Diagn Interv Radiol 2008; 14:103-105

Noninvasive imaging findings of idiopathic renal arteriovenous fistula

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ABSTRACT
Renal arteriovenous fistula (AVF) is an uncommon clinical entity, which can be congenital, acquired, or idiopathic. Diagnosis is aided by radiological studies, with digital subtraction angiography as a gold standard. However, Doppler ultrasound with color Doppler interrogation and computed tomography (CT) angiography are alternative imaging techniques that are noninvasive and can be used for patients to whom no intervention is planned. In this report, we present a case of idiopathic renal AVF diagnosed by Doppler ultrasound and CT angiography. Gray-scale ultrasound showed a cyst-like lesion which was confirmed to be a focal aneurysmatic dilatation with heterogeneous fill-in and turbulent blood flow on color Doppler and spectral analysis. CT angiography demonstrated multiple aneurysmatic dilatations of the segmental branch and early opacification of right renal vein on the arterial phase, consistent with renal AVF.

Key words: • *renal aneurysm* • *renal arteriovenous fistula* • *Doppler ultrasound* • *computed tomography angiography*

Idiopathic renal arteriovenous fistula (AVF) is relatively rare, accounting for 3% to 5% of all renal AVFs, typically demonstrating an aneurysmal appearance; it has a significant influence on the hemodynamics (1). The most common symptom of renal AVF is hematuria; other clinical manifestations include hypertension, left ventricular hypertrophy, cardiac failure, and abdominal pain (2). Digital subtraction angiography is the gold standard for diagnosis of renal AVF; however, it is invasive. Noninvasive modalities are the choice of imaging renal AVF in patients who are asymptomatic and for whom no intervention is planned. This report describes the noninvasive imaging findings of a case of idiopathic renal AVF.

Case report

A 39-year-old woman presented with chronic left flank pain to our hospital. She had no dysuria or macroscopic hematuria. Blood pressure, ECG, and chest radiograph were normal. She had lithotripsy for left kidney stone 2 years prior to this visit. There was no history of surgery, trauma, or infection of the right kidney.

She was well oriented, and her physical examination was normal. Blood pressure was 120/90 mm Hg. Complete blood count, blood urea, and creatinine were within normal limits. Urine analysis revealed 29 red blood cells/field.

A urinary system ultrasound was performed, revealing no kidney or bladder stones and no parenchymal or collecting system abnormality of either kidney. On gray-scale ultrasound, there was a cyst-like lesion at the inferior pole of the right kidney (Fig. 1a), which was confirmed to be a focal aneurysmatic dilatation with heterogeneous fill-in on color Doppler (Fig. 1b). Turbulent blood flow with maximum velocity of 229 cm/s was obtained, indicative of a fistula on spectral analysis (Fig. 1c).

Computed tomography (CT) angiography demonstrated multiple aneurysmatic dilatations of the segmental branch of the inferior pole which were clearly visible on coronal maximum intensity projection (MIP) images, and early opacification of right renal vein on the arterial phase when compared with the unenhanced normal left renal vein (Fig. 2).

The patient declined further investigation or treatment, as she had no subjective complaints related to this finding.

Discussion

Renal AVFs are relatively uncommon lesions, which can be congenital, acquired, or idiopathic. The majority (70%) are iatrogenic and occur as a result of renal biopsy, blunt or penetrating trauma, inflammation, malignancy, or renal surgery (3). The exact cause of congenital fistulas (20%) is unknown; however, they are thought to be present at birth or

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Received 20 June 2007; revision requested 23 July 2007; revision received 27 July 2007; accepted 5 September 2007.

