Measurement of Ureteric Stone Diameter in Different Planes on Multidetector Computed Tomography — Impact on the Clinical Decision Making

Syed M. Nazim, M. Hammad Ather, and Nadir Khan

OBJECTIVE To determine if the measurement of ureteric stone in coronal reconstruction plane is different from the measurement in axial plane and whether the difference can impact the management decision in patients with ureteric colic.

METHODS All patients who underwent unenhanced multidetector computed tomographic (MDCT) scan for the evaluation of reno-ureteral colic in outpatient clinics and emergency room were evaluated. The scans were evaluated on Picture Archiving Computer System with a 3-mm axial and reformatted 3-mm coronal sections. Maximal stone diameter was measured in 2 dimensions in the axial and reformatted coronal sections by 2 reviewers. Only scans with isolated, unilateral, solitary ureteric calculi were included in the final analysis. All patients were monitored up to 4 weeks after MDCT to determine the clinical outcome.

RESULTS A total of 331 patients (272 male and 59 female; mean age ± standard deviation, 39.8 ± 13.8 years) were included. One hundred seventy-one (51.7%) stones passed spontaneously during the follow-up period. There was a 20% underestimation of maximal stone diameter in axial plane for all stones and a 17% for the stones that passed spontaneously or with medical expulsive therapy, as compared with measurement on coronal reconstruction.

CONCLUSION Measuring the transverse stone diameter on axial images of MDCT scan underestimates size of ureteric stone. This can have an impact on counseling of patients and their clinical outcome, coronal reformatted images be used for size estimation. UROLOGY 83: 288—293, 2014. © 2014 Elsevier Inc.

Unenhanced helical computed tomographic (CT) scan is the imaging of choice for the diagnosis of urolithiasis in symptomatic patients with reported sensitivity and specificity close to 100%.[1,2] The 2 most important factors that guide clinical management are stone size and its location.[3] There is a reverse linear relationship between stone size and spontaneous passage; hence, determination of maximal stone size is crucial while counseling the patient and selecting the appropriate treatment strategy. Determination of maximal stone size is crucial indicator in clinical decision making for intervention or use of medical expulsive treatment for which various α blockers have been used with comparable efficacy.[4] Lee et al[5] recently noted that longitudinal stone diameter was a significant predictor of stone expulsion with medical expulsive therapy (MET), and coronal reconstruction might help to better choose a patient who is suitable for MET.

With the improved resolution and multiplaner reformations, multidetector computed tomography (MDCT) has considerably improved imaging from cross sectional (axial) imaging to true 3-D image.[6] The coronal reconstruction of CT scan helps not only for better stone detection but also reportedly for accurately assessing the stone size oriented in vertical plane, especially the ureteric stones.[7] Many modifications have been suggested to improve the stone size estimation, including using an algorithm.[8] However, the most commonly used method is estimation on coronal and reconstructed images.

The present study is designed to determine if measurement of ureteric stone in coronal reconstruction plane is different from the measurement in axial plane and whether the difference can predict the outcome for urolithiasis in patients with renal colic.

MATERIALS AND METHODS

This prospective study was conducted over a duration of 12 months from April 1, 2011 to March 31, 2012. All the consecutive unenhanced CT scan (CT kidneys, ureters, and

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From the Department of Surgery, Aga Khan University, Karachi, Pakistan; and the Department of Radiology, Aga Khan University, Karachi, Pakistan

Reprint requests: M. Hammad Ather, M.B.B.S., F.C.P.S. (Urol), F.E.B.U., Department of Surgery, Aga Khan University, PO Box 3500, Stadium Road, Karachi 74800, Pakistan. E-mail: hammadather@gmail.com

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bladder [KUB]) done for the evaluation of reno-ureteral colic at the outpatient clinics and emergency room were included.

The initial evaluation of all patients were done in the emergency room and outpatient clinics with history, physical examination, laboratory tests, and then with a subsequent MDCT. All CT examinations were conducted on a 64-slice MDCT machine (Aquilion, Toshiba Medical Systems, Shimoishigami, Otawara-Shi, Japan) without oral or intravenous contrast. Three millimeters axial and reformatted 3-mm coronal sections were evaluated on picture-archiving computer system (View Pro-X version 4.0.6.2; Rogan-Delft, Veenendaal, Holland). Our protocol for CT KUB scans the abdomen from the xiphi-sternum to the lower border of symphysis pubis. It is taken once the patient has an urge to void. All scans are obtained with 120 kV and 250-300 mA exposure factors.

We analyzed only patients with a solitary, unilateral ureteric stone in the line of ureter and excluded patients with multiple and/or bilateral ureteric stone, stone in the kidney or bladder. We also excluded patients who had stone in solitary renal unit, pregnant female patients, those with fever and suspected active urinary tract infection, and renal insufficiency requiring active intervention. All patients were started on MET.

