Abdominal Imaging

Published online: 28 January 2004

Abdom Imaging (2004) 29:263–266
DOI: 10.1007/s00261-003-0098-7

THE QUERY CORNER

Ureteral colic: US versus CT

I. I. Rabi, the Nobel prize-winning physicist, has told of an early influence upon his sense of inquiry: On returning from grade school each day, his mother would ask, not "Did you learn anything today?," but rather "Did you ask a good question today?"

Readers are urged to contribute questions intended to elicit a focus of illumination from an authority. They should often be directed toward "How?" or "Why?", bridging the field of imaging with normal and pathologic anatomy, physiology, biochemistry, and other clinical disciplines, and may be accompanied, if necessary, by a single illustration and up to three references. If authors wish to have their questions published anonymously, this should be indicated when the question is submitted. The selection of questions published remains an editorial decision. Items published in *The query corner* will be covered in MEDLINE/Index Medicus.

Q In suspected ureteral colic, what is the usefulness of ultrasonography (US) and of unenhanced computed tomography (CT)? Does accuracy depend on the composition and size of the calculus? How often does bowel gas mitigate clear visualization by US? If colic is due to a cause other than lithiasis, e.g., a blood clot, how reliable is each of these modalities, beyond the demonstration perhaps of obstructive signs? How do they compare in cost, radiation, and ease of performance? Can the findings indicate the likelihood of spontaneous passage of a stone?

The Editor-in-Chief

A Since its introduction in 1995 by Smith et al. [1], unenhanced helical CT (UHCT) has become the imaging test of choice for suspected renal colic at an increasing number of institutions and practices throughout the United States and Europe. Its sensitivity and specificity for detection of lithiasis range between 92% and 99%. UHCT allows rapid and accurate determination of whether a stone is present anywhere in the urinary tract, including calculi as tiny as 1 mm. The scan requires no contrast medium, it can be performed in the acute phase, and it takes only 5 to 10 min of imaging time. It also may identify significant alternative or additional diagnoses [1]. Despite these advantages, UHCT has a serious drawback: ionizing radiation. The CT benefits may be outweighed by the increase in radiation dose. Because patients are often young, they are at lifetime risk for recurrent episodes of renal colic and therefore new exposures.

Before the introduction of CT, the intravenous urogram had been replaced, with excellent results, by a combination of plain abdominal film and US [2]. In fact, in many European hospitals, CT is not routinely performed as the initial technique in the diagnosis of a patient with flank pain. Radiology articles in the literature comparing US with CT have produced conflicting results: sensitivity for detection of lithiasis range between 12% and 93% for US and between 91% and 96% for CT. With regard to sensitivity for obstructive uropathy signs, the reports range between 73% and 100% for both techniques. Recently, three comparative studies have found improved results for US [3–5]. In a study with 43 patients with confirmed ureteral colic, US had a sensitivity of 93% versus 91% for CT in the diagnosis of ureterolithiasis [3]. In a study by Catalano et al. [4], CT had a greater sensitivity than did radiography combined with US (92% vs. 77%) for a group of 82 patients with ureteral lithiasis. In the third study, ureteral lithiasis was confirmed in 56 patients, with a sensitivity of 79% for US combined with plain film versus 93% for CT [5]. The results of these three studies contradict the opinion of some investigators stating that ureteral lithiasis is seldom diagnosed by US. Certainly we believe that careful dedication is needed to obtain adequate results when using US. On the one hand, the plain abdominal film should be used as a guide for the sonogram because it shortens the procedure and improves its results. On the other hand, most lithiasis are located in the proximal ureter or at the ureterovesical junction, where they can be easily seen by US (Figs. 1 and 2). Thus, hydration of the patient, which is part of the therapy for renal colic, will help detect lithiasis: the ureter is more dilated and the bladder is full, making it easier to see the distal ureter. Stones in the middle ureter are indeed hard to detect, but this is an infrequent location (6–15%).

