MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2024.11.513.517

To Compare the Efficacy of High-Resolution USG and CT IVU in Early Detection and Management of Urolithiasis

OPEN ACCESS

Key Words
Urolithiasis, ultrasound, CT IVP, sensitivity, specificity

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Received: 09 September 2024
Accepted: 15 October 2024
Published: 11 November 2024

Citation: Deepak Kumar Nandlal Bhimani, Meet J. Patel, Sonali Gadhavi, Twinkle Vasava and Anand Vachhani, 2024. To Compare the Efficacy of High-Resolution USG and CT IVU in Early Detection and Management of Urolithiasis. Res. J. Med. Sci., 18: 513-517, doi: 10.36478/makrjms.2024.11.513.517

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ABSTRACT
Urolithiasis is a common clinical condition, with kidney and ureteric calculi being the most frequently encountered types. Ultrasound (USG) and CT Intravenous Pyelogram (CT IVP) are commonly used diagnostic modalities for detecting urolithiasis. This study aimed to evaluate and compare the sensitivity, specificity and diagnostic accuracy of USG and CT IVP in detecting lower ureteric and renal calculi. A total of 110 patients were enrolled in this study between December 2016 and September 2018. Patients aged between 18 and 75 years were examined using both USG and CT IVP for the detection of lower ureteric and renal calculi. The results from both modalities were analyzed, focusing on the detection rates, sensitivity, specificity and predictive values. Out of 110 patients, CT IVP detected 61 patients (55.45%) with lower ureteric calculi, while USG detected only 10 patients (9%). CT IVP showed a sensitivity of 99.99% and specificity of 100%, whereas USG demonstrated a low sensitivity of 18.87% and a high specificity of 100%. The positive predictive value of CT IVP was near-perfect (100%), while the negative predictive value for USG was low (15.69%). This study confirms that CT IVP remains the gold standard for detecting urolithiasis due to its high sensitivity, specificity and diagnostic accuracy. USG, while specific, has limited sensitivity and should not be relied upon for comprehensive detection of lower ureteric calculi. The poor performance of USG is attributed to factors such as body habitus, bowel gas and operator-related errors.

INTRODUCTION

The rising global prevalence of urolithiasis, or kidney stone disease, has significantly impacted healthcare systems due to the intense pain and complications it causes, including UTIs and chronic renal failure[1]. This burden underscores the importance of accurate imaging techniques for effective diagnosis and management. Advances in imaging have greatly improved diagnostic accuracy, particularly in acute cases of renal colic, a common consequence of urolithiasis[2]. Urolithiasis affects approximately 12% of people in their lifetimes, with men three times more commonly affected, typically between 30 and 60 years of age[2]. Historically, plain radiographs and intravenous urography (IVU) were the primary imaging methods for urinary tract calculi, but their limitations-such as low sensitivity and radiation exposure-have led to the development of safer and more effective alternatives[1,3]. Abdominal ultrasonography is a commonly used initial diagnostic tool due to its accessibility and lack of radiation risks, though it has limited sensitivity for ureteral stones, detecting about 19% of cases[3]. Advances such as Color Doppler and 3D ultrasound have improved stone detection but still face challenges in certain anatomical areas[4]. Unenhanced computed tomography (CT) is now a major advancement in urolithiasis imaging, nearly replacing traditional methods due to its high sensitivity (95–98%) and specificity (94-100%)[1]. CT's accuracy, speed and ability to assess obstructive effects have made it an invaluable tool for diagnosis[5]. CT urography (CTU), developed with multi-detector and dual-energy CT technology, offers further improved detection and is now the preferred modality for diagnosing urolithiasis[6]. This study aims to compare CT urography with ultrasound in detecting ureteric calculi in patients at the Department of Radio Diagnosis, Dhiraj Hospital, Vadodara, India, evaluating diagnostic accuracy to confirm CTU's role as a reliable tool for managing urolithiasis in clinical practice[6].

