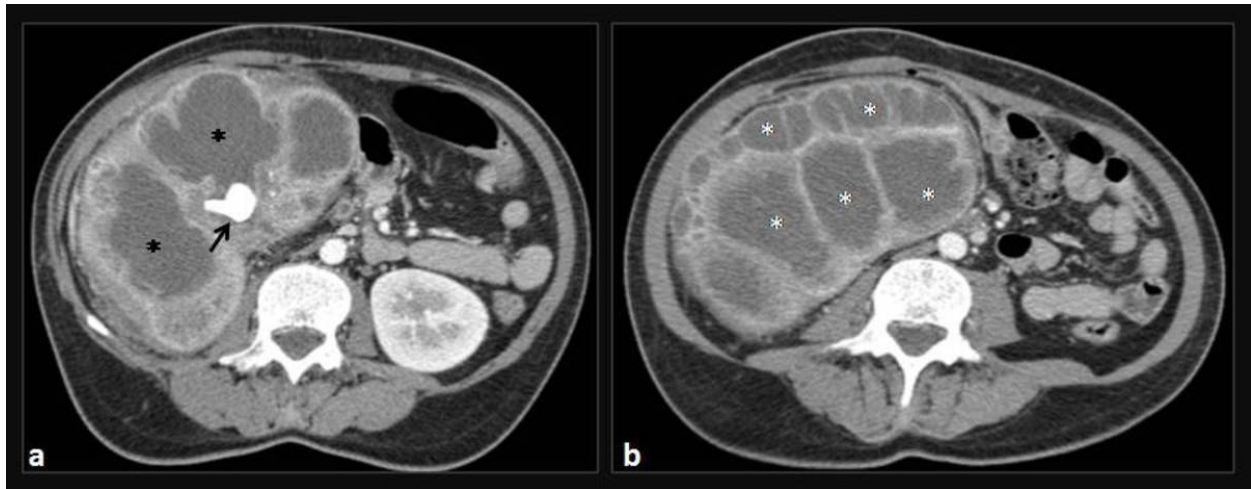


Fig. 21: Xanthogranulomatous pyelonephritis (same case as in fig.20). Axial contrast-enhanced CT images demonstrate an enlarged right kidney, with distention of the collecting system (black *) and multiple oval hypodense collections (white *) replacing renal parenchyma. A staghorn-shaped calculus within a relatively contracted renal pelvis is also seen (arrow).

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

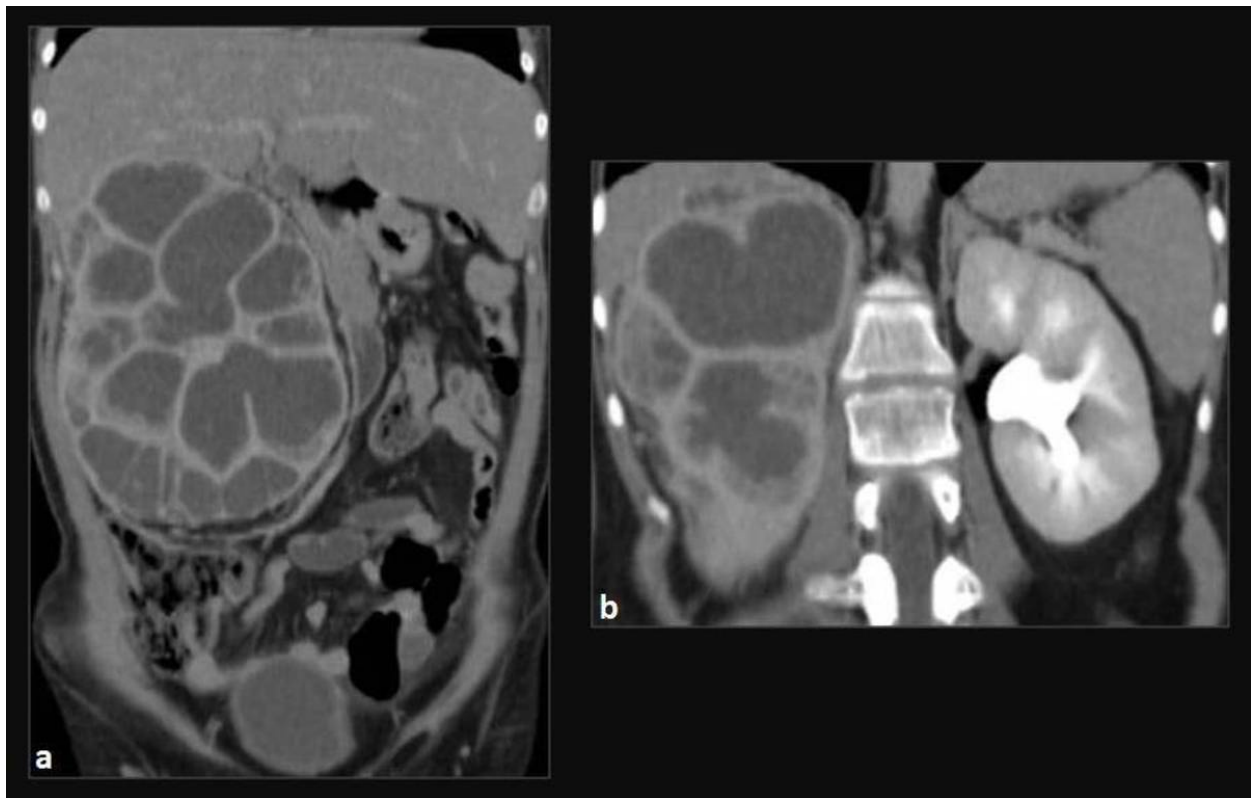


Fig. 22: Xanthogranulomatous pyelonephritis (same case as in figs. 20 and 21). Coronal contrast-enhanced CT images (excretory phase) demonstrate an enlarged right kidney with multiple oval hypodense collections replacing renal parenchyma. Renal function is not seen in the affected side.

References: Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Portugal

- A less common manifestation of xanthogranulomatous pyelonephritis is a focal form which is seen in approximately 10% of patients.

Renal tuberculosis

- In renal tuberculosis **ultrasonographic evaluation** may demonstrate granulomatous lesions as masses of mixed echogenicity, with or without necrotic areas of caseation and calcifications. Mucosal thickening and stenosis of the calyces may also be detected by US as well as mucosal thickening of the renal pelvis and ureter, ureteral strictures and hydronephrosis. Additionally bladder changes as mucosal thickening and reduced capacity are commonly seen.

- **CT** imaging findings in renal tuberculosis depend on the stage of disease. The earliest findings are focal hypoperfusion areas on contrast-enhanced CT, with a striated

nephrogram. As the parenchymal granulomas coalesce, CT can demonstrate a masslike lesion (tuberculoma) with central low attenuation representing caseous necrosis. A moth-eaten calyx secondary to papillary necrosis is another finding that may be seen.

- As the disease progresses the host launches a fibrotic reaction in response to infection, causing stricture formation of the calyceal infundibula, which leads to uneven caliectasis and eventually incomplete opacification of the calyx (phantom calyx).

- Calcification is present in a large number (40 -70%) of cases. The extension of calcifications ranges from thin rims surrounding low attenuation areas of focal cortical inflammation to diffuse, uniformly radiodense areas that extensively replace portions or all of the renal parenchyma (autonephrectomy) in late stage disease ([Fig. 23](#) on page 38, [Fig. 24](#) on page 39 and [Fig. 25](#) on page 40).