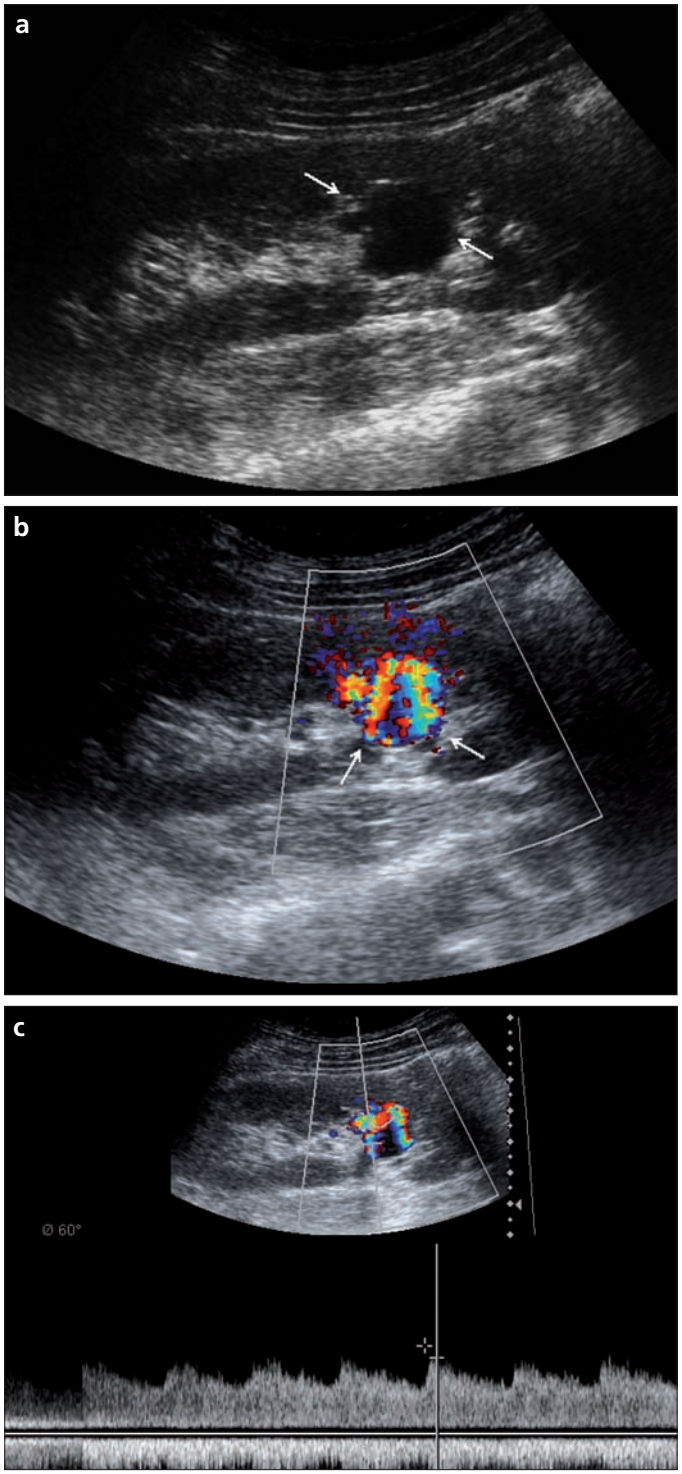

Figure 1. a-c. On gray-scale ultrasound **(a)**, a cyst-like lesion at the inferior pole of the kidney is seen *(arrows)*, which has heterogeneous fill-in on color Doppler ultrasound (**b**, *arrows*). Spectral analysis **(c)** shows turbulent flow with increased flow velocity of 229 cm/s.

to result from a congenital aneurysm that erodes into the adjacent vein (2). In general, congenital lesions typically have a cirsoid appearance, and acquired or idiopathic lesions are usually aneurysmal (4). The cirsoid type of renal AVF frequently causes hematuria, as it is commonly found beneath the mucosa of the renal collecting system; the idiopathic or acquired types cause abdominal bruit, hypertension, headache, and palpitation, resulting from a large amount of blood flowing through the AVF (5). Idiopathic lesions are usually aneurysmal acquired AVF, with a single cavernous channel and well-defined arterial and venous elements (6).

The right kidney is more frequently involved than the left, and women are affected twice as often as men (7). The peak incidence occurs in patients between 30 and 40 years old; they are rarely found in pediatric population (2).