MATERIALS AND METHODS

This observational study was conducted to evaluate the diagnostic accuracy of high-resolution ultrasound (USG) compared to CT urography (CTU) for detecting urolithiasis in patients referred to the Department of Radio diagnosis at SBKS Institute of Medical Sciences, Vadodara, Gujarat. A total of 110 patients, aged over 18 years, euthyroid and with normal renal function tests, were included. Patients presented with renal colic symptoms and underwent an initial evaluation with high-resolution USG. Following the USG assessment, patients meeting the criteria proceeded to CTU for further evaluation.

Inclusion Criteria: Included patients with clinical symptoms indicative of urolithiasis or with relevant family or medical history of the condition.

Exclusion Criteria: Comprised patients with renal failure (attributable to causes other than urolithiasis), pregnant women, those with high serum creatinine levels (>1.3mg/dL) and patients with thyroid disease.

The high-resolution ultrasound examination was performed using a Logiq P9 GE ultrasound system equipped with a 3–5 MHz transducer, while Doppler imaging was applied as necessary for assessing acute flank pain. For CT urography, a Siemens Emotion 16 CT scanner was used with non-ionic, water-soluble contrast media at a dose of 1.5mL/kg based on patient weight. Scanning was carried out in unenhanced, nephrographic and excretory phases to optimize anatomical visualization and detect calculi. Patient data, including demographics, clinical symptoms and laboratory results (such as haemogram, renal function tests and urinalysis), were documented. Sensitivity, specificity and accuracy of ultrasound were calculated against CT urography as the gold standard, using SPSS v20 with a significance level of $p<0.05$. Outcomes were recorded based on the presence, location and number of calculi within the kidney, ureter and bladder.

RESULT AND DISCUSSIONS

The study was carried out at the Department of Radiodiagnosis, Dhiraj General Hospital, Pipariya, Vadodara. 110 patients were included in the study between the time period of October 2016 to September 2018. In this study, the majority of patients (41.81%) were in the 21–40-year age group, comprising 28 males and 18 females. The second most common age group was 41–60 years, representing 38.18% of the study groups, followed by patients aged 61 years and older (14.5%). The overall male-to-female ratio was 1.9:1, with 65.45% (72) of patients being male and 34.54% (38) female. In this study, among the 72 male patients, 27 (37.5%) were found to have a single renal calculus, while 17 (23.61%) exhibited multiple calculi on ultrasound. Of the 38 female patients, 9 (23.68%) had a single renal calculus and 6 (15.78%) had multiple calculi detected on ultrasound. In this study, among the 72 male patients, 27 (37.5%) were found to have a single renal calculus and 17 (23.61%) had multiple calculi detected via ultrasound. Among the 38 female patients, 9 (23.68%) had a single renal calculus and 6 (15.78%) were detected with multiple calculi on ultrasound. In present study, out of 72 male patients, 29 (40.27%) were found to have a single renal calculus and 18 (25%) presented with multiple calculi on CT IVP. Among the 38 female patients, 12 (31.57%) had a single renal calculus, while 6 (15.78%) were detected with multiple calculi on CT IVP. The detection accuracy for single renal calculi is similar between both modalities., however, CT IVP demonstrates higher accuracy in detecting single calculi compared to ultrasound. Similarly, while the detection accuracy for multiple renal calculi is comparable between the two imaging techniques, CT IVP exhibits greater accuracy in

Table 1. Demographic Data of Study Participants

Parameters		Number
Age (years)	1-20	6
	21-40	46
	41- 60	42
	61 and above	16
Gender	Male	72
	Female	38
Single Calculi	Male	27
	Female	9
Multiple calculus	Male	17
	Female	6

Data are expressed as n.

Table 2. Renal calculi Detected According to Gender on Ultrasound

Gender	Single calculus	Multiple calculus
Male	27	17
Female	9	6
Total	36	23

Table 3: Renal Calculi Detected on CT IVP According to Gender

Gender	Single calculus	Multiple calculus
Male	29	18
Female	12	6
Total	41	24

Table 4: Comparison of Ultarsound and CT IVP for Detection of Single Calculus

Modality	Male	Female
Ultrasound	27	9
CT IVP	29	12

Table 5: Comparison of Ultarsound and CT IVP for Detection of Multiple Calculus

Modality	Male	Female
Ultrasound	17	6
CT IVP	18	6

Table 6: Comparison of Ultrasound and CT IVP for Diagnostic Accuracy for Lower Ureteric Calculus