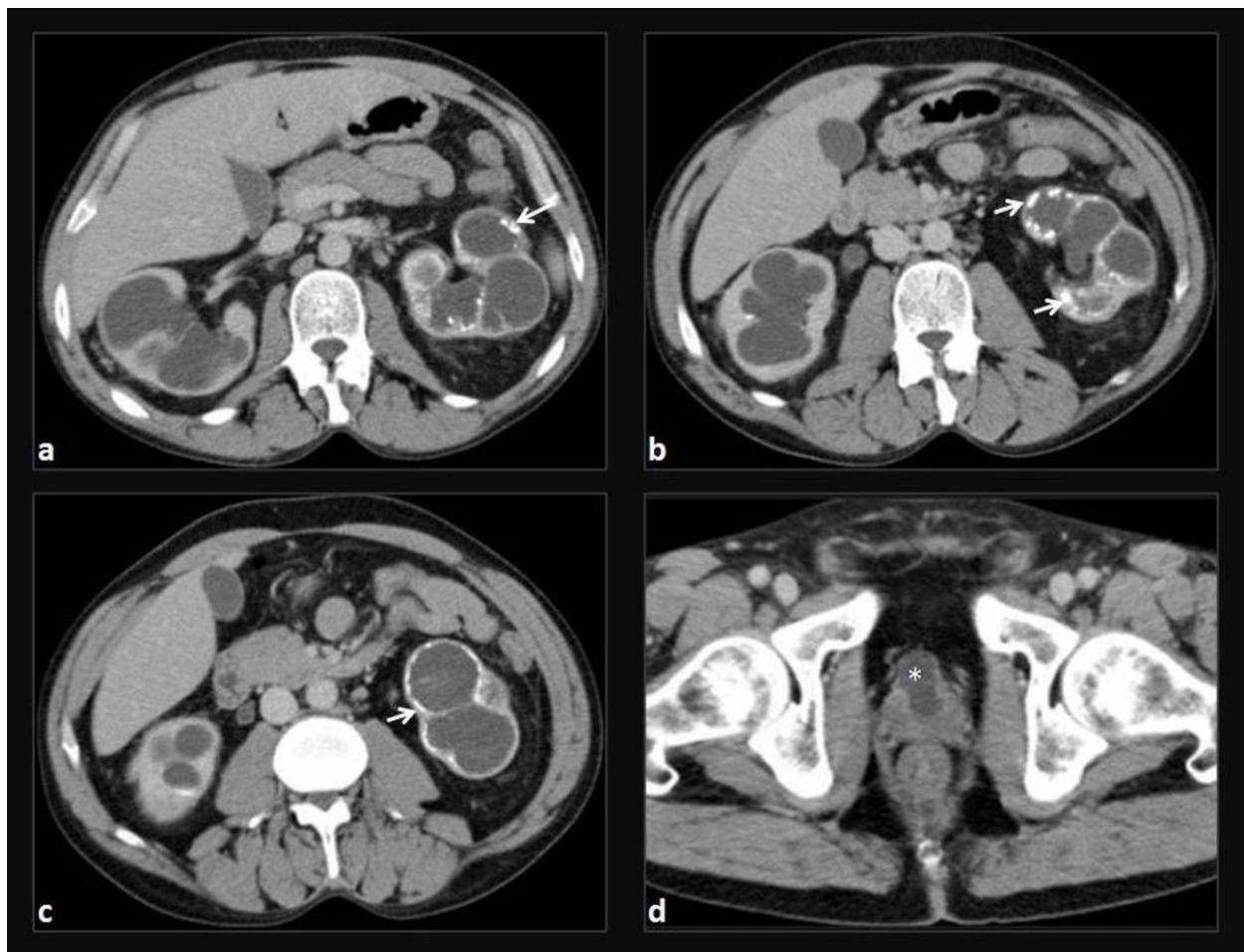


Fig. 23: Renal tuberculosis. Axial contrast-enhanced CT images demonstrate bilateral dilatation of the collecting system, with marked reduction of the renal parenchyma

thickness. The left kidney shows multiple thin calcifications (arrows). The bladder is contracted (*).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal



Fig. 24: Renal tuberculosis (same case as in fig.23). Coronal contrast-enhanced CT images demonstrate bilateral dilatation of the collecting system, with marked reduction of the renal parenchyma thickness and multiple thin calcifications in the left kidney. A stenosis in the distal right ureter is also seen (arrow). The bladder is contracted (*).

References: Serviço de Radiologia, Centro Hospitalar Tondela - Viseu, Portugal



Fig. 25: Renal tuberculosis. Axial non-contrast (a and b) and contrast-enhanced (c and d) CT images show a smaller, non-functioning left kidney, partially replaced by multiple coarse calcifications.

References: Courtesy of Dr. Fernando Calejo Pires, Serviço de Radiologia, Centro Hospitalar Vila Nova de Gaia / Espinho, Portugal

Images for this section:

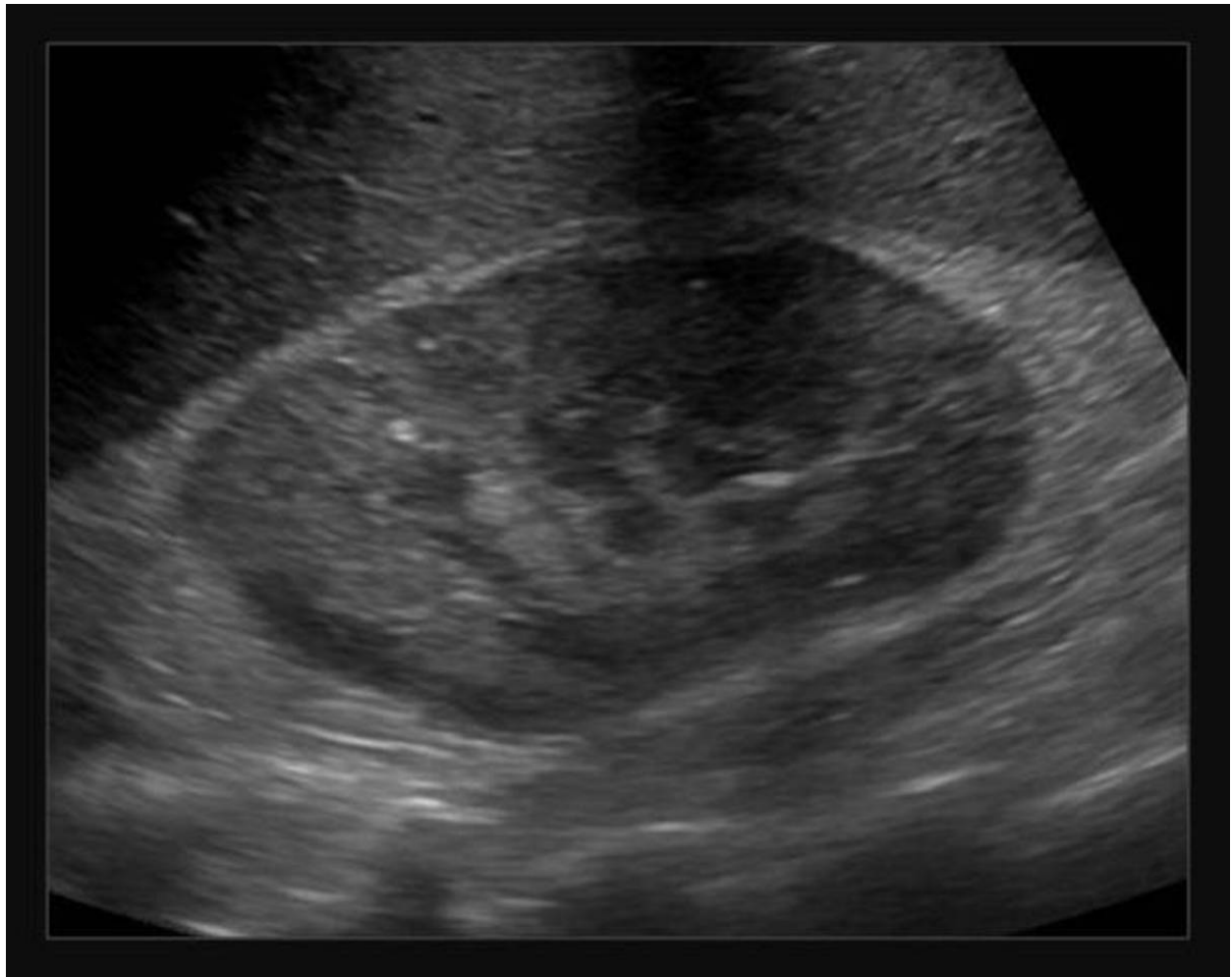


Fig. 1: Acute pyelonephritis. Ultrasound scan shows an enlarged right kidney with diffuse hyperechogenicity of the parenchyma and loss of differentiation.

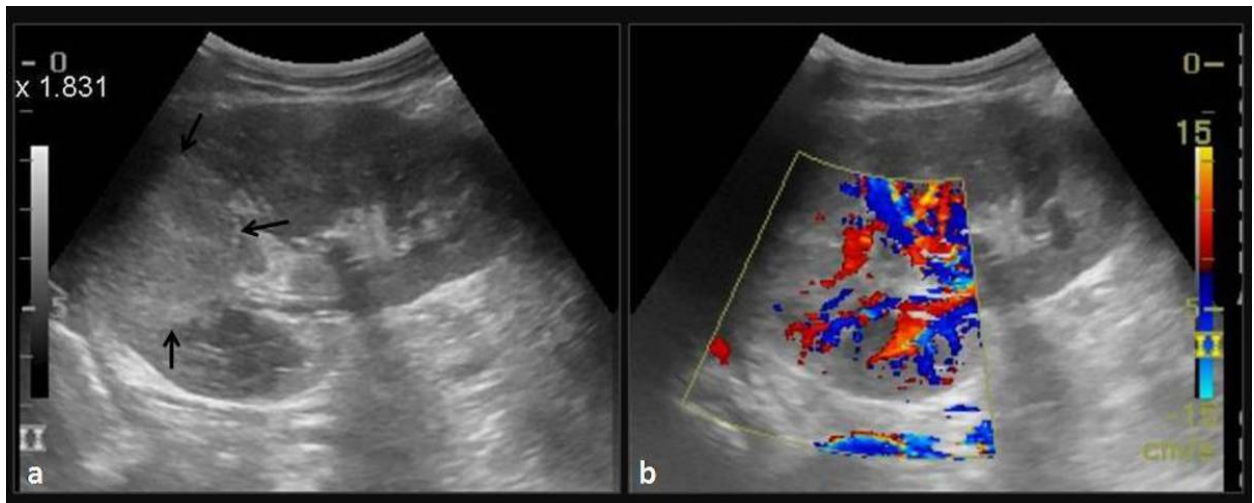


Fig. 2: Acute bacterial pyelonephritis. (a) US scan shows a wedge-shaped hyperechoic focus (arrows) in the upper pole of the right kidney related to acute bacterial

pyelonephritis. (b) Color flow US image demonstrates diminished flow through the involved area.

