

Diagnostic Accuracy Of Ultrasound For The Diagnosis Of Ureteric Stone In Adults Taking Computed Tomography As Gold Standard

Talha Khalid¹, Syed Muhammad Yousaf Farooq¹, Hassan Ali¹, Ayesha Khan², Muhammad Mubashir¹, Zainab Afzal¹, Eisha Laraib¹, Fatima Naeem¹, Shayza Ashraf¹

¹University Institute of Radiological Sciences & Medical Imaging Technology, The University of Lahore, Pakistan.

² Health Service Academy, Islamabad, Pakistan.

DOI: 10.47750/pnr.2023.14.04.72

Abstract

Background: CT scan is considered as gold standard imaging modality for diagnosis nephrolithiasis but its utility is limited due to harmful radiation especially in children and pregnant females. **Objective:** To find the diagnostic accuracy of ultrasound for the diagnosis of ureteric stone in adults taking computed tomography as gold standard. **Methodology:** This cross-sectional study was carried out in the Department of Radiology, Sharif Medical City Lahore. 197 patients of nephrolithiasis were selected using non-probability convenient sampling technique. Adult male and female patients of all ages fulfilling the inclusion criteria were included in the study. Data was collected after the approval from research ethical committee, The University of Lahore. Ultrasonography and computed tomography of all patients were done and findings were noted. The data was entered and analyzed using SPSS software version 25. Mean and SD were calculated for quantitative variables. Frequencies and percentages were calculated for qualitative variables. Sensitivity and specificity was calculated for ultrasound. **Results:** Total of 197 patients were examined. Mean age of the patient was 50.3 ± 14 years with a range of 20 years to 60 years. The sensitivity of the ultrasound for the diagnosis of ureteric stone, at 85.19%, indicates that it correctly identifies the presence of the condition in 85.19% of individuals who actually have the condition. The specificity, however, is lower at 48.57%, suggesting that the test accurately identifies the absence of the condition in only 48.57% of individuals who do not have it. The overall accuracy of the ultrasound is 78.68%, meaning that it provides correct results (both true positives and true negatives). **Conclusion:** Ultrasound have high sensitivity and low specificity for the diagnosis of ureteral calculi and has several advantages including its availability, lower cost and no risk of radiation exposure as compared to CT. Ct should be reserved for that patient for whom ultrasonography is not able to give a diagnosis.

Keywords: Diagnostic accuracy, CT-Scan, Ultrasound, Ureteric Stone.

INTRODUCTION:

Ureterolithiasis, also known as ureteric calculi, is the presence or formation of stones within the ureters, which are the tubes responsible for the passage of urine from the kidneys to the bladder.¹ Most of these stones, approximately 80%, are found to be composed predominantly of calcium. Comparatively, approximately 15% of these ureter stones are made of struvite, which is magnesium ammonium phosphate formed by urea-splitting gram-negative bacteria.² A smaller percentage of these ureter stones is made up of uric acid stones, while an even smaller number of them contain cysteine.³ The symptoms which are produced by the presence of a calculus in the ureter are well known.⁴ The pain is situated down to the groin and may be referred to the testicle or upper part of the thigh, its location depending on the site of impaction in the ureter.⁵ It is a common cause of urological outpatient load or any surgical emergency department.⁶ Its prevalence in different ethnic groups in a study have been shown 29.5% of Egyptians, 24.9% of Pakistani, 23.3% of Indian, 20.5% of Yemeni, 17.6% of Sudanese, 16.2 of Bangladeshi and 7.4% of Saudi Arabian. Other population-based studies investigated prevalence and incidence rates of urolithiasis in different countries.⁷ A surprisingly high 15% prevalence of urolithiasis was observed in the rural population of Thebes in Greece. In Iceland the age-standardized prevalence for the 30- 79 years age group was 4.3% for men and 3.0% for women, with no

significant increase over time.⁸ The incidence was 562 per 100 000 per year among men and among women was 197 per 100 000 per year. Its prevalence is relatively high in America which accounts for 12% in men and 7% in women, the risk is more with the previous history of ureteric stones and is there is a family history More commonly seen in patients within age group of 35-45.⁹ American guideline recommends CT scan as first choice for ureteric stone diagnosis while European says the ultrasound as the initial modality (The ultrasound sensitivity, specificity, accuracy for renal stones detection were 67.8%, 100% and 81.2% when compared to low dose CT and the ultrasound sensitivity, specificity 92.59%, accuracy for ureteral stones detection were 6.90%, 100% and 43.75% respectively when compared to low dose Data from some developing countries showed prevalence figures similar to those previously described in Western countries. In Iran the prevalence was estimated as 5.7%, slightly more frequent in males (6.1%) than females (5.3%) whereas the annual incidence of urolithiasis.¹⁰

