Acute Urinary Tract Disorders

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KEYWORDS

• Flank pain • Urolithiasis • Hemorrhage • Pyelonephritis • Urinary obstruction

KEY POINTS

- Flank pain is a nondiscriminatory symptom due to the autonomic innervation of multiple organ systems, including the urinary tract.
- Low-dose computed tomography (CT) is the recommended test for patients who have an initial presentation with flank pain from presumed urinary colic.
- Most patients with pyelonephritis do not require imaging unless they fail to respond to antibiotics within 72 hours.
- Patients who present with pyelonephritis and any of the following conditions should be imaged at presentation: patients who are pregnant, diabetic, elderly, or immunocompromised or have a history of stone disease or congenital genitourinary (GU) abnormalities.
- The most common cause of renal infarction is an embolus from a cardiac source, whereas the most common cause of nontumoral renal vein thrombosis (RVT) is coagulopathy, such as in nephrotic syndrome.

INTRODUCTION

Acute urinary tract disorders often manifest as flank pain and are a common complaint of patients who present to the emergency department (ED). The pain is often a vague, poorly localized sensation that can have a variety of causes. Laboratory and clinical findings, such as hematuria, are neither sensitive nor specific for determining the cause of the flank pain. Accordingly, imaging is an important tool in determining a diagnosis and management plan. Patients with acute urinary tract disorders who present with pain include those with calculi, as well as renal infection, vascular disorders, and hemorrhage.

ANATOMY

The flank is the region between the posterior costal margin and the top of the iliac crest. The referred pain to the flank is due to both the dermatomal pattern of autonomic innervation and the common embryologic origin of various organs. The renal capsule and collecting system are innervated by sympathetic fibers from the T12 dermatome. In addition to the kidneys and ureters, these fibers also innervate gastrointestinal organs, resulting in poor pain localization. Pain from mid to lower ureteral distention radiates into the testes or labia, given the common embryologic origin from the urogenital ridge. Stimulation of the sympathetic fibers by either visceral organ distention or inflammation causes both pain and autonomic symptoms such as nausea and vomiting.[1]

IMAGING TECHNIQUE

The American Urological Association[2] and the American College of Radiology (ACR)[3] recommend low-dose (for body mass index [BMI] <30)

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noncontrast CT for the initial presentation of flank pain (Table 1). Noncontrast CT is a fast, readily available technique that provides a broad overview of the abdomen and pelvis, which is especially useful in the setting of vague symptoms. In addition, CT also provides important information for the management of renal calculi, such as stone burden and precise calculus location.

Miller and colleagues[4] performed a study to evaluate the utility of intravenous (IV) contrast in patients with flank pain and found that of the 708 patients who received IV contrast only 43 (6%) had actionable findings that required IV contrast, including 32 patients who had pyelonephritis, for which imaging is not initially indicated unless the patient has complicating factors.[5] Of the 8 patients, 6 with renal cell carcinoma had masses large enough to be distinguished without IV contrast.[4] Specific indications for IV contrast in patients who present with flank pain include unilateral renal stranding/enlargement with risk factors for renal infarct or vein thrombosis (ie, patients with dysrhythmia, thromboembolic disease history, or elevated levels of lactate dehydrogenase), perirenal fluid collection, renal mass/complicated cyst, or unexplained hematuria.[6]

During the past decade, there has been an emphasis on reducing the radiation dose of CT scans performed for flank pain given the young age and frequency of imaging within the affected patient population. Poletti and colleagues[7] demonstrated 100% sensitivity for calculi greater than 3 mm and nonurinary tract disorders for low-dose CT (30 mAs, 1.6–2.1 mSv) in patients with BMI less than 30. Ciaschini and colleagues[8] reconstructed raw CT data at 100%, 50%, and 25% of the original tube current using simulation software and demonstrated sensitivities of 91.7%, 83.3%, and 67.1%, respectively, for each reconstruction level. Although the sensitivity for stone detection is high, stone size measurements can vary on low-dose CT by 20% compared with standard-dose CT.[7]

Methods for dose reduction include the use of automated tube current modulation, increased slice thickness, and decreased tube current and/or voltage. Automatic tube current modulation maintains constant image quality by altering tube current based on patient size and allows for a reduction in effective dose of up to 66%, without any difference in stone conspicuity[9] and is routinely used. Memarsadeghi and colleagues[10] demonstrated that, although fewer stones are detected at a 5-mm section thickness, all missed stones measured less than 3 mm (in the range in which most pass spontaneously). By reducing tube voltage to 100 kV (dose reduction of 35%), there is an increase in noise of 30%. However,

Table 1
Sensitivity and specificity for detecting stones

Modality	Sensitivity	Accuracy	Key Points
XR	58%–62% (renal or ureteral)[3,12] 45%–58% for ureteral calculus[12,13]	61%[21]	• Main utility: surgical planning SWL, stent placement, follow up calculus • No information concerning hydronephrosis
XR + US	79%[21]	71%[21]	• Can be used in young women and patients with prior history of stones
IVU	85%[19]	92%[21]	• Requires IV contrast
CT	95%–96%[3]	98%[3]	• Low-dose (for BMI <30) NCCT study of choice for acute flank pain new presentation
US	24%–57% (renal/ureteral calculus)[3,20] 73%–86% (secondary signs of obstruction)	69%[21]	• Useful in the following population: young women, pregnant women, prior history of calculus
MR imaging	50%–60% (renal/ureteral calculus) 100% (secondary signs of obstruction)[26,27]	—	• Examination of choice for hydronephrosis in the first trimester • T1 postcontrast can increase specificity for a calculus, but gadolinium not allowed in pregnancy

Abbreviations: IV, intravenous; IVU, intravenous urography; NCCT, noncontrast computed tomography; SWL, shockwave lithotripsy; US, ultrasonography; XR, radiography.