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DIAGNOSTIC ACCURACY OF COLOUR DOPPLER ULTRASOUND USING TWINKLING ARTEFACT FOR THE DIAGNOSIS OF RENAL AND URETERIC CALCULI KEEPING NON ENHANCED CT KUB AS GOLD STANDARD

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ABSTRACT

Objective: To determine the diagnostic accuracy of colour Doppler ultrasound using twinkling artefact for the diagnosis of renal and ureteric calculi keeping non enhanced CT KUB as gold standard.
Study Design: Cross sectional study.
Place and Duration of Study: Departments of Diagnostic Radiology, HITEC Hospital Taxila Cantt and Akbar Niazi Teaching Hospital, Islamabad, from Jan to Jun 2020.
Methodology: The sample size of 320 patients was calculated using WHO Calculator. Non probability consecutive sampling was used for recruitment of patients. It comprised patients between ages 12-60 years irrespective of gender presenting with acute flank pain. All patients underwent colour Doppler ultrasound and subsequently CT-KUB analysis (gold standard) to determine the diagnostic accuracy of twinkling artefact on colour Doppler imaging. Data was collected on prescribed proforma and analysed using SPSS-17. Chi-square test and ROC curve analysis were used for diagnostic accuracy measurement.
Results: Study results showed that twinkling artefact on colour Doppler had a sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 91.2%, 95.7%, 98.7%, 75.2% and 92.2% respectively. Likelihood ratio for positive test was 21.8.
Conclusion: Twinkling artefact on colour Doppler allows detection of renal and ureteric calculi with reasonable accuracy and can be used as an alternative tool in settings where CT scan cannot be done.

Keywords: CT-KUB, Urolithiasis, Twinkling artefact.

INTRODUCTION

Urolithiasis is a major health problem worldwide[1]. Most of these patients present with acute flank pain in emergency department. The diagnostic approach for detection of urinary tract calculi varies in each setup[2,3], depending on various factors. Important factors that need consideration include the local prevalence of stone disease, available medical resources, relative costs in a particular system and the merits and limitations of each diagnostic modality[4].

Both ultrasound and CT can be used for the detection of renal tract calculi[5-7]. There is a growing trend to use ultrasound to detect renal and ureteric calculi as it is cheap, readily available and does not expose the patient to ionizing radiation. Ultrasound shows urinary tract calculi as linear echogenic foci casting posterior acoustic shadowing. One of the major limitations of grey scale sonography is the presence of small echogenic foci at tissue interfaces of kidney which do not cause posterior acoustic shadowing. These can be false positively interpreted as small renal calculi or conversely may obscure small adjacent renal calculi leading to false negative results. Another limitation in case of ureteric calculi is the presence of overlying bowel gas which obscures underlying details.

The twinkling artefact produced by colour Doppler ultrasound is an emergency tool for detecting renal and ureteric calculi. This artefact also known as "colour comet tail artefact" appears as a rapidly alternating mixture of red and blue colour seen on or behind a reflecting irregular interface where shadowing is expected as shown in fig-1. It is produced due to a form of intrinsic noise known as phase (or clock) jitter at rough interfaces composed of reflecting materials[8,9]. This artefact improves the accuracy of ultrasound in detection of renal and ureteric calculi[10].

Computed tomography is usually considered gold standard with sensitivity and specificity approaching 93% and 100% respectively[7]. It shows urinary tract calculi as calcific density foci in kidneys and ureters as shown in fig-2. Associated features like hydronephrosis or signs of urinary tract infection such as perinephric fat stranding, mucosal thickening or emphysematous pyelonephritis are also clearly seen. However there are certain limitations associated with it, which

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include high cost, limited availability and above all, ionizing radiation to the patient.

The aim of this study is to determine the diagnostic accuracy of twinkling artefact in our target population so that it can be used as an adjunct to grey scale ultrasound in detecting urinary tract calculi. This is highly beneficial to the patients as ultrasound is readily available, inexpensive and avoids unnecessary ionizing radiation.

METHODOLOGY

It was a cross sectional validation study at the departments of Diagnostic Radiology, HIT Hospital Taxila Cantt and Akbar Niazi Teaching Hospital Islamabad, from Jan to Jun 2020. Study was conducted after approval from hospital ethics committee. A sample size of 320 patients was calculated with 95% confidence interval, 5% significance level and 8% prevalence using WHO calculator. Patients presenting with acute flank pain were selected from indoor and outpatient departmentsreferred to Radiology department for KUB ultrasound. Patients were explained about the study and informed consent was taken. Patients between the ages of 12-60 years were included in the study, irrespective of gender. Demographic features were recorded on the proforma.

Real time grey scale ultrasound (GE Logic G-6 Pro) was done using 3.5MHz curvilinear probe in supine and decubitus position with deep inspiration. The number and location of all echogenic foci with posterior acoustic shadowing noted. Then colour Doppler ultrasound was done using PRF slightly greater than that used for evaluation of renal vessels. The number, location and size of twinkling foci were recorded.