The aim of renal AVF treatment is to preserve renal parenchymal function and eradicate symptoms and hemodynamic effects associated with the abnormality. Indications for treatment are progressive increase in the size of the fistula; recurrent or persistent hematuria; and hemodynamic effects associated with the abnormality, especially decompensation, hypertension, and high-output heart failure (8).

Recently endovascular techniques are used even for giant aneurysms with AVFs. For small renal AVFs, macroparticules or methyl cyanoacrylate glue should be used. For larger fistulas, coils or detachable balloons must be used; if there is concern for systemic and pulmonary embolism, high-flow AVF should be managed by open resection or ligation (9, 10).

There are multiple imaging modalities to demonstrate renal AVF. Intravenous pyelography shows a filling defect in the collecting system, most commonly suggesting urothelial tumor or blood clot. Color Doppler ultrasound reflects the mosaic pattern and perivascular soft tissue color speckling. On spectral analysis, increased flow velocity, decreased arterial resistance, and arterial wave forms in the outflow vein are obtained (11). Color Doppler ultrasound is also very useful in assessment of renal cystic lesions (as in our case), for the differential diagnosis of simple or complicated cyst and vascular pathologies, and for showing the vascularization of the septae or the solid component of the cystic lesion.

Although arteriography is the gold standard for evaluating renal AVF, it is invasive. With advances in multidetector CT, we can obtain thin slices, which allow us to demonstrate the pathology in multiplanar images. Because the imaging is fast, the dynamics of the AVF can be shown easily, leading to accurate diagnosis.

Our patient was an adult woman with an idiopathic renal aneurysm with AVF who had no prior surgery or trauma.

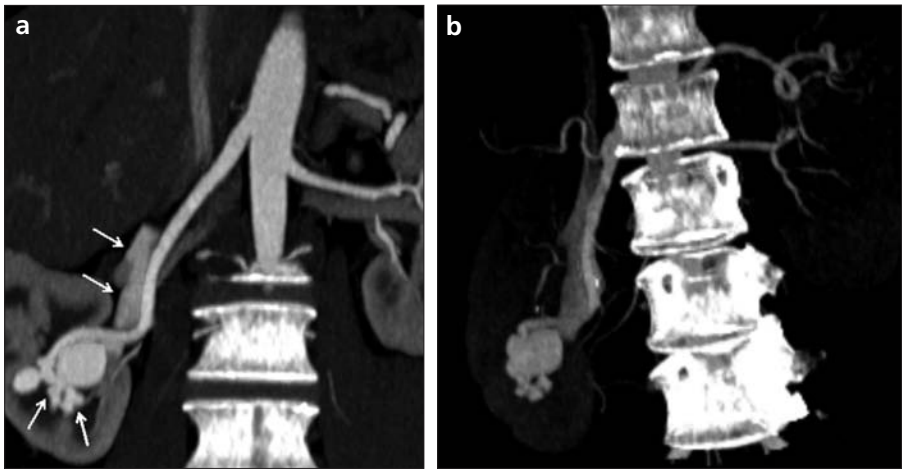

Figure 2. a, b. CT angiography maximum intensity projection (MIP) reconstructions **(a, b)** show the early opacification of right renal vein *(arrows)*, almost as bright as renal artery, indicating arteriovenous fistula with multiple aneurysms of the segmental arteries.

The lesion at the right kidney was incidentally seen on ultrasound performed for left flank pain. Although she had no subjective complaint, she had microscopic hematuria detected by urine analysis. The preceding Doppler ultrasound revealed findings suggestive of renal AVF. CT angiography was capable of noninvasively showing the renal aneurysm with AVF, the extension of the aneurysm, and the feeding vessels. She had normal urea and creatinine levels, so injection of intravenous contrast media was of no risk to the patient. Renal catheter angiography can demonstrate the smallest feeding vessels and intralesional vessels, but visualization of these vessels is important only if an interventional procedure is planned. If observation instead of intervention is elected, there is no indication for arteriography (the patient in our case declined arteriography).

In conclusion, in diagnosing renal AVF, noninvasive methods like Doppler ultrasound and CT angiography should be preferred to invasive renal catheter angiography. These noninvasive methods can also be used for follow-up for cases in which observation is preferred to intervention.

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