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# Is Ultrasound as Accurate as Computed Tomography Urogram in Detecting Urinary Tract Calculi: - A Retrospective Study.

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***Abstract***

***Aim:*** *To determine the (i) sensitivity and specificity of ultrasound (USG) in the detection of urinary tract calculi, (ii) size of renal calculi detected on USG and comparing with CTU, and (iii) size of renal calculi not seen on USG but detected on computed tomography urogram (CTU).*

***Methods:*** *A total of 100 patients' USG and CTU were compared retrospectively for the presence of calculi. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value of USG were calculated with CTU as the gold standard.*

***Results:*** *From the 100 sets of data collected, 40 calculi were detected on both USG and CTU. The sensitivity and specificity of renal calculi detection on USG were 53% and 85% respectively. The mean size of the renal calculus detected on USG was 6.8 mm ± 3.8 mm and the mean size of the renal calculus not visualized on USG but detected on CTU was 3.5 mm ± 2.7 mm. The sensitivity and specificity of ureteric calculi detection on USG were 12% and 97% respectively. The sensitivity and specificity of urinary bladder calculi detection on USG were 20% and 100% respectively.*

***Conclusion:*** *This study showed that the accuracy of US in detecting renal, ureteric and urinary bladder calculi Were 68%, 80% And 99% Respectively.*

***Keywords:*** *Urolithiasis, nephrolithiasis, urinary tract calculi, ultrasound, computed tomography urogram.*

## I. Introduction

Urolithiasis is a common finding in patients who present with acute flank pain and/or haematuria. The average global prevalence of urolithiasis was 3.25% in the 1980s and 5.64% in the 1990s, and is seen increasingly across sex, race and age.[1] The incidence of urinary tract stone disease is increasing. According to the National Health and Nutrition Examination Survey, as of 2012, 10.6% of men and 7.1% of women in the United States are affected by renal stone disease, compared to just 6.3% of men and 4.1% of women that were affected in 1994.[2] Epidemiological surveys have been previously reviewed showing that in economically developed countries the prevalence rate ranged between 4% and 20%.[3] Radiological studies have an important role in the early diagnosis of urolithiasis. Ultrasound (USG) is the most appropriate and useful screening tool as it is easily available, radiation-free, reproducible, inexpensive and non-invasive.[4] An USG that is negative for calculi may prompt the need for unenhanced computed tomography urogram (CTU).

CTU was shown to be highly sensitive and specific for ureteric stones.[3] Its significant advantages over other modalities in the detection of urolithiasis includes accuracy, non-usage of intravenous contrast media, as well as the abilities to evaluate secondary effects of obstruction, and detect other potential sources of pain[5] but patients are inevitably exposed to radiation. The sensitivity and specificity of CTU in detecting ureteric calculi has been reported to range 94 - 100% and 92 - 100%, respectively.[4]

There has been little direct comparison between USG and CTU in the detection of urolithiasis. CTU as being the gold standard, our study aims to determine the sensitivity of USG in detecting urinary tract calculi. The patients suspected of having renal tract calculi undergo a work-up that includes urinanalysis, KUB radiograph, and USG as first line investigations. A positive USG may or may not proceed to CTU but all negative USG will undergo CTU for further evaluation. But is it really necessary for patients to be exposed to the radiation by a CTU? i.e why, this study has set out to see how many negative USG proved to be positive on CTU.

## II. Materials And Methods

This study was conducted after approval by the institute ethical committee. Patient informed consent was not obtained as this is a retrospective review.

**Subjects**

A retrospective study involving patients who had undergone USG and CTU for suspected urinary tract calculi over a period of 12 months, from January 2014 to December 2015.

**Examination technique**

CTU was performed in the Department of Radiology at our centre. No oral or intravenous contrast media was given. Calculus was defined as hyper dense focus in the kidney, ureter and/or bladder. Ultrasound scanning included evaluation of the kidneys in multiple anatomic planes and maximum calculus measurement was recorded. Calculus on ultrasound was characteristically demonstrated as highly echogenic focus with distinct posterior acoustic shadowing.

**Data collection and statistical analysis**

Data was collected from the hospital Picture Archiving and Communication System (PACS). Demographic data including age, sex were collected. A review of the USG and CTU of each patient was done with documentation of the imaging findings including presence or absence of calculus, site (right or left urinary tract or both), location (kidney, ureter or bladder), and calculus size in millimeter. With CTU as the gold standard, sensitivity, specificity, accuracy, positive predictive value and negative predictive value of USG for the detection of calculus at each of the three locations (kidney, ureter and bladder) were calculated.

## III. Results

A total of 100 patients were included in the study. The patients were predominantly in the late adulthood and elderly age groups, with 40 patients (40%), 25 patients (25%) and 35 patients (35%) aged between 25-39, 40-59 and 60-79 years old respectively. The mean age was 52 years old.

