Journal of Health and Rehabilitation Research 2791-156X JHRR

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Original Article

Assessment of Computed Tomography and Ultrasonography in Detection of Ureteric Calculi

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Conflict of Interest: None.

*Manzoor K., et al. (2023). 3(2): **DOI**: https://doi.org/10.61919/jhrr.v3i2.157*

ABSTRACT

Background: Urolithiasis, a common urological condition, presents diagnostic challenges. While CT scans are considered the gold standard for detecting ureteric calculi, the role of ultrasonography is also significant, especially in varied clinical scenarios.

Objective: This study aims to assess the diagnostic accuracy of ultrasonography compared to CT scans in the detection of ureteric calculi.

Methods: An observational study was conducted on 200 patients at the Combined Military Hospital, Peshawar. Participants included males and females aged 18-60 years, presenting with acute renal pain. Exclusion criteria included individuals without informed consent, multiple comorbidities, a history of kidney donations, or a family history of renal calculi. Ultrasonography was performed using an Ecoste Mylab 7 color Doppler machine with 3.5, 5, and 7.5 MHz probes. CT scans were conducted using the Siemens CT Somatom Sensation 64, without the administration of any contrast medium. Data were analyzed using SPSS version 26.0.

Results: Ultrasonography detected ureteric calculi in 33% of patients (66 calculi), while CT scans detected 60% (118 calculi). The breakdown of calculi location for ultrasonography included 20 renal, 15 pelvic ureteric junction, 12 upper ureter, 8 lower ureter, 7 vesicoureteric junction obstruction, and 4 bladder. CT scan results showed 45 renal, 25 pelvic ureteric junction, 20 upper ureter, 11 lower ureter, 9 vesicoureteric junction obstruction, and 8 bladder calculi. The gender distribution in the study was 55% male and 45% female, with the mean age being 35 ± 16.79 years for males and 36 ± 17.24 years for females. The most common presenting complaints were flank pain (36%), lower back pain (25%), and burning micturition (15%).

Conclusion: CT scans exhibit higher diagnostic accuracy for ureteric calculi compared to ultrasonography, thus reaffirming their role as the gold standard in this context. However, the radiation risks and economic implications of CT scanning necessitate a balanced approach to its use, emphasizing the importance of comprehensive patient evaluation and physician awareness of radiation risks.

Keywords: Urolithiasis, Ultrasonography, CT Scan, Ureteric Calculi, Diagnostic Accuracy, Radiation Risk.

INTRODUCTION

Urolithiasis, a predominant urological disorder, affects approximately 12% of the population (1), presenting predominantly as reno-ureteral colic, a frequent symptom encountered in both hospital emergency departments and urology clinics. This condition is often marked by acute renal colic, an intensely painful manifestation of kidney stones. The pain, usually colicky in nature, typically fluctuates in intensity and duration, often lasting between 20 and 60 minutes. The incidence of urinary stones is not negligible; between 5% and 15% of the population may develop them at some point (2), with nearly half of these individuals potentially facing recurrent episodes of colicky pain. Importantly, as stones progress through the urinary system, they can lead to complications such as hydronephrosis and obstruct urine flow, posing significant health risks.

The prevalence of nephrolithiasis exhibits notable geographical variability within Pakistan, with certain areas such as Dera Ghazi Khan reporting a high prevalence rate of 12% (3). The diagnostic process for renal calculi is multi-faceted, incorporating elements

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such as a thorough patient history, physical examination, evaluation of present symptoms, blood biochemistry analysis, and an imaging profile. Traditional imaging techniques for stone detection include X-ray KUB, Ultrasonography, and CT scans (4). More recently, the focus has shifted towards advanced imaging modalities like non-contrast surged CT (NCCT) and Magnetic Resonance Urography (MRU), especially for evaluating flank pain (5). NCCT, in particular, stands out for its high specificity (94%-99%) and sensitivity (95%-98%), making it the gold standard for identifying urinary tract stones in patients presenting with acute flank pain and suspected renal calculi (6).

However, ultrasonography (US) remains a widely used and competitive method for kidney stone detection due to its safety, non-invasive nature, and suitability in special cases like pregnancy and pediatric patients (7). Previous research indicates that ultrasound demonstrates a sensitivity and specificity range of 24%-81% and 83%-100%, respectively, in detecting renal stones (8). Ultrasound's inherent advantages include its affordability, non-invasive and radiation-free nature, and widespread availability. Stones typically appear on ultrasound as highly echogenic foci with significant acoustic shadowing. Yet, identifying ureteral calculi, particularly in the abdominal and upper pelvic regions, is challenging due to interference from intestinal loops and bone structures that obscure the retroperitoneum (9).

