Case-Based Points on the Role of Imaging in Kidney Disease

Juan J. Olivero, Sr., MD

HOUSTON METHODIST HOSPITAL, HOUSTON, TEXAS

The column in this issue is supplied by Juan Jose Olivero, MD, who recently retired as a nephrologist at Houston Methodist Hospital and member of the hospital's Nephrology Training Program. Dr. Olivero obtained his medical degree from the University of San Carlos School of Medicine in Guatemala, Central America, and completed his residency and nephrology fellowship at Baylor College of Medicine in Houston, Texas.

Kidney disease has traditionally been detected through biochemical analysis of blood and serum, although this kind of testing does not always lead to a definitive diagnosis. In recent years, however, the boom in sophisticated imaging techniques has widened the diagnostic options available to nephrologists. This issue's Points to Remember column offers a case-based review of commonly used imaging modalities and their role in detecting and/or confirming kidney disease.

Plain film of the abdomen has limited use nowadays, although it can be used to assess metabolic activity of kidney stone disease. It can also provide evidence of renal osteodystrophy due to secondary hyperparathyroidism, which is a common complication in patients with chronic kidney disease (CKD). Renal ultrasound is important in assessing kidney size and echogenicity, evaluating obstructive pathology, and identifying kidney cysts and renal masses.

Intravenous pyelogram has been replaced by computed tomography (CT), which provides more detailed anatomy of the kidneys, adrenals, and surrounding structures including arterial and venous circulation. Specific CT renal protocols are available to define kidney masses using a urogram contrast, which helps evaluate the ureters and bladder. Ideally, patients with stage 3 or 4 CKD would benefit from nephrology clearance to prevent dye-induced nephrotoxicity. At times, CT may be done without intravenous contrast to avoid worsening kidney function. CT angiography can be used for screening if some form of arterial pathology is suspected, although arteriography remains an important tool since it can also facilitate angioplasty and stent deployment in addition to its diagnostic capabilities.

Magnetic resonance imaging (MRI) is the preferred test to evaluate extra-adrenal pheochromocytoma. However, it necessitates a cooperative patient since it is a longer procedure than CT and requires immobilization to obtain an accurate reading. Magnetic resonance angiogram (MRA) may sometimes help define a renal angiomyolipoma and can also be useful when evaluating a berry brain aneurysm in patients with polycystic kidney disease. However, the use of gadolinium in patients with impaired kidney function (eGFR < 40 mL/min) can result in nephrogenic systemic fibrosis; therefore, use of this contrast is contraindicated under these circumstances.

Finally, voiding cystourethrogram is a dynamic test that is most useful in the evaluation and grading of vesicoureteral reflux.

We present herein four cases that offer interesting imaging findings with practical teachable messages.

CASE 1

A 56-year-old male with poorly controlled type II diabetes presented to the emergency room with fever (103° F), resting tachycardia (120 bpm), and hypotension (90/60 mm Hg) associated with an altered mental status. Initial evaluation showed significant pyuria, bacteriuria, microscopic hematuria, and a white blood cell count of 20K. A kidney, ureter, bladder (KUB) x-ray showed features of emphysematous pyelonephritis (Figure 1). After urine and blood cultures were obtained, the patient was immediately administered intravenous antibiotics followed by a percutaneous drain.

Fast Takes

- Emphysematous pyelonephritis (EPN) is a necrotizing infection of the renal parenchyma and its surrounding areas, leading to gas formation in the kidney parenchyma, collecting system, and perinephric tissue.
- EPN occurs mostly in patients with poorly controlled diabetes (96% of the cases), and urinary obstruction can complicate the process in 22% of patients.
- *E. coli* (69%) and *Klebsiella pneumoniae* (29%) are the most common pathogens responsible for this serious condition.
- Mortality in EPN can be as high as 40% in patients treated with antibiotics alone and can also be related to the duration of disease before initiating therapy, the patient's age, and other comorbid conditions. The combined approach of