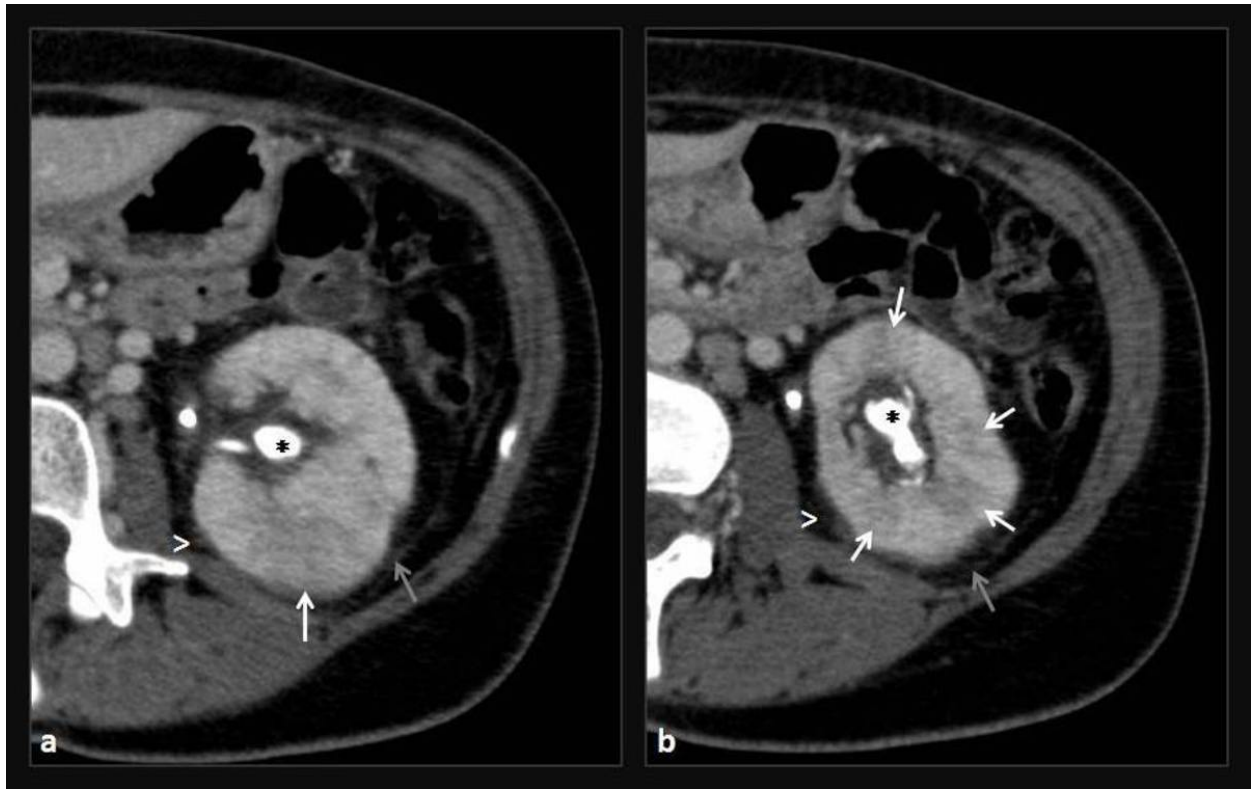


Fig. 3: Acute pyelonephritis. Contrast-enhanced axial CT images show several wedged-shape areas of decreased enhancement consistent with a striated nephrogram (white arrows). They also demonstrate a large stone in the renal pelvis (*), perinephric stranding (arrowheads) and thickening of Gerota fascia (grey arrow).



Fig. 4: Acute pyelonephritis. Contrast-enhanced axial CT image (excretory phase) shows several wedged-shape areas of decreased enhancement consistent with a striated nephrogram (arrows).

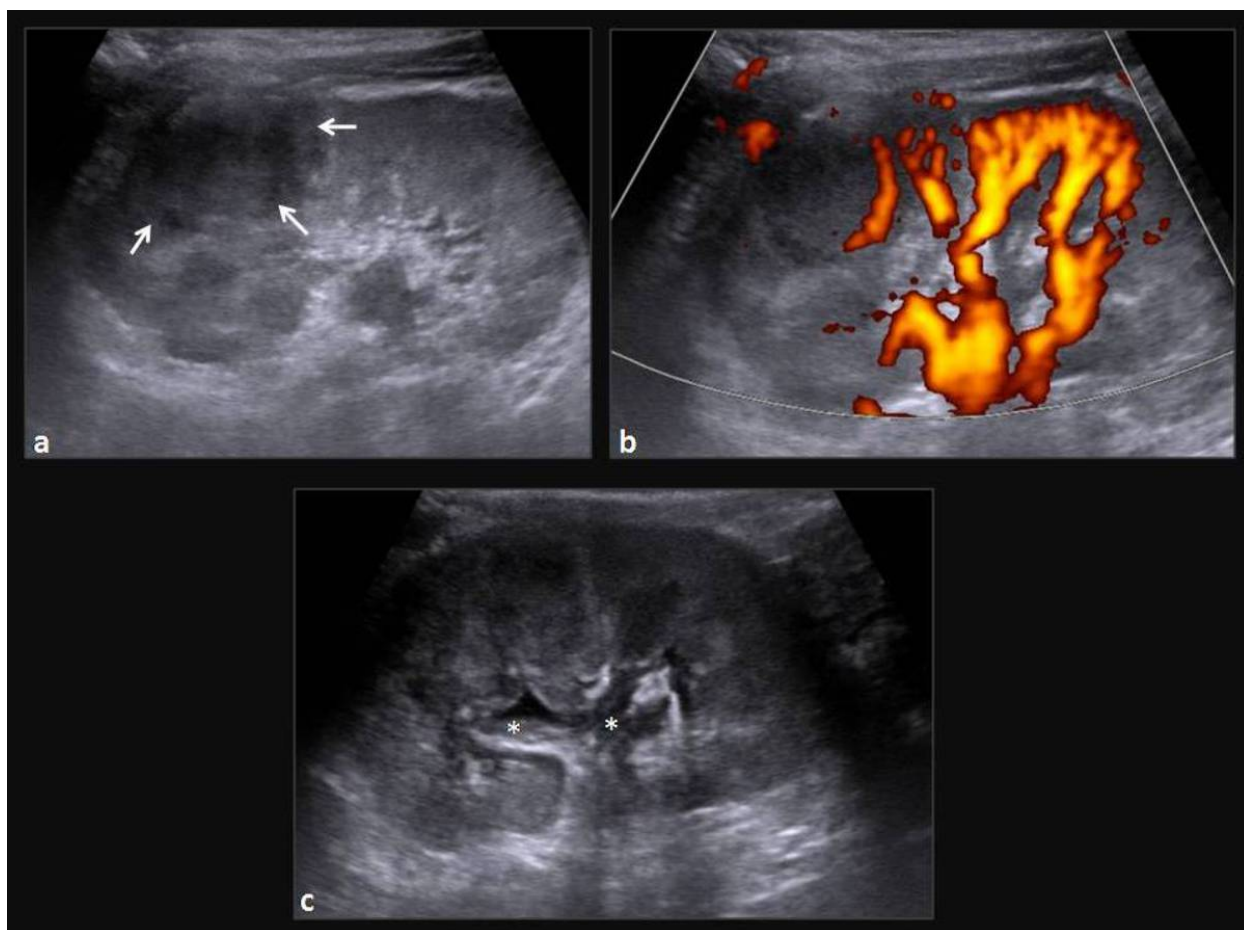


Fig. 5: Focal acute pyelonephritis. (a) US scan demonstrates a hypoechoic "mass" (arrows) in the upper pole of the right kidney, a finding that is worrisome for a solid tumor. (b) Power Doppler image demonstrates diminished flow through the involved area. (c) There is also thickening of the walls of the collecting system (*).

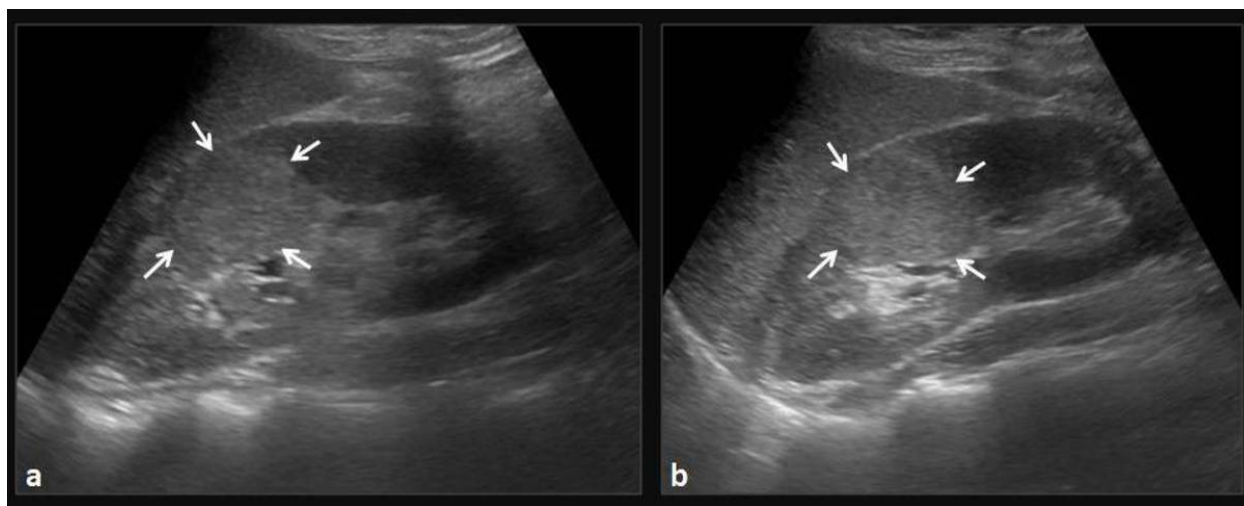


Fig. 6: Masslike appearance of acute bacterial pyelonephritis. US scan demonstrates a geographic, slightly lobulated, hyperechoic "mass" (arrows) in the mid pole of the right kidney, a finding that is worrisome for a solid tumor.

