

Diagnostic Accuracy of Transabdominal Ultrasound in Detection of Renal Calculi Keeping Non-Enhanced CT KUB as Gold Standard

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ABSTRACT

Objective: To determine the diagnostic accuracy of transabdominal ultrasound in detection of renal calculi keeping non-enhanced CT KUB as gold standard.

Study Design: Cross sectional study.

Place and Duration of Study: Department of Radiology, Combined Military Hospital, Multan Pakistan. from Sept 2024 to Feb 2025.

Methodology: A total of 209 patients, who presented to radiology department for computed tomography scan of kidney, ureter and bladder with suspicion of renal calculi were enrolled in study. They were first subjected to transabdominal ultrasound for detection of renal calculi and later all the patients underwent computed tomography scan (gold standard). The diagnostic accuracy, sensitivity and specificity of transabdominal ultrasound in detection of renal calculi were determined.

Results: Patients were having mean age of 37.7 ± 11.3 years whereas female to male ratio of 1:0.9. Sensitivity at 83.3%, specificity at 84.2%, positive predictive value at 84.9% and negative predictive value at 82.5%. Overall diagnostic accuracy of transabdominal ultrasound in detecting renal calculi was 83.7%.

Conclusion: Transabdominal ultrasound is a valuable, safe, and accessible first-line tool for detecting renal calculi, showing good diagnostic accuracy in comparison to CT KUB. While not a substitute for CT in all cases, its high specificity and ease of use make it an effective initial imaging choice especially when radiation exposure or cost is a concern.

Keywords: Diagnostic accuracy, Computed tomography, Renal calculi, Radiation exposure, Transabdominal ultrasound.

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INTRODUCTION

The stone in the ureteric pathways is called urolithiasis. This remains a fair reason of urological outpatient workload of any surgical emergency sector.¹ Prevalence is on the rise and increased by almost 70% over the previous 15 years in various areas of the world, with an annual and lifetime prevalence of 3%–5% and 15%–25%, respectively.² Data indicated that 40–50% of Pakistanis have urolithiasis.³ Stone formation is a complex illness that involves both metabolic and environmental components, particularly in men who are between the ages of 30 and 60 years.⁴ The patient must undergo diagnostic workup to make a diagnosis and treatment in order to be freed from the related colicky discomfort.⁵

A non-enhanced CT scan is increasingly becoming the preferred investigation modality due to its sensitivity and specificity, which range from 96% to 100%. As a result, non-enhanced CT scans are

regarded as the gold standard for identifying urinary tract stones.⁶ Common techniques for identifying these stones in the past included intravenous urography, ultrasonography, and plain X-rays of the kidney, ureter, and bladder (KUB),⁷ as the sensitivity of ultrasonography in the past for the detection of ureteric stones was poor. However, due to the advancement in technology and further improvement in ultrasound machines and transducers, the detection of ureteric stone has reported 96.3% of sensitivity and 80.7% of specificity.⁸

Wahab M et al studied 80 patients with suspected renal colic. Patients had a mean age of 36.47 ± 8.243 years. Ureteric stones had prevalence of 70% (n=56). Trans-abdominal ultrasound was having sensitivity at 69.64%, specificity at 66.6%, PPV at 82.92%, NPV at 48.48% whereas accuracy at 68.75% for diagnosing the ureteric calculus.⁹ Similarly, Javed M *et al.* from Islamabad, Pakistan conducted a study on 115 patients. The prevalence of urolithiasis was 62.6%. The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of transabdominal ultrasonography in urolithiasis was

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measured as 65.27%, 72.09%, 79.66%, 55.36% and 67.83% respectively.¹⁰

Owing to the introduction of newer technology, sonography sensitivity has reached a higher level than it was previously reported. Ultrasound is also a cheap, safe, noninvasive and easily available imaging modality. No study has been reported from South Punjab on the value of ultrasound in detecting renal calculi. This trial was scheduled to evaluate diagnostic accuracy of this technique, keeping non-enhanced CT abdomen as gold standard in patients referred for imaging to our setting from urologists. According to evidence obtained from this study, the risk of exposing to ionizing radiation by CT scans in patients would be minimized.