Gender wise, there were 58 males and 42 females. In 40% of patients, the time interval between the USG and CTU was within 1month. The interval was within 2 months for 28% and in the remaining 32%, it was more than 2 months.

***Detection of renal calculi***

From the 100 data collected patients, 30 renal calculi were detected on both USG and CTU (Table I). There were 6 false positive cases. The sensitivity and specificity of renal calculi detection on ultrasound were 52% and 86% respectively. The positive predictive value (PPV) was 84% and negative predictive value (NPV) was 57%. The accuracy of ultrasound in detecting renal calculi was 68%. Of the 30 renal calculi detected on USG, 23 calculi were measured. The remaining 7 calculi not measured were too small and described as tiny or too large and described as staghorn calculi. The majority of calculi detected by USG measured 5.1-10 mm (Table II). The minimum, maximum and average size documented was 3.5 mm, 22 mm and 6.8 mm ± 3.8 mm respectively.27 renal calculi were not detected on USG but positive on CTU and 37 findings were true negative (Table I). Of the 27 calculi not detected on USG but detected on CTU, 5 were described as tiny and the other 22 were measured on CTU. The majority of calculi not detected by USG measured ≤ 5 mm (Table II). The minimum, maximum and average size of calculi that were not detected on USG was 2 mm, 13 mm and 3.5 mm ± 2.7 mm respectively.

***Detection of ureteric calculi***

Ultrasound detected only 3 of the 20 ureteric calculi that were detected on CTU giving a low sensitivity of 12% (Table IV). However, it showed a high specificity of 97%. The accuracy of ultrasound in detecting ureteric calculi was 81%. The PPV and NPV were 63% and 81% respectively.

***Detection of urinary bladder calculi***

For the detection of urinary bladder calculi, ultrasound achieved 20% sensitivity and 100% specificity (Table V). The PPV was 100% with NPV of 99%. The accuracy was 99%.

## IV. DISCUSSION

The study showed that USG had limited value for the detection of renal calculi. The sensitivity and specificity of 52% and 86% respectively were lower compared to two previous studies that had reported 81% and 100%, and 76% and 100% for sensitivity and specificity respectively.[6,7]

The poor sensitivity and the high false negative rates (41%) of USG demonstrated in the study are related to multiple factors. Calculi might have been missed at USG due to lack of acoustic shadowing of the calculus.[8] The presence of posterior acoustic shadowing depends on the size of the calculus. Therefore, the smaller the calculus, the more likely it could be missed.[3,8] The other factors would be the body habitus,[7] the selection of the transducer power, and focal length.[8] The excellent contrast resolution of CTU allows discrimination of slight differences in attenuation, allowing better visualisation of stones. Furthermore, CTU has the ability to acquire a volume of data that includes the entire urinary system and not just the kidneys only. USG may miss stones within some parts of the urinary tract, [8] especially the ureters.

However, our sensitivity exceeded that of another study, which reported a sensitivity of 24%, but a slightly higher specificity of 90%.[9] The longer time interval between ultrasound and CTU (45% within 1 month, the rest 1 month or more) in this study could have contributed to this discrepancy, in contrast to 1 month or less in previous studies.

With regard to the size of renal calculi that were detected, our study showed that the mean size of the calculi detected on USG was 6.8 mm ± 3.8 mm, comparable to a study that reported a mean size of 7.1 mm ± 1.2 mm.[10] Of the 27 renal calculi not detected on USG, 83% measured ≤ 5 mm. A study showed that 73% of calculi not visualized on USG were 3 mm or less in size comparable to our study.[10]

USG lacks sensitivity for the detection of ureteric calculi. However, it is fairly specific when calculi are seen. A prospective study in 1998 achieved a sensitivity of 19% and a specificity of 97%.[10] Another study in 2007 showed a slightly higher sensitivity of 23% and specificity of 100%.[11]

The specificity of calculi detection on USG is greater in the ureter than in the kidneys. In our study, almost similar results were achieved, with low sensitivity of 12% and high specificity of 97%. This is because the diagnosis of ureteric calculus is greatly aided by the presence of hydroureter.[3,11,12] The low sensitivity is attributable to the presence of bowel gas, which commonly obscures the ureters, and a large body habitus with thick subcutaneous fat that reduces visibility.[6,13]

Also our study showed the accuracy of USG in detecting renal, ureteric and urinary bladder calculi was 68%, 80% and 99% respectively. Findings of this study, the following imaging algorithm is recommended.

