OPEN ACCESS ORIGNAL ARTICLE

DIAGNOSTIC ACCURACY OF ULTRASOUND IN DETECTION OF SYMPTOMATIC URETERIC CALCULI TAKING NON CONTRAST CT SCAN AS A GOLD STANDARD.

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ABSTRACT

BACKGROUND: Urolithiasis is defined as the presence of calculi in the urinary tract. Multiple studies have shown that urinary tract stones are one of the most common incidental findings in medical imaging. These stones are potentially dangerous and can cause severe impairment to renal function if they remain undiagnosed for a long time. To evaluate the diagnostic accuracy of ultrasound in the detection of symptomatic ureteric calculi taking a non-contrast CT scan as a gold standard. **METHODOLOGY:** A cross sectional analytical study was conducted in 9 months at Department of Diagnostic Radiology D.H.Q Hospital Jhang, Pakistan. 100 patients were selected with Consecutive sampling technique, Age of 18 to 80 years, both genders, Patients who presented with urinary symptoms and were suspected to have a urinary stone patients were included in this study. Patients with renal masses, previous renal surgeries, renal transplants and end-stage renal disease and pregnant females and patients not willing to participate in the study were excluded. **RESULTS:** The sensitivity of Ultrasound was 90.91%, specificity was 100%, Predictive positive value was 100% and predictive negative value was 10% so the diagnostic accuracy was 91%. **CONCLUSION:** Study concluded that the sensitivity of USG for diagnosis of ureteric calculi was high.

KEY WORDS: Computed Tomography, Ultrasound, Urolithiasis

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How to Cite This Article: Ali M[1], Farooq SMY[2] **DIAGNOSTIC ACCURACY OF ULTRASOUND IN DETECTION OF SYMPTOMATIC URETERIC CALCULI TAKING NON CONTRAST CT SCAN AS A GOLD STANDARD.** J Peop Univ Med Health Sci. 2025:15(2),13-20. http://doi.org/10.46536/jpumhs/2025/15.02.619

Received On 25 APRIL 2025, Accepted On 30 JUNE 2025, Published On 30 JUNE 2025.

INTRODUCTION

The kidneys, ureters, and bladder are parts of the urinary system. The urinary tract makes, transport, and store the urine in the body. Urolithiasis is the formation of stones in the urinary tract. There are different types of urinary stones as for as variation in their chemical composition concern and the biological process by which they are formed. Calcium stones are more predominant and account for about 70%_80% of all urinary stones (Coe, F et.al 2005). Urolithiasis is a prevalent condition affecting the urinary system, with its occurrence increasing globally in recent decades. In North America, the prevalence has risen from 7% to 13%, in Europe from 5% to 9%, and in Asia from 1% to 5% over the past 30 years. In China, the incidence has also increased from 4% to 6.4% in the last decade, with men being twice as likely to be affected compared to women. Studies indicate that in Pakistan, around 16% of the population is affected by kidney stones, with varying rates among different age groups, reaching as high as 31.5% in 40-49 year-olds, 29.6% in 30-39 year-olds, and 12.2% in 20-29 year-olds. Recurrence of urolithiasis is

