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Urology

Efficacy of Ultrasonography for the Detection of Ureteral Stone

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ABSTRACT

OBJECTIVE:
To assess the efficacy of ultrasonography (US) for the detection of ureteral stone using non- contrast computed tomography (NCCT) as a standard reference.

MATERIALS AND METHODS:
From December 2014 to April 2016, 209 patients underwent both NCCT and US. The sensitivity and specificity of US to detect ureteral stone was evaluated. The detection rates using US imaging were examined according to location and stone size. The sizes of stones determined in the longest axis of NCCT and US were compared. We also performed group classification based on size to examine whether stone sizes measured by NCCT and US were similar. Moreover, the factors that may affect the detection of ureteral stone by US were also analyzed.

RESULTS:
Out of 418 ureters, NCCT could detect 133 stones, whereas US could detect 82 stones, yielding a sensitivity of 58.6 % and a specificity of 94.7%. Expectedly, detection rate of US increased with stone size but was lower for distal ureter (34.4%). With hydronephrosis, the sensitivity of US proved from 26.5% to 69.7%. Stone sizes measured by US correlated positively with those by computed tomography. Interestingly, stone size and the presence of hydronephrosis were factors that independentlyaffected ureteral stone detection by US.

CONCLUSION:
The results indicate that, US may be useful as an initial imaging modality for detecting ureteral stone.

KEYWORDS :

Introduction:
Urinary tract stone disease is a very common disease & can cause uretric colic or complicated urinary tract infection or azotemia, and needs urgent care. Therefore, imaging for urinary stones, particularly for ureteral stones, is critical both in the emergency department as well as in urology department.

Because of its high sensitivity and specificity, non contrast-enhanced computed tomography (NCCT) is generally accepted as the gold standard among the commonly used imaging modalities for suspected urinary stone. However, with growing concerns about the health effects of cumulative radiation exposure, over-utilization of NCCT is becoming a serious public health issue.

Therefore, it is desirable to explore alternative approaches. In this respect, ultrasonography (US) is a very attractive modality as it is radiation free and inexpensive.

We report the efficacy of US for the detection of renal stone in 209 patients. The objective of this study was to determine the efficacy of US for detecting ureteral stone in the same cohort.

Objective:
To assess the efficacy of ultrasonography (US) for the detection of ureteral stone using non-contrast-enhanced computed tomography (NCCT) as a standard reference.

Materials and methods:
We reviewed our database of patients from December 2014 to April 2016, who underwent both NCCT and US imaging within 24 hour. Indications for imaging included symptoms such as acute flank pain or hematuria.

Patients with solitary kidney or urinary diversion were excluded from this study. Clinical data about age, body mass index, sex, stone location, and stone size were retrospectively collected. NCCT was performed from the upper abdomen to the pelvis with axial images taken at 2- or 3-mm intervals.

US was performed using gray scale sonography with a 3.5-MHz convex transducer. NCCT and US examinations were reviewed in a blind retrospective manner, and US images were reviewed without reference to NCCT findings. Stone size was defined using longest axis of NCCT and US. The sensitivity of US was calculated using NCCT as the standard reference.

Stones were classified according to size in groups of 0-5.0 mm, 5.1-10.0 mm, and >10.1 mm. The sensitivity and specificity of detecting ureteral stones were calculated by examining the correlation between US and NCCT findings in each ureter. Stone density and skin-to stone distance were measured by NCCT.

A standard statistical software program using SPSS version 22 was used. The chi square or Fisher exact test was used to determine any significant difference in the normal data between the 2 groups.

The 2-tailed Student t test was used to analyze differences in continuous variables. P values of <.05 were considered significant.

Results:
Studied a total 209 patients
Majority were males 130 (62.2%)
Mean age (SD) – 56.9 years (12.2)
186(89%) patients had pain, 175(83.7%) had hematuria
Positive CT findings - 133 (63.6%)

To assess the efficacy of US for the detection of ureteral stone, we first compared NCCT and US findings and calculated the sensitivity of US.
Positive USG findings – 82(39.2%)
Mean (SD) calculi size in USG – 9.58(6.2) mm
Mean (SD) stone density in CT– 808.9(213)
Hydronephrosis – 99 (47.3%)
Ipsilateral renal stones – 87(41.6%)

USG Findings	CT findings	
	Positive	Negative
Positive	78	4
Negative	55	72

Fig.1: Detection of ureteral stone in 209 patients.