METHODOLOGY

This cross-sectional study was conducted in department of Radiology, Combined Military Hospital, Multan, Pakistan over six months starting from Sept 2024 to Feb 2025. This study was started after permission from Hospital Ethical Review Board vide notification number 141/2023. Sample size was calculated using OpenEpi calculator with reference parameters of prevalence of renal stone at 62.6%¹⁰, expected sensitivity at 65.3 %¹⁰, expected specificity at 72.1%¹⁰ while keeping the absolute precision at 10% and confidence level at 95%. The calculated sample size turned out to be 209.

Inclusion Criteria: Patients of either gender aging 20 to 65 years who presented with new onset flank pain >3 accessed by Visual analogue score (VAS >3), burning micturition, vomiting and hematuria for duration ≤ 7-days (accessed by history) referred to radiology department for evaluation of suspected renal calculi by CT scan were included.

Exclusion Criteria: Patients weighing > 90 kg, BMI ≥ 30 kg/m², pregnant women (confirmed by urinary pregnancy test) and patients who had previous surgery due to urolithiasis (accessed by history) were excluded.

A total of 209 patients with suspected renal stones referred to Diagnostic Radiology Department were included in trial in the consecutive non probability fashion after getting informed written consent from them. Patient characteristics including age, gender, BMI and duration of symptoms were noted. First of all, the patients were subjected to transabdominal ultrasound diagnostics by using Toshiba Xario 200 on the standard grayscale image (in

B-mode) and the absence or presence of stones was noted as a bright with a dark distal shadow. Then the same patients were subjected to non-enhanced CT-scan of abdomen, it started from the diaphragm to symphysis pubis. Tube voltage 120kVp, tube current 270-350 mAs, slice thickness 5 mm and reconstruction 1.25mm were kept as the standard parameters in all CT scans. Radio-dense opacity in the renal cortex or pelvis was labelled as renal stone. All CT scans were done without oral or intravenous contrast using Toshiba CT system. Two consultant radiologists with ≥ 5-year post fellowship experience reported the ultrasound abdomen and CT-scans separately who were unaware of the status of the patient. The presence (yes/no) and size of the largest calculus in millimeter (in case of multiple calculi) were reported in all patients either undergoing ultrasound or CT scan. The obtained data was noted on proforma.

All the obtained data was studied by statistical software package for social sciences (SPSS) version 25. Age, duration of symptoms, number and size of calculi is presented as mean and standard deviation. The gender, presence of calculi (yes/no) and location of calculi is presented as frequency and percentages. A 2x2 contingency table constructed taking non-enhanced CT-KUB as reference standard and sensitivity, specificity, positive predictive value, negative predictive value and accuracy for ultrasound was determined. Patient flow diagram is shown in Figure.

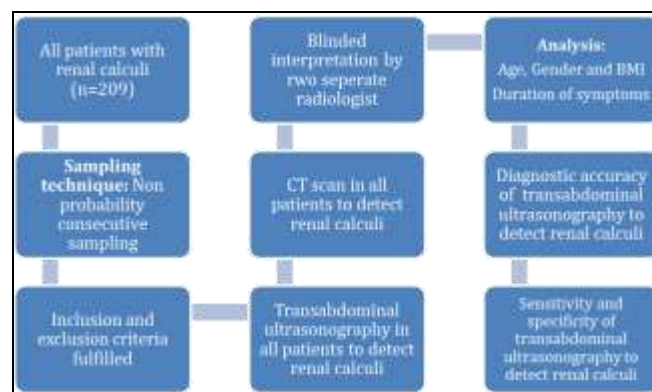


Figure : Patient Flow Diagram

RESULTS

All patients enrolled in study completed the trial successfully. The mean age of the patients turned out to be 37.7±11.3 years. Incidence of renal calculi was greater in females with male to female ratio 0.9:1. The details of the basic parameters are as per Table-I.