Imaging evaluation of patients with acute flank pain is traditionally based on intravenous urography (IVU) as the standard screening tool for detecting urinary calculi.¹¹ IVU requires IV contrast medium, with its associated potential risks. In addition, the length of this examination may preclude rapid evaluation of patients in an emergency setting.¹² These considerations have led to the use of other techniques, such as the combination of plain abdominal radiography and ultrasound (US), and more recently unenhanced helical CT.¹³ Plain radiographs are not sensitive to nonradio-opaque calculi or to non-calculus obstruction. Plain radiography also lacks specificity, as phlebitis, which is common pelvic calcifications, are not always readily differentiated from urinary tract calculi.¹⁴

The purpose of this study determines Computed Tomography is widely used as a primary imaging technique for evaluation of urinary tract abnormalities. MDCTU (multi-detector CT urography) has a number of advantages for imaging the urinary tract. Multi-detector CT are very useful for studying urinary system structure and pathology especially in patients with suspected urinary tract obstruction. However, due to easy accessibility, less side effects, no contraindications and cost effectiveness supports this as an initial diagnostic modality.

METHODOLOGY:

This cross-sectional study was carried out in the Department of Radiology, Sharif Medical City Lahore. 197 patients of nephrolithiasis were selected using non-probability convenient sampling technique. Adult male and female patients of all ages fulfilling the inclusion criteria were included in the study. Data was collected after the approval from research ethical committee, The University of Lahore. Ultrasonography and computed tomography of all patients were done and findings were noted. The data was entered and analyzed using SPSS software version 25. Mean and SD were calculated for quantitative variables. Frequencies and percentages were calculated for qualitative variables. Sensitivity and specificity was calculated for ultrasound.

RESULTS:

A total number of 197 patients were recruited for this study. Mean age of all patients was 50.3 ± 14 years with a range of 20 to 60 years. Genders among the sample of 197 individuals are as follows: Female 98 (49.7%) and Male 99 (50.3%). There were 25 (12.7%) with hematuria. 50 (25.4%) had ureteral dilation. Out of 197, 87 (44.2%) had mild and 110 (55.8%) had moderate hydronephrosis.

Table 1: Comparison between USG and CT for the diagnosis of ureteric stone

	Diagnosis on CT		Total
	Present	Absent	

Diagnosis on USG	Present	138	18	156
	Absent	24	17	41
Total		162	35	197

Among the individuals who underwent CT scans, 162 were diagnosed with the condition being evaluated, while 35 did not have the condition. Regarding the results of the USG, 156 individuals showed stone USG, out of which 138 were also confirmed by CT. Additionally, 18 individuals had positive findings on USG but were not diagnosed with the condition on CT. On the other hand, 41 individuals had negative USG findings, with 24 of them being confirmed to have the condition on CT, and 17 individuals not having the condition based on CT.

These results suggest that USG had a relatively high sensitivity (138 out of 162) but lower specificity (24 out of 35) when compared to CT. This means that USG was effective in identifying most individuals with the condition but had a higher likelihood of producing false-positive results. CT, being the gold standard, provided a more definitive diagnosis and helped confirm or rule out the presence of the condition.

Table 2: Accuracy of Ultrasound for the diagnosis of ureteric stone

Statistic	Value	95% CI
Sensitivity	85.19%	78.76% to 90.27%
Specificity	48.57%	31.38% to 66.01%
Positive Likelihood Ratio	1.66	1.19 to 2.30
Negative Likelihood Ratio	0.31	0.18 to 0.50
Disease prevalence (*)	82.23%	76.17% to 87.30%
Positive Predictive Value (*)	88.46%	84.67% to 91.41%
Negative Predictive Value (*)	41.46%	30.00% to 53.93%
Accuracy (*)	78.68%	72.29% to 84.18%

The sensitivity of the ultrasound for the diagnosis of ureteric stone, at 85.19%, indicates that it correctly identifies the presence of the condition in 85.19% of individuals who actually have the condition. The specificity, however, is lower at 48.57%, suggesting that the test accurately identifies the absence of the condition in only 48.57% of individuals who do not have it. The overall accuracy of the ultrasound is 78.68%, meaning that it provides correct results (both true positives and true negatives).

