Is Hydronephrosis on Ultrasound Predictive of Ureterolithiasis in Patients with Renal Colic?

Kevan M. Sternberg,* Vernon M. Pais, Jr., Troy Larson, Jullet Han, Natalia Hernandez and Brian Eisner†

From the Division of Urology, University of Vermont Medical Center (KMS, TL), Burlington, Vermont, Section of Urology, Dartmouth-Hitchcock Medical Center (VMP, JH), Lebanon, New Hampshire, and Department of Urology, Harvard Medical School, Massachusetts General Hospital (NH, BE), Boston, Massachusetts

Purpose: Renal ultrasound accurately identifies hydronephrosis but it is less sensitive than computerized tomography for the detection of ureterolithiasis. We investigated whether the presence of hydronephrosis on ultrasound was associated with a ureteral stone in patients who underwent both ultrasound and computerized tomography during the evaluation of acute renal colic.

Materials and Methods: We retrospectively reviewed the records of patients from 3 institutions who were evaluated for acute renal colic by both ultrasound and computerized tomography between 2012 and 2015. Patients were included in analysis if ultrasound and computerized tomography were performed on the same day. The presence of ureterolithiasis, stone location and hydronephrosis was reviewed and compared between imaging modalities.

Results: Ureteral stones were present in 85 of 144 patients. Ultrasound identified hydronephrosis in 89.8% of patients and a ureteral stone in 25.9%. Computerized tomography identified hydronephrosis in 91.8% of patients and a ureteral stone in 98.8%. In 75.0% of cases the presence or absence of hydronephrosis on ultrasound correctly predicted the presence or absence of a ureteral stone on computerized tomography. Hydronephrosis on ultrasound had a positive predictive value of 0.77 for the presence of a ureteral stone and a negative predictive value of 0.71 for the absence of a ureteral stone.

Conclusions: Hydronephrosis on ultrasound did not accurately predict the presence or absence of a ureteral stone on computerized tomography in 25.0% of the patients in this study. Ultrasound is an important tool for evaluating hydronephrosis associated with renal colic but patients may benefit from other studies to confirm the presence or absence of ureteral stones.

Key Words: ureteral calculi; hydronephrosis; ultrasonography; tomography, x-ray computed; diagnostic imaging

Abbreviations and Acronyms

CT = computerized tomography

ED = emergency department

NCCT = noncontrast CT

US = ultrasound

Accepted for publication April 26, 2016.

No direct or indirect commercial incentive associated with publishing this article.

The corresponding author certifies that, when applicable, a statement(s) has been included in the manuscript documenting institutional review board, ethics committee or ethical review board study approval; principles of Helsinki Declaration were followed in lieu of formal ethics committee approval; institutional animal care and use committee approval; all human subjects provided written informed consent with guarantees of confidentiality; IRB approved protocol number; animal approved project number.

* Correspondence: Division of Urology, University of Vermont Medical Center, 111 Colchester Ave., Burlington, Vermont 05401 (telephone: 802-847-2884; e-mail: Kevan.sternberg@uvmhealth.org).

† Financial interest and/or other relationship with Ravine Group, Boston Scientific, Bard, Retrophin and Olympus.

RENAL colic is a common presenting symptom of ureterolithiasis and it often prompts imaging to evaluate the presence or absence of ureteral calculi. CT is the gold standard imaging modality to evaluate renal colic due to its superior sensitivity and specificity for urolithiasis compared with other imaging modalities.[1,2] In recent years due to concerns about cost and ionizing radiation exposure associated with CT[3–5] renal US has received renewed interest as an alternative first line imaging modality to evaluate acute renal colic.[6–9]

0022-5347/16/1964-1149/0
THE JOURNAL OF UROLOGY®

http://dx.doi.org/10.1016/j.juro.2016.04.076
Vol. 196, 1149-1152, October 2016
Printed in U.S.A.

A recent prospective study of CT vs US in the evaluation of ED cases of renal colic showed that the use of US as a first line imaging modality was not associated with an increased incidence of stone related complications compared with CT.[10] However, the results of this study must be balanced with the reported inferior ability of US to identify ureteral calculi compared with CT.[11]

In the current study we sought to evaluate how often the presence or absence of hydronephrosis on US is associated with the presence or absence of ureterolithiasis in patients evaluated for acute renal colic. The results of this study will help clinicians understand whether ultrasound alone can be confidently relied on to diagnose ureterolithiasis. It may also guide the choice of potential additional imaging.