There is one interesting point about the performance of US in detecting calculi: in our series and the one by Catalano et al., all the patients in whom the US missed the calculus passed the stone spontaneously (10 of the 11 patients with

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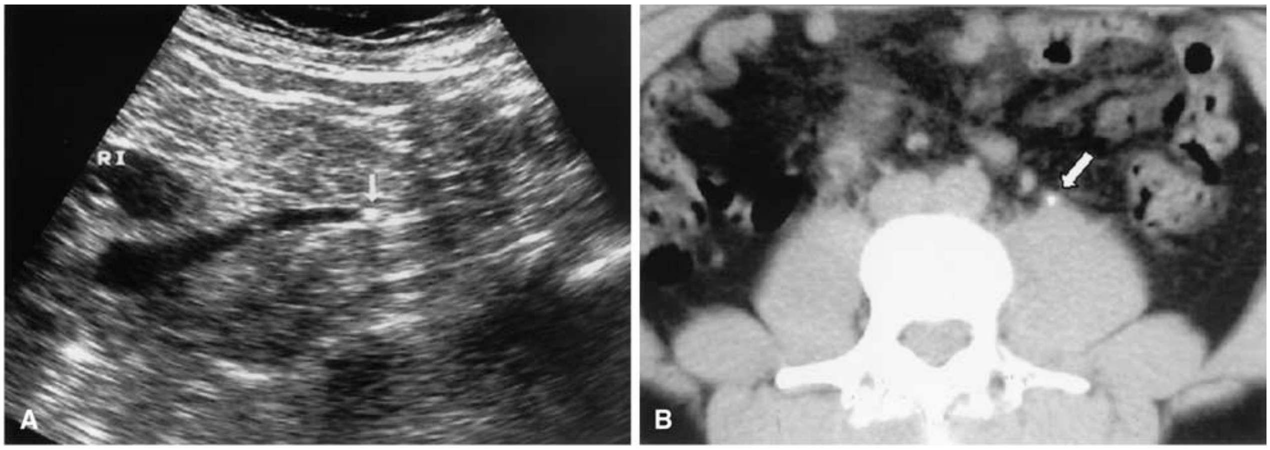

Fig. 1. Acute left flank pain in a 60-year-old woman. **A** Longitudinal US scan with patient in the left lateral decubitus position shows a stone (*arrow*) in the middle ureter that produces slight ureteral dilatation and hydronephrosis. **B** CT demonstrates a left mid-ureteral calculus (*arrow*) surrounded by soft tissue (rim sign).