DISCUSSION:

The sensitivity of the test, at 85.19%, indicates that it successfully detects the presence of the condition in the majority of individuals who actually have it. This suggests that the test is relatively effective in identifying true positive cases. The specificity of the test, at 48.57%, is comparatively lower. This means that the test has a higher probability of producing false-positive results, identifying individuals as having the condition when they actually do not. This lower specificity could potentially lead to unnecessary further investigations or treatments for individuals who are falsely

identified as positive. Its prevalence in different ethnic groups in a study have been shown 29.5% of Egyptians, 24.9% of Pakistani, 23.3% of Indian, 20.5% of Yemeni, 17.6% of Sudanese, 16.2 of Bangladeshi and 7.4% of Saudi Arabian.³ The initial diagnosis and then treatment are necessary to relieve the patient from the colicky pain associated with it. Non-enhanced CT scan is being evolved as the investigation of choice because of the sensitivity of 96-100% and specificity of 96-100%.^{2,4,5} Because of this Non-enhanced CT scan is consider as the gold standard in detecting stone in the urinary tract.^{1,2,6} Though ultrasound is considered as the primary modality for evaluation of urinary tract stones because it is cheap, readily available, non-invasive. Trans-abdominal ultrasound Renal stone is the clinical presentation of flank pain radiating towards groin. Its prevalence is highly variable across various geographical regions and between races and is influenced by socio-economic and environmental factors. Trans- abdominal ultrasound's sensitivity, specificity, and diagnostic accuracy in cases of urinary tract calculi were evaluated to be 68.3 %, 66.7 %, and 67.95 %, respectively, in our study. Maryam Javed, et al. in 2018 conducted a study; transabdominal ultrasonography's sensitivity, specificity, and diagnostic accuracy for detecting urolithiasis were calculated to be 65.27 %, 72.09%, and 67.83 %, respectively. In our study proximal ureter was the commonest site with 79 (40.1%) calculi Present and Absent 118(59.9%) among 197 Patient. Distal ureter was the second commonest site with 81 (41.1%) calculi Present and Absent 116(58.9%) among 197 Patient.¹⁶ In another study of. Faiq SM et al reported that CT has 100% sensitivity, US has 52.6% sensitivity and KUB X-ray has 89.5% sensitivity in the detection of ureteric calculus. On other hand Javed M et al reported that Transabdominal ultrasonography's sensitivity, diagnostic accuracy, and specificity for urolithiasis were estimated to be 85 %, and 78.6% respectively and they further stated that the transabdominal sonography can possibly be utilized effectively in detecting calculi in proximal ureter, kidneys, urinary bladder or vesicoureteral junction. Maximum renal stone value 45.2% (n=89) on Right side and minimum value was 17.8%(n=35) bilateral side renal stone among 197 patient.¹⁷ In this study right side ureteric calculus was in 30.0% cases, 38.8% cases had left ureteric calculus and 8.3% had bilateral ureteric calculus. Although in the study of Ahmed F et al. s. Out of all 31(51.7%) were males and 29(48.3%) were females. Right side ureteric calculus was found in 30.0% cases, 38.8% cases had left ureteric calculus and 8.3% had bilateral ureteric calculus In our study urolithiasis was found in men more than women. However another study of Rashid et al As per gender distribution in this study males were 31(51.7%) and 29(48.3%) were females. Large number of patients was in age group 20-60 as shown in (Table 2). Most common complaint of the patient was flank pain which was found in (n= 88) 47.7% patients followed by burning micturition, hematuria, ureteral dilatation, side of stone and having % age of 74.6%, 25.6%, 12.8% and 15.4% respectively. Urolithiasis was found in 80.76% of patients (n=63) undergone CT KUB. On the CT scan, 95 calculi were detected in 78 patients.¹⁸ Kidney was the most common site of urinary calculi with 44 (46.31%) calculi located in kidneys. Distal ureter was the second commonest site with 14 (14.7%) calculi. Bladder and urethra were the sites with 1(1.1%) calculus. Renal colic is pain that occurs when a stone blocks urinary tract. It has the potential to be quite painful and it necessarily requires quick medical attention. Diagnosis of this condition is necessary for early diagnosis of the site and size of stone. Though ultrasound is considered as the primary modality for evaluation of urinary tract stones because it is cheap, readily available, non-invasive and radiations free (Sasui et al, 2021).¹⁹ Our findings are consistent with the findings of the majority of studies conducted in this area. Ultrasonography was found to be an adequate method for detecting urolithiasis in the study Toru, et al. (Kanno et al, 2014) conducted same study on 856 people, and the results showed that ultrasound sensitivity was 78.9% and specificity was 83.7 %. Ultrasound is effective for detecting kidney stones, according to study. As a result, ultrasonography should be taken into account for both acute and follow up renal stone examinations. Transabdominal ultrasonography provides significant advantages diagnostic technique for urolithiasis, especially in pregnant women and children, in our opinion. NPV of 48.48% and accuracy of 68.75% for detecting the ureteric stone.²⁰

CONCLUSION:

Ultrasound have high sensitivity and low specificity for the diagnosis of ureteral calculi and has several advantages including its availability, lower cost and no risk of radiation exposure as compared to CT. Ct should be reserved for that patient for whom ultrasonography is not able to give a diagnosis.

