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Original Research Article

ULTRASONOGRAPHY VERSUS COMPUTED TOMOGRAPHY FOR DETECTION OF UROLITHIASIS

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Abstract: *Urolithiasis, or urinary stone disease, is a common condition with potentially severe health implications if undetected or untreated. While computed tomography (CT) is the gold standard for detecting urolithiasis, ultrasonography (USG) is often preferred in clinical practice due to its accessibility, non-invasiveness, and lower cost. Evaluating the diagnostic accuracy of USG compared to CT can help guide its use in diagnosing urolithiasis.* ***Objective:*** *To determine the diagnostic accuracy of ultrasonography in detecting urolithiasis, using computed tomography as the gold standard.* ***Methods:*** *This cross-sectional study included 320 patients suspected of urolithiasis, aged 18-70, who were examined at the Department of Radiology in collaboration with the Department of Urology at Sir Ganga Ram Hospital, Lahore from January 2024 to July 2024. CT scans were conducted using the Toshiba Aquilion TSX-101A/4 slice CT Scanner, while ultrasound imaging was performed with the Toshiba Aplio 500, using a 3.5 MHz curved transducer. Data analysis focused on diagnostic accuracy, sensitivity, and specificity of USG compared to CT.* ***Results:*** *The mean age of the patients was 42.08±15.38 years, with a male predominance of 54.4% (174/320). The average body mass index (BMI) was 24.48±4.57 kg/m², and the mean stone size detected was 18.18±10.86 mm. Ultrasonography demonstrated a sensitivity of 95.8%, specificity of 100%, and overall diagnostic accuracy of 96.5% in detecting urolithiasis when compared to CT.* ***Conclusion:*** *Ultrasonography shows high sensitivity (95.8%) and excellent specificity (100%) in detecting urolithiasis, with an average detected stone size of 18.18±10.86 mm. These findings support the use of USG as a reliable, accessible diagnostic tool for urolithiasis, especially when CT is not readily available.*

Keywords: Urolithiasis, Ultrasound, Computed Tomography

Introduction

Urinary stone disease is increasingly prevalent, with a lifetime risk of about 12% in men and 6% in women (1). Renal colic is one of the leading causes of emergency admissions and requires a diagnostic tool which is accurate & readily available not only to confirm urolithiasis but also to exclude other serious abdominal conditions in need of immediate intervention (1). The most common cause of renal colic is a calculus impacted in the ureter or less. Frequently passage of blood clot. sloughed papilla and crystalluna. The increased risk of urolithiasis is associated with geographical distribution, environmental and diet factors and obesity (2).

People often associate kidney and ureteral stones with flank pain. However, symptoms can vary from severe pain to no pain at all, depending on stone characteristics — such as the size, shape, and location of the stone in the urinary tract. Unfortunately, clinical findings are non-specific; therefore, radiological imaging has become a key diagnostic tool in evaluation of the patients with flank pain. Moreover, stone characterization through imaging allows management plan (e.g. surgical retrieval of large calculi versus the use of analgesics and hydration for smaller ones) (1).

Various imaging modalities like plain radiography, intravenous urography (IVU), ultrasonography and computed tomography (CT) are used in assessing the calculi (3). IVU requires an intravenous contrast medium with its associated potential risks (4). In addition, the length of this examination may preclude rapid evaluation of tile patients in an emergency setting. Plain radiographs are not sensitive to radiolucent calculi. Plan radiography also lacks specificity, as phleboliths, common pelvic calcifications, are not always readily differentiated from urolithiasis.

The sensitivity of non-contrast CT to detect stones is 100%, and the specificity is 99% (5,6). According to a comparative study given in Guidelines on Urolithiasis, the sensitivity and specificity of non-contrast CT to detect urinary stones is 100% each (10). Because of its high sensitivity and specificity, CT is considered to be the gold standard for visualizing urinary calculi (6-10). Despite being specific and sensitive, having shorter examination time and avoidance of IV contrast medium, CT benefits may be outweighed by its most important disadvantages i.e. high radiation dose and high cost (7). Patients are often young, they are at a lifetime risk of recurrent episodes of renal colic and therefore new exposures. As an imaging modality for urolithiasis, ultrasound has a sensitivity of 81-96% and a specificity of 100% (3). A study published in 2012 established the sensitivity and specificity of detecting specific stones on ultrasound were 40% and 84% respectively (8). Whereas, another study showed the overall sensitivity and specificity of ultrasonography in the diagnosis of renal stone disease to be 58% and 91% respectively (9). At our facility, Sir Ganga Ram Hospital, there is an increasing trend in using CT as an initial diagnostic imaging tool for urolithiasis despite the availability of ultrasound which has the added benefits of being cheap, readily available, noninvasive, caries no ionizing radiation and does not require IV contrast medium. The rationale of my study is to evaluate the diagnostic

accuracy of ultrasonography in detecting urolithiasis as no previous health data is available, whereas international literature shows a clear controversy in its sensitivity and specificity (3). This will not only help develop the confidence of our consultants in ultrasonography as the initial diagnostic modality of choice resulting in better efficacy of the treatment plan but will also reduce the cost; radiation exposure; and examination time.