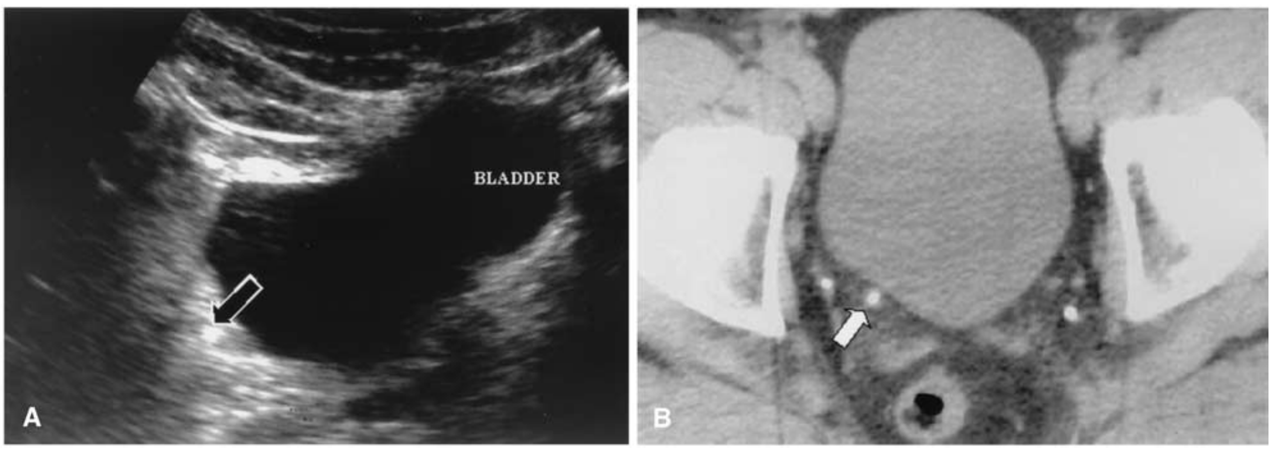

Fig. 2. Lower abdominal pain in a 45-year-old man. **A** Transverse US scan shows a lithiasis (*arrow*) near the right ureterovesical junction. US also demonstrated hydronephrosis and ureteral dilatation (not shown). **B** CT demonstrates a stone (*arrow*) in the distal right ureter just above the ureterovesical junction with a positive rim sign. At the same level are two phleboliths on each side.

false negative results in our series had calculi smaller than 5 mm). This is consonant with published data indicating that up to 98% of stones smaller than 0.5 cm in diameter, especially in the distal ureter, pass spontaneously. According to these results, the combination of plain film and US should show "practical" results similar to those of CT because there would be no change in patient outcome. Knowing the size and location of a calculus is of limited value in patients with minor colic because the treatment is conservative unless complications arise. It is only then that this information becomes relevant.

Imaging calculi

In general, all stones regardless of their chemical composition (including uric acid, cystine stones, xanthine, and matrix stones) are depicted by US and CT. All lithiases are seen on CT as radiodense calcifications approaching the density of bone. Recently, indinavir stones, which are relatively radiolucent, have been reported to be undetectable on CT.

The sensitivity of US depends on stone size. Fowler et al. [6] found that US is a poor modality for demonstrating renal calculi of 3.0 mm or smaller (sensitivity for small calculi was 13%). Despite the advantages of helical CT, the optimal parameters for the study of urolithiasis have not been determined. Saw et al. [7] investigated helical CT parameters on the accuracy of measurements with regard to stone size and radiologic density. They found that small stones with low attenuation may not be detectable when scanned at a wide collimation.

Bowel gas

Bowel gas is a real problem when exploring the ureter. Examination may be improved by compression and by changing the patient's position. Undoubtedly, bowel gas plus overweight is the worse combination for performing a sonogram. Nevertheless, we studied a group of relatively overweight patients (45 of 66 patients with grade I obesity) and found no statistical relation between calculus detection by US and a patient's body mass index [5]. It is possible that, with a larger percentage of subjects with a higher degree of obesity, the results might turn out differently. However, routine use of harmonic imaging has been proven to improve demonstration of acoustic shadowing in lithiasis and to increase diagnostic confidence in obese patients.

Imaging urinary obstruction

CT and US are very accurate techniques to detect obstructive signs (nearly 100% sensitivity). In a patient with flank pain and obstructive uropathy, ureteral stone is the first condition to be considered. Other diseases also may obstruct the ureter: extrinsic ureteral obstruction may be secondary to retroperitoneal metastases, pelvic malignant disease, or gynecologic and intestinal inflammatory disorders. In this clinical setting, both techniques have demonstrated a high sensitivity in identifying the cause of the obstruction. Intrinsic ureteral obstruction, in addition to ureteral calculi, may be due to other causes, such as blood clots, fungus ball, or urothelial tumors. In these instances, UHCT and US perform poorly. Intravenous urography, retrograde pyelography, and magnetic resonance imaging are the techniques of choice for determining the cause of obstructive intrinsic uropathy. Ureteral dilatation without obstruction is usually associated with renal infection.