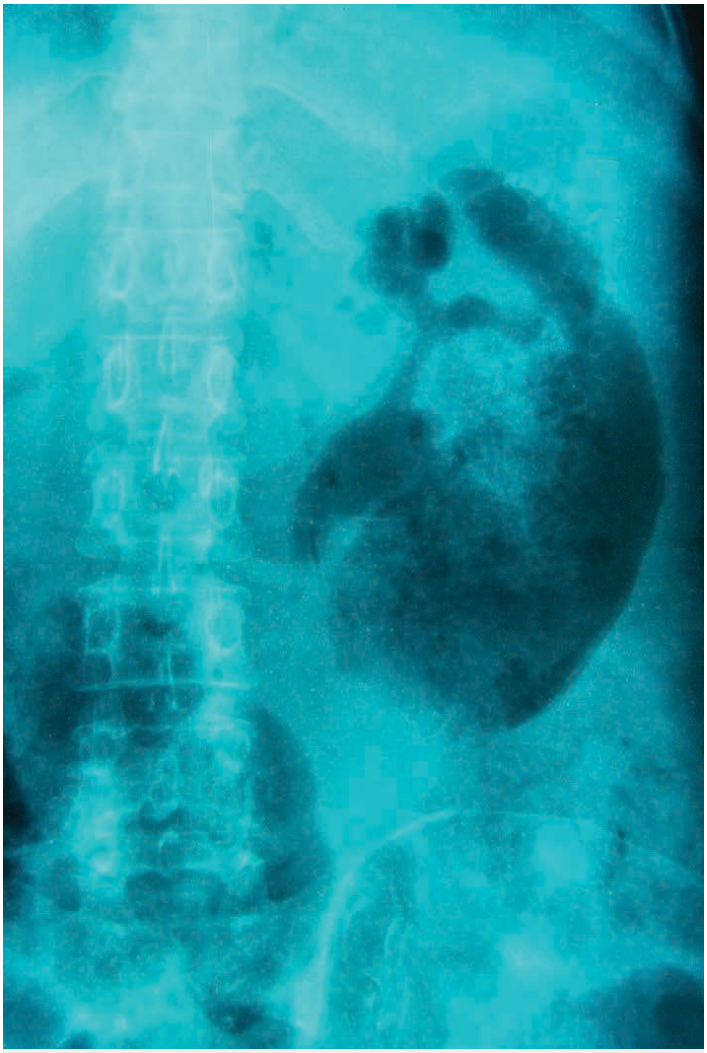

Figure 1.
Plain film of the abdomen shows significant amount of gas in the left kidney.

antibiotics and percutaneous drainage can reduce mortality to 18%.

- In severe cases, nephrectomy resulted in a success rate of 90%.
- Histopathologic findings have shown features of vascular thrombosis, with or without renal infarction, and arteriolonephrosclerosis, which frequently complicates diabetes.[1]

CASE 2

A 20-year-old male with a drug addiction came to the emergency room complaining of severe abdominal pain and arthralgia and presenting with shortness of breath, hemoptysis, and altered mental status. On admission, he was severely hypertensive (250/140 mm Hg), disoriented, and acutely ill, with a summation gallop and rales on both lung fields and a diffusely tender abdomen. His hypertension proved to be resistant to conventional therapy, and plasma renin levels were extremely high with suppressed aldosterone. Selective renal and abdominal arteriogram showed marked contour irregularities with multiple macro aneurysms in the medium-sized kidney arteries and in the mesenteric circulation (Figures 2,3) consistent with polyarteritis nodosa (PAN). Hepatitis B surface antigen test was positive. Unfortunately, this patient signed out against medical advice and was lost for follow up.

Figure 2.
Renal arteriogram shows macroaneurysms of the renal circulation.

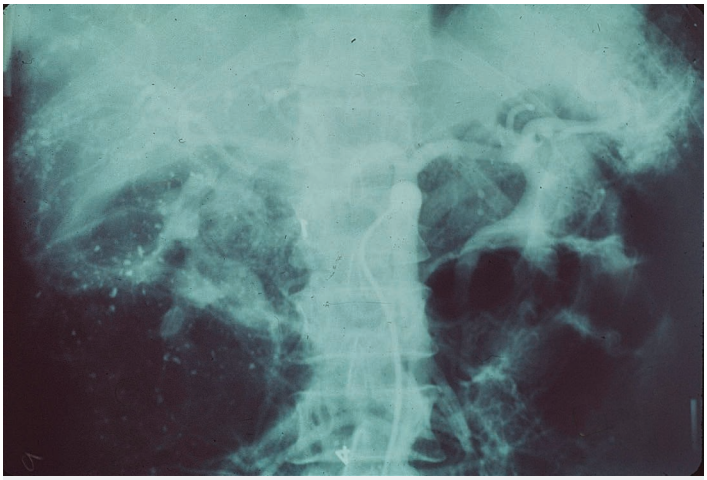

Figure 3.
Abdominal arteriogram shows macroaneurysms of the mesenteric circulation.

Figure 4.
(Left) Initial intravenous pyelogram (IVP) shows a dense nephrogram of the right kidney with no visualization of the collecting system compared to the contralateral kidney. (Right) Repeat IVP shows a normal study with full visualization of the normal-appearing collecting system bilaterally.