The limitation of our study was the extended time interval between ultrasound and CTU. Approximately 55-60% of the patients had their ultrasound and CTU done at more than 1 month apart. Accuracy of ultrasound could be affected as calculi could have moved or changed in size during this period of time.New ultrasound technique such as the use of Doppler ultrasound to detect “twinkling artefact” could potentially improve urolithiasis detection on sonography, and should certainly be looked into in future studies.[14]

## V. Conclusion

The sensitivity and specificity of USG in detecting renal calculi was 52% and 86% respectively and the mean size of renal calculi not visualized on USG was 3.5 mm ± 2.7 mm. Our study showed that the accuracy of USG in detecting renal, ureteric and urinary bladder calculi was 68%, 80% and 99% respectively.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **Table II: Size of detected and undetected renal calculi on USG** | | | | |
| **Calculus size (mm)** | | **Number Detected (%)** | | **Number Undetected (%)** | | |
| ≤ 5 | | 10 (34) | | 23 | (85) | |
| 5.1 – 10 | | 12 (41) | | 3 | (13) | |
| ≥ 10.1 | | 08 (25) | | | 1 (2) | |
| Total | | 30 (100) | | 27 (100) | | |

Calculi described as tiny have been classified as ≤ 5 mm.

Calculi described as staghorn have been classified as ≥ 10.1 mm

| | | | |
|---|---|---|---|
| | | **Table III: percentage error in USG** | |
| **Findings** | | | |
| | | **Total** | |
| True positive (TP) | | 30 | |
| True negative (TN) | | 27 | |
| False positive (FP) | | 06 | |
| False negative (FN) | | 37 | |
| Total | | 100 | |
| Percentage error (FP+FN/Total) | | 44 % | |
| | | | |
| P = 0.727 | | | |
| | | | |

**Table IV:** Detection of ureteric calculi on USG and CTU

| USG | CTU | | |
|---|---|---|---|
| | **Normal** | **Abnormal** | **Total** |
| Normal | 79 | 17 | 96 |
| Abnormal | 1 | 3 | 4 |
| Total | 80 | 20 | 100 |

**Table V:** Detection of urinary bladder calculi on USG and CTU

| USG | CTU | | |
|---|---|---|---|
| | **Normal** | **Abnormal** | **Total** |
| Normal | 97 | 2 | 99 |
| Abnormal | 0 | 1 | 1 |
| Total | 97 | 3 | 100 |

## References


[1]. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010; 12(2-3): e86-96.

[2]. Scales CD Jr, Smith AC, Hanley JM, Saigal CS, Urologic Diseases in America Project. Prevalence of kidney stones in the United States. Eur Urol 2012;62:160-5

[3]. Trinchieri A. Epidemiology of urolithiasis. Arch Ital Urol Androl. 1996;68:203–250.

[4]. Turk C KT, Petrik A, Sarica K, *et al.* Guidelines on urolithiasis 2014. http://uroweb.org/wp-content/uploads/22-Urolithiasis_LR.pdf. Accessed on 6 Feb 2015.

[5]. Renard-Penna R, Martin A, Conort P, *et al.* Kidney stones and imaging: What can your radiologist do for you? World J Urol. 2015; 33(2): 193-202.

[6]. Ather MH, Jafri AH, Sulaiman MN. Diagnostic accuracy of ultrasonography compared to unenhanced CT for stone and obstruction in patients with renal failure. BMC Med Imaging. 2004; 4(1): 2.

[7]. Passerotti C, Chow JS, Silva A, et al. Ultrasound versus computerized tomography for evaluating urolithiasis. J Urol. 2009; 182(4 Suppl): 1829-34.

[8]. King W, 3rd, Kimme-Smith C, Winter J. Renal stone shadowing: an investigation of contributing factors. Radiology. 1985; 154(1): 191-6.

[9]. Fowler KA, Locken JA, Duchesne JH, *et al.* US for detecting renal calculi with nonenhanced CT as a reference standard. Radiology. 2002; 222(1): 109-13.

[10]. Yilmaz S, Sindel T, Arslan G, *et al.* Renal colic: comparison of spiral CT, US and IVU in the detection of ureteral calculi. Eur Radiol. 1998; 8(2): 212-7.

[11]. de Souza LR, Goldman SM, Faintuch S, *et al.* Comparison between ultrasound and noncontrast helical computed tomography for identification of acute ureterolithiasis in a teaching hospital setting. Sao Paulo Med J. 2007; 125(2): 102-7.

[12]. Patlas M, Farkas A, Fisher D, *et al.* Ultrasound vs CT for the detection of ureteric stones in patients with renal colic. Br J Radiol. 2001; 74(886): 901-4.

[13]. Tepeler A, Nakada S. Radiology Imaging for Ureteral Stones. In: Patel SR, Nakada SY, editors. Ureteral Stone Management: Springer International Publishing; 2015. p. 21-8.

[14]. Kielar AZ, Shabana W, Vakili M, *et al.* Prospective evaluation of Doppler sonography to detect the twinkling artifact versus unenhanced computed tomography for identifying urinary tract calculi. J Ultrasound Med. 2012; 31(10): 1619-25.