METHODS

Study Population

Institutional review board approval was obtained prior to the initiation of the study. A multicenter retrospective review was performed to identify patients who underwent US and then CT on the same day to evaluate acute renal colic and suspected ureterolithiasis between March 2012 and December 2015. Patients older than 18 years were included in study if they were evaluated for the chief complaint of renal colic and underwent US and then subsequent CT within 24 hours of each other. Patients were excluded if imaging studies were done more than 24 hours apart or they were younger than 18 years. Radiology studies were obtained in the ED or in the outpatient setting depending on where the patient was evaluated. Only formal radiology US done by US technicians were evaluated. Patients with point of care US, typically performed at the bedside in the ED, were excluded as these studies are not uniformly interpreted formally by radiologists. All CT images were obtained using a low dose stone protocol.

Statistical Analysis

Statistical analysis was performed on all 144 patients who met inclusion criteria. Ureteral stone presence and hydronephrosis were recorded as dichotomous variables. These parameters were quantified as proportions and compared between imaging modalities using descriptive statistics. Positive and negative predictive values were calculated using the frequency of positive, false-positive, negative and false-negative findings when US was used as the screening test and CT was used as the confirmatory diagnostic test. Additional statistical analysis was performed in patients who did not have a ureteral stone identified on US but had ureterolithiasis on CT. Ureteral stone maximum diameter in mm and location (proximal, middle or distal) were recorded and analyzed using descriptive statistics.

RESULTS

Data were analyzed on 144 patients who underwent both renal US and CT on the same day. The average time between obtaining US and CT images was 3 hours 14 minutes. Of the patients 78 (54.2%) were female. Average $\pm$ SD age of the group was 45.1 $\pm$ 15.5 years and average body mass index was 28.6 $\pm$ 8.6 kg/m^2. A total of 87 patients (60.4%) were evaluated in the ED and the remaining 57 (39.6%) were evaluated in the outpatient setting.

Ureterolithiasis was detected in 85 patients (59.0%). Of these 85 patients with a ureteral stone US identified the presence of a ureteral stone in 22 (25.9%) and CT identified the presence of a ureteral stone in 84 (98.8%). Of the 63 ureteral stones identified on CT but not seen on US 62 were available for further analysis. The average size of these stones was 5.3 mm and the location on CT was proximal in 13 (21.0%), middle in 12 (19.3%) and distal in 37 (59.7%). Of the 62 stones missed on US 30 (48.4%) were 5 mm or larger. Table 1 shows the average size of the missed ureteral stones by location.

Hydronephrosis was present in 98 patients (68.1%). Of these 98 patients with hydronephrosis US identified the presence of hydronephrosis in 88 (89.8%) and CT identified the presence of hydronephrosis in 90 (91.8%). US and CT were concordant on the presence or absence of hydronephrosis in 126 patients (87.5%) in the entire cohort. In 18 patients (12.5%) in the cohort US and CT differed in terms of the presence or absence of hydronephrosis (table 2).

In 68 patients (47.2%) the presence of hydronephrosis on US was associated with a ureteral stone on NCCT. In 40 patients (27.8%) the absence of hydronephrosis on US was associated with no ureteral stone on NCCT. Therefore, in 108 patients (75.0%) the presence or absence of hydronephrosis on US correctly predicted the presence or absence of a ureteral stone on NCCT. In 16 cases (11.1%) US showed no hydronephrosis but CT demonstrated the presence of a ureteral stone. Conversely, in 20 cases (13.9%) US demonstrated hydronephrosis but CT failed to reveal the presence of a ureteral stone (table 2). Of those 20 cases only 1 had a ureteral stone present on US.

No alternative abdominal pathology was found on CT that would account for the presence of hydronephrosis in these cases, suggesting that all were cases of recently passed ureteral stones with residual hydronephrosis. Overall, hydronephrosis on

Table 1. *Result in 62 patients with CT confirmed ureteral stone but ureteral stone missing on US*

	Missed Stones	
Location	No. (%)	Av Diameter (mm)
Proximal	13 (21.0)	5.8
Middle	12 (19.3)	7.6
Distal	37 (59.7)	4.4