Stone Evaluation

The CT scan films were reviewed independently by a radiologist (N.K.) and a urologist (S.M.N.) who had about 6+ years of experience of reading CT KUB with an average of 20-25 films per week. Patients' symptoms and side of pain were noted, and these clinical findings were then correlated with the scan to support the diagnosis of stone. Maximum diameter of the ureteral stone was measured in axial and reformatted coronal sections on Picture Archiving Computer System. The measurement of axial and coronal plane for each stone was given to separate reviewers to reduce bias. To facilitate the interpretation, the reviewers were allowed to use the zoom function on the workstation. Each stone was measured in 2 dimensions, along its maximum visualized diameter and the other one perpendicular to it. This would also give us an estimate of its area.

$$\text{Stone area} = \text{maximum diameter} \times \text{perpendicular diameter}$$

The stones were divided into 3 locations, upper, mid, and lower. Calculi above the sacroiliac joint were deemed in upper segment, those anterior to sacroiliac joint were midureteral, and those below were deemed in lower segment. In addition, they were also classified as at ureteropelvic junction and at ureterovesical junction (UVJ). The patients were followed up prospectively up to 4 weeks with x-ray KUB, urinalysis, ultrasound KUB, and the clinical outcome (whether stone passed spontaneously/not passed or needed any surgical intervention).

Statistical Analysis

The statistical analyses were performed on SPSS version 19 software. The continuous variables were expressed as mean ± standard deviation, and *t* test was used for comparison. For the nominal variables, chi-square test, ANOVA, and post hoc tests were used. A *P* value of .05 was considered significant.

RESULTS

Over the duration of the study, total numbers of CT KUB performed for evaluation of flank pain were 1587, out of which 331 (21%) qualified the inclusion and exclusion criteria and were included in the final analysis. The mean age of patients was 39.8 ± 13.8 years (range, 15-85). There were predominantly male, that is, 272 (82.2%) and 59 (17.8%) female patients in the analysis. The distribution of stone was same on the right (49%) and the left sides (51%).

The mean largest coronal diameter measured for all stones was 7.0 ± 4.0 mm (range, 1.5-24), and the mean largest axial diameter was 5.6 ± 3.0 mm (range, 0.8-25; $P < .001$). Similarly the mean largest coronal area was 41.6 ± 50.4 mm^2 (range, 2.1-376.4) as compared with mean largest axial area 29.2 ± 35 (range, 0.64-347.4; $P < .001$; Fig. 1).

Most stones were located in the distal ureter (n = 150, 45%), followed by proximal ureter (n = 131, 40%) and

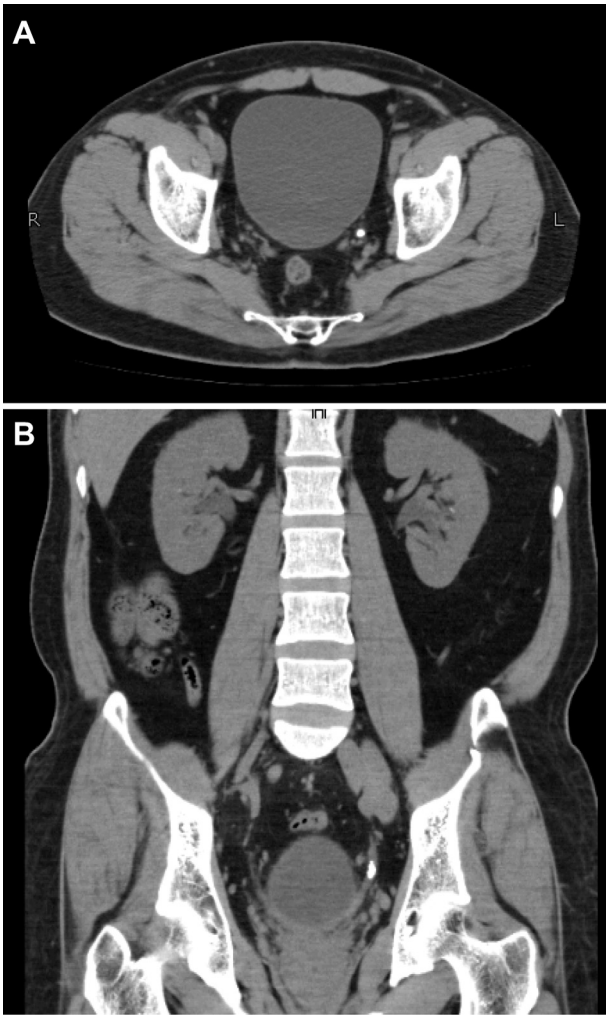

Figure 1. Stone size measurement with implication in clinical outcome in a 53-year-old man presented with left flank pain. He required ureteroscopy after 4 weeks of failed conservative management. **(A)** Multidetector computed tomography axial view shows distal ureteric stone measuring 4.9 mm in maximal diameter. **(B)** Coronal reformations show a vertically oriented stone measuring 10.4 mm in maximal diameter.