Diagnostic modalities	Lower ureteric calculus Diagnosed on CT IVP	Lower ureteric calculus Diagnosed on Ultrasound
Number of patients	61	10

Table 7: Detection of Ureteric Calculi on Ultrasound and CT IVP

Ultrasound	CT IVP		
	Normal	Abnormal	Total
Normal	49	51	100
Abnormal	0	10	10
Total	49	61	110

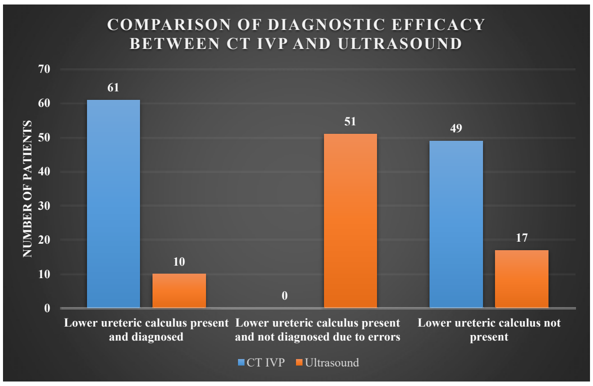

Fig. 1: Comparison of Diagnostic Efficacy Between Ultrasound and CT IVP for Lower Ureteric Calculus

identifying multiple calculi than ultrasound. In this study, a total of 110 patients were evaluated for lower ureteric calculi. Of these, 61 patients (55.45%) were diagnosed with lower ureteric calculi with associated signs on CT IVP. Among the 61 patients, 39 (35.45%) were male and 22 (20%) were female. In contrast, only 10 patients (9%) were diagnosed with lower ureteric calculi on high-resolution ultrasound, with 6 (5.45%) males and 4 (3.63%) females identified. In this study, out of 110 patients, only 10 (9%) were diagnosed with lower ureteric calculi using ultrasound. Additionally, 17 (16%) patients showed no calculi in the lower ureters on ultrasound tracing, while 83 (75%) patients had poor visualization of the lower ureters and vesicoureteral junctions due to errors. In comparison, 61 (55%) patients were diagnosed with lower ureteric calculi on CT IVP, while 49 (45%) patients showed no calculi. Notably, no errors (0%) were observed in the detection of lower ureteric calculi using CT IVP. In this study, out of 110 patients, CT IVP diagnosed 61 patients with lower ureteric calculi, while ultrasound diagnosed only 10 patients with lower ureteric calculi. In 49 patients, no calculi were detected on CT IVP, although indirect signs of lower ureteric calculi were present, which were confirmed not to be due to calculi. Additionally, ultrasound failed to diagnose lower ureteric calculi in 51 patients due to errors, but all these undiagnosed cases were accurately detected by CT IVP without any errors. In this study, out of 110 patients, CT IVP diagnosed 61 patients with lower ureteric calculi, while ultrasound diagnosed only 10 patients with lower ureteric calculi. In 49 patients, no calculi were detected on CT IVP, although indirect signs of lower ureteric calculi were present, which were confirmed not to be due to calculi. Additionally, ultrasound failed to diagnose lower ureteric calculi in 51 patients due to errors, but all these undiagnosed cases were accurately detected by CT IVP without any errors. According to present study, ultrasound detected only 10 out of 61 calculi identified on CT IVP, resulting in a low sensitivity of 9.09%. The accuracy of ultrasound in detecting lower ureteric calculi was also low, with a specificity of 16.39%. The positive predictive value (PPV) and negative predictive value (NPV) for ultrasound were 100% and 49%, respectively. Using CT IVP as the gold standard, CT IVP successfully detected all 61 calculi, yielding a sensitivity of 100% and an accuracy of nearly 100% in detecting lower ureteric calculi.

