

Acute Pyelonephritis

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Clinical History

A 41-year-old woman presents with 2 days of right-sided flank pain and low-grade fever. Renal ultrasound (US) (Figs. 1A, B) is requested. What is your diagnosis?

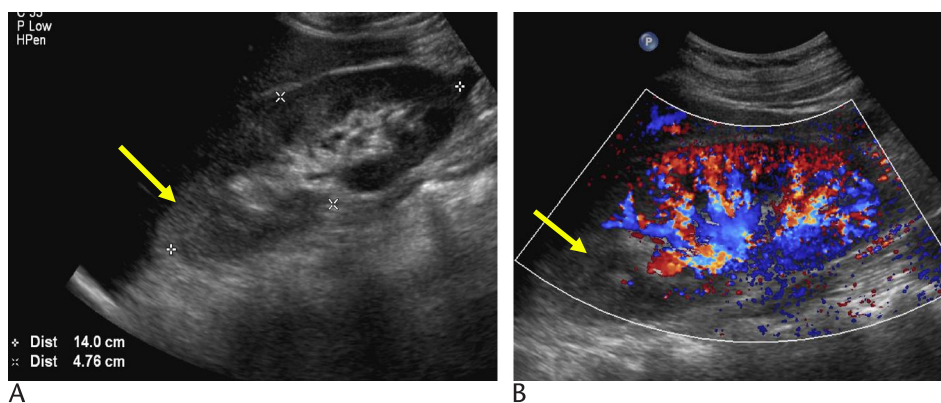


FIGURE 1. Sagittal gray-scale (A) and color Doppler (B) images of the right kidney demonstrate an enlarged right kidney (measuring 14 cm in length) with focal increased echogenicity, loss of corticomedullary differentiation, and decreased perfusion in the upper pole.

IMAGING FINDINGS

See Figures 1–3.

ACUTE PYELONEPHRITIS

Pyelonephritis is an infection of the renal parenchyma, usually caused by an ascending infection from the lower urinary tract, with *Escherichia coli* representing the most common offending pathogen.¹ Clinical features including flank pain, fever, hematuria, pyuria, and leukocytosis usually suffice for the diagnosis. Imaging is reserved for patients with atypical

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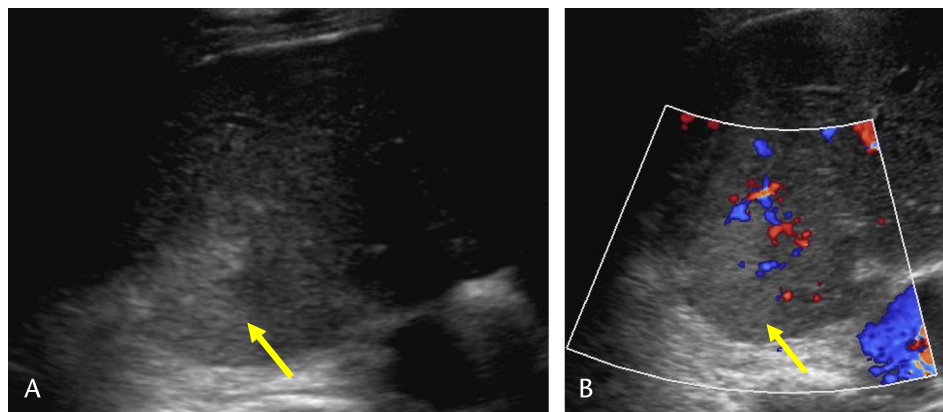


FIGURE 2. Transverse gray-scale (A) and color Doppler (B) images of the right kidney demonstrate a wedge-shaped hyperechoic region with decreased perfusion on color Doppler US.

presentations, high risk for complications, or inadequate response to treatment, thereby raising concern for confounding factors such as abscess, perinephric collection, calculi, or obstruction. Patients with high risk of complications include the elderly, persons with diabetes, and immunocompromised patients.¹

In most patients with acute pyelonephritis, the kidney appears normal on US. On gray-scale sonography, there may be diffuse or focal enlargement of the kidney, sometimes with a mass-like appearance. The involved areas are usually hyperechoic (Figs. 3A, C) and may be wedge shaped or round. Less frequently, the infected areas demonstrate decreased or mixed echogenicity on sonography.²

Color and power Doppler evaluation typically shows decreased perfusion in the affected parenchyma (Figs. 1B and 2B), which has been attributed to arteriolar vasoconstriction and interstitial edema in response to bacterial infection.³ Other possible sonographic features include loss of corticomedullary differentiation, decreased visualization of renal sinus fat, urothelial thickening,⁴ and/or intraparenchymal gas.

As in this patient, the focal areas of altered parenchymal echogenicity on US correspond to focal wedged-shaped regions of hypoattenuation on contrast-enhanced computed tomography (CECT) scans (Figs. 3A–D). Other findings on CT include a striated nephrogram, focal or diffuse renal enlargement, and/or perinephric stranding. Although color and power Doppler techniques aid in the sonographic evaluation, CECT is more accurate in detecting changes of pyelonephritis than conventional sonography. Also, CT is the preferred method for detecting complications and associated findings such as renal or perinephric abscess, calculi, and presence and cause of obstruction.⁵

In a study of induced pyelonephritis in a pig model, CECT showed a sensitivity and specificity of 86.8% and 87.5% compared with power Doppler US with a reported sensitivity and specificity of 74.3% and 56.7%.³ Although not currently widely available, contrast-enhanced sonography shows promise in further improving diagnostic accuracy with US. In one study, contrast-enhanced US reported a sensitivity of 82%, which compared with a reported 84% sensitivity

for CECT in detecting parenchymal changes in cases of clinical pyelonephritis.⁵ Technetium Tc 99m dimercaptosuccinic acid scintigraphy has long been regarded as the criterion standard in the diagnosis of pyelonephritis in the pediatric population, and power Doppler sonography has shown comparable results (73.8% sensitivity and 85.7% specificity with ^{99m}Tc-dimercaptosuccinic acid scintigraphy as the reference standard), making this modality an attractive nonradiating method for diagnosis.⁴

The patient in this case had a urine culture that subsequently grew *E. coli* and was treated successfully with intravenous followed by oral antibiotics.