Table-I: Summary of Participant Demographics and Clinical Features (n=209)

Parameter	Mean±SD	Range
Age in Years	37.70±11.30	24-60
Body Mass Index -Kg/m ²	25.27±1.86	23-29
Duration of symptoms in days	3.45±1.50	1-7

Ultrasonography confirmed the presence of renal calculus in 50.7% patients with mean size of 3.2±1.42mm whereas CT scan confirmed the calculus presence in 51.7% of the patients with mean size of 2.9±1.60. The range of calculus size diagnosed on ultrasonography varied from 0.5 to 6mm whereas this range on CT scan varied from 0.2 to 6mm. A 2x2 cross tabulation is drawn for findings of transabdominal ultrasonography and CT scan, Table-II.

Table-II: Diagnostic Accuracy of Transabdominal Ultrasound in the Detection of Renal Calculi – 2x2 Contingency Analysis (n=209)

Transabdominal Ultrasonography	CT scan	
	Positive (n=108)	Negative (n=101)
Positive (n=106)	90 (83.3%)	16 (15.8%)
Negative (n=103)	18 (16.7%)	85 (84.2%)

Sensitivity= True Positive/ (True Positive +False Negative) = 83.3%

Specificity= True Negative / (True Negative +False Positive) = 84.2%

Positive Predictive Value= True Positive/ (True Positive+ False Positive) = 84.9%

Negative Predictive Value= True Negative/ (True Negative +False Negative) = 82.5%

Diagnostic Accuracy= (True Positive +True Negative)/All Patients = 83.7%

The diagnostic performance of transabdominal ultrasound in detecting renal calculi was evaluated using standard statistical measures. Sensitivity was 83.3%, specificity was 84.2%, positive predictive value was 84.9%, and negative predictive value was 82.5%. Overall diagnostic accuracy of transabdominal ultrasound in detecting renal calculi was 83.7%.

DISCUSSION

The present study demonstrated that transabdominal ultrasound (US) achieved a sensitivity of 83.3%, specificity of 84.2%, PPV of 84.9%, NPV of 82.5%, and overall diagnostic accuracy of 83.7% in detecting renal calculi, when compared to non-enhanced CT KUB as the gold standard. These findings align closely with those reported in several recent studies, reinforcing the role of ultrasound as an effective initial imaging modality in the evaluation of urolithiasis.

In a 2024 study by Raza *et al.* transabdominal ultrasound showed a sensitivity of 71.28% and specificity of 95%, with an overall diagnostic accuracy of 75.4% in detecting renal and ureteric stones, which is slightly lower in sensitivity but higher in specificity compared to the current study.¹¹ Similarly, Mustafa *et al.* found ultrasound sensitivity to be 67.29% and specificity 69.84%, with an accuracy of 68.24% when detecting ureteric calculi, indicating considerable variability depending on stone location.¹² Our study's sensitivity of 83.3% is notably higher than the sensitivity reported Riaz *et al.* which found ultrasound sensitivity for renal stones to be around 68.3% with similar specificity estimates at 66.7%.¹³ These variations are likely due to differences in operator experience, patient population, and stone characteristics, including size and anatomical location.

When comparing PPV and NPV, the current study's values (84.9% and 82.5%, respectively) are within the range reported in the literature. A study by Abbas *et al.* evaluating ultrasound for renal stones in a local population found a PPV of 86% and NPV of 79%, closely matching our findings.¹⁴ High PPV supports the reliability of ultrasound in confirming the presence of calculi when detected, while the moderate NPV underscores the need for further imaging—particularly CT—in cases with negative ultrasound but persistent clinical suspicion.

Notably, our overall diagnostic accuracy of 83.7% is superior to the 75%–80% accuracy range reported in multiple recent studies. Rao *et al.* for example, observed an accuracy of 57.68% in a prospective evaluation of emergency department patients using ultrasound for urolithiasis.¹⁵ This may reflect improved training, equipment, standardized scanning protocols or the relative higher range of calculus size in our study setting. Another relevant comparison comes from Krakhotkin *et al.* who reported greater than 90% sensitivity and specificity when using ultrasound for detection of renal stones ≤10mm, by experienced radiologists.¹⁶ Our study, performed under standardized radiological supervision, supports the idea that operator expertise is a key factor in maximizing ultrasound's diagnostic potential.