There are several extra-urologic conditions that may simulate a renal colic, such as hepatobiliary, renal, and gynecological disorders. These conditions are usually diagnosed by US. Gastrointestinal diseases such as acute appendicitis, epiploic appendagitis, Crohn disease, and acute diverticulitis are also accurately depicted by US. A study in a large series of patients comparing the efficacy of US and CT in detecting noncalculous causes of acute flank pain found that both imaging modalities had a comparable accuracy [8].

Cost, radiation dose, and ease of performance

With regard to the cost, there is great variability among countries and not much literature written about it. In a study performed at a university hospital in Europe, the cost was €28.60 for US and €15.61 for a plain film (total, about €44), and the cost for UHCT was €74 [9]. In the United States, the approximate cost of abdominal UHCT in the same year was $183 and the cost of US plus plain radiography in 1997 was $57. Thus, in general, CT has a slight higher cost than does plain film plus US.

There is no agreement concerning CT dose measurement, with different data reported in the literature. When considering the effective dose as a measure of patient risk, the mean effective dose for UHCT can vary from 0.98 to18 mSv, equivalent to two to 36 plain films [10]. Dose reduction can be achieved by increasing the pitch with single-detector CT and by decreasing the miliampere-second with single-detector and multidetector CT settings. Low-dose unenhanced CT has markedly reduced the radiation dose to the patient (0.98–1.5 mSv), although at the expense of lowering image quality, thus increasing the risk of missing alternative or additional significant diagnoses (up to 25% in some series). We have to keep in mind that many patients may receive additional radiation doses with follow-up studies (calculus not being expelled), new episodes of colic (75% of patients), or complementary examinations to solve diagnostic doubts.

Training to perform basic US examinations is a fairly quick process for a resident in radiology. A combination of adequate technical training and familiarity with US features will allow the resident to evaluate hydronephrosis and part of the ureter. A higher level of skill and expertise (similar to CT) is needed when confronted with alternative diagnosis in non-urologic cases. Mean examination time for an plain abdominal film and a sonogram varies between 20 and 40 min. In our experience, plain film evaluation previous to US may significantly reduce the examination time. UHCT is extremely fast and largely independent of the operator and patient. Patients can be scanned rapidly in 5 to 10 min without delay. The examination can be performed in ill patients, and the quality of the examination is unaffected by the presence of increased amounts of bowel gas, obesity, or severe abdominal pain. The images can be reconstructed at smaller intervals, and multiplanar reformations can be performed. A fast learning curve for this technique has been established. Pitfalls of UHCT include mistaking a ureteral calculus for a phlebolith or other non-urinary tract calcification, thin patients with scarce abdominal fat where it may not be easy to distinguish the ureter and at times to sort out whether a stone is at the ureterovesical junction or in the bladder.

Spontaneous passage

Findings for predicting clinical outcome include degree of obstruction, stone size, and location. Several studies have tried to prove the relation of the degree of obstructive uropathy signs in UHCT to the likelihood of spontaneous passage of a stone. The results in the literature are conflicting: some investigators have reaffirmed the usefulness of obstructive signs for predicting stone passage, whereas others have denied it. With respect to stone location, it is generally accepted that stones in the distal ureter have a higher probability of spontaneous passage [2, 11]. Nevertheless, the only factor that will accurately predict spontaneous passage is stone size: it has been proven extensively that most calculi smaller than 5 to 6 mm will resolve with conservative treatment [11]. In a series of 51 cases of urolithiasis, a significant difference in stone size was found between patients treated conservatively (3.3 ± 1.3 mm) and patients who underwent intervention (7 ± 6.2 mm) [12].

Conclusion

CT is by far the most accurate technique for the detection of ureteral lithiasis. Although we accept the advantages of spiral CT over US, i.e., speed of the investigation and the increased sensitivity, we must question the radiation dose, unnecessary in most patients with suspected ureteral colic. US can achieve a high rate of diagnosis with similar practical value as CT. US combined with plain film can be a valid alternative in the initial evaluation and follow-up in most patients with renal colic. CT should be reserved for complicated cases with a negative US examination.

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