common, with rates ranging from 6-17% after one year, 21-53% after 3-5 years, and a lifetime recurrence rate of 60-80%. Urolithiasis is a complex disorder with a global prevalence of approximately 2-20%, making it the third most common urinary tract disease after urinary tract infections (UTI) and prostatic issues. The prevalence of urolithiasis is increasing worldwide, with rates ranging from 1-5% in Asia, 7-13% in North America, and 5-9% in Europe. A study in Pakistan found a 3% prevalence of urolithiasis and a 5% likelihood of silent stones among the general population. The primary chemical composition of stones includes calcium oxalate (50-70%), uric acid (10-20%), and ammonium-magnesium phosphate (5-10%), either in pure form or in combination with calcium phosphate. Cysteine calculi shows an average prevalence of 1-2% (Ather MH, et.al 2004). It is approximated that around 6% of females will encounter one or more kidney stone episodes in their lifetimes, with a recurrence rate of 50%. One out of four patients with kidney stones has a family history of the condition, which triples the risk of developing stones. Men are more frequently impacted than women (Kim HC, et.al 2014). Symptoms in a patient with urinary stones include renal colic, side pain, painful urination, and blood in the urine. This is considered an urgent situation that requires medical attention, and sometimes it can lead to complications such as high blood pressure, swelling of the kidney, swelling of the ureter, urinary tract infections, chronic kidney disease, diabetes, and end-stage kidney disease (Manzoor, I et.al 2018). The diagnosis of urinary tract stones relies on the patient's history, physical examination, symptoms, blood tests, and imaging results. X-ray of the Kidney, Ureter, Bladder (KUB), Intravenous Pyelography (IVP), Ultrasound, and Computed Tomography (CT) scan are commonly used imaging techniques for identifying stones (Masarani M et.al 2007). Research indicates that non-contrast CT KUB is the preferred method for identifying stones in the ureter due to its high accuracy (96-100%). Urologists recommend CT scans as the most reliable tool for investigating kidney, ureter, and bladder stones (Liu N et.al 2020). Ultrasound (US) has gained popularity as an imaging method for assessing urinary stones, as it is safe, radiation-free, readily available, and cost-effective (Ahmad SK et.al 2014). However, drawbacks include variability between operators and challenges in detecting ureteric stones. The accuracy of ultrasound in detecting urinary stones varies depending on factors like patient's body shape, operator's skill, and the location and size of the stone. The sensitivity of ultrasound improves for ureteric stones when combined with x-ray KUB (Bacha R et.al 2019). Color Doppler ultrasound aids in identifying urinary stones, with the twinkling artifact indicating the presence of stones (Iqbal S et.al 2017). This artifact, also known as the 'color comet-tail artifact,' is a color Doppler effect seen as a rapid color change just behind an immobile object. It is particularly useful in diagnosing urolithiasis (Abid A, et.al 2021). The twinkling artifact on color Doppler ultrasound of urinary stones appears as a swift mix of red and blue colors over or behind the stone where shadowing would typically occur on B-mode imaging (SHAMS H et.al 2020). The appearance of the twinkling artifact can be influenced by various machine settings, such as the location of the focal zone. For instance, placing the focal zone below a rough surface enhances the twinkling artifact visibility compared to placing it above. Other settings affecting the twinkling artifact include color write priority, grayscale gain, and pulse repetition frequency. Adjusting these settings can impact the strength of the twinkling artifact signal. (Nestler T 2019). Urinary calculi is an emergency condition that causes severe pain in the abdomen and

blocks the passage of urine at any place. CT (Computed Tomography) is used as a gold standard tool for the detection of kidney and ureteric stones. In peripheral areas, most hospitals have no C.T facility but an Ultrasound facility is available there. So, we want to evaluate the diagnostic accuracy of ultrasound in the detection of ureteric stones by using greyscale and color Doppler ultrasound as for as availability, cost, and radiation hazardous concern relative to CT scan. Any findings that are detected will help in further management and treatment. To evaluate the diagnostic accuracy of ultrasound in the detection of symptomatic ureteric calculi taking a non-contrast CT scan as a gold standard.

METHODOLOGY: This was an analytical study with a cross-sectional design. It was carried out at the Diagnostic Radiology Department of D.H.Q Hospital Jhang, Pakistan. The research lasted for 9 months following the approval of the synopsis. The sample size was determined with a 95% confidence level and a 5% margin of error. The expected sensitivity is 96% and the prevalence is 20%.

$$n = \frac{z^2_{\left(1-\frac{\alpha}{2}\right)} Sn(1-Sn)}{L^2 \times Prevalence}$$

$$= \frac{(1.96)^2 (0.96)(1-0.96)}{(0.05)^2 \times 0.2}$$

100 Individuals were Included

Consecutive sampling technique was used to conduct this research study. The inclusion criteria for the study was: Patients who presented with urinary symptoms and were suspected to have a urinary stone. The Patients with age 18-80 years and both male and female patients were included. Patients with renal masses, previous renal surgeries, renal transplants and end-stage renal disease. Pregnant females and patients not willing to participate in the study were excluded from the study.

EQUIPMENT

- **Ultrasound:** SIEMENS ACUSON NX3 ELITE color Doppler and TOSHIBA NEMIO XG color Doppler equipped with both convex probe (3,5Mhz) and linear probe (9, 15 MHz
- **MDCT:** TOSHIBA (AQUILLION 16) multidetector Computed Tomography

DATA COLLECTION PROCEDURE

Following the approval from the university's ethical committee, participants meeting the specified criteria were enrolled in the research project. Each participant provided informed consent after being informed of the potential advantages and anticipated risks. The researcher personally recorded fundamental demographic and medical details on a prepared data form. Patients were required to have a full bladder for the exam by drinking around one liter of water60 minutes before the appointment. In cases where bowel gases obscure findings, graded compression will be used and the patient was directed to walk for 15 to 20 minutes. The patient was exposed from abdomen to pelvis including the urinary bladder. The patient was evaluated in different positions including supine, right and left decubitus, and prone positions after applying the gel. Ureteric was traced by sliding, tilting, rocking, and rotating the probe in longitudinal and transverse planes. Ultrasonography was performed using Siemens Acuson NX3 Elite and Toshiba Nemio XG followed by MDCT Toshiba (Aquilion 16) with dedicated protocols in the Radiology Department of D.H.Q Hospital Jhang. The patient was in a supine position with arms above the head and was instructed to hold their breath during the CT procedure. CT images from the upper pole of the kidney to below pubic symphysis was taken Thin slices of 2- 3mm were taken and multiplanar reconstruction was used for detail. Non Contrast enhance CT KUB was performed for the confirmation of

stone.Following Quantitative and qualitative variables were recorded.