Urinary stones are classified based on their location (renal, ureteric, urethral, and bladder stones) and chemical composition (calcium and non-calcium stones). The majority of stones are calcium-based, accounting for 75% to 85% of cases in various populations, often linked to metabolic alterations due to different diseases (10). Uric acid stones, forming about 10% of kidney stones, are comparatively less common. Additionally, a plain abdominal radiograph often lacks specificity in differentiating between phleboliths and ureteric calculi, and it is also insensitive to radiolucent calculi and obstructions not caused by stones (11). This study aims to assess the accuracy of Ultrasonography versus CT scan in the detection of Renal Calculi, providing critical insights into the effectiveness of these imaging modalities in clinical practice.

MATERIAL AND METHODS

This observational study was conducted on a cohort of 200 individuals at the Combined Military Hospital (CMH) in Peshawar, employing convenience sampling as the methodology for participant selection. Ethical approval for the study was sought and obtained from the Ethical Review Committee of the Armed Forces Institute of Radiology and Imaging in Peshawar, Pakistan, ensuring adherence to ethical standards. The study predominantly included patients, both females and males, who presented with acute renal pain in the emergency department of CMH Peshawar. Prior to their inclusion in the study, written informed consent was duly obtained from each patient and, where necessary, from their guardians as well.

The inclusion criteria for the study were meticulously defined. Participants were eligible if they were aged between 18 to 60 years and presented with acute renal pain. Moreover, it was imperative that they had no prior history of renal implants. Conversely, individuals were excluded from the study if they did not provide informed consent or had multiple comorbidities, a history of kidney donations, or a family history of renal calculi. A thorough history-taking process was undertaken for each participant to ensure adherence to these criteria.

Regarding the radiological examinations conducted, the study employed both Ultrasonography and CT scans. Ultrasonography was performed using an Ecoste Mylab 7 colour Doppler machine, equipped with probes of varying frequencies (3.5, 5, and 7.5 MHz), by a consultant radiologist. This imaging technique was chosen for its ability to non-invasively visualize the kidneys, ureter, and urinary bladder across several anatomical planes, facilitating the detection of stones and the assessment of their size. Doppler imaging technology was specifically utilized to enhance the visualization of these structures.

CT scans were conducted using the Siemens CT Somatom Sensation 64. Patients undergoing CT scans were positioned supine on the examination table, preferably with a full bladder to optimize imaging of the urinary tract. The scan extended from the upper abdominal area to the pubic symphysis, with images captured at intervals of five millimeters. Notably, no intravenous or oral contrast agents were administered during the CT scans. The detection of calculi was based on identifying hyperdense foci within the urethra, urinary bladder, ureter, and kidneys.

For the analysis and documentation of the collected data, SPSS version 26.0 was employed. The study meticulously computed the mean and standard deviation (SD) for quantitative data, while for qualitative data, the frequency and percentage were calculated. This comprehensive approach to data analysis was instrumental in ensuring the robustness and reliability of the study findings, thereby contributing significantly to the field of urological research.

RESULTS

The results of the study offer insightful data on the presenting complaints of patients and the distribution of calculi as detected by Ultrasonography and CT Scan.

In terms of presenting complaints among the 200 participants, the most common was flank pain, experienced by 72 patients, accounting for 36% of the total. Lower back pain was the second most frequent complaint, reported by 50 participants, making up 25% of the cases. Burning micturition was noted in 30 patients, constituting 15% of the sample. Hematuria and hydronephrosis were also notable complaints, present in 20 (10%) and 16 (8%) patients, respectively. Additionally, 12 patients, or 6% of the study population, presented with fever and other complications.

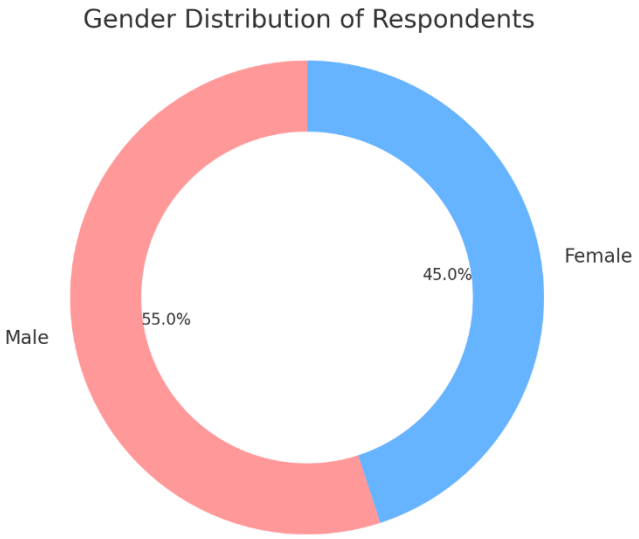

Figure 1 Gender Distribution

Table 1 Presenting Complaint of Patients

Complaints	Participants	Percentage
Flank Pain	72	36%
Lower Back Pain	50	25%
Burning Micturation	30	15%
Hematuria	20	10%
Hydronephrosis	16	8%
Fever and other complications	12	6%
Total	200	100%

Table 2 Calculi distribution

Variable	Ultrasonography	CT Scan
Ureteric Calculi Detected in Patients	33%	60%
Total Calculi Distribution Based on Location		
Renal	20	45
Pelvic Ureteric junction	15	25
Upper Ureter	12	20
Lower Ureter	8	11
Vasoureteric Junction Obstruction	7	9
Bladder	4	8
Total Calculi	66	118