The present study was conducted at the Department of Radiodiagnosis, Dhiraj General Hospital, Pipariya, Vadodara, spanning from December 2016 to September 2018. A total of 110 patients, aged between 18 and 75 years, were included in the study. The majority of patients (41.81%) were in the 21 to 40-year age group, with 28 males and 18 females. The second most common age group was 41-60 years (38.18%), followed by patients aged 61 years and above (14.5%). The male to female ratio in this study was 1.9:1, with 72 males (65.45%) and 38 females (34.54%) participating. Of the 110 patients, 61 patients (55.45%) were diagnosed with lower ureteric calculi on CT IVP, including 39 males (35.45%) and 22 females (20%). In contrast, only 10 patients (9%) were diagnosed with lower ureteric calculi using high-resolution ultrasound, including 6 males (5.45%) and 4 females (3.63%). Additionally, 17 patients (16%) showed no calculi in the lower ureters on ultrasound, while 83 patients (75%) had errors and poor visualization of the lower ureters and vesicoureteral junctions, preventing proper tracing. On CT IVP, 61 patients (55%) were correctly diagnosed with lower ureteric calculi and no errors were found in its detection. In contrast, ultrasound detected only 10 of the 61 calculi identified by CT IVP, resulting in an accuracy of 16.39%. Further analysis revealed that 51 patients (83.60%) with lower ureteric calculi, which were undiagnosed on ultrasound, were correctly identified on CT IVP, without any errors. These findings are in line with the study by Yilmaz S *et al.* (1998), which compared ultrasound and unenhanced spiral CT scans for ureteric calculi detection, showing similar low sensitivity of ultrasound (19%) but high specificity (97%)[7]. Likewise, in a study by Hammad Ather *et al.* (2014), the sensitivity of ultrasound for detecting ureteral calculi was only 37%[8]. Similarly, Bakin *S et al.* (2015) found that out of 41 ureteric calculi detected on CTU, only 4 were detected by ultrasound, resulting in a sensitivity of 12%, with high specificity (97%) and accuracy of 81%, along with a PPV of 63% and NPV of 81%[6]. In the present study, ultrasound detected only 10 of 61 calculi on CT IVP, indicating a sensitivity of 18.87% and high specificity (~100%). The positive predictive value (PPV) was 100%, but the negative predictive value (NPV) was only 15.69%. These results were consistent with those found by Bakin et al. (2015), who observed a low sensitivity for ultrasound in detecting ureteric calculi. Another study, conducted in 2015, reported a sensitivity of 53% and specificity of 85% for renal calculi detection with ultrasound, with an accuracy of 67%, which is higher than the sensitivity observed in our study[6]. The accuracy of ultrasound in detecting lower ureteric calculi has been reported to vary, with a study showing a sensitivity of 40%, specificity of 84% and accuracy of 53%[9,10]. Ultrasound's performance is generally lower compared to CT, which has been consistently shown to have near-perfect sensitivity for detecting ureteric calculi. In the present study, CT IVP had a sensitivity of 99.99% and an accuracy of nearly 100%, confirming its superior diagnostic ability for detecting lower ureteric calculi. Regarding renal calculi detection, the study found that 72 males had 29 (40.27%) single calculi and 18 (25%) multiple calculi detected by CT IVP, compared to 27 (37.5%) single calculi and 17 (23.61%) multiple calculi detected by ultrasound. In contrast, among 38 females, CT IVP detected 12 (31.57%) with single calculi and 6 (15.78%) with multiple calculi, whereas ultrasound detected 9 (23.68%) with single calculi and 6 (15.78%) with multiple calculi. Overall, while ultrasound is a valuable tool in imaging, its lower sensitivity in detecting lower ureteric calculi compared to CT IVP highlights the need for CT IVP as the gold standard for accurate diagnosis in these cases. These findings align with previously published studies, emphasizing the complementary role of CT in the management of ureteric calculi.

CONCLUSION

This study demonstrates that ultrasound (USG) has limited value for detecting urolithiasis compared to CT IVP, showing low sensitivity (18.87%) and negative predictive value (15.69%) for lower ureteric calculi but high specificity (100%). CT IVP exhibited near-perfect sensitivity (99.99%) and specificity (100%) in detecting lower ureteric calculi. Factors like body habitus, bowel gas and transducer settings contribute to the poor sensitivity of USG. Despite these limitations, CT IVP remains the gold standard due to its excellent contrast resolution, ability to visualize the entire urinary system and low radiation dose.

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