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Validity of Ultrasonography for Detection of Renal and Ureteric Calculi in Patients of Renal Colic Keeping CT Scan as a Gold Standard

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ABSTRACT

Objectives: To assess the validity of ultrasonography (USG) for detection of renal and ureteric calculi in patients of renal colic by taking computerized tomography (CT) scan as a gold standard.
Study Design: Cross-sectional analytical study.
Place and Duration of Study: KRL General Hospital, Islamabad Pakistan, from Jan to Dec 2019.
Methodology: 110 patients with suspected renal colic presenting in emergency and outpatient departments were recruited through non-probability convenience sampling. Both adult female and male patients irrespective of their age, fulfilling the inclusion criteria were included. Transabdominal USG and unenhanced CT of all patients were performed, and findings were recorded.
Results: CT scan was taken as gold standard and sensitivity, specificity, positive predictive values, negative predictive values, and diagnostic accuracy of ultrasound in detecting renal calculi were 73.08%, 94.83%, 92.68%, 79.71%, and 84.54% respectively. While these values in detecting ureteric calculi by USG were 14.81%, 89.65%, 80%, 27.37% and 34.54% respectively.
Conclusion: Ultrasonography (USG) can be used to identify renal calculi on the x-ray in patients with renal colic, but it is less effective at detecting ureteric calculi. CT is reserved for cases where ultrasonography is unable to provide conclusive results due to the higher costs and ionizing radiation risks.

Keywords: CT, Diagnostic, Renal Colic, Ultrasonography.

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INTRODUCTION

Acute renal colic is a painful condition that develops as a result of renal and ureteric calculi. It's usually episodic, with each episode lasting anywhere from a few minutes to an hour. Symptoms include nausea, vomiting, and frequent and urgent urination.[1] The prevalence of urinary calculi is rising globally and in the last decade, the highest increase in incidence has been observed in the age group of 15–19 years.[2]

Regional and geographical variability has also been reported in stone prevalence. In Pakistan prevalence of nephrolithiasis is variable and the highest prevalence of 12 percent has been reported in South Punjab.[3] Based on location urinary calculi can be classified into renal, ureteric, vesicular, and urethral calculi. Pathologically these can be classified into calcium-containing and non-calcium-containing calculi. Calcium-containing calculi are the most prevalent making up 75 percent to 85 percent of all renal stones while Uric acid calculi make approximately 10 percent of all renal stones. Commonly used imaging modalities for the detection of renal and ureteric calculi include X-rays, ultrasonography (USG), and computerized tomography (CT) scans.[4]

Since it was first introduced by Smith et al. in 1995,[5] unenhanced helical computed tomography scan has quickly evolved into a tool for rapid assessment of patients presenting with renal colic and nowadays has become an investigation of choice for evaluating patients with renal colic .[6-9] However, due to ionizing radiations, contraindication in pregnant females and children, unavailability at most primary healthcare centers along high operative and maintenance costs make it less suitable as initial or first-line diagnostic imaging modality.[10]

Many studies[7-9] have shown unenhanced computerized tomography as a more effective investigation than ultrasonography for imaging renal and ureteric calculi in patients presenting with acute renal colic.

The limited use of CT KUB in the diagnosis of urinary tract calculi in Pakistan is due in large part to a lack of availability, high cost, and a dearth of technical

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expertise. So this study was conducted to compare the diagnostic accuracy of ultrasonography and CT in the detection of urolithiasis, as it has the advantage of lower radiation dose and easy availability in our setups. By using computerised tomography scans as our gold standard, we were able to determine the validity of ultrasonography for the detection of kidney and ureteric calculi in patients with renal colic.

METHODOLOGY

This cross-sectional analytical study was carried out in the Department of Diagnostic Radiology at KRL General Hospital from January to December 2019. Sample size was calculated using WHO sample size calculator taking confidence interval 95%, margin of error 7%, reported prevalence of urolithiasis 19%.[11] The estimated sample size came out to be 110 individuals. Convenience sampling was used.

