Acute Flank Pain: Multi-detector Computed Tomographic Evaluation in the Emergency Room

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Abstract
Acute nontraumatic pathological conditions of the kidneys include frequent hematuria, renal colic, and acute renal failure. Infections and renal vascular problems are frequently encountered in an emergency department. In this pictorial review, we aim to discuss patterns of acute renal pathologies and explain hints for differential diagnosis with computed tomographic findings.

Keywords: Renal, tomography, flank pain

Introduction
Various renal pathologies can be detected by computed tomography (CT) in patients referring to the emergency room with acute abdominal pain. Emergency physicians and radiologists often play an important role in the evaluation and management of acute renal diseases.

In the diagnosis of acute renal pathologies, anamnesis, clinical and laboratory findings, and physical examination are of primary importance. Imaging methods are of equal importance as these diagnostic methods. Often, ultrasonography is the first choice for imaging. However, there are clinical limitations with ultrasonography. Some of these limitations are: the need for patient cooperation, the presence of artifacts due to intestinal gases, and some technical disadvantages in diagnosing the vascular pathologies. It is also easier to exclude other non-kidney causes such as acute appendicitis, psoas abscess, diverticulitis, which cause abdominal pain with CT. Although CT involves radiation exposure, contrast agent allergy, and contrast nephropathy risks (in some patients), it is a fast performing modality with a high diagnostic value that should be preferred when ultrasonography is insufficient.

Hematuria
Hematuria is commonly seen in a wide spectrum of urinary diseases (1). The causes of gross hematuria are urinary system infections, urolithiasis, and neoplasms of genitourinary system (2).

Hematuria may be evaluated by multi-detector CT (MDCT) of nephrographic, excretory phase, or without contrast. MDCT without contrast helps evaluate nephrolithiasis which is one of the main reasons of hematuria and allows imaging from the kidney to the bladder (3).

A typical CT urography procedure obtains non-contrast images, and nephrographic phase images are obtained 90-100 s after intravenous nonionic contrast injection (100-150 mL of 300 mg I/mL at 2-4 mL/s, 2.5- to 5-mm slice thickness) (4).
Renal parenchymal abnormalities, especially masses, are best visualized via nephrographic phase images by which other abdominal organs can also be evaluated. Delayed thin slice images from the kidneys to the bladder reveal contrast distended urinary system and are used to detect uroepithelial diseases (3). Pyelographic phase images are obtained 5-15 min after contrast administration and are used to evaluate uroepithelium. However, economical analyses reveal that MDCT are most cost-effective in patients with persistent hematuria and normal ultrasonographic findings (4).

Renal cell carcinoma and transitional cell carcinoma have typically higher density than urine and their densities are measured to be 5-30 Hounsfield units (HU) in CT without contrast administration. Malignant renal and urothelial tumors show early contrast enhancement and washout (4, 5). Thus, in the nephrographic phase, contrasted urothelial lesions may be detected in urine with low density (Figure 1).

Increase in density up to more than 20 HU after contrast administration is a sign of malignancy (4, 6). Infiltration may cause focal delays in contrast enhancement. Ureteric obstruction maybe best visualized in nephrographic phase and can be easily distinguished from a stone. The other findings of transitional cell carcinoma are thickening of the wall, stenosis, and infiltration of periurethral fat tissue (4).

Renal colic and urolithiasis

Acute flank pain and renal colic are commonly encountered in emergency departments. The lifetime incidence of urolithiasis is approximately 12% (7, 8). The patients are generally between 30 and 60 y, and the occurrence is three times more common in men (7). It has been shown in many studies that abdominal CT without contrast administration has a higher specificity and sensitivity for detecting stones in the urinary system compared with other modalities (9).

Multi-detector CT without contrast is a fast and reliable diagnostic method for urinary stones. There is no requirement of intravenous contrast administration and thus allergic--anaphylactic reactions and nephrotoxicity risks do not exist. The analysis maybe performed in a very short time and has a high sensitivity for distinguishing stones and other causes of renal colic (7). However, there is radiation exposure in CT. Thus, nowadays low-dose tomographic studies are gaining importance. Researchers have reported that in patients with acute abdomen who refer to the hospital with urinary colic CT examinations with low-dose radiation (25 mAs) have the same diagnostic sensitivity as the examinations with standard radiation dose (100 mAs) (10). McLaughlin and colleagues stated that the use of iterative reconstruction techniques increases diagnostic ability (11).

However, on some occasions of renal anomaly and variations such as duplication of renal collective system, CT urographic study, which includes excretory phase after intravenous contrast administration, may be useful for diagnosis (Figure 2).

Increase in kidney dimensions may be observed because of swelling and edema in acute obstructions. This has been reported at an incidence of 36%-71% in different studies. Perinephritic edema has been reported in 36%-82% of the patients. Decrease in renal density due to obstruction may be seen in patients with kidney stone (9). Hydronephrosis, hydrouretere, and perinephritic fat stranding have a predictivity of 90% for obstruction of the urinary system due to stone disease (4, 12).

Figure 1. The axial abdominal computed tomography (CT) images of a patient obtained in the nephrogram phase because of hematuria. The lesion was diagnosed as transitional cell carcinoma (white arrow) which fills the left renal sinus and shows contrast enhancement, solid lesion with a density higher than urine.
moniae, Proteus mirabilis, and Pseudomonas aeruginosa (18). The prognosis may be mortal if evaluated by X-ray graphy, because the gas in the renal parenchyma may be confused with the intestinal gas (19). CT is useful in detecting the extension of the infection, parenchymal gas formation, and the evaluation of complications (18, 19). There are subtypes of EPN according to the images on the CT. In Type 1, there is parenchymal destruction but no fluid collection or gas extension from medulla to cortex. Subcapsular or perinephral crescentic gas formation may be seen. The nonexistence of fluid collection is the result of a weak immune response. Mortality rate is high (66%). However, in type 2, there exist confined, bubbly, intrarenal gas pattern, renal and perirenal fluid collections, and gas formation in renal pelvis. Mortality rate is nearly 18% (19). Formation of gas may reach perirenal region, renal vein, and inferior vena cava (Figure 4, 5).

Renal vascular pathologies
Arterial dissections are frequent in malignant hypertension, atherosclerosis, trauma, fibromuscular dysplasia, connective tissue diseases such as Marfan syndrome, Ehler-Danlos syndrome (20-22). Cocaine abuse and extracorporeal shock wave lithotripsy cases were also reported (22). The most common localization of primary dissection of perinephric arteries is renal arteries (20). The extension of false lumen may cause a narrowing in the true lumen, and diminished renal blood flow may cause renal infarct. Less than 25% of renal artery dissections occur spontaneously and frequently in men of fourth
and fifth decades with no previous health problems (20, 23). The most common clinical presentation is persistent and severe hypertension with an acute onset. However, severe upper abdominal pain resembling a renal colic may also be seen (24). Because of this, even if there is no history of trauma in a patient with acute flank pain and hypertension, isolated renal artery dissection may also be taken into consideration (20, 25). Angiography with catheter is a gold standard in diagnosis; however, it is possible to evaluate by CT angiography noninvasively (22, 25). In CT renal perfusion defects, areas without contrast enhancement and hypodense image in renal artery may be seen (Figure 6).

**Conclusion**

Acute renal pathologies are a wide spectrum of diseases which may be life-threatening. Early diagnosis is important in prognosis,
early onset of therapy, and in decreasing complications. MDCT is an important modality in acute renal pain.

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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