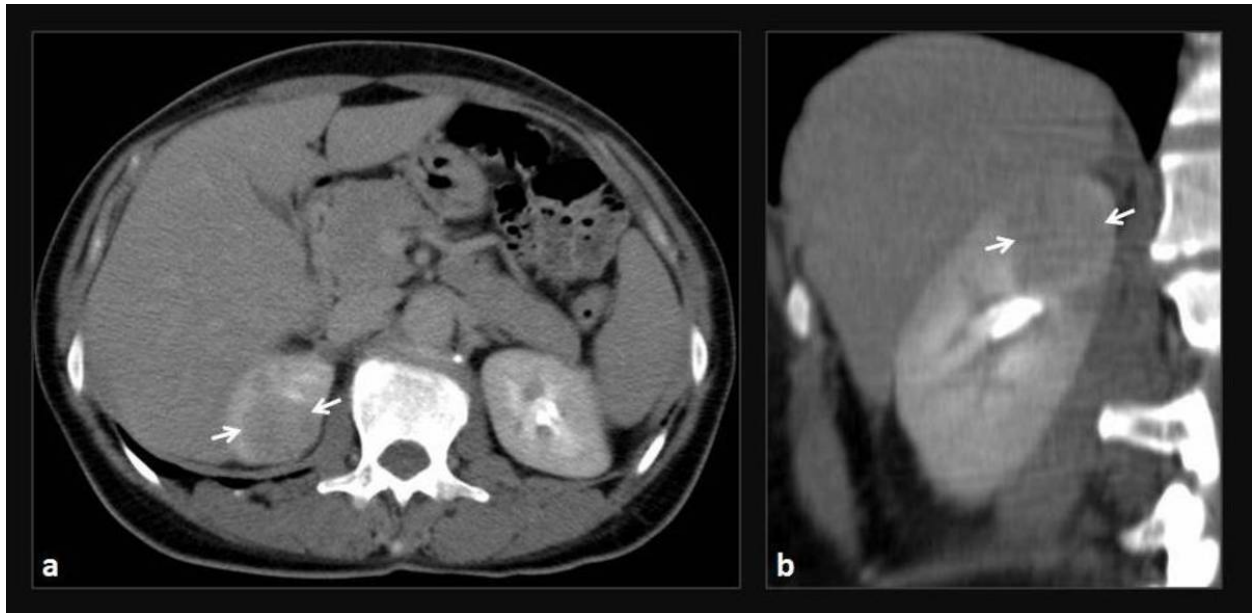


Fig. 7: Focal acute pyelonephritis. Axial (a) and coronal (b) contrast-enhanced CT images (excretory phase) show a nodular hypodense area in the upper pole of the right kidney, representing a focus of pyelonephritis.

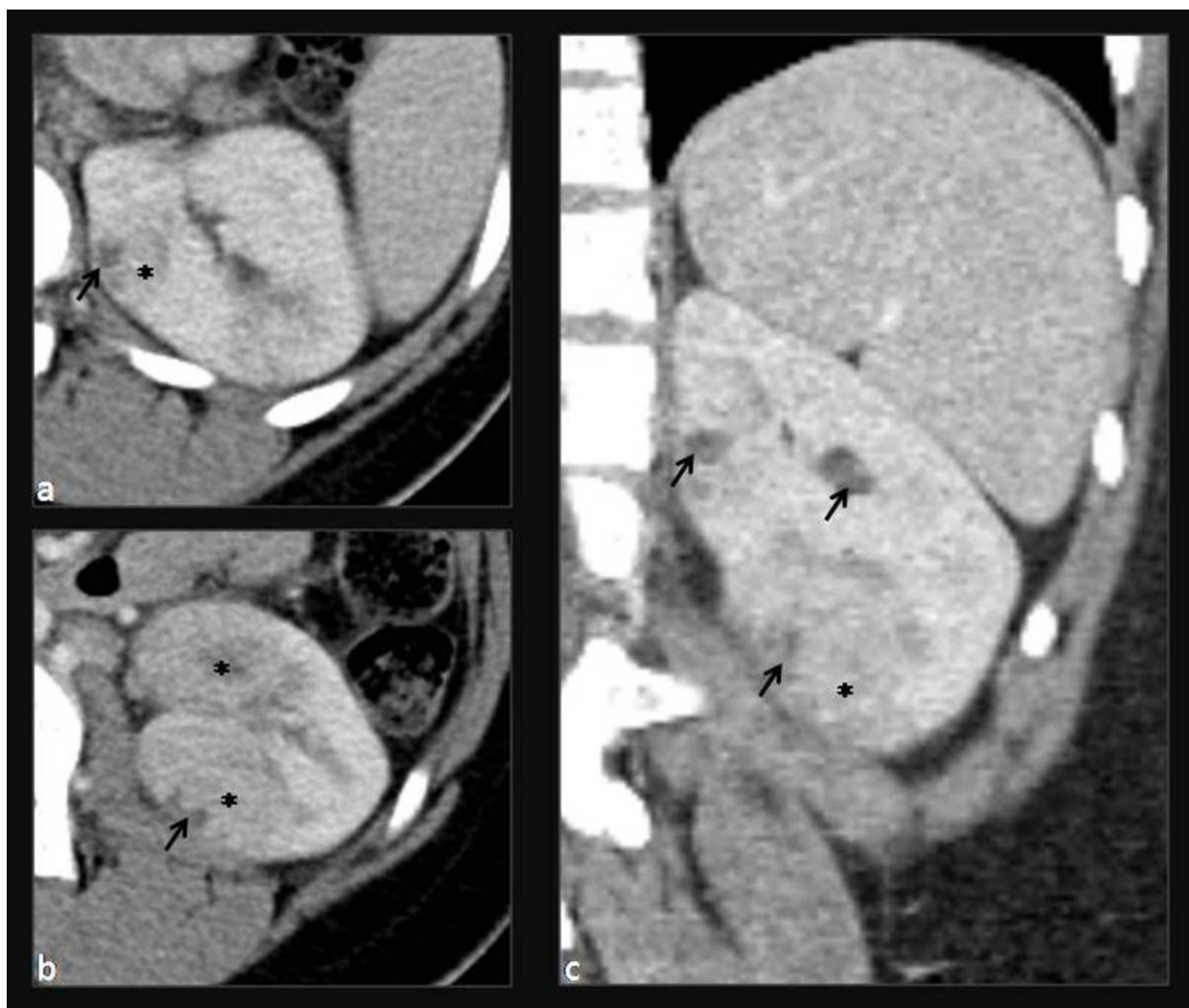


Fig. 8: Acute pyelonephritis with microabscesses. Axial (a and b) and coronal (c) contrast-enhanced CT images show several wedged-shape areas of decreased enhancement (*) and small collections representing microabscesses (arrows) which were not seen on ultrasound scan.