Inclusion Criteria: For inclusion in the study, patients of either sexes aged 18 to 45 years had to present to the outpatient department with complaints of flank pain and one or more of the following: increased frequency of urination (more than twice the previous level), oliguria (less than 400 millilitres per 24-hour period), dribbling of urine (based on prior experience), or hematuria. Psychiatric patients, pregnant women.

Exclusion Criteria: Those who refused to consent, and those with known pelvic pathology were all excluded from the study.

Ethics review committee letter number "KRL-HI/PUB/ERC/Oct21/06" approved data collection. All of the patients were examined using a colour doppler machine equipped with convex and linear probes from GE Logiq P7 colour doppler machine. Doppler imaging in grayscale and colour was used to examine the kidneys, ureters, and urinary bladder from various angles. Toshiba's Aquilion 64-slice computerised tomography machine was used, and the procedure was as follows: 2mm images were taken from the diaphragm to pubic symphysis of a supine patient with a well-distended urinary bladder on the CT table. There was no oral or intravenous contrast administered. The presence of calculus in the kidneys, ureters, urinary bladder, or urethra was determined. In addition to the trainee researcher, an experienced radiologist reviewed the CT images.

We used SPSS version 20:00 to analyse the data, which was entered into a performa with columns for each participant's age, gender, and number of calculi.

The following formulas were used to calculate ultrasonography's sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy using CT findings as the gold standard: TP / (TP + FN) x 100 = TP sensitivity.

The following is the precision in terms of TN: By using the following formula, you can calculate your positive predictive value: Calculate the negative predictive value by multiplying the number TN by 100. TP + TN/(TP+FP+FN+TN x 100) Accuracy There are four types of false negatives: true positive (TP), true negative (TN), and false positive (FP) (false positive).

RESULTS

Patients in the study ranged in age from 22 to 60, with a mean age of 39.71±10.31 years. A total of 36.36 percent of patients were between the ages of 30 and 40; 32.72 percent were between the ages of 31 and 40; and 17.27 percent were between the ages of 41 and 50. Our study included 60 male participants (54.6%) and 50 female participants (45.4%). 41 patients were positive with renal stone on CT scan but only 38(92.7%) were positive on USG. Similarly, 69 patients had no stones reported in CT scan but only 55(79.8%) patients USG report appeared negative, as shown in Table-I.

Table-I: Single Table Analysis for Renal Calculi: CT Scan Vs USG (n=110)

	Renal Calculi on USG	
	Yes/Positive	**No/Negative**
Renal calculi on CT		
Yes/Positive	38(92.7%)	3(7.31%)
No/Negative	14(20.28%)	55(79.8%)

Table-II: Showing the Diagnostic Parameters of USG Detecting Renal Calculi (n=110)

Diagnostic Parameters Of USG detecting Renal Calculi	**Values**
Sensitivity= True Positive/(True Positive +False Negative)	73.08%
Specificity= True Negative /(True Negative +False Positive)	94.83%
Positive Predictive Value= True Positive/(True Positive+ False Positive)	92.68%
Negative Predictive Value= True Negative/(True Negative +False Negative)	79.71%
Diagnostic Accuracy= (True Positive +True Negative)/All Patients	84.54%

The Sensitivity & Specificity of USG detecting renal calculi reported was 73.08% & 94.83%. The PPV, NPV and diagnostic accuracy were 92.68%, 79.71%, and 84.54% as shown in Table-II.

15 patients were positive with ureteric calculi on CT scan but only 12(80%) were positive on USG. 95 patients had no stones on CT scan whereas only 26(27.3%) were negative for ureteric calculi on USG, as shown on Table-III.

Table-III: Single Table Analysis for Ureteric Calculi: CT Scan Vs USG (n=110)

	Ureteric Calculi on USG	
	Yes/Positive	No/Negative
Ureteric calculi on CT		
Yes/Positive	12(80.0%)	3(20.0%)
No/Negative	69(72.7%)	26(27.3%)

Ultrasonography was found to have a sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of 14.81 percent, 89.65 percent, 80 percent, 27.37 percent, and 34.54 percent in the detection of ureteric calculi using CT scan as the gold standard, as documented in Table-IV.