Methodology

A total of 320 patients were included in this study as sampling units from the Department of Urology, Sir Ganga Ram Hospital, Lahore. After informed consent, patients fulfilling the inclusion criteria were enrolled in the study. Demographic features were obtained as laid out in the attached proforma. This study was a cross-sectional study design. The sample size was estimated using a 95% confidence level: an expected sensitivity of 40% with a 15% margin of error and; a specificity of 84% with a margin of error, taking an expected prevalence of urolithiasis as 9%, was 320. Patients of any age who complained of pain hematuria with suspicion of urinary stones were included.
CT scan for urolithiasis was obtained through standard protocols on Toshiba Aquilion TSX-101A/4 slice CT Scanner. Ultrasound for urinary stones was done by using a Toshiba Aplio 500 with a curved transducer of 3.5 MHz. To avoid any controversy all the findings of CT and ultrasonography for the presence or absence of urinary stones were assessed by a single consultant to determine the diagnostic accuracy of ultrasonography taking CT as the gold standard. Data was collected as per the proforma annexed.
Collected data was entered and analyzed using the statistical software SPSS version 20. USG and CT were presented by frequency and percentages. A 2x2 contingency table was generated to calculate sensitivity, specificity, diagnostic accuracy, positive predictive value and negative predictive value by taking CT as the gold standard.

Results

The mean age of the patients was 42.08±15.38 years. Regarding gender distribution, 174 patients (54.4%) were male while the remaining 146 patients (45.6%) were female. The mean BMI was 24.48±4.57 (kg/m2) and the mean stone size was 18.18±10.86 mm. Diagnostic accuracy of ultrasonography in detecting urolithiasis taking CT as the gold standard showed sensitivity 95.8%, specificity 100%, PPV 100%, NPV 82.8% and diagnostic accuracy 96.5%. Stratification about age, gender, BMI and stone size was carried out and presented in Table: 1.

Table 1: Impact of the Contributing Factor on the Accuracy of the Ultrasonography

Variables	CT Findings								
	Constructs	**Yes**	**No**	**P-value**	**Sen**	**Spe**	**PPV**	**NPV**	**Accuracy**
Age	18-40	131	23	0.001	95.4%	100%	100%	79.3%	96.1%
	41-70	136	30	0.001	96.3%	100%	100%	85.7%	96.9%
Gender	Male	147	27	0.001	97.9%	100%	100%	90%	98.2%
	Female	120	26	0.001	93.3%	100%	100%	76.4%	94.5%
Size of Stone	Present	195	0	-	94.3%	100%	100%	-	94.3%
	Absent	72	0	-	100%	a	100%	a	100%

Discussion

CT is the gold standard for assessing renal stones' size, number, and location. Several recent studies have investigated the value of sonography for detecting renal stones using CT as the reference standard (10,11).
In addition to grey-scale evaluation, colour Doppler improves the detection of ureteral jets which is a good predictor of the absence of ureteral obstruction (145). Patients with high-grade ureteral obstruction will have asymmetric jets on colour Doppler imaging and either (1) complete absence of the jet on the affected side or (2) continuous, low-level flow from the symptomatic side. Patients with low-grade ureteral obstruction may or may not have asymmetric ureteral jets (12).
Previous research has demonstrated that the sensitivity of sonography for renal stone detection depends on stone size (13). About the size of renal calculi that were detected, this study showed that the mean size of the calculi detected on USG was 18.18±10.86 mm.
Our results indicated that USG showed a sensitivity of 95.8%, specificity of 100% positive predictive value of 100%, negative predictive value of 82.8% and diagnostic accuracy of 96.5%. The findings of the current study are consistent with a study by Ather et al (11). used CT to evaluate the diagnostic accuracy of sonography for detecting renal stones. These authors concluded that sonography is highly sensitive and specific (81% and 100%, respectively) for detecting renal calculi.
Winkel et al reported that B-mode US and colour-Doppler used separately and in combination showed 55% sensitivity and 99% specificity (positive predictive value (PPV) 67% and negative predictive value (NPV) 98% (14).
In another study carried out by Viprakasit et al, there were 203 urinary calculi in 90 urinary tracts identified on ultrasonography. The sensitivity, specificity, and accuracy of detecting stones in the US were 40%, 84%, and 53% (8). Urinary tract ultrasonography (US) is a widely used imaging method as it is safe, rapid, comfortable to patients, and relatively low cost compared to the IVU and the computerized tomography (CT) scan. The sensitivity of the US for the detection of urinary calculi is widely variable in the literature depending on the site and size of the calculus and the patient morphology (15).

Conclusion

The sensitivity and specificity of USG in detecting urolithiasis were 95.8% and 100%, respectively and the mean size of renal calculi visualized on USG was

18.18±10.86 mm. Sonography offers many advantages over other methods that are used to diagnose renal problems, including lack of radiation exposure, wide availability, and low cost.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-SGHL-0232/23)
Consent for publication
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

AYESHA AFZAL
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
USMAN AFZAL
Conception of Study, Final approval of manuscript.
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Coordination of collaborative efforts.

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