Some studies, such as that by May *et al.* emphasize that stone size significantly impacts detection rates. They noted that sensitivity dropped to 57% for stones <5 mm compared to 89% for stones ≥5mm, highlighting ultrasound's limits in recognizing smaller calculi, which could explain the false negatives

observed in our trial.¹⁷ Additionally, factors such as obesity, hydronephrosis, and overlying bowel gas have also been identified as limiting factors.¹⁸

In conclusion, while the diagnostic performance of transabdominal ultrasound in our study is slightly superior to the average reported in the literature, variability in sensitivity and accuracy across studies reflects the technique's operator dependence and anatomical limitations. These challenges have been emphasized in recent analyses such as the impact of stone size,¹⁹ patient BMI, location of the calculus and scanning protocols affecting the diagnostic outcomes.²⁰ Furthermore, Nelson *et al.* advocated for the continued use of ultrasound as a frontline tool, particularly in initial screening scenarios or in resource-constrained environments, citing its favorable safety and accessibility profiles.²¹ Nonetheless, ultrasound remains an essential modality in the diagnostic algorithm of urolithiasis, especially when interpreted in conjunction with clinical findings and followed by CT when necessary.

CONCLUSION

Transabdominal ultrasound is a valuable, safe, and accessible first-line tool for detecting renal calculi, showing good diagnostic accuracy in comparison to CT KUB. While not a substitute for CT in all cases, its high specificity and ease of use make it an effective initial imaging choice—especially when radiation exposure or cost is a concern.

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Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

AS & AL: Conception, study design, drafting the manuscript, approval of the final version to be published.