DATA ANALYSIS PROCEDURE

SPSS version-23 was utilized for data input and analysis. Numerical factors such as Age weight and stone dimensions were displayed using mean±SD, while categorical factors like gender, stone position, acoustic shadow, twinkling artifact, and stone type were illustrated through frequency and percentage. A 2x2 table was created to determine Sensitivity, Specificity, Positive predictive value, negative predictive value, and diagnostic accuracy. The MCNemar test was employed, and statistical significance was set at P-value < 0.05.

ETHICAL CONSIDERATIONS

The research adhered to the guidelines established by the ethical board of the University of Lahore, ensuring that the participants' rights were upheld.

- Every participant provided written consent.
- Confidentiality was maintained for all information and data collected.
- Participants' identities were kept anonymous during the research.
- Subjects were assured that the study procedure carried no negative consequences or risks.
- Participants were informed of their freedom to withdraw from the study at any point.

RESULTS

Out of 100 patients, 57(57%) were male and 43(43%) were females. The mean of weight was 65.2500 and S/D ±12.16418 The mean of age was 40.8700 and S/D ±12.00560. The mean of size of stone on ultrasound was 14.5078 and S/D ±18.60523. The mean of size of stone on CT scan was 13.4273 and S/D ± 8.94053.

TABLE 1: DEMOGRAPHIC DATA OF THE PARTICIPANTS

	Frequency	***%***
Age		
(Mean ± SD)	40.87	12.0
Gender		
Male	57	57.0
Female	43	43.0
Weight		
(Mean ± SD)	65.25	12.16
Stones		
Absent	10	10.0
Present	90	90.0
Size of stone		
Ultrasonography Stone Size (Mean ± SD)	13.05	9.26
Computed Tomography Stone Size (mm) (Mean ± SD)	13.29	8.99

Findings of Ultrasonography and Computed-tomography

Out of 100 patients, there were 90 (90.0%) patients who diagnosed with stones on ultrasound. Out of 100 patients, there were 90 (90.0%) patients who diagnosed with stones on ultrasound. Out of these 90 patients 50 (50%) had stones on right side and 40 (40%) had stone on left side. Out of 100 patients, there were 90 (90.0%) patients who diagnosed with ureteric stones on ultrasound. Out of these 90 patients 33 (33%) had stones on proximal site, 17 (17%) had on middle and 40(40%) had stone on distal site. Out of 100 patients, there were 88 (88.0%) patients who present acoustic shadowing on ultrasound. Out of 100 patients, there were 88(88.0%) patients who present twinkling artifact on ultrasound. Out of 100 patients,

there were 99 (99.0%) patients who diagnosed with stones on CT scan. Out of 100 patients, there were 99 (99.0%) patients who diagnosed with stones on CT scan. Out of these 99 patients 56 (56%) had stones on right side and 43 (43%) had stone on left side. Out of 100 patients, there were 99 (99.0%) patients who diagnosed with ureteric stones on CT scan. Out of these 99 patients 39 (39%) had stones on proximal site, 18 (18%) had on middle and 42 (42%) had stone on distal site (See table 2).

TABLE 2: FINDINGS OF ULTRASONOGRAPHY AND COMPUTED-TOMOGRAPHY

	Frequency	***%***
UltrasonographyStone		
Absent	10	10.0
Present	90	90.0
UltrasonographyUreteralStoneSide		
Absent	10	10.0
Right	50	50.0
Left	40	40.0
Ultrasonography Ureteral Stone Position		
Proximal	33	33.0
Middle	17	17.0
Distal	40	40.0
Absent	10	10.0
Ultrasonography Acoustic Shadow		
Present	88	88.0
Absent	12	12.0
UltrasonographyTwinklingArtifacts		
Absent	12	12.0
Present	88	88.0
Computed-tomography Stone		
Absent	1	1.0
Present	99	99.0
ComputedTomographyUreteralStoneSide		
Right	56	56.0
Left	43	43.0
Absent	1	1.0
Computed-tomography Urethral Stone Position		
Proximal	39	39.0
Middle	18	18.0
Distal	42	42.0

Diagnostic Accuracy of Ultrasound in Detection of Symptomatic Ureteric Calculi

The sensitivity of Ultrasound was 90.91%, specificity was 100%, Predictive positive value was 100% and predictive negative value was 10% so the diagnostic accuracy was 91%. (Table 3).

