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CME CREDIT

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# Imaging in Practice

## A patient with acute flank pain

A 50-YEAR-OLD MAN presents to the emergency department with colicky right flank pain radiating to the groin. He reports that the pain is severe and began 3 hours earlier. On physical examination he is writhing and unable to sit still, with tenderness to palpation of the right flank and hypoactive bowel sounds. His vital signs are normal. Urinalysis reveals hematuria without white blood cells.

You think the likely diagnosis is renal colic. With all of the available imaging options, what is the best way to assess for renal calculi in the acute setting?

**What is the best way to assess for renal calculi in the acute setting?**

### PLAIN ABDOMINAL RADIOGRAPHY: NOT FOR THE INITIAL EXAMINATION

According to the classic radiologic literature, 70% to 90% of urinary tract calculi are sufficiently radio-opaque to be detected by plain radiography of the kidneys, ureter, and bladder (KUB films).[1]

However, in 1997, Levine et al[2] reported that KUB films had a sensitivity of only 45% and specificity of 77% in the prospective detection of ureteral calculi. This poor sensitivity is in part due to calculi overlying the sacrum, as well as other abdominal and pelvic calcifications (ie, phleboliths, costal cartilage calcifications, enteroliths) that make the definitive diagnosis of urinary calculi difficult in the acute setting.

Some of the advantages of a standard KUB examination (including oblique views) are that it costs less than computed tomography (CT) or ultrasonography, it can be rapidly done, and it is readily available. It is useful for following known radio-opaque calculi, but it is not recommended for initial evaluation.

### INTRAVENOUS UROGRAPHY: THE OLD GOLD STANDARD

Until recently, intravenous urography was the gold standard for detecting urolithiasis. It provides information about ureteral anatomy, site and degree of obstruction, and effect of obstruction on function.

However, the reported sensitivity of intravenous urography for detecting calculi is only 64%, with a high specificity of 92%.[3] Another drawback is that it uses intravenous contrast, which is relatively contraindicated in patients with previous contrast reactions or with renal insufficiency. Intravenous urography is also time-consuming, typically requiring 45 to 60 minutes to complete—and can take up to 2 to 3 hours if the collecting system is obstructed.

Of importance, diagnoses other than urolithiasis are only rarely identified on intravenous urography but are commonly seen on unenhanced CT of the abdomen and pelvis.

### ULTRASONOGRAPHY HAS LOW SENSITIVITY

Ultrasonography can be used to diagnose nephrolithiasis and urolithiasis, and is the imaging test of choice for pregnant patients with acute flank pain. Its advantages are that it does not use ionizing radiation or intravenous contrast, it can visualize hydronephrosis, and it can sometimes identify other conditions.

However, in a 2002 study by Fowler et al,[4] the sensitivity of ultrasonography was only 44% for detecting any urinary tract calculi and only 24% for individual calculi. It is less



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## Ureteral calculus: Computed tomographic appearance

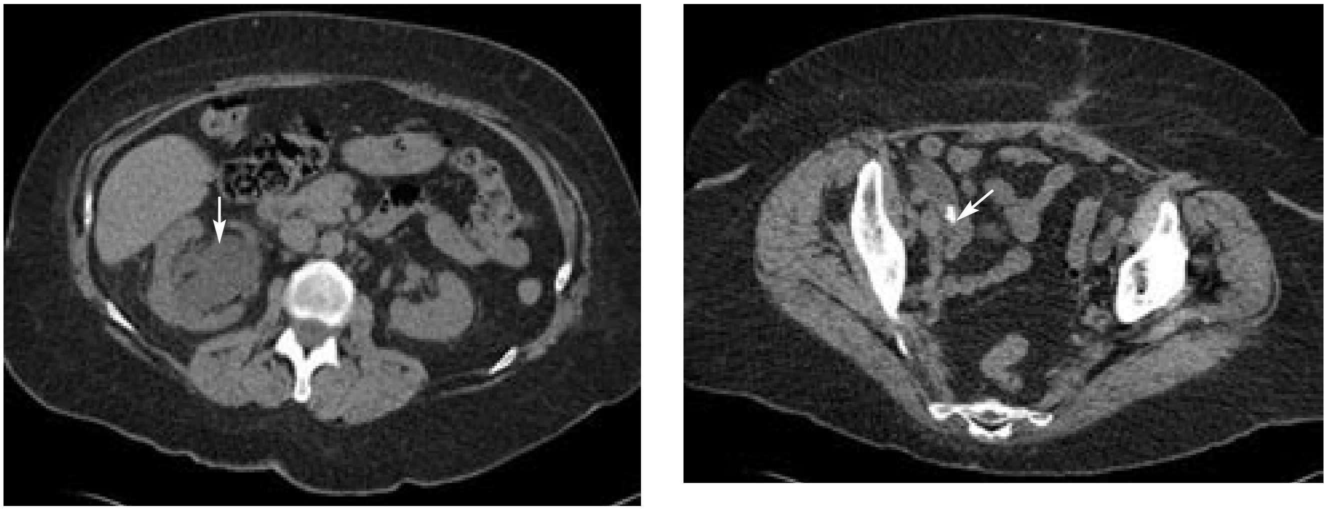

**FIGURE 1.** Nonenhanced computed tomographic scans. **Left,** right hydronephrosis (arrow), with some stranding of the perinephric fat. **Right,** an irregularly shaped calculus (arrow) is lodged within the mid-portion of the dilated right ureter, causing the hydronephrosis.

effective for small stones; 73% of calculi not visualized by ultrasonography are smaller than 3 mm. Ureteral calculi are especially difficult to visualize with ultrasonography, and typically are seen only when there is a dilated ureter or a stone at the ureterovesical junction. Often only the secondary signs such as hydronephrosis may be seen.