Fast Takes

- Hepatitis B (HepB) surface antigen-positive status has been associated with both PAN and drug abuse.[2]
- PAN needs to be considered in the differential diagnosis of patients presenting with features of vasculitis, particularly if they are HepB positive.
- Several therapeutic modalities have been tried with varying results, including the use of steroids, cyclophosphamide with or without antivirals, and plasma exchange.
- Seroconversion of HepB antigenemia resulted in decreased relapses and a generally better prognosis.
- The major cause of death in PAN is gastrointestinal involvement.
- The frequency of HepB virus-PAN has decreased with improved blood safety and vaccination campaigns.[3]

CASE 3

A 28-year-old male with a drug addiction was brought to the emergency room complaining of back pain after sustaining an automobile accident when his car was hit from behind. Physical exam was unremarkable except for needle tracks on both arms. Initial evaluation disclosed microhematuria. Intravenous pyelogram (IVP) showed a normal functioning left kidney, but only a dense nephrogram effect was seen in the right kidney (Figure 4 left). The possibilities of right renal artery dissection/tear related to deceleration trauma was considered, with right kidney pelvis blood clot also part of the differential diagnosis. Shortly after his admission, the patient passed some tissue in his urine, which was sent to pathology. A repeat IVP showed a normal right kidney and normal collecting system (Figure 4 right). The tissue specimen recovered from the urine proved to be masses of septate hyphae and mycelia, which on culture disclosed *Aspergillus fumigatus* (Figure 5). Repeat urine tests and fungal serologies remained negative with negative chest x-ray and an uneventful clinical course without the need for specific therapy.

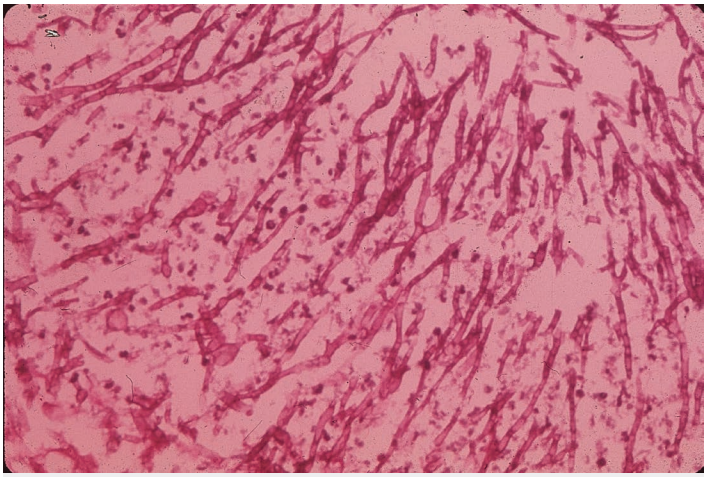

Figure 5.
Spontaneously voided tissue sample shows septated hyphae and mycelia (*Aspergillus fumigatus*).

Fast Takes

- Fungus ball of the renal pelvis leading to obstruction is a rare complication of systemic mycotic infections,[4] usually present in chronic debilitating diseases such as cancer, diabetics, and parenteral drug abuse and in immunocompromised individuals.[5]
- This condition usually requires urologic manipulation and prolonged intravenous antifungal therapy.
- In some instances, bilateral renal pelvis fungus ball can lead to anuria and kidney failure.[6]
- This patient presents a series of unique events: hospitalization for an unrelated reason (a car accident) and then spontaneous resolution of his problem, with such luck that he saved the tissue he passed while in the hospital.
- Passing tissue in the urine is an abnormal finding, and the specimen should be sent to pathology and microbiology for analysis (as it was in this case).
- More common causes of spontaneously passing tissue in the urine would be papillary necrosis or an organized blood clot from any etiology.

CASE 4

A 38-year-old man with a history of hematuria and recurrent urinary tract infections came to the emergency room because of dysuria, chills, and fever. On examination, he was febrile (102.5 °F), tachycardic (heart rate 110 bmp), and had diffuse abdominal pain on palpation. KUB x-ray showed bilateral large radiopaque stones consistent with staghorn calculi (Figure 6).

Fast Takes

- Staghorn calculi are composed of struvite (magnesium ammonium phosphate) and develop in the setting of recurrent urinary tract infections, with urease-producing bacteria (*Proteus*, *Klebsiella*, *Pseudomonas*, and *Enterobacter*) leading to an alkaline urine pH.
- In the KUB (plain film of the abdomen), they appear as branching calcific densities involving and outlining the renal collecting system.
- Treatment requires surgical removal of the stones (even fragments) by means of percutaneous nephrolithotomy and/or extracorporeal shock wave lithotripsy; this is frequently followed by cystoureteroscopy for fragment removal.[7]
- Following surgical treatment, oral urease inhibitors such as acetohydroxamic acid (Lithostat) have also been used as adjuvant therapy but not as the sole form of treatment.

Figure 6.
Plain film of the abdomen shows bilateral large radiopaque stones consistent with stag horn calculi.

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