

SHORT COMMUNICATION

Diagnostic accuracy of ultrasonography in predicting urolithiasis for patients with hydronephrosis in comparison to computed tomography urography

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Abstract:

The main objective of this study was to evaluate the diagnostic accuracy of ultrasonography (US) in predicting urolithiasis and to answer whether there is a significant association between the presence of hydronephrosis with the presence of urolithiasis. This retrospective study involved radiology reports of 57 patients underwent both US of kidney, ureter and bladder (KUB) and computed tomography urography (CTU) examinations within 24 hours to each other and were selected based on inclusion criteria. Radiology reports of US and CTU were reviewed for the presence and degree of hydronephrosis, presence of calculi and location of calculi. The diagnostic accuracy was calculated using cross-tabulation function on SPSS and the association of presence of hydronephrosis and urolithiasis on CTU was analyzed using Chi-Squared test on SPSS with $\alpha=0.05$. US had a sensitivity of 83.8%, specificity of 60%, positive predictive value (PPV) of 0.79 and negative predictive value (NPV) of 0.67 in predicting urolithiasis based on US findings of hydronephrosis in comparison to CTU. The presence of hydronephrosis was significantly associated with the presence of urolithiasis on CTU (chi square: 11.5, df= 1, $p < 0.001$). The ultrasound had diagnostic accuracy of 75% in predicting urolithiasis based on ultrasound findings of hydronephrosis. The presence of hydronephrosis was associated with the presence of urolithiasis. However, other factors that might affect the presence of hydronephrosis should be considered such as the stone location and size.

Keywords: *Computed tomography; hydronephrosis; ultrasound; urography; urolithiasis*

1. INTRODUCTION

Hydronephrosis is a swelling of the kidney due to dilation of renal pelvis and calyces caused by the accumulation of urine. Hydronephrosis is usually caused by the presence of stones in urinary tract system (urolithiasis) but it may also occur because of the obstructions of urinary tract system by a tumour, blood clot or inflammation. Urolithiasis is the formation of calculus or stones that can be found in many parts of the urinary tract system (kidney, ureter and bladder). Urolithiasis is the most common cause patient complaints of having renal colic pain and haematuria which is blood in the urine. According to Bakin, Hing, Inn, & Annuar, [1], the incidence of urolithiasis in Malaysia was reported to have increased over 20 years (1962-1981) by 224 to 442 per 100 000 population .

Radiology examinations have an important role to evaluate a patient suspected having urolithiasis. Ultrasound and plain x-ray radiograph of kidney, ureter and bladder (KUB) are used as the first-line imaging modality for screening patients

presented with renal colic symptoms [2]. Ultrasound involves non-ionizing radiation which is also widely available, reproducible and low cost make it as a very useful first-line imaging modality, especially for pregnant and paediatric patients. According to Portis & Sundaram (2001), US of KUB is a highly sensitive to renal calculi and hydronephrosis which may be a sign of urinary tract obstruction, but it less accurately defined the severity of obstruction [3]. Computed tomography urography (CTU) is used as second-line imaging modality if an ultrasound of KUB results are insufficient or inconclusive and require more details. Compared to other imaging modality, CTU is the gold standard due to high sensitivity and specificity to evaluate urinary tract calculi [2]. Therefore, this study was conducted to evaluate the diagnostic accuracy of ultrasonography in predicting urolithiasis and to answer whether there is a significant association between the presence of hydronephrosis with the presence of urolithiasis

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2. MATERIALS AND METHODS

This study has been approved by the UiTM research ethics committee (REC/517/18) and Faculty of Medicine UiTM (500-FPR (PT. 14/5)) prior to the initiation of the study.

2.1 Subject selection

This study retrospectively retrieved radiology reports of patients underwent US of KUB and CTU within 24 hours to each other for a complain of renal colic pain and suspected having urolithiasis from January 2015 to December 2018. Radiology reports of patients younger than 18 years old and both imaging examinations were done more than 24 hours apart to each other were excluded from this study. Radiology reports were included in this study if the reports were formally reported and validated by the radiologist for patients from ED, inpatients and outpatients.

2.2 Data Collection

A total of 61 patients underwent both examinations on the same day based on information from registration books of US and CT from the year 2015 to year 2018. However, radiology reports of 4 patients were unable to retrieve and leaving 57 radiology reports of patients that met the inclusion criteria. Demographic data of gender and age were recorded and the presence and degree (mild, moderate or severe) of hydronephrosis were retrieved based on ultrasound reports. The presence of hydronephrosis and the location of urolithiasis were collected based on CTU reports.

2.3 Statistical Analysis

The statistical analysis was done for all data obtained from 57 patients' radiology reports who met the inclusion criteria. The presence of hydronephrosis by ultrasound of KUB and presence of urolithiasis by CTU reports were analysed by using cross tabulation function on Statistical Package for the Social Sciences (SPSS) version 21. The mean age, gender, degree of hydronephrosis, presence of calculi and location of calculi were recorded and analysed using descriptive statistics method used frequencies and percentages.

The presence of hydronephrosis by US reports was set as a screening test and the presence of urolithiasis by CTU reports was used as a confirmatory test. The sensitivity, specificity, positive predictive values (PPV) negative predictive values (NPV) were calculated using Bayesian Theorem on Microsoft Office Excel based on the frequency of positive, false-negative, negative and false-positive findings. The association of the presence of hydronephrosis with the presence of urolithiasis by CTU reports were analysed using the Chi-Squared test on SPSS version 21 with $\alpha=0.05$.