When examining the distribution of calculi detected through diagnostic imaging, the study revealed significant differences between Ultrasonography and CT Scan results. Ureteric calculi were detected in 33% of patients via Ultrasonography, whereas CT Scan identified these in 60% of cases. A detailed breakdown based on the location of the calculi showed that for Ultrasonography, 20 renal, 15 pelvic ureteric junction, 12 upper ureter, 8 lower ureter, 7 vesicoureteric junction obstruction, and 4 bladder calculi were

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identified, totaling 66 calculi. In contrast, CT Scan results indicated a higher count with 45 renal, 25 pelvic ureteric junction, 20 upper ureter, 11 lower ureter, 9 vesicoureteric junction obstruction, and 8 bladder calculi, summing up to 118 calculi in total.

These findings underscore the variability in diagnostic effectiveness between Ultrasonography and CT Scan, particularly in the detection and localization of urinary tract calculi. The disparities in calculi detection rates and distribution patterns highlight the importance of selecting appropriate diagnostic modalities based on the clinical presentation and suspected location of calculi.

DISCUSSION

This observational study, encompassing 200 respondents, revealed notable findings in the realm of urinary calculi detection. Ultrasonography detected 33% of urinary calculi, whereas CT scans identified 60% of calculi. These results further consolidate the position of CT scans as the gold standard for the detection of ureteric calculi.

In contrast to a study conducted in Lahore which proposed ultrasonography as the initial imaging modality for renal calculi (11), our study diverges in its focus on overall ureteric calculi detection. This distinction is critical as it underscores the specific efficacy of each modality in different aspects of urinary tract stone detection. Supporting our findings, other research indicates that while ultrasonography is sensitive to hydronephrosis and renal stones, its sensitivity significantly decreases for ureteral calculi (9,12). This aligns with our observations and suggests a nuanced understanding of the capabilities of ultrasonography in urological diagnostics.

Further evidence, as shown in the work of M Patlas et al., presents a contrasting viewpoint where ultrasonography was deemed as diagnostically equivalent to CT scans (13). However, this conclusion might be attributed to their smaller sample size (62 participants) compared to the present study's 200 participants. This discrepancy in sample size might explain the variation in outcomes, highlighting the impact of study scale on research conclusions.

In agreement with our study, S Abramson et al. and A. Aslaksen and J.H. Gothlin's research both advocate for the use of CT scans in significant diagnosis and treatment planning, as well as in detecting urinary calculi, where ultrasonography detected calculi in only 28% to 33% of cases (14,15). This further reinforces the superiority of CT scans in specific diagnostic scenarios, particularly in emergency settings as suggested by Michelle R Carter et al., although their study did not focus on ureteric calculi (16).

An interesting demographic aspect of our study is the socioeconomic classification of the patients. The majority, constituting 49%, belonged to the lower-middle class, followed by 33.3% from the middle class and 17.6% from the lower class. This demographic distribution offers insights into the accessibility and utilization of diagnostic modalities in different socioeconomic strata.

Additionally, our findings align with research by Ather MH et al., suggesting that CT scans are the only feasible imaging modality for patients with renal insufficiency and failure (17). This is an important consideration in clinical decision-making, especially in managing patients with compromised renal function.

Despite these significant insights, the study faced limitations such as its small sample size, observational nature, and the exclusion of patients with normal results. There was also a lack of a control group and no correlation study with risk factors. These limitations point towards the need for more comprehensive future studies to further elucidate these findings.

CT scans play an indispensable role in the accurate diagnosis of ureteric calculi, which is crucial for effective clinical decision-making and patient counseling. Particularly in emergency situations, the diagnostic accuracy of CT scans for ureteric calculi is unmatched. However, it is also imperative to consider the potential radiation risks and economic implications of CT scanning (20). A thorough anamnesis and physical examination of patients are vital in mitigating unnecessary radiation exposure. Moreover, increasing physician awareness about the risks associated with ionizing radiation can significantly contribute to reducing patient exposure to these potentially harmful elements.

CONCLUSION

In conclusion, this study reinforces the critical role of CT scans in the precise diagnosis of ureteric calculi, affirming its status as the gold standard in this domain. Its superior diagnostic accuracy, especially in emergency settings, makes it an invaluable tool in clinical decision-making and patient counseling. However, this comes with caveats, including the potential risks associated with ionizing radiation and the economic burden of CT scanning. Therefore, it is imperative to balance the use of CT scans with careful patient evaluation, including thorough anamnesis and physical examinations, to minimize unnecessary exposure to radiation. Additionally, enhancing physician awareness about the risks of ionizing radiation is crucial in reducing patient exposure and optimizing healthcare outcomes. These findings have significant implications for both clinical practice and patient safety, advocating for a judicious use of CT scans in the diagnosis of ureteric calculi while considering the broader health implications and resource utilization.

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