Table 3: Diagnostic accuracy in detecting ureteric calculi

Parameter	Estimate	Lower - Upper 95% CIs
Sensitivity	90.91%	(83.62, 95.14[1])
Specificity	100%	(20.65, 100[1])
Positive Predictive Value	100%	(95.91, 100[1])
Negative Predictive V alue	10%	(1.788, 40.42[1])
Diagnostic Accuracy	91%	(83.77, 95.19[1])

DISCUSSION

Renal colic caused by urinary tract stones can manifest as a sudden abdominal condition, placing a considerable strain on the accident and emergency (A&E) and surgical outpatient department (OPD). The ACR, AUA, and EAU have outlined varying recommendations for additional investigations in such cases (Jatoi A et.al 2021).

The ACR and AUA recommend CT KUB as the preferred imaging method for urolithiasis, while EAU prefers ultrasound (Barbas C et.al 2002, YuzlanM et.al 2018). Low-dose noncontrast CT is considered the gold standard for suspected urolithiasis due to its high accuracy in diagnosis. It can precisely identify the location and size of stones (including those in the ureter), detect complications, and uncover other potential causes of abdominal pain such as appendicitis or intestinal blockage (Kamal SS et.al 2022).

In our research, we determined that transabdominal ultrasonography had a sensitivity of 90.09%, specificity of 100%, and diagnostic accuracy of 91% in cases of kidney stones. This aligns closely with findings from previous studies. For instance, Gottlieb et al. conducted a study on 856 patients and found Ultrasonography was found to have an 89.9% sensitivity and a 93.7% specificity in identifying kidney stones, a finding that was verified by non-enhanced CT scans. (Gottlieb et.al 2018).

Another study by Mills L et al. involving 2759 patients showed that ultrasound as the initial diagnostic tool resulted in lower radiation exposure compared to CT scans without compromising diagnostic efficacy or causing any adverse effects (Mills L et.al 2018). Similarly, Sen V et al. reported that transabdominal ultrasound demonstrated An accuracy of 88.75% was achieved with a sensitivity of 79.64%, specificity of 86.6%, positive predictive value of 92.92%, and negative predictive value of 48.48% in detecting ureteric stones (Sen V et.al 2017).

Rahmouni A and colleagues found that CT scan showed a sensitivity of 100%, ultrasound demonstrated a sensitivity of 92.6%, and KUB X-ray displayed a sensitivity of 89.5% in the study. detecting kidney stones (Rahmouni A, et.al 2016). Conversely, Noreen A et al. found that transabdominal ultrasonography had a sensitivity of 89.7%, diagnostic accuracy of 87.83%, and specificity of 82.09% for nephrolithiasis, suggesting its effective use in detecting stones in various parts of the urinary system (Noreen A et.al 2016).

Ultrasonography can also provide insights into the severity and extent of obstruction caused by stones. However, visualizing the mid-ureter can be challenging due to interference from bowel gas shadows. YuzlanM et al. documented that ultrasonography had a sensitivity of 75.4% and specificity of 16.7%, with positive and negative predictive values of 97.18% and 1.69%, respectively (YuzlanM et.al 2018).

In our study, out of 100 patients, 90 (90.0%) were diagnosed with stones via ultrasound, with 50% on the right side and 40% on the left side. This distribution differed slightly from the findings of Noreen A et al., where left- and right-side stones were detected in 47.2% and 52.8%

of cases, respectively. The average age of patients in our study was 40.87±12.01 years, consistent with the findings of Jatoi A et al. (mean age of 36.47±8.24 years) (Noreen A et.al 2016). Abid A et al. also reported a similar average age of 39.69±9.91 years in their cases (Abid A, et.al 2021).

Gender distribution in our study showed that 57% were male and 43% were female, contrasting with findings from Sorokin I et al., where males accounted for 58.4% and females for 41.6% of cases (Sorokin I, et.al 2017). Hirsch M et al. found a different gender distribution with 53.8% females and 46.3% males (Hirsch M et.al 2011), indicating variability across studies. Further research with larger sample sizes and multi-center studies are needed to explore this topic comprehensively.

CONCLUSION

Study concluded that the sensitivity of USG for diagnosis of ureteric calculi was high.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

FUNDING: The work was not financially supported by any organization. The entire expense was taken by the authors.

ACKNOWLEDGEMENTS: We are thankful to all who were involved in our study.

AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared

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