3. RESULTS AND DISCUSSION

A total of 57 patients with radiology reports and met the inclusion criteria were included in this study. The mean age of selected patients with radiology reports was 51 ± 14.6 (range from 22 to 80) years old. Out of 57 patients, 35 (61.4%) were males and 22 (38.6%) were females. Ultrasound of KUB was able to detect 39 patients (68.4%)

presented with hydronephrosis and 18 patients (31.6%) were detected with no hydronephrosis.

For CTU examination, 31 patients (54.4%) were detected with hydronephrosis and 26 patients (45.6%) were detected with no hydronephrosis. The presence of calculi was detected in 37 patients (64.9%) by using CT. In 37 patients with urolithiasis detected by CTU examination, CT detected kidney stones in 6 patients, ureteric stones in 28 patients and bladder stones in 3 patients.

3.1. The sensitivity and specificity of ultrasound in predicting urolithiasis based on ultrasound findings of hydronephrosis.

For false negative finding by the US, 6 patients (10.5%) reported by the US with no hydronephrosis proved to have urolithiasis in CTU reports. For false positive findings, the US reported 8 patients (14.0%) with hydronephrosis but proved to be no urolithiasis by CTU reports.

The US had a sensitivity of 83.8% and specificity of 60% in detecting any hydronephrosis for any presence of urolithiasis on CTU examination. The positive predictive value (PPV) was 0.79 and negative predictive value (NPV) was 0.67. The diagnostic accuracy of ultrasound in predicting urolithiasis for patient presented with renal colic pain and suspected having urolithiasis was 75% (Table 1).

Receiver Operating Characteristic (ROC) analysis was performed and the area under the curve was 0.72 with a confidence interval (CI) 95% [0.571,0.867] with a standard error of 0.075 and p-value is 0.007 ($p < 0.05$). Since the assumption made was that the US has high sensitivity and specificity in predicting urolithiasis based on US findings of hydronephrosis, thus null hypothesis was rejected as the test was statistically significant.

Table 1: Diagnostic accuracy of ultrasound in predicting urolithiasis

Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
83.8%	60%	0.79	0.67	75%

The assumption made prior to the study was accepted as the US findings of hydronephrosis had high sensitivity of 83.8%. The previous study conducted by Carmody et al. (2017) [4], shows similar results with sensitivity of 84.8% and specificity of 70.8% and Noble et al. [5] stated that US had a sensitivity of 61-82% when comparing with CT and appropriate clinical setting.

Ultrasound findings of hydronephrosis had PPV of 0.79 in predicting the presence of urolithiasis and NPV of 0.67 in predicting the absence of urolithiasis. A similar study conducted by Sternberg, Pais, et al. [2] to predict the presence of ureteral stones by using hydronephrosis findings had a PPV of 0.77 in predicting the presence of ureteral stones and NPV of 0.71 in predicting the absence of ureteral stones. The results from both studies show that the US findings of hydronephrosis had high predictive value in predicting the presence and absence of urolithiasis and ureteral stones.

3.2. Association of the presence of hydronephrosis on ultrasound with the presence of urolithiasis on CTU examination.

From Pearson Chi-Square test, significant association was observed between the presence of hydronephrosis and the presence of urolithiasis (chi-square = 11.5, df = 1, $p < 0.001$). Prior assumption made before the initiation of the study was there is a significant association between the presence of hydronephrosis on US of KUB and the presence of urolithiasis on CTU. Since the test was statistically significant, the null hypothesis was rejected. Therefore, the presence of hydronephrosis on US of KUB is dependent and significantly associated with the presence of urolithiasis found on CTU examination.

From 57 selected patients, 31 patients (54.4%) were detected with hydronephrosis on US of KUB and the presence of the urolithiasis were proved by CTU examination. According to Noble et al. (2015), the incidence of hydronephrosis in patients with proved ureteral stones has been reported to increase from 69 to 83% [5]. A prior study found that the presence of hydronephrosis on the US was associated with the presence of ureteral stones on CTU in 68 patients (47.2%) [2].

There are several factors that might affect the presence of the hydronephrosis found on the US such as the location and size of the calculi. From this study, it was found that out of 37 patients proved to have urolithiasis on CTU, most of the patient with 27 patients (47.4%) had both ureteral stones and hydronephrosis found on the US. Ureteral stones are more likely to cause the presence of hydronephrosis and hydroureter in patient complaints of renal colic or flank pain. This results can be supported by the findings reported by Alshoabi [6], which the study found consistent findings with the previous study that the stones in kidney and ureter were the most cause of the presence of hydronephrosis. However, the location of the stones was not associated with the presence or severity of hydronephrosis, the only stone size was proved to have a significant association with the presence and degree of hydronephrosis [5].

A similar studie investigating the relationship between the degree or severity of hydronephrosis and the size of the ureteral stone reported similar findings which the degree of hydronephrosis had significant association with the size of the stones [5, 6, 7]. The results from these studies above can be concluded as the severity of hydronephrosis increases with an increase in the size of ureteral stones. The US would not accurately provide the location and stone size because of the limitation of visualizing the middle ureter. Another alternative that can be used is the combination of the US and x-ray KUB in the evaluation of a patient with renal colic or suspected having urolithiasis.

4. CONCLUSION

From this study, we can conclude that ultrasound findings of hydronephrosis had high sensitivity of 83.8% with a positive predictive value (PPV) of 0.79 in predicting patients with urolithiasis found by CTU examination. The presence of hydronephrosis on the US has a significant association with the presence of urolithiasis on CTU examination. The ultrasound has high sensitivity and accurate in detecting the presence or absence of hydronephrosis.

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