Hence, the sensitivity of US is 58.6% and Specificity is 94.7%
We also analyzed the association between the presence and absence of hydronephrosis and detection rate of stones confirmed by NCCT. With hydronephrosis, the sensitivity of US proved from 26.5% to 69.7%.

Interestingly, stone size and the presence of hydronephrosis were factors that independently affected ureteral stone detection by US. This indicates that the detection of ureteral stone without ureteral obstruction by US is very difficult. Overall, the sensitivity of US improved from 26.5% to 69.7%.

Hydronephrosis	US Findings	
	Positive N (%)	Negative N (%)
Present	69(69.7)	30(30.3)
Absent	9(26.5)	25(73.5)

Fig.2: The relationship between hydronephrosis and US findings.

Next, the detection rate of ureteral stones by US was categorized according to location and stone size. The detection sensitivity in the distal ureter was found to be lower than in other sites. Expectedly, the detection rate was found to increase with stone size. For stones>5 mm, which are considered clinically important, the sensitivity was high at 63.4% compared with 33.3% for small stone <5 mm.

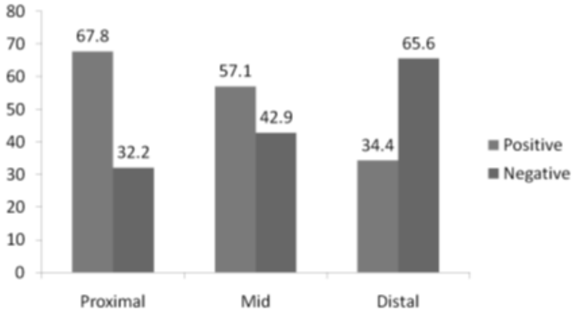

Fig.3: US detection according to stone site.

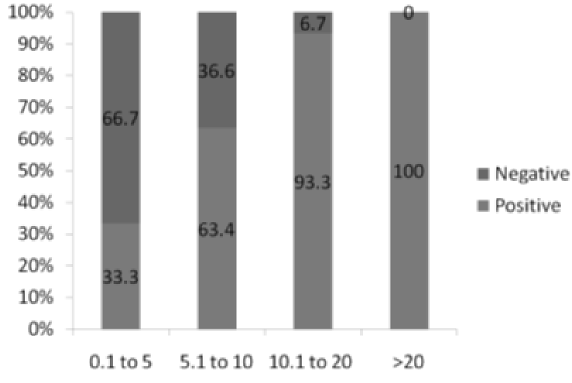

Fig.4: US detection according to stone size (mm)

To investigate the accuracy of the stone size measurement by US, we compared stone sizes measured by both NCCT and US Stone sizes measured by US strongly correlated with those by computed tomography (CT) (Pearson correlation coefficient, 0.7733; P<.001).

We then further performed multivariate analysis to determine the factors that independently affected the detection of ureteral stone and found these to be stone size and the presence of hydronephrosis.

Factor	**US Findings**	**P Value**	
	Positive(n=78) N(%)	Negative(n=55) N(%)	
Age	55.8±11.4	58.3±12.8	.23
Sex Male Female	48(57.8) 30(60)	35(42.2) 20(40)	.97
Pain Present Absent	66(55.9) 12(80)	52(44.1) 3(20)	.07
Hematuria Present Absent	68(56.6) 10(77)	52(43.4) 3(23)	.15

Fig.5: Potential factors affecting US detection rates -1

Factor	US Findings	P Value	
	Positive(n=78)N (%)	Negative(n=55)N(%)	
BMI	23.7±1.8	23.8±2.29	.92
Side Right Left	48(58.5) 30(58.8)	34(41.5) 21(41.2)	.97
Site Proximal Mid Distal	59(67.8) 8(57.1) 11(34.3)	28(32.2) 6(42.9) 21(65.7)	<.001

Fig.6: Potential factors affecting US detection rates -2

Factor	US Findings	P Value	
	Positive (n=78)N(%)	Negative(n=55) N(%)	
Calculi size in CT	9.9±6.2	5.4±1.9	<.001
Stone density	890.2±196.5	693.5±181.0	<.001
Hydronephrosis Present Absent	 69(69.7) 9(26.4)	 30(30.3) 25(73.6)	<. 001
Ipsilateral renal stones Present Absent	 51(59.3) 27(57.4)	 35(40.7) 20(42.6)	0.83

Fig.7: Potential factors affecting US detection rates -3

Conclusion:

The result of our study suggests that US may be effective for the detection of ureteral stone. Therefore, we suggest that US should be considered for the evaluation of both acute and follow-up of ureteral stone cases.

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