Original Article

Validity of Ultrasonography for the Detection of Renal and Ureteric Calculi in Patients of Renal Colic

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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.

Methodology: This cross-sectional study was conducted at KRL General Hospital Islamabad from 1st January 2019 to 31st December 2019. One hundred and ten 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: For diagnosing renal calculi in patients with renal colic, the diagnostic accuracy of USG is adequate, and it can be utilized as a first-line investigation, especially in children and pregnant women, where CT is contraindicated. However, USG, on the other hand, is less suitable for detecting ureteric calculi due to its limited sensitivity and specificity. USG due to its low operational expenses, economic effectiveness, ready availability, and lack of ionizing radiations justify its usage as an initial diagnostic modality, with CT reserved for cases where ultrasonography is inconclusive.

Keywords: Ultrasonography, CT, renal colic, diagnostic

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. Atypical symptoms such as nausea, vomiting, and frequent and urgent urination may also be present in certain individuals. Research studies reveal that urinary calculi afflict 5% to 15% of the population at some time in their lives, with 50% of those affected suffering from recurring bouts of renal colic. Also, as these calculi move down the urinary tract, they may obstruct urinary flow and cause hydronephrosis.[1]

Urinary calculi are becoming more commonplace worldwide, with the age range of 15 to 19 years older showing the largest increase in occurrence over the past ten years.[2] There have also been reports of variations in stone prevalence by region and geography. Nephrolithiasis prevalence varies throughout Pakistan; South Punjab has been found to have the greatest frequency, at 12%.[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% to 85% of all renal stones while Uric acid calculi make approximately 10% 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]

Several 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 objective of our study was to determine the validity of ultrasonography for the detection of renal and ureteric calculi in patients of renal colic by taking a computerized tomography scan as the gold standard.

Methodology

The study was conducted at the Department of Diagnostic Radiology, KRL General Hospital, Islamabad, from January 2019 to December 2019. A total of 110 patients were recruited for the study.

Adult male and female patients presenting to emergency and outpatient departments with acute renal colic were included in the study. Pregnant females, patients with known pelvic pathology, and patients with chronic renal disease were excluded from the study.

USG of the patients was performed by senior resident and consultant radiologist using GE Logiq P7 color doppler machine furnished with convex (3-5 MHz) and linear (9-11 MHz) probes. Both greyscale and color Doppler was used for the assessment of kidneys, ureters, and urinary bladder in different anatomical planes.

Computerized tomography was performed on Toshiba Aquilion 64 slice machine with the following protocol: The patient with adequately distended urinary bladder was placed in a supine position on the CT table and 2mm images were acquired from the diaphragm to the pubic symphysis. No oral or IV contrast was given. Any hyper-dense focus in the kidneys, ureters, UB, and urethra was deciphered as calculus. CT images were read by the trainee researcher and reviewed by a consultant radiologist.

All the data were entered on a proforma comprising columns for age, sex, number of calculi, and analyzed using SPSS version 20. Sensitivity, specificity, positive predictive value, negative predictive value predictive, and diagnostic accuracy were calculated for ultrasonography by taking findings of CT as gold standard using the following formulae:

Sensitivity: TP / (TP + FN) x 100

Specificity: TN / (TN + FP) x 100

Positive predictive value: TP/ (TP+FP) x 100

Negative predictive value: TN (FN + TN) x 100

Accuracy: TP + TN/ (TP+FP+FN+TN x 100

Where TP (true positive), TN (true negative), FN (false negative), and FP (false positive).

The study proposal was submitted to the ethical review board of KRL Hospital Islamabad and approval was taken, wide letter no "KRL-HI-PUB-ERC/Oct21/06". The patients' consent to participate in the study was obtained by complying declaration of Helinski.

Results

The mean age of the patients in the study was 39.71±10.31 years ranging from 22 to 60 years. Figure-1.

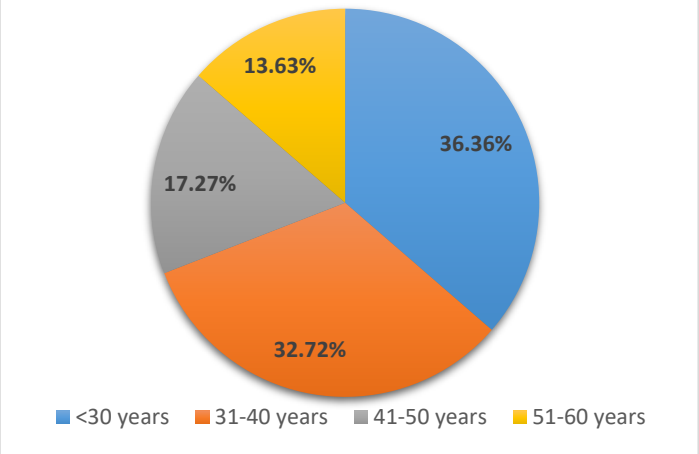

Figure 1: Age-Wise Distribution of Patients.