Another limitation of ultrasonography is that it requires a skilled operator, who may not always be available at every facility.

Finally, due to technical factors such as the orientation of the stone and ultrasound shadows that obscure portions of the stone, the size of a calculus measured on ultrasonography can be either overestimated or underestimated. Therefore, treatment decisions based on stone size should not be based solely on information obtained by ultrasonography.

## NONENHANCED CT: THE NEW GOLD STANDARD

Most radiologists and urologists consider nonenhanced CT the new gold standard for detecting urinary calculi in the acute setting. With reported sensitivity of 95% to 96% and specificity of 98%,[2] this test is superior to all others for detecting calculi. Nearly all stones are dense and thus visible on CT, with the sole exception to date of indinavir-induced stones in a patient with human immunodeficiency virus infection treated with that protease inhibitor.

Secondary signs of obstruction (stranding in the perinephric fat, ureteral dilation, ureteral wall edema) are also easily identified (FIGURE 1) and are useful for diagnosing calculi that have recently passed or that are difficult to visualize.[5] CT studies are also fast, typically taking less than 10 minutes.

In most cases, intravenous contrast need not be used, so renal function and the potential for contrast reaction are not issues. Only occasionally, and usually with an inexperienced reader, is contrast needed to distinguish between a pelvic phlebolith and distal ureteral stone. Contrast-enhanced CT may be indicated if there are findings that suggest renal or other pathology that needs to be evaluated further.

Nonenhanced CT has also proved useful in providing alternative diagnoses in many patients with flank pain. In a 2004 study by Rucker et al,[6] nearly 30% of patients with acute flank pain had a diagnosis other than renal calculi. The most common alternate diagnoses are adenexal masses, pyelonephritis, diverticulitis, and appendicitis. Life-threatening conditions such as ruptured abdominal aortic aneurysm can also be detected with nonenhanced CT.

**Nearly 10% of people have a renal stone at some point in their lives**



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## TAKE-HOME POINTS

Acute flank pain is a common presenting symptom in emergency departments and acute care facilities, giving rise to more than 450,000 visits annually. Nearly 10% of people have a renal stone at some point in their lives, with rates of recurrence as high as 50%.

Therefore, imaging is recommended at the patient's initial presentation.[7] It important to know not only if a calculus is present, but also its size and location. A ureteral stone smaller than 4 mm will likely pass spontaneously, but a larger one will probably require intervention. Distal calculi are also more likely to pass than those located more proximally.

Although imaging using ionizing radiation is important in the diagnosis of renal calculi as well as a multitude of other diseases, it comes with a price. In a 2000 study, Liu et al[8] calculated that the effective radiation dose of nonenhanced CT using an acute flank pain protocol was 2.8 mSv, which was approximately double the dose of intravenous urography, and at least four times as much as a series of KUB and oblique views. The estimated risk of developing a neoplasm from a CT scan with an effective dose of 10 mSv is approximately 1 in 2,000.[9] Although the risk of radiation-induced cancer in any one person for one study is minimal, it is something to consider, especially in patients who undergo repeated imaging studies.

In summary, nonenhanced CT is the imaging test of choice for a patient who presents with acute flank pain. It is rapid, accurate, and readily available. The primary exception is in pregnant patients, for whom ultrasonography is the most appropriate initial study. A plain abdominal film can be useful for follow-up of a patient with known radio-opaque ureteral calculi. If nonenhanced CT is unavailable, intravenous urography may be diagnostic but is not as sensitive or specific.

## REFERENCES


1. **Brant WE.** Pelvicalyceal system, ureters, bladder, and urethra. In: Brant WE, Helms CA, editors. Fundamentals of Diagnostic Radiology, 2nd edition. Baltimore: Williams and Wilkins, 1999:794–796.
2. **Levine JA, Neitlich J, Verga M, Dalrymple N, Smith RC.** Ureteral calculi in patients with flank pain: correlation of plain radiography with unenhanced helical CT. Radiology 1997; 204:27–31.
3. **Niall O, Russell J, MacGregor R, Duncan H, Mullins J.** A comparison of noncontrast computerized tomography with excretory urography in the assessment of acute flank pain. J Urol 1999; 161:534–537.
4. **Fowler KA, Locken JA, Duchesne JH, Williamson MR.** US for detecting renal calculi with nonenhanced CT as a reference standard. Radiology 2002; 222:109–113.
5. **Smith RC, Verta M, McCarthy S, Rosenfield AT.** Diagnosis of acute flank pain: value of unenhanced helical CT. AJR Am J Roentgenol 1996; 166:97–101.
6. **Rucker CM, Menias CO, Bhalla S.** Mimics of renal colic: alternative diagnoses at unenhanced helical CT. Radiographics 2004; 24:S11–S33.
7. **Rosenfield AT, Newhouse JH, Bluth EI, et al.** Acute onset flank pain, suspicion of stone disease. American College of Radiology Appropriateness Criteria. http://www.acr.org.
8. **Liu W, Esler SJ, Kenny BJ, Goh RH, Rainbow AJ, Stevenson GW.** Low-dose nonenhanced helical CT of renal colic: assessment of ureteric stone detection and measurement of effective dose equivalent. Radiology 2000; 215:51–54.
9. **U.S. Food and Drug Administration, Center for Devices and Radiological Health.** www.fda.gov/cdrh/ct.


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