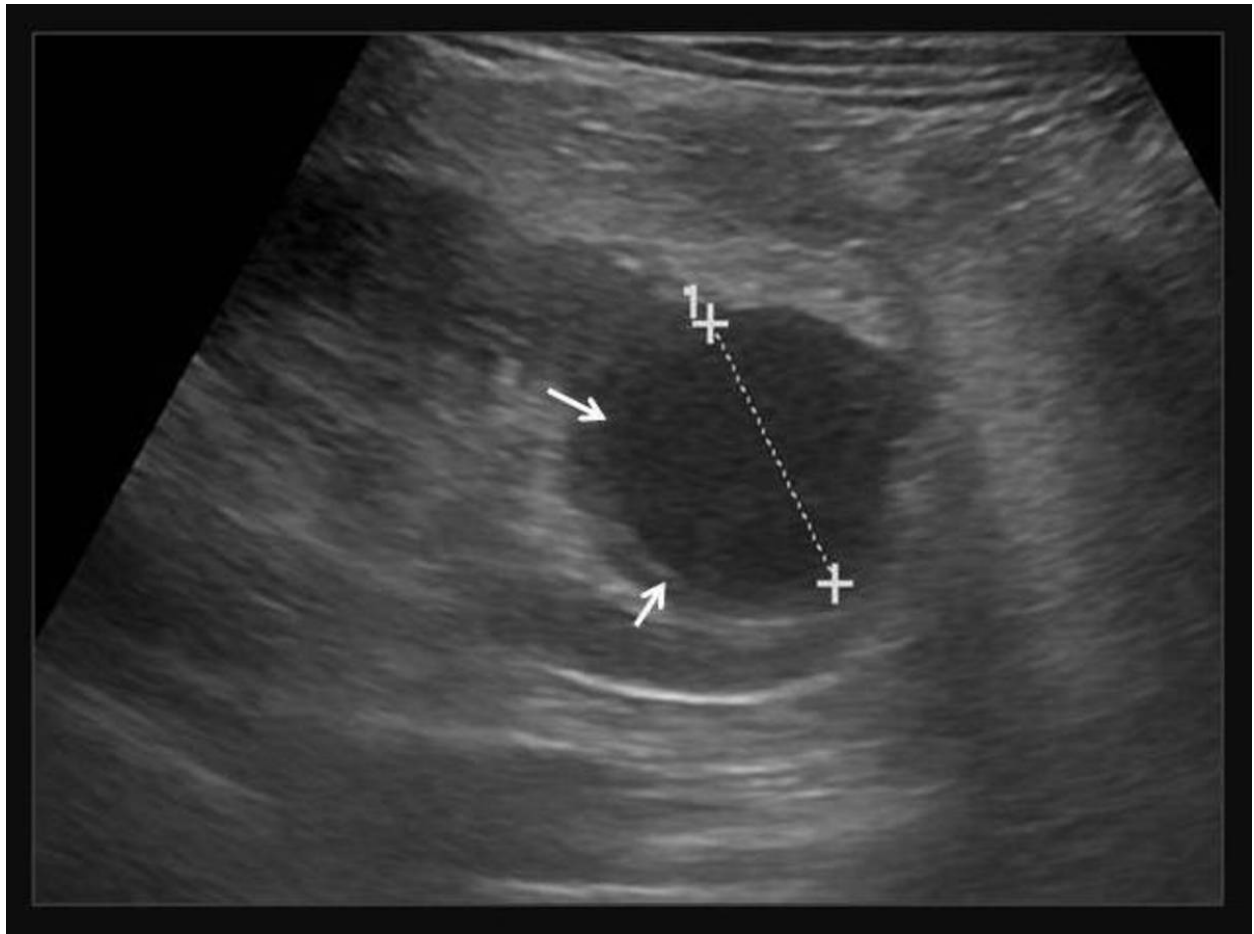


Fig. 9: Renal abscess. US scan of the left kidney shows a well-defined hypoechoic lesion near the lower pole, with a visible pseudocapsule (arrows).

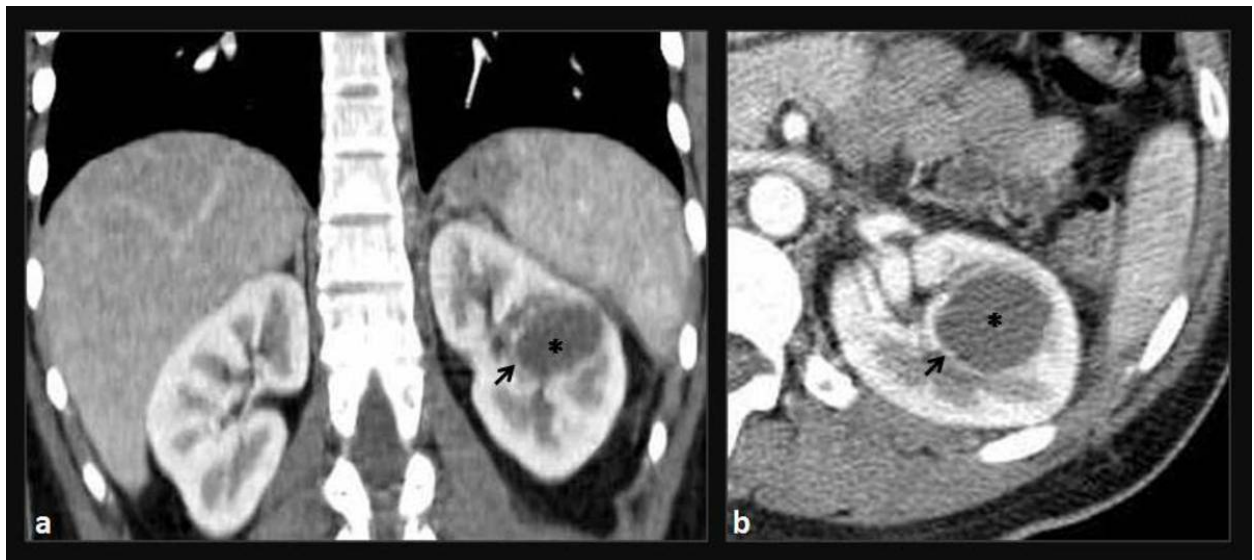


Fig. 10: Renal abscess (same case as in fig.9). Coronal (a) and axial (b) contrast-enhanced CT images show a round low-attenuation collection (*) with enhancing walls (arrows), in the mid pole of the left kidney.



Fig. 11: Multiple renal abscesses. Axial contrast-enhanced CT images show an enlarged and heterogeneous left kidney, with multiple hypodense collections representing abscesses (white arrows). There is also dilatation of several calyces in the lower pole, which are filled with dense material (pyonephrosis) (black arrows).

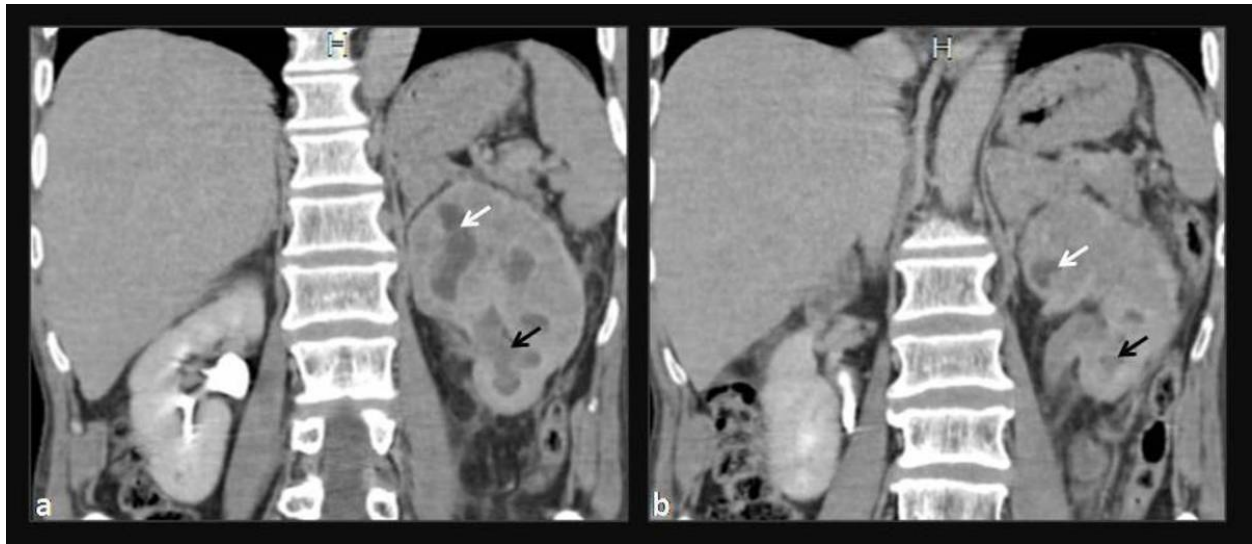


Fig. 12: Multiple renal abscesses (same case as in fig. 11). Coronal contrast-enhanced CT images show an enlarged and heterogeneous left kidney, with multiple hypodense collections representing abscesses (white arrows). There is also dilatation of several calyces in the lower pole, which are filled with dense material (pyonephrosis) (black arrows).

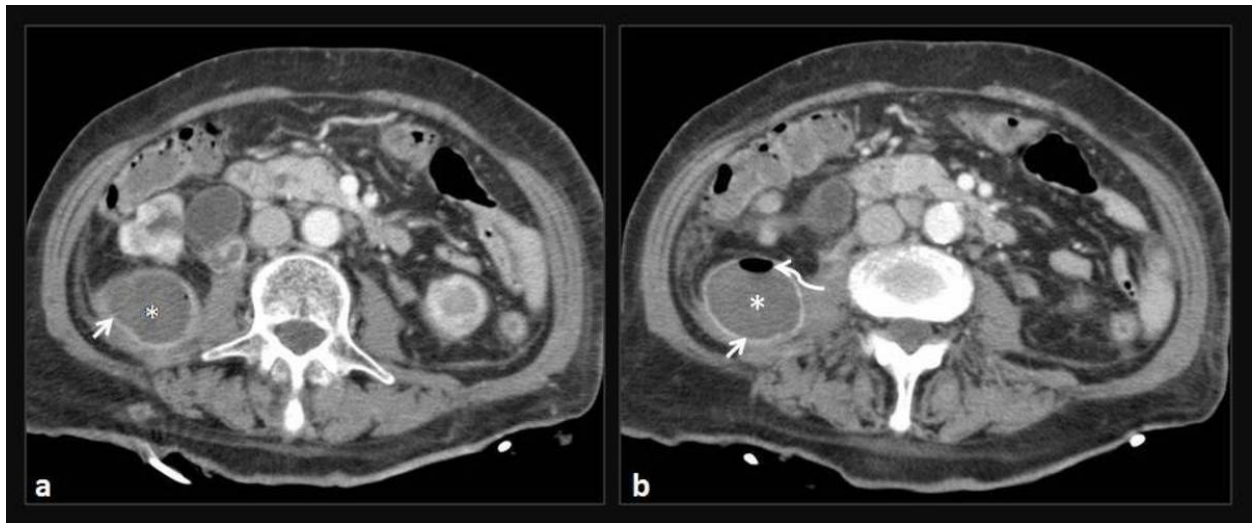


Fig. 13: Extraparenchymal abscess. Axial CT images show a well-defined low-attenuation collection (*), with enhancing walls (arrows) and gas (curved arrow), in the right retroperitoneal region.