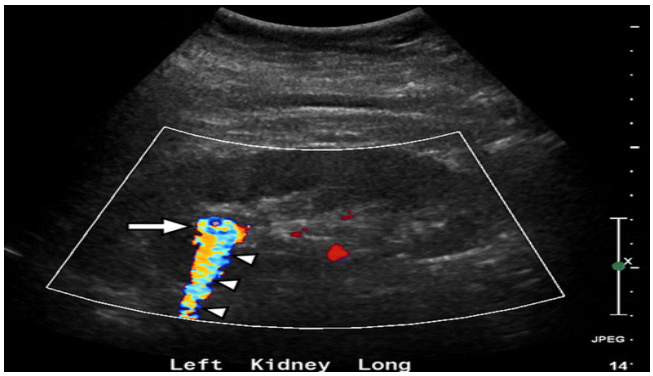

Figure-1: Twinkling artefact.

Figure-2: Non contrast CT detecting ureteric stone.

All patients then underwent non enhanced CT KUB on Toshiba aquition 64 slice computed tomography with 2mm slice thickness. These findings from grey scale ultrasound, colour Doppler ultrasound and non enhanced CT KUB was entered in a proforma and compared keeping non enhanced CT KUB as gold standard.

Ethical code of conduct maintained and female chaperone or doctor was present for the female patients at the time of imaging.

All data collected was analyzed using SPSS-17. Frequencies and percentages were obtained for the variables where applicable. Mean and standard deviations were calculated for continuous variables. Effect modifier like age, gender, BMI was controlled through stratification. Post stratification diagnostic accuracy was measured using Chi-square test and ROC curve analysis.

RESULTS

A total of 320 patients between ages 12-60 years and of either sex were taken. There were 228 (71.3%) true positive, 67 (20.9%) true negative, 3 (0.9%) false positive and 22 (6.9%) false negative patients as shown in table-I. This study results showed that twinkling artifact on colour Doppler had a sensitivity, specificity,

Table-I: Cross-tabulation of color Doppler and CT-KUB results.

Twinkling artefact	CT-KUB		
	Positive	Negative	Total
Positive	228 (71.3%)	3 (0.9%)	231(72.2%)
Negative	22 (6.9%)	67 (20.9%)	89 (27.8%)
Total	250 (78.2%)	70 (21.8%)	320 (100%)

Table-II: Diagnostic accuracy of Twinkling artefact.

Diagnostic Accuracy	Percentage
Sensitivity	91.2%
Specificity	95.7%
Positive predictive value	98.7%
Negative predictive value	75.2%
Overall accuracy	92.2%
Likelihood ratio for positive test	21.8

positive predictive value, negative predictive value and accuracy of 91.2%, 95.7%, 98.7%, 75.2% and 92.2% respectively. Likelihood ratio for positive test was 21.8

as shown in table-II. ROC curve analysis showed 93% accuracy as shown in fig-3.

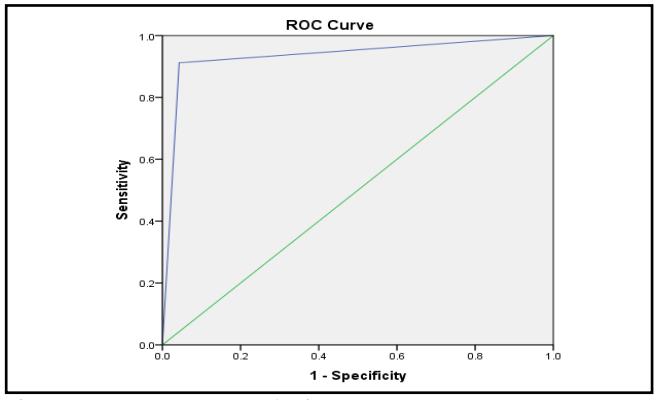

Figure-3: ROC curve analysis.

DISCUSSION

Renal and ureteric calculi are a common problem in primary care practice. Patients may present with the classic symptoms of renal colic and hematuria. Others may be asymptomatic or have atypical symptoms such as vague abdominal pain, acute abdominal or flank pain, nausea, urinary urgency or frequency, difficulty urinating, penile pain, or testicular pain[11]. Ultrasound of the kidneys and bladder reliably characterizeshydronephrosis and does not involve ionizing radiation. It is the preferred initial imaging modality in these patients especially presented in emergency department with acute flank pain. There is a growing trend to use ultrasound to detect renal and ureteric calculi as it is cheap, readily available and does not expose the patient to ionizing radiation. The twinkling artefact produced by colour Doppler ultrasound is an emergency tool for detecting renal and ureteric calculi. This artefact also known as "colour comet tail artefact" appears as a rapidly alternating mixture of red and blue colour seen on or behind a reflecting irregular interface where shadowing is expected. It is produced due to a form of intrinsic noise known as phase (or clock) jitter at rough interfaces composed of reflecting materials. This artefact improves the accuracy of ultrasound in detection of renal and ureteric calculiand enables the urologists to initiate definitive management at an earlier stage. This artefact improves the sensitivity and specifity of ultrasound in the detection of urinary tract calculi.