Sensitivity = 73.08%, Specificity = 94.83%, Positive Predictive Value = 92.68%

Negative Predictive Value = 79.71%, Diagnostic accuracy = 84.54%

Out of 110 patients, 60 were male and 50 were female, USG detected 38 renal calculi in 38 out of 110 patients with sensitivity and specificity of 73.08% and 94.83%, respectively. Positive predictive value, negative predictive value, and diagnostic accuracy were 92.68%, 79.71%, and 84.54%, respectively as shown in Table I.

Table I: Single Table Analysis for Renal Calculi.

	Renal calculi on USG		Total
	Present	Absent	
Present	38	3	41
Absent	14	55	69
Total	52	58	110

Sensitivity, specificity, positive predictive values, negative predictive values and diagnostic accuracy of ultrasonography for detection of ureteric calculi using CT scan as gold standard were 14.81%, 89.65%, 80%, 27.37%, and 34.54% respectively as documented in Table II.

Table II: Single Table Analysis for Ureteric Calculi

	Ureteric calculi on USG		Total
	Present	Absent	
Present	12	3	15
Absent	69	26	95
Total	81	29	110

Sensitivity = 14.81%, Specificity = 89.65%, Positive Predictive Value = 80%

Negative Predictive Value = 27.37%, Diagnostic Accuracy = 34.54%

Discussion

While transabdominal ultrasonography does not expose patients to ionizing radiation, it is widely available and easy to use.[11,12] As a result, clinicians choose ultrasonography for patients with acute renal colic. Transabdominal USG can accurately detect hydronephrosis in patients with urinary calculi and renal calculi bigger than 5mm in size.[13] But, to our knowledge, only a few studies explicitly compare these strategies in an emergency teaching hospital.[14] Ultrasonography's sensitivity and specificity for renal calculi are 45 percent and 88 percent, respectively.[15]

Patients with renal colic present with pain in the lumbar region radiating towards the groin and accurate detection of renal calculi is a must for clinical decision making and guiding the management decisions. In patients with nephrolithiasis most frequently observed symptom is pain in the lumbar region followed by burning sensation, heaviness, and pain in the hypogastrium. In patients with ureteric calculi most reported symptoms include flank pain, dysuria, haematuria, and urinary retention.[15]

Renal colic has a variable prevalence across different geographical locations and is also highly influenced by environmental and socio-economic factors. The gold standard test for identifying renal and ureteric calculi, non-contrast CT scans have great sensitivity and specificity. However, their usage is restricted by ionising radiation and its unavailability in low-level healthcare facilities in developing nations such as Pakistan. On the other hand, ultrasound is easily available, less costly, and an easy to operate imaging modality.[4]

In our study, 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. The sensitivity, specificity, positive predictive values, negative predictive values, and diagnostic accuracy of ultrasonography in detecting ureteric calculi were 14.81%, 89.65%, 80%, 27.37%, and 34.54% respectively.

Few studies have been previously done to study the validity of ultrasonography in detecting ureteric and renal calculi. One of the studies from the USA showed sensitivity and specificity of ultrasonography as 66.7% 97.4% respectively in the detection of renal calculi in the pediatric population while Negative and positive predictive values were 79.2% and 95.2% respectively.[22] Another study from the USA reported a specificity of 91% for the detection of renal calculi on ultrasonography.[16]

A study in Jordan revealed sensitivity and specificity of ultrasonography of 91% and 58% respectively for detection of renal calculi.[17] Another study from Iran showed sensitivity and specificity of 75.4% and 16.75 respectively for detection of urinary tract calculi on ultrasonography.[18] A study done in Mayo hospital lahore reported sensitivity and specificity of ultrasonography as 93% and 95% for diagnosing renal calculi.[23]

According to published research, the combined sensitivity and specificity of ultrasonography for the identification of ureteric and renal calculi are 45% and 88%, respectively.[19] A thorough review of the literature reveals that the degree of hydronephrosis[20] and the size of the calculus are directly related to the diagnostic accuracy of ultrasonography, which is affected by a number of factors when it comes to the detection of urolithiasis.[21]

The absence of posterior acoustic shadowing, tiny size, low attenuation values, and intestinal gases obstructing the majority of the ureter are probably the causes of calculus not being visible on ultrasonography. Additionally, there may be some variation in the literature because of differences in the age groups, the radiologist's expertise, the environment, gender, and ethnicity, as well as because of the sample size.

The findings of our study are similar to those of many international studies conducted previously and our study aimed at validating similar findings in local population. In a developing country like ours CT,

even though gold standard in diagnosing renal and ureteric calculi, is not readily available and also costly so ultrasound can be used as first line investigation as concluded in our study with CT reserved only for those cases where ultrasound findings are negative in the presence of clinical findings of renal colic.

Limitations 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

Ultrasonography is suitable as a first-line imaging modality in patients presenting with renal colic. It is less suitable for the detection of ureteric calculi because of its low sensitivity and specificity. However, its low operational costs, cost-effectiveness, ready availability, and absence of exposure to ionizing radiations validate its use.

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