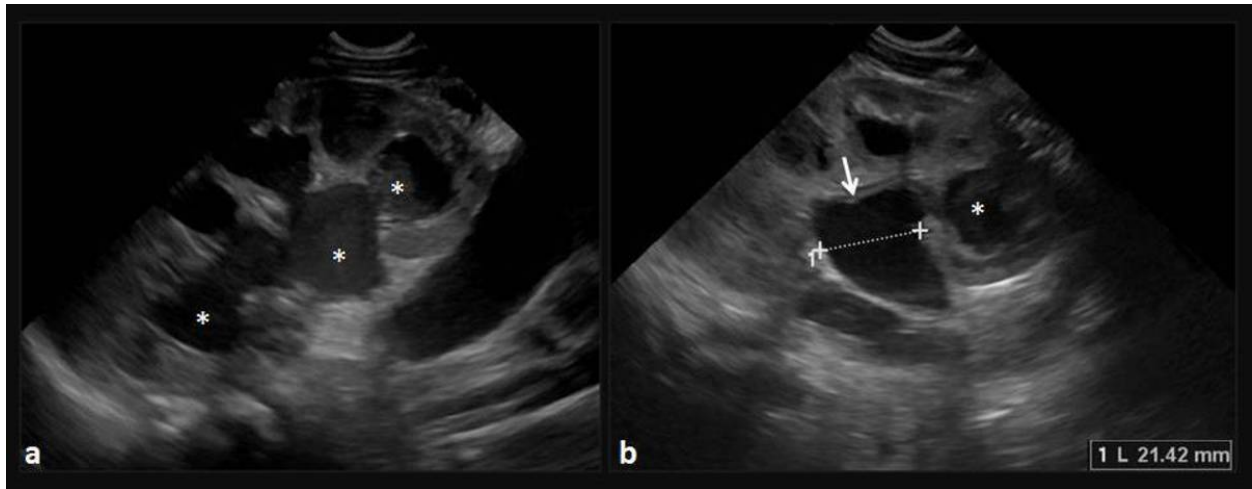


Fig. 14: Pyonephrosis. US scan images show a dilated collecting system that is partially filled with echogenic debris (*). There is also thickening of the collecting system walls (arrow).

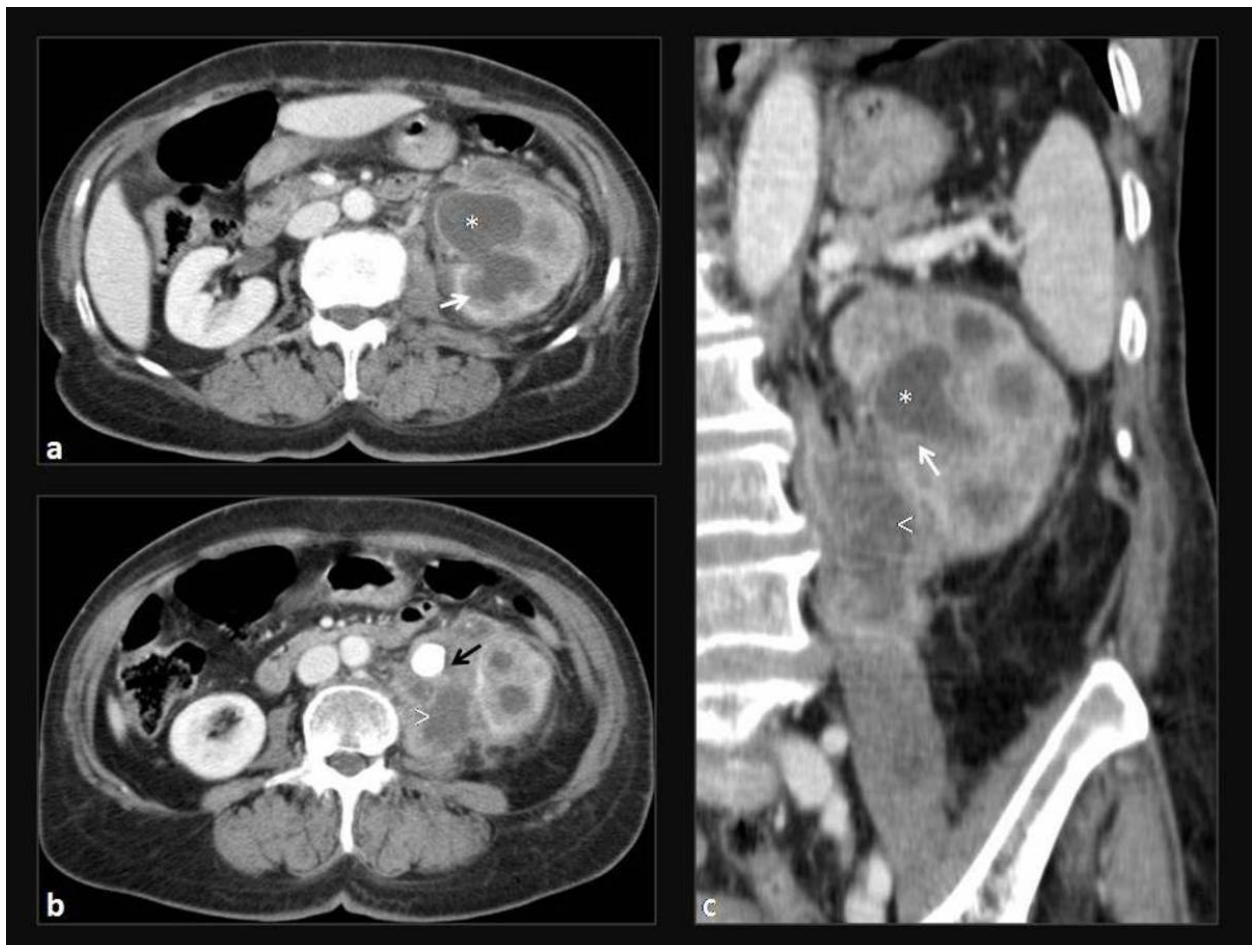


Fig. 15: Pyonephrosis. Axial (a and b) and coronal (c) CT images show a dilated collecting system (*) with thickening of its walls (white arrows). There is also a perinephric abscess

with extension to psoas muscle (arrowhead), and a large stone in the proximal ureter (black arrow).

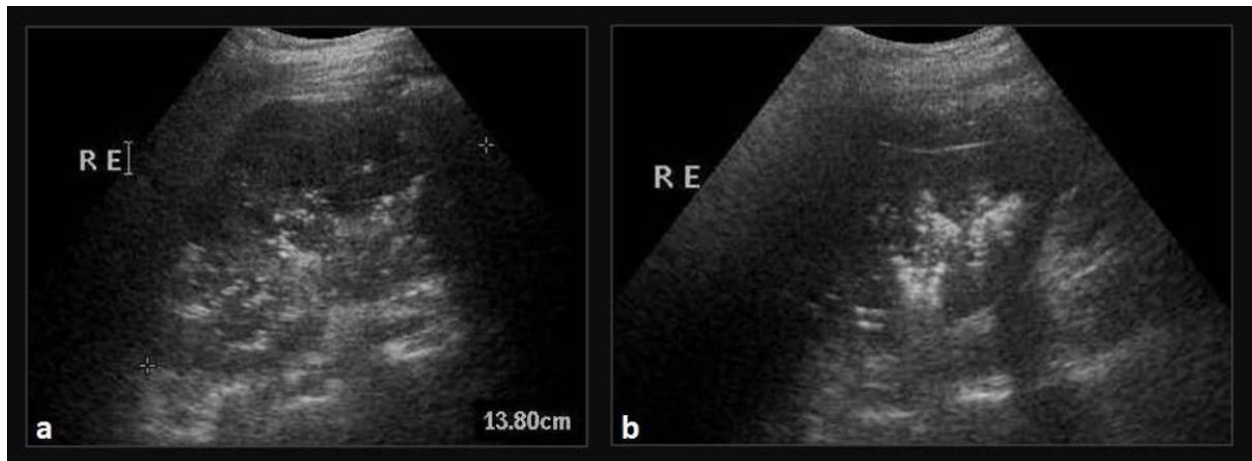


Fig. 16: Emphysematous pyelonephritis. US images show multiple hyperechoic foci with dirty shadowing consistent with gas, in the left kidney.



Fig. 17: Emphysematous pyelonephritis (same case as in fig. 16). Axial contrast-enhanced CT images show multiple air bubbles within both the renal parenchyma and the collecting system, with associated fluid collections (*).