Table-IV: Showing the Diagnostic Parameters of USG Detecting Ureteric Calculi (n=110)

Diagnostic Parameters Of USG detecting Ureteric Calculi	Values
Sensitivity= True Positive/(True Positive +False Negative)	14.81%
Specificity= True Negative /(True Negative +False Positive)	89.65%
Positive Predictive Value= True Positive/(True Positive+ False Positive)	80%
Negative Predictive Value= True Negative/(True Negative +False Negative)	27.37%
Diagnostic Accuracy=(True Positive +True Negative)/All Patients	34.54%

DISCUSSION

Patients are not exposed to ionizing radiation when using transabdominal ultrasonography, but it is widely available and simple to use.[12,13] As a result, doctors prefer to use ultrasound to diagnose acute renal colic in their patients. Hydro nephrosis can be accurately detected by transabdominal USG in patients with urinary and renal calculi of at least 5mm in diameter.[14]

Many studies have compared these strategies in an emergency teaching hospital, but to our knowledge, only a few have done so.[15] Ultrasonography has a sensitivity of 45 percent and a specificity of 88 percent when it comes to detecting renal calculi.[16] Renal colic is characterized by pain in the lower back that radiates to the groin, and accurate renal calculi detection is essential for clinical decision making and guiding management decisions in the clinical setting. The most common symptom in patients with nephrolithiasis is lumbar pain, followed by burning, heaviness, and hypogastric pain. The most commonly reported symptoms in patients with ureteric calculi are flank pain, dysuria, hemorrhagic urine, and urinary retention.[17]

Different geographic locations have a wide range of renal colic prevalence, which is heavily influenced by environmental and socioeconomic factors. Noncontract CT scans are the gold standard, but their use is limited by ionizing radiation. Ultrasound, on the other hand, is readily available, less expensive, and simple to use.[4]

Ultrasound was found to have a 73.08 percent sensitivity, a 94.83 percent specificity, a 92.68 percent positive predictive value, and an 84.54 percent diagnostic accuracy. Some studies have shown ultrasound to be 66.7 percent and 974 percent specific and negative predictive values.[18]

Another study from the United States found that ultrasonography had a specificity of 91% for the detection of renal calculi.[19] Ultrasonography has a sensitivity of 91% and a specificity of 58% for the detection of renal calculi in Jordan.[20] Urinary tract calculi can be detected with a sensitivity of 75.4 percent and a specificity of 16.75 percent on ultrasonography from Iran.[21]

For the diagnosis of renal calculi, a study at the Nawaz Sharif Social Security Hospital in Lahore found that ultrasonography had a sensitivity of 93% and a specificity of 95%.[22] Ultrasonography's combined sensitivity and specificity for the detection of renal calculi and ureteric calculi, respectively, are 45 percent and 88 percent in the literature pool.[23]

As a result of the many variables that influence ultrasonography's diagnostic accuracy in diagnosing urolithiasis, it's clear that the degree of hydro nephrosis and size of the calculus are both important considerations.[24]

Small size, low attenuation, absence of posterior acoustic shadowing and bowel gases may be to blame for the lack of agreement in the literature on the subject.

What it has added to medical knowledge and its clinical Significance:

Many previous international studies have found similar results, so we set out to see if the local population could corroborate those findings as well. In developing countries like ours, ultrasound can serve as the first line of investigation in the diagnosis of

renal and ureteric calculi because of its limited accessibility and high costs. CT should only be used if ultrasound is negative and clinical signs of renal colic are present.

LIMITATION OF STUDY

Our study was a single center-based experience having non-inclusion of pregnant females, and non-probability sampling., which can be the limitations of our study.

CONCLUSION

Patients with renal colic can benefit from using ultrasound as their first imaging modality. Because of its low sensitivity and specificity, it is less suitable for the detection of ureteric calculi. Aside from that, the lack of radiation exposure and the low operating costs make it an attractive option.

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Authors' Contribution

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

MT & MWA: Data acquisition, data analysis, critical review, approval of the final version to be published.

MMK & MA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

NNU & HM: 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.

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