AS & NS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

HRI & KR: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

- Castellani D, Ragonese M, Di Rosa M, Marzio V, Di Gianfrancesco L, Bassi P, et al. An Italian multicenter analysis of emergency admissions and treatment of upper tract urolithiasis during the lockdown and reopening phases of the COVID-19 pandemic: Are we ready for a second wave of the outbreak. *Int J Urol* 2021; 28(9): 950-954. <https://doi.org/10.1111/iju.14612>
- Nassir AM. Prevalence and characterization of urolithiasis in the Western region of Saudi Arabia. *Urol Ann* 2019; 11(4): 347-352.
- Sumreen L, Tanveer R, Shamim T. Practice of *Berberis vulgaris* and *Lycopodium clavatum* in urolithiasis: a systemic review. *Int J Homoeopath Sci* 2021; 5(3): 136-140. <https://doi.org/10.33545/26164485.2021.v5.i3c.417>
- Hameed T, Mengal S, Mengal MA, Yousaf M. The study on urolithiasis in human population of Baluchistan. *Pak-Euro J Med Life Sci* 2019; 2(1): 1-4.
- Al B, Sunar MM, Zengin S, Sabak M, Bogan M, Can B, et al. Comparison of IV dexametoprolfen, trametamol, fentanyl, and paracetamol in the treatment of renal colic in the ED: A randomized controlled trial. *Am J Emerg Med* 2018; 36(4): 571-576. <https://doi.org/10.1016/j.ajem.2017.09.019>
- Iftikhar N, Ayaz S, Maryam S, Rauf A, Fatima M. Comparison of kidney-ureter-bladder radiography with computed tomography scout film for the diagnosis of renal calculi taking axial computed tomography as gold standard. *J Pharm Pharm Sci* 2020; 8(4): 194-199.
- Hsu JT, Tseng JS, Chen M, Sun FJ, Chen CW. Preoperative estimate of natural ureteral length based on computed tomography and/or plain radiography. *Sci Rep* 2021; 11(1): 194. <https://doi.org/10.1038/s41598-021-91658-6>
- Liu N, Zhang Y, Shan K, Yang R, Zhang X. Sonographic twinkling artifact for diagnosis of acute ureteral calculus. *World J Urol* 2020; 38(2): 489-95.
- Wahab M, Tariq K, Ishtiaq M, Ahmad K, Aslam M. Diagnostic accuracy of ultrasound in detecting ureteric stone keeping non-enhanced CT as gold standard. *Ann Punjab Med Coll.* 2019; 13(3): 223-225. <https://doi.org/10.29054/apmc/2019.752>
- Javed M, Nasrullah F. Diagnostic accuracy of trans-abdominal ultrasonography in urolithiasis, keeping CT KUB as gold standard. *J Islamabad Med Dent Coll* 2018; 7(3): 204-207.
- Raza A, Zubair J. Diagnostic accuracy of transabdominal ultrasonography in urolithiasis, keeping CT KUB as gold standard. *J Biol Allied Health Sci* 2024; 4(2): 3-6. <https://doi.org/10.56536/jbahs.v4i.18>
- Mustafa MA, Arshad AA, Hafeez Z, Hafeez RS, Chughtai AS, Qadir SA, et al. Diagnostic accuracy of ultrasound in detecting ureteric calculi as compared to CT. *Pak J Med Health Sci.* 2023; 16(11): 348. <https://doi.org/10.53350/pjmhs20221611348>
- Riaz M, Naeem MA, Ali A, Arshad N, Latif F. Diagnostic Accuracy of Trans-Abdominal Ultrasound in Detection of Urinary Tract Calculi as Compared to CT KUB. *EAS J Radiol Imaging Technol* 2022; 4(4): 74-78. <https://doi.org/10.36349/easjrit.2022.v04i04.002>
- Abbas SK, Al-Omary TSS, Fawzi HA. Ultrasound accuracy in evaluating renal calculi in Maysan province. *J Med Life* 2024; 17(2): 226-232. <https://doi.org/10.25122/jml-2023-0477>
- Rao A, Toor A, Fatima M, Noor J, Sabir R, Rose S, et al. Diagnostic Accuracy of Ultrasound for the Evaluation of Ureteric Calculi Taking Non-Enhanced Computed Tomography as a Gold Standard. *J Health Med Nursing* 2021; 90(0): 15-19. <https://doi.org/10.7176/JHNM/90-04>
- Krakhotkin DV, Chernylovskiy VA, Sarica K, Tsaturyan A, Liatsikos E, Makevicius J, et al. Diagnostic value ultrasound signs of stones less than or equal to 10 mm and clinico-radiological variants of ureteric colic. *Asian J Urol* 2023; 10(1): 39-49. <https://doi.org/10.1016/j.ajur.2022.03.015>
- May PC, Haider Y, Dunmire B, Cunitz BW, Thiel J, Liu Z, et al. Stone-mode ultrasound for determining renal stone size. *J Endourol* 2016; 30(9): 958-962. <https://doi.org/10.1089/end.2016.0341>

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18. Grimwood A, Thomas K, Kember S, Aldis G, Lawes R, Brigden B, et al. Factors affecting accuracy and precision in ultrasound guided radiotherapy. *Phys Imaging Radiat Oncol* 2021; 18(2): 68-77. <https://doi.org/10.1016/j.phro.2021.05.003>
 19. Vijayakumar M, Ganpule A, Singh A, Sabnis R, Desai M. Review of techniques for ultrasonic determination of kidney stone size. *Res Rep Urol* 2018; 10(1): 57-61. <https://doi.org/10.2147/RRU.S128039>
 20. Nery DR, Costa YB, Mussi TC, Baroni RH. Epidemiological and imaging features that can affect the detection of ureterolithiasis on ultrasound. *Radiol Bras* 2018; 51(5): 287-292. <https://doi.org/10.1590/0100-3984.2017.0113>
 21. Nelson BP, Sanghvi A. Out of hospital point of care ultrasound: current use models and future directions. *Eur J Trauma Emerg Surg* 2016; 42(3): 139-150. <https://doi.org/10.1007/S00068-015-0494-Z>
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