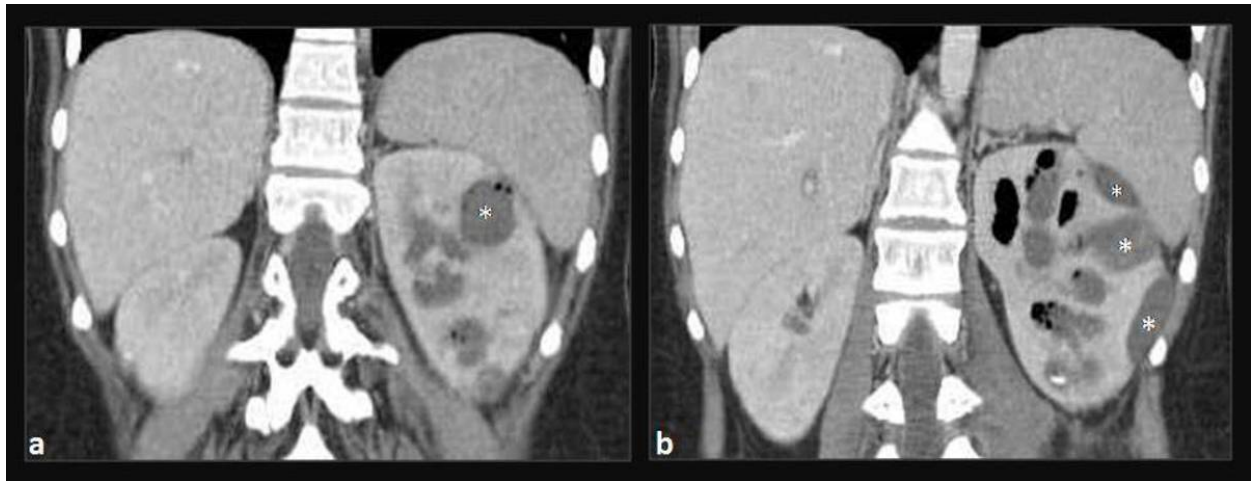


Fig. 18: Emphysematous pyelonephritis (same case as in figs. 16 and 17). Coronal contrast-enhanced CT images show multiple air bubbles within both the renal parenchyma and the collecting system, with associated fluid collections (*).

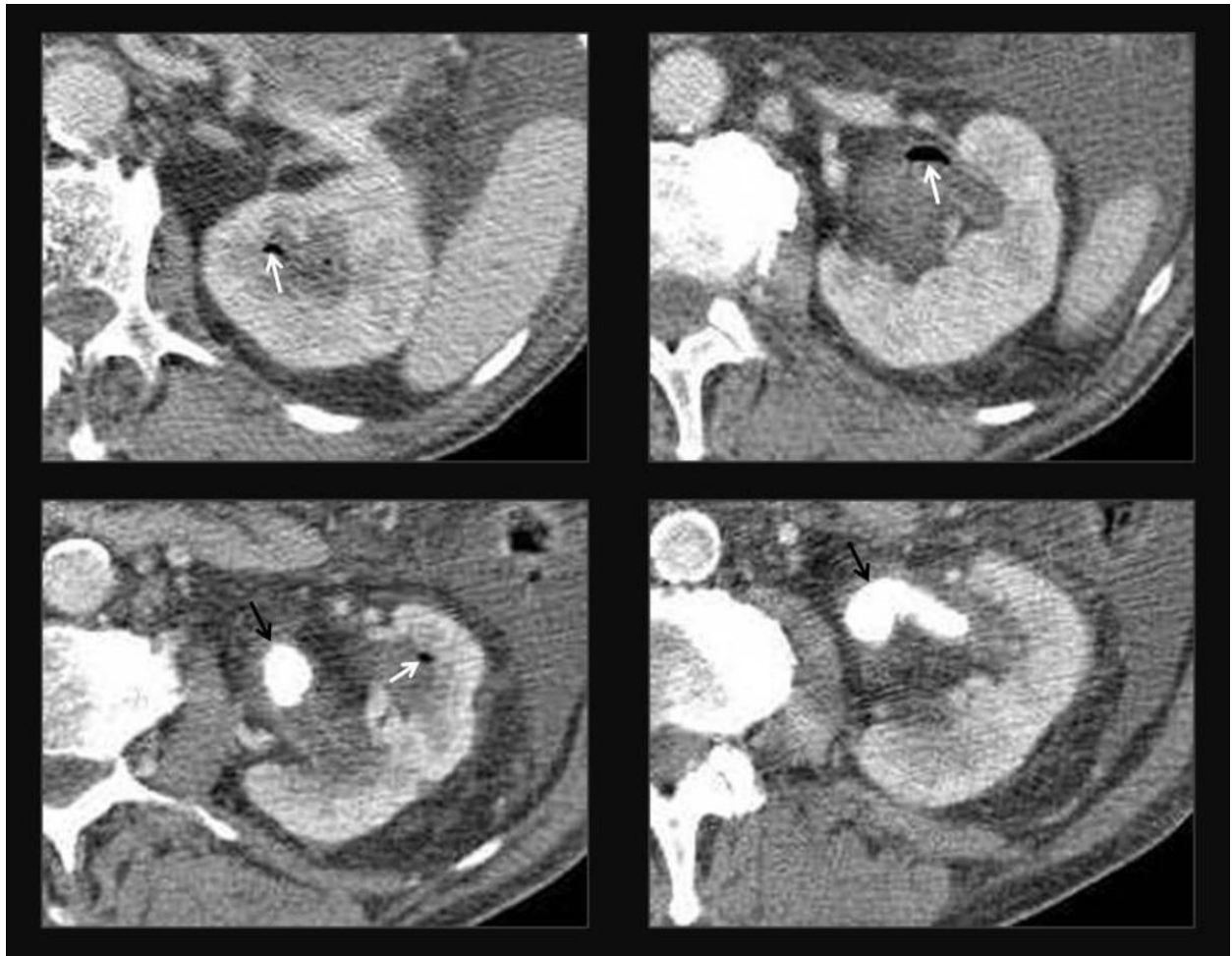


Fig. 19: Emphysematous pyelitis. Axial contrast-enhanced CT images show a dilated collecting system with multiple air bubbles (white arrows). Dilatation is caused by a large staghorn-shaped stone (black arrows). There is no evidence of gas collections in the renal parenchyma.

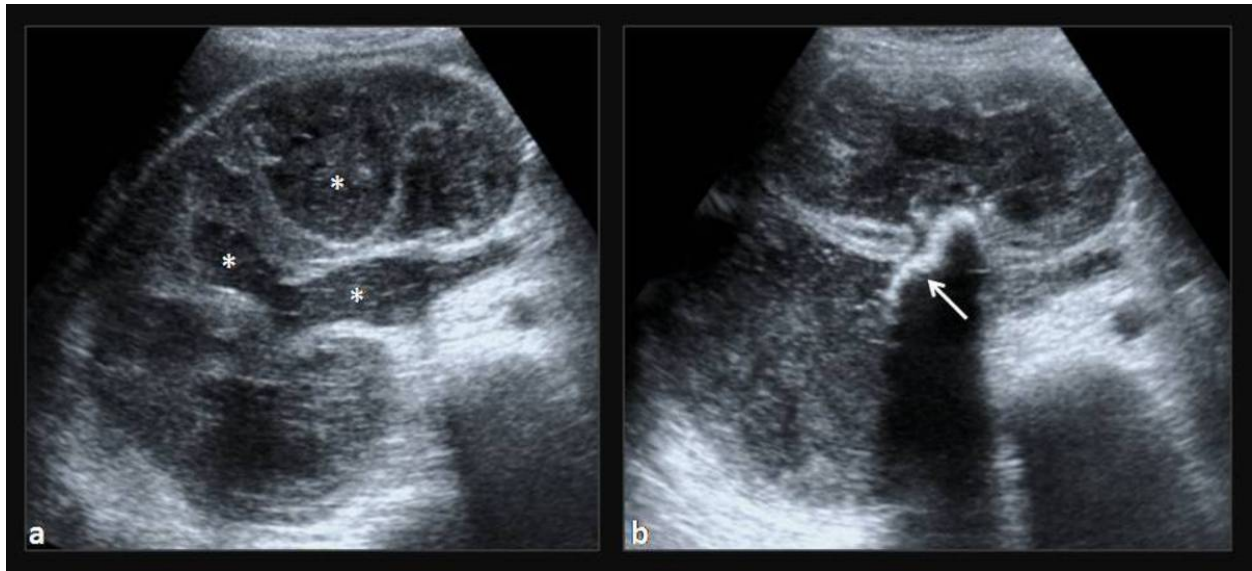


Fig. 20: Xanthogranulomatous pyelonephritis. (a) US scan shows an enlarged right kidney with distention of the collecting system secondary to inflammatory debris (*). (b) A central shadowing calculus is also seen (arrow).

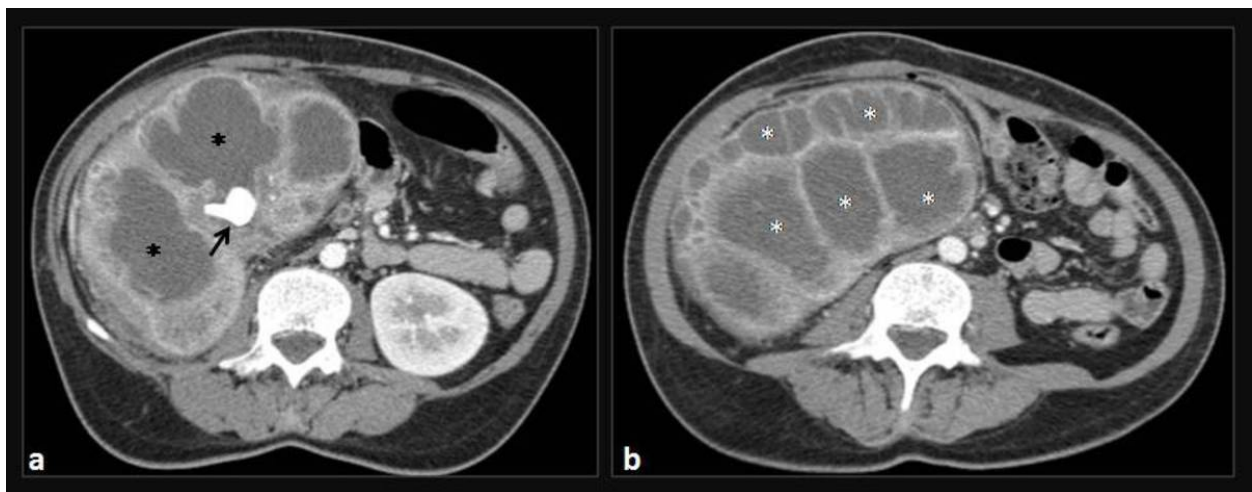


Fig. 21: Xanthogranulomatous pyelonephritis (same case as in fig.20). Axial contrast-enhanced CT images demonstrate an enlarged right kidney, with distention of the collecting system (black *) and multiple oval hypodense collections (white *) replacing renal parenchyma. A staghorn-shaped calculus within a relatively contracted renal pelvis is also seen (arrow).