DIFFERENTIAL DIAGNOSIS

The main differential considerations for a focal renal parenchymal abnormality with decreased perfusion include renal abscess, mass, and infarct. Renal abscess will show central liquefaction on US and CT as opposed to focal pyelonephritis. If neoplasm or infarcts are considerations, follow-up imaging can be obtained as focal infection will show response to appropriate treatment, whereas the former entities will persist.

TEACHING POINTS

1. Although a kidney with pyelonephritis frequently appears normal on US, be aware of findings, sometimes subtle, including diffuse or focal enlargement of the kidney, variation in parenchymal echogenicity (usually hyperechoic), loss of corticomedullary differentiation, decreased visualization of renal sinus fat, urothelial thickening, and/or intraparenchymal gas.
2. Color and power Doppler evaluation typically demonstrates decreased perfusion in the affected parenchyma.
3. Because imaging in pyelonephritis is reserved for patients with atypical presentations, high risk for complications, or inadequate response to treatment, evaluation of the kidney must include assessment for intrarenal or perinephric abscess, calculi, and obstruction.

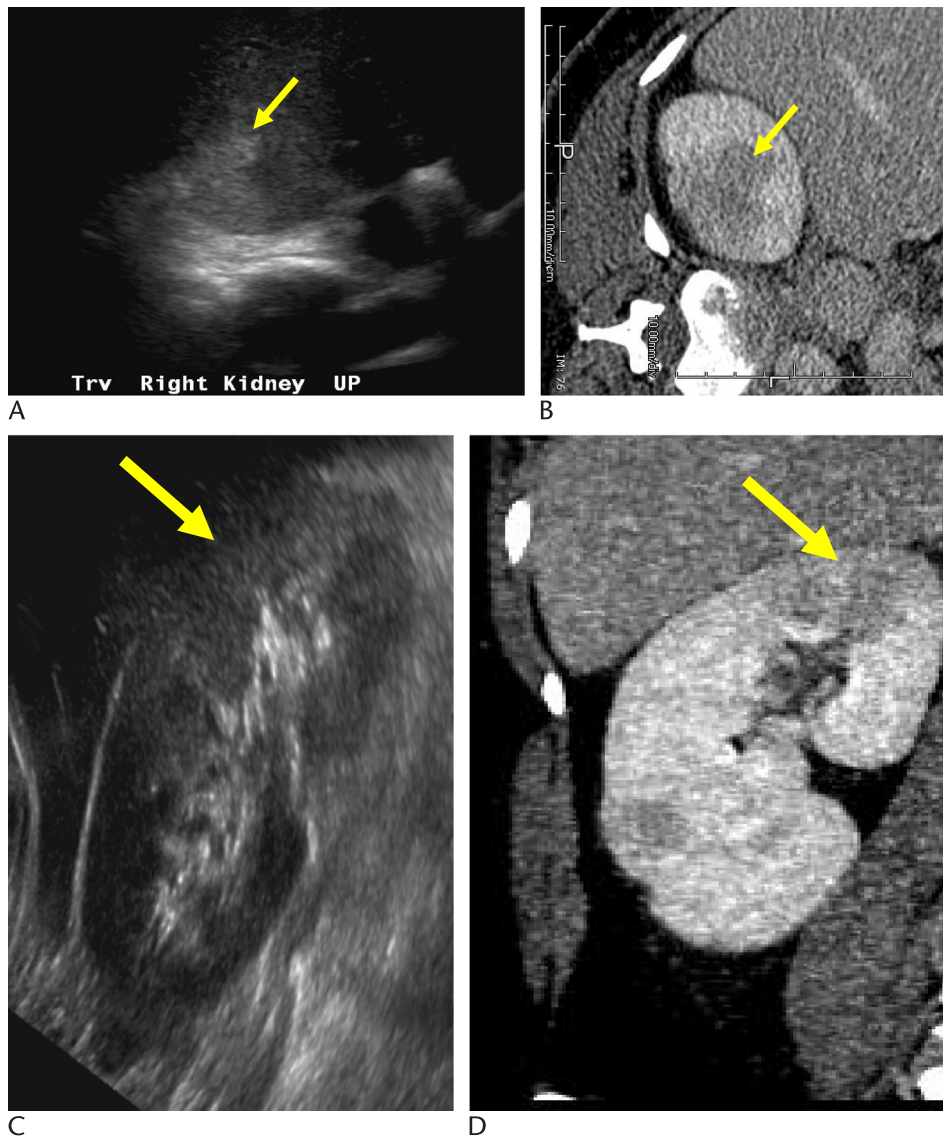


FIGURE 3. Transverse US (A), transverse CECT (B), sagittal US (C), and coronal-reformatted CT (D) images of the right kidney demonstrate focal echogenic regions on US (A, C) in the upper pole renal parenchyma with loss of corticomedullary differentiation and corresponding areas of decreased enhancement on postcontrast CT (B, D). Orientation of the axial CT and longitudinal US are rotated to match the corresponding other modality. (An additional smaller focus of decreased enhancement is seen in the lower pole of the kidney on the coronal reformatted CT image [D]).

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