REFERENCES:

1. Park SJ, Yi BH, Lee HK, Kim YH, Kim GJ, Kim HC. Evaluation of patients with suspected ureteral calculi using sonography as an initial diagnostic tool: how can we improve diagnostic accuracy?. *Journal of Ultrasound in Medicine*. 2008 Oct;27(10):1441-50.
2. Ather MH, Jafri AH, Sulaiman MN. Diagnostic accuracy of ultrasonography compared to unenhanced CT for stone and obstruction in patients with renal failure. *BMC medical imaging*. 2004 Dec;4(1):1-5.
3. Rodger F, Roditi G, Aboumarzouk OM. Diagnostic accuracy of low and ultra-low dose CT for identification of urinary tract stones: a systematic review. *Urologia internationalis*. 2018;100(4):375-85.
4. Xiang H, Chan M, Brown V, Huo YR, Chan L, Ridley L. Systematic review and meta-analysis of the diagnostic accuracy of low-dose computed tomography of the kidneys, ureters and bladder for urolithiasis. *Journal of medical imaging and radiation oncology*. 2017 Oct;61(5):582-90.
5. Pichler R, Skradski V, Aigner F, Leonhartsberger N, Steiner H. In young adults with a low body mass index ultrasonography is sufficient as a diagnostic tool for ureteric stones. *BJU international*. 2012 Mar;109(5):770-4.
6. Brisbane W, Bailey MR, Sorensen MD. An overview of kidney stone imaging techniques. *Nature Reviews Urology*. 2016 Nov;13(11):654-62.
7. Javed M. Diagnostic Accuracy of Trans-Abdominal Ultrasonography in Urolithiasis, keeping CT KUB as Gold Standard. *Journal of Islamabad Medical & Dental College*. 2018 Nov 18;7(3):204-7.
8. McGrath TA, Frank RA, Schieda N, Blew B, Salameh JP, Bossuyt PM, McInnes MD. Diagnostic accuracy of dual-energy computed tomography (DECT) to differentiate uric acid from non-uric acid calculi: systematic review and meta-analysis. *European Radiology*. 2020 May;30(5):2791-801.
9. Sandhu C, Anson KM, Patel U. Urinary tract stones—part I: role of radiological imaging in diagnosis and treatment planning. *Clinical radiology*. 2003 Jun 1;58(6):415-21.
10. Kluner C, Hein PA, Gralla O, Hein E, Hamm B, Romano V, Rogalla P. Does ultra-low-dose CT with a radiation dose equivalent to that of KUB suffice to detect renal and ureteral calculi?. *Journal of computer assisted tomography*. 2006 Jan 1;30(1):44-50.
11. Smith-Bindman R, Aubin C, Bailitz J, Bengiamin RN, Camargo Jr CA, Corbo J, Dean AJ, Goldstein RB, Griffey RT, Jay GD, Kang TL. Ultrasonography versus computed tomography for suspected nephrolithiasis. *New England Journal of Medicine*. 2014 Sep 18;371(12):1100-10.
12. Patlas M, Farkas A, Fisher D, Zaghal I, Hadas-Halpern I. Ultrasound vs CT for the detection of ureteric stones in patients with renal colic. *The British journal of radiology*. 2001 Oct;74(886):901-4.
13. Ulasan S, Koc Z, Tokmak N. Accuracy of sonography for detecting renal stone: comparison with CT. *Journal of Clinical Ultrasound*. 2007 Jun;35(5):256-61.
14. Moore CL, Daniels B, Ghita M, Gunabushanam G, Luty S, Molinaro AM, Singh D, Gross CP. Accuracy of reduced-dose computed tomography for ureteral stones in emergency department patients. *Annals of emergency medicine*. 2015 Feb 1;65(2):189-98.
15. McCarthy CJ, Baliyan V, Kordbacheh H, Sajjad Z, Sahani D, Kambadakone A. Radiology of renal stone disease. *Int J Surg*. 2016;36:638-46.
16. Patti L, Leslie SW. *Acute Renal Colic*. StatPearls. Treasure Island (FL)2019.
17. Brisbane W, Bailey MR, Sorensen MD. An overview of kidney stone imaging techniques. *Nat Rev Urol*. 2016;13:654.
18. Haroun A, Hadidy A, Mithqal A, Mahafza W, Al-Riyalat N, Sheikh-Ali R. The role of B-Mode ultrasonography in the detection of urolithiasis in patients with acute renal colic. *Saudi J Kidney Dis Transpl*. 2010;21(3):488-93.
19. Ray AA, Ghiculete D, Pace KT, Honey RJDA. Limitations to Ultrasound in the Detection and Measurement of Urinary Tract Calculi. *Urology*. 2010;76(2):295-300.
20. Goertz JK, Lotterman S. Can the degree of hydronephrosis on ultrasound predict kidney stone size? *Am J Emerg Med*. 2010;28(7):813-6.