In this study we intended to determine the diagnostic accuracy of colour Doppler ultrasound using twinkling artefact for the diagnosis of renal and ureteric calculi keeping non enhanced CT KUB as gold standard. Our results showed that twinkling artefact on colour Doppler had a sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 91.2%, 95.7%, 98.7%, 75.2% and 92.2% respectively. Likelihood ratio for positive test was 21.8.

These results are similar with the data already published on the same subject. In a similar study Ripollés *et al*[12] analyzed the value of ultrasound using the twinkling sign in the diagnosis of ureteral stones in patients with renal colic in the emergency setting. Their results showed sensitivity and specificity as 90% (91.2% in present study) and 100% (95.7% in present study), respectively. The positive predictive value was 100% (98.7% in present study) and the negative 67% (75.2% in present study). The accuracy was 92% (92.2% in present study). Authors concluded that the twinkling artifact on colour Doppler imaging is useful for the early detection of the calculi, especially in the middle tract of the ureter, usually the most difficult place in sonographic diagnosis. Detection of smaller stones was also eased.

Winkel *et al*[13] in their prospective study evaluated the usefulness of the twinkling artefact on colour-Doppler ultrasound in diagnosing urolithiasis. Ultrasound and standard computed tomography (CT) were performed blinded on 105 patients. Grayscale ultrasound and colour-Doppler used individually and in combination exhibited 55% sensitivity and 99% specificity (positive predictive value 67% and negative predictive value 98%).

Sen *et al*[14] in their prospective study aimed to evaluate the use of twinkling artifact on color Doppler Ultrasonography as an alternative imaging modality to non-contrast-enhanced computed tomography in patients with ureteral stones. Their results showed that twinkling artefact on color Doppler USG was detected in 92 (86.8%) patients. larger and proximal ureteral stones had more twinkling artefacton color Doppler USG. Authors concluded that twinkling artefacton color Doppler USG could be a good and safe alternative imaging modality with comparable results between NCCT. It was hence helpful in diagnosis and follow-up of patients with ureterolithiasis.

Korkmaz *et al*[15] in their retrospective study evaluated the effectiveness of twinkling artifacts in detecting calculi <5 mm in diameter in patients with renal colic pain who had undergone urinary grayscale Ultrasonography and computed tomography imaging assays. Their results demonstrated that twinkling artefact can be recommended as a significant marker of urolithiasis, and co-operative usage of doppler and gray-

scale methods can yield satisfactory results comparable with CT.

Kielar *et al*[16] in their prospective evaluated the diagnostic accuracy of the twinkling artefact compared to unenhanced computed tomography in detecting urolithiasis. Their results showed that there were 6 false-positive and 22 false-negative instances of twinkling artefacts. On gray-scale evaluation looking for an echogenic focus with shadowing, there were 8 false-positive and 40 false-negative findings. The positive predictive value (PPV) of the twinkling artefact for identifying calculi was 94%, and the sensitivity was 83%. The PPV of gray-scale sonographic shadowing was only 64.9%, and the sensitivity was 80.2%. They concluded that the twinkling artefact has a high PPV for detecting renal andurinary tract calculi. Evaluation for the twinkling artefact is a complementary technique to standard gray-scale shadowing of calculi and improves detection of urolithiasis on sonography.

Mitterberger *et al*[17] compared the detection of urinary stones using standard gray scale ultrasound for diagnostic accuracy using the colour Doppler "twinkling sign". Their results highlighted that Seventy-seven stones were present in 41 patients, including 47 intrarenal stones, 5 stones in the renal pelvis, 8 stones at the ureteropelvic junction, 5 ureteral stones and 12 stones at the ureterovesical junction. Based upon gray scale sonography the diagnosis of stone was made with confidence in 66% (51/77) of locations. Based upon Doppler sonography using the twinkling sign, the diagnosis of stone was made with confidence in 97% (75/77) of locations. Clustered ROC analysis demonstrated that the Doppler twinkling sign (Az=0.99) was significantly better than conventional gray scale criteria (Az=0.95) for the diagnosis of urinary stones (p=0.005). Authors concluded that the colour Doppler twinkling sign improves the detection, confidence and overall accuracy of diagnosis for renal and ureteral stones with minimal loss of specificity.

CONCLUSION

Twinkling artefact on colour Doppler allows detection of renal and ureteric calculi with reasonable accuracy and can be used as an alternative tool in settings where CT scan cannot be done.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any authors.

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