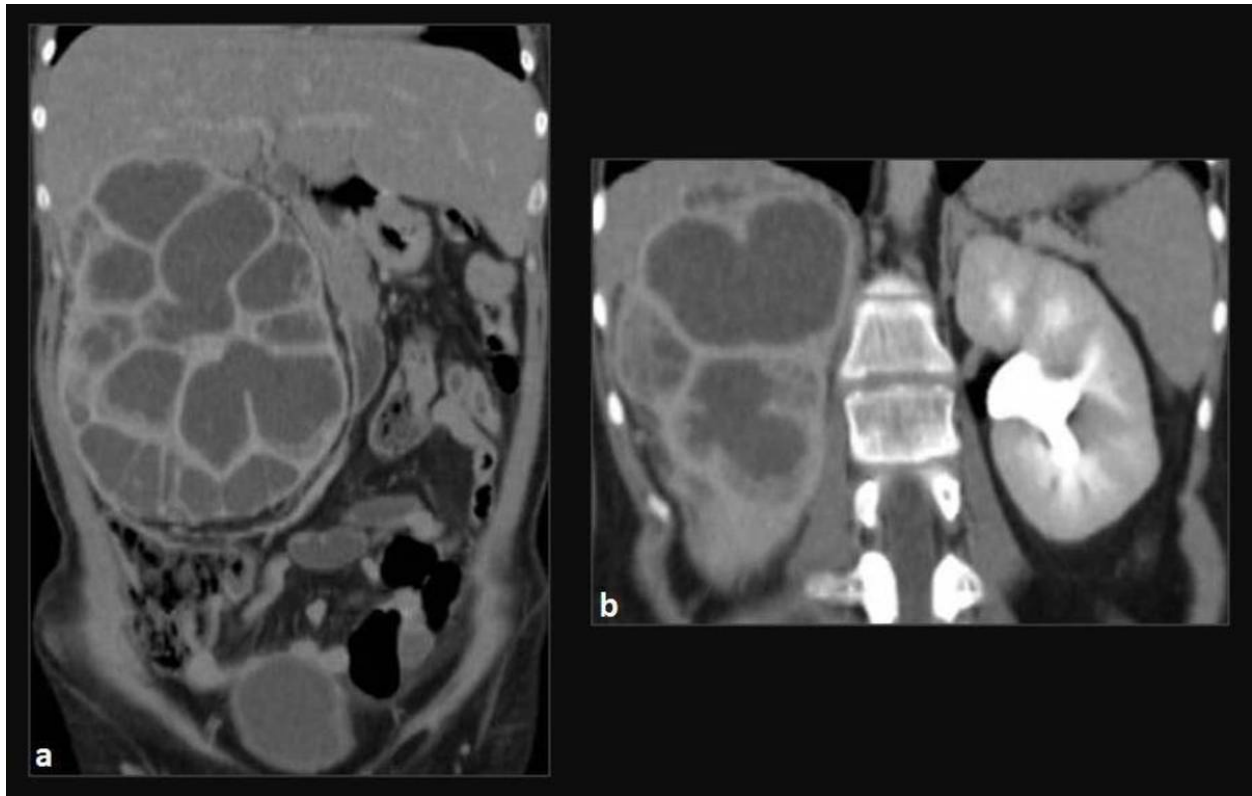


Fig. 22: Xanthogranulomatous pyelonephritis (same case as in figs. 20 and 21). Coronal contrast-enhanced CT images (excretory phase) demonstrate an enlarged right kidney with multiple oval hypodense collections replacing renal parenchyma. Renal function is not seen in the affected side.

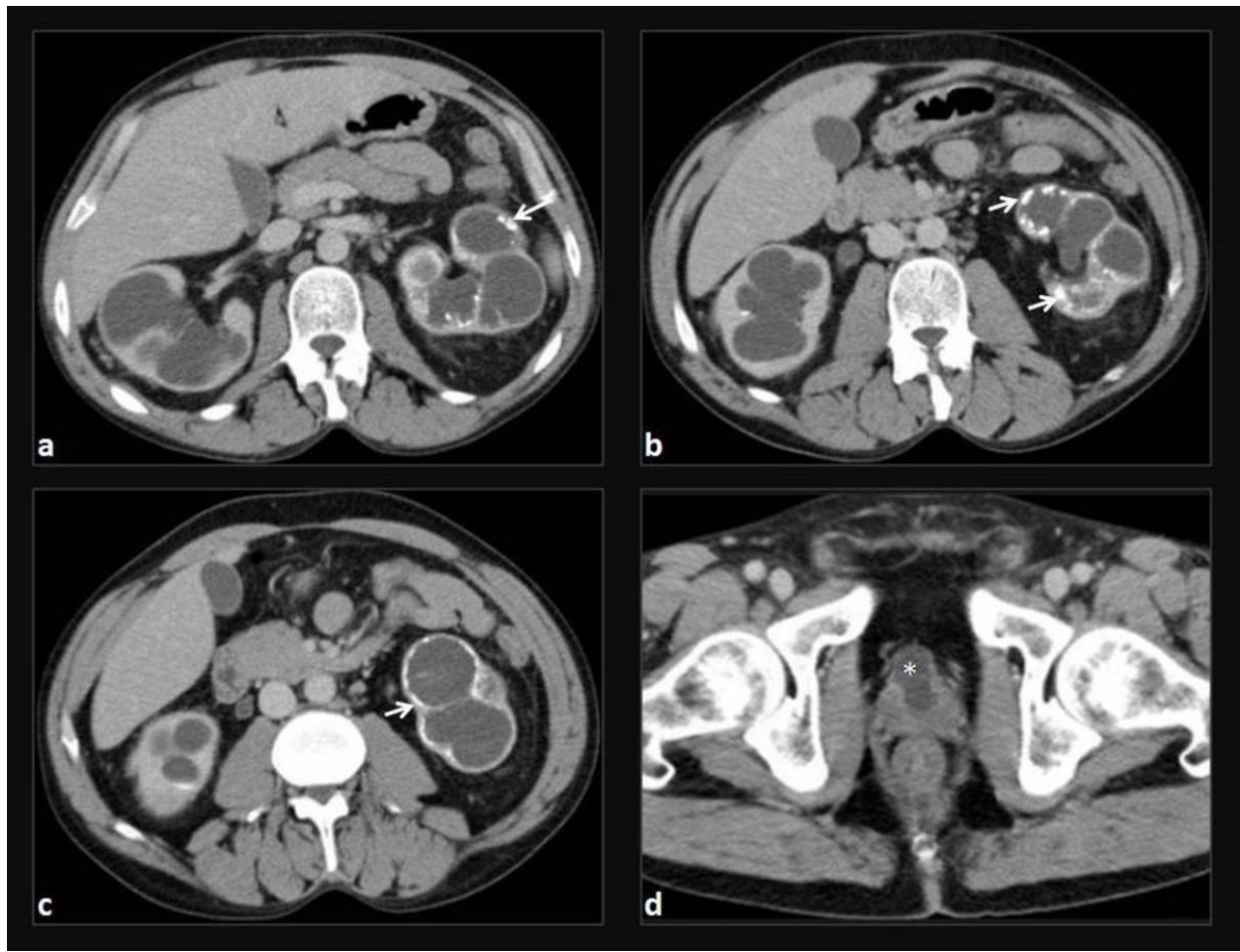


Fig. 23: Renal tuberculosis. Axial contrast-enhanced CT images demonstrate bilateral dilatation of the collecting system, with marked reduction of the renal parenchyma thickness. The left kidney shows multiple thin calcifications (arrows). The bladder is contracted (*).



Fig. 24: Renal tuberculosis (same case as in fig.23). Coronal contrast-enhanced CT images demonstrate bilateral dilatation of the collecting system, with marked reduction of the renal parenchyma thickness and multiple thin calcifications in the left kidney. A stenosis in the distal right ureter is also seen (arrow). The bladder is contracted (*).



Fig. 25: Renal tuberculosis. Axial non-contrast (a and b) and contrast-enhanced (c and d) CT images show a smaller, non-functioning left kidney, partially replaced by multiple coarse calcifications.

Conclusion

- Radiographic evaluation is not necessary in most patients with suspected pyelonephritis but it plays a role in high-risk patients or in those who do not respond to conventional therapy.
- Acute pyelonephritis is the most common renal infection but a variety of other infectious conditions can be seen.
- Many of these processes require urgent management so it is imperative for the radiologist to be familiar with their imaging findings.

Personal information

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