Normal Ureter Size on Unenhanced Helical CT

OBJECTIVE. Unenhanced helical CT is the imaging method of choice when evaluating patients with acute flank pain and suspected ureterolithiasis. In addition to directly identifying stones in the lumen of the ureter, CT secondary signs of obstruction such as ureteral dilatation are frequently present and can be helpful in establishing a diagnosis. The purposes of this study were to define ureteral dilatation on unenhanced helical CT and determine the range of normal ureter size.

MATERIALS AND METHODS. We retrospectively reviewed the unenhanced helical CT studies of 212 consecutive patients with acute flank pain whose CT scans showed acute ureterolithiasis. The size of the ureter was determined on the asymptomatic side as well as on the obstructed side. Mean ureteral diameter was determined as the largest transverse dimension along the course of the ureter beginning 1–2 cm below the ureteropelvic junction.

RESULTS. The mean size of ureters on the asymptomatic side was 1.8 mm with a standard deviation (SD) of 0.9 mm. The mean size of ureters on the obstructed side was 7 mm with an SD of 3.2 mm. In 96% of patients, the ureter diameter on the asymptomatic side was 3 mm or smaller.

CONCLUSION. Three millimeters should be considered the upper limit of normal size for nonobstructed ureters on unenhanced helical CT.
who had previous CT scans for suspected ureterolithiasis were excluded from the study. All CT examinations were performed using a HiSpeed Advantage CT scanner (General Electric Medical Systems). Images were obtained from the tops of the kidneys through the bladder base using 5-mm-thick sections and a pitch of 1. The images were examined using soft-tissue window settings on the scanner console at a level of 40 H and a width of 400 H.

The size of the ureter was determined on the asymptomatic side and the obstructed side using electronic calipers (Fig. 1). All examinations were retrospectively reviewed together by two observers. For each patient and on each side, ureteral diameter was determined as the largest transverse dimension along the course of the ureter beginning 1–2 cm below the ureteropelvic junction. Single measurements were taken. We determined the section on which the measurement was performed by visual inspection while scrolling the images.

Results

The mean size of ureters on the asymptomatic side was 1.8 mm (range, 1–6 mm) with a standard deviation (SD) of 0.9 mm. In our study, 203 patients (96%) had ureters on the asymptomatic side that measured 3 mm or less. The mean size of ureters on the obstructed side was 7 mm (range, 1–20 mm) with an SD of 3.2 mm. In 14 cases (6.6%) the ureteral diameter on the symptomatic side was less than 3 mm.

Discussion

Unenhanced helical CT has a high sensitivity (97%) and a high specificity (96%) for detecting ureteral stone disease [4]. Most ureteral stones, including uric acid stones (which are not visible on radiographs), are visible on unenhanced CT images. Although prior reports indicate that only 5% of ureteral stones will not be revealed on CT, these studies were interpreted retrospectively by experts in the CT diagnosis of stone disease [5, 6].

In certain small subsets of patients, stones may not be readily apparent, even on unenhanced CT, making radiologic diagnosis of ureterolithiasis more complex. Such cases include stones of all chemical compositions that are smaller than 1 mm; small stones with relatively low attenuation that are difficult to detect; stones that have recently passed; indeterminate calcifications along the course of the ureter (e.g., phleboliths and arterial calcifications) that may be mistaken for a ureteral stone; and stones consisting of pure protease inhibitors, such as indinavir sulfate (Crixivan, Merck & Co.), which may not be revealed on CT [7–9]. Furthermore, radiologists frequently encounter cases in which a stone is not identified on initial review of the images but is identified when the level of suspicion increases because of the presence of secondary signs of obstruction such as ureteral dilatation. These secondary signs prompt the observer to examine the images more carefully to identify a stone.

Whereas ureteral size may be of no consequence when a radiologist encounters a straightforward case in which a ureteral stone is readily identified, in the more complex cases such as those just described, the presence or absence of ureteral dilatation may be crucial to make or exclude the diagnosis. When a stone is not readily visualized on unenhanced CT in a patient with acute flank pain, the presence of both ureteral dilatation and perinephric stranding has a positive predictive value of 99% and the absence of both findings has a negative predictive value of 95% [10].

Being able to properly identify ureteral dilatation is likewise important in diagnosing conditions other than obstruction by ureterolithiasis. Chronic vesicoureteral reflux and congenital anomalies of the urinary tract (e.g., posterior urethral valves, megareuter, and prune-belly syndrome) may result in dilatation of the ureter. Similarly, infectious processes (e.g., Escherichia coli, Pseudomonas, and Citrobacter) can impair ureteral peristalsis, which can cause ureteral dilatation on CT [11, 12]. Inflammatory processes adjacent to the ureter, such as appendicitis or diverticulitis, may also impair ureteral peristalsis and result in ureteral dilatation [13–15]. Compression of the ureter by a pelvic or an abdominal mass can cause unilateral or bilateral dilatation of the ureter. Therefore, the presence of ureteral dilatation even in the absence of perinephric stranding may be an important clue to the diagnosis even when stone disease is absent.

This investigation was limited in that the widest diameter for measurement was determined visually by scrolling through the images. Exact measurements throughout the length of the ureter were not performed. In addition, a single measurement of each ureter was taken. Consequently, no conclusions can be reached regarding the reproducibility of finding and measuring the ureter. Although both of these limitations are worth noting, we believe that the results are nonetheless valid in determining the normal ureter diameter.

In view of the fact that correctly identifying ureteral dilatation may be crucial to arrive at a correct diagnosis, the need for a definition of what constitutes ureteral dilatation on unenhanced CT is clear. On the basis of the results of this study, we have established 3 mm as the up-
per limit of normal for ureter diameter on unenhanced CT. Although for many cases reliance on such a measurement will be unnecessary, in the more complex cases and for more inexperienced observers, such a measurement may be helpful.

References
4. Smith RC, Verga M, McCarthy S, Rosenfeld AT.

**CT of the Ureter**

Diagnosis of acute flank pain: value of unenhanced helical CT. *AJR* 1996;166:97–101

The ARRS 2004 annual meeting categorical course will be on women’s imaging. The course will address breast imaging, obstetric and gynecologic imaging, and imaging in osteoporosis.