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Evaluation of Twinkling Artifact in Color Doppler Ultrasonogram as a Diagnostic Tool for Kidney Stones

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Abstract
Introduction: *Ultrasonographic (US) color Doppler twinkling (or twinkle) artifact is a phenomenon that may aid in the detection of nephrolithiasis. Commonly seen in the Doppler circuitry of the US machine, this artifact is probably caused by a type of intrinsic noise known as clock jitter at color Doppler imaging when insolating certain rough reflective surfaces. It appears as a distinct point of alternating colors that may or may not have a comet tail.*
Aim of the study: *The study aimed to evaluate the diagnostic usage of twinkling artifact in color Doppler ultrasonogram for detection of kidney stones.*
Methods: *This prospective clinical study was conducted at the Department of Radiology and Imaging. The study period was one year, starting from 1st July 2013 to 30th June 2014. A total number of 59 clinically suspected subjects were selected by purposive sampling method.The collected data were processed and analyzed using SPSS software. The results were presented in tables, figures, diagrams, etc.*
Result: *This current cross-sectional study was to evaluate diagnostic accuracy, specificity, and predictive values of twinkling artifacts in color Doppler ultrasonogram. Among the 54 patients, 19 (35.18%) were female and 35 (64.82%) were male. The patients' ages ranged from 31 to 64 years, with a mean age of (SD) 13.42 years.Among 54 subjects, echogenic structures were unilateral in 40 (74.07%) cases and bilateral in 14 (25.92%) cases.Among 72 suspected stones 50 (69.44%) had posterior acoustic shadow and the rest 22 (30.56%) had no posterior acoustic shadow. Regarding twinkling artifact, among 72 suspected stones, 42 (58.33%) had twinkling artifacts, and the rest 30 (41.67%) had no twinkling artifacts.Among those 72 twinkling artifacts-producing structures 39 were confirmed as renal stones. Out of 42 cases in which a twinkling artifact was present, the CT scan was positive in 39 and negative in only 3 cases, and in the rest 30 did not show the artifact. With specificity, sensitivity, positive predictive value, and negative predictive value of 90.90%, 100%, 92.85%, and 100%, respectively, it was discovered that the Doppler twinkling artifact had a diagnostic accuracy of 95.83%.*
Conclusion: *The findings of the present study can be concluded that the presence of a twinkling artifact in color Doppler ultrasonogram was a useful finding for the diagnosis of renal calculus and this twinkling artifact had good diagnostic usefulness when grayscale sonography was combined with Color Doppler ultrasonogram.*
Keywords: *Artifact, Urinary, Stones, Color-Doppler, Ultrasonogram.*

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I. Introduction

Ultrasonographic color Doppler twinkling artifact is a phenomenon that may aid in the detection of nephrolithiasis. This artifact, which is likely due to a form of intrinsic noise known as phase jitter within the Doppler circuitry of the ultrasonographic machine, is commonly observed at color Doppler imaging when insolating certain rough reflective surfaces. It appears as a distinct point of alternating colors that may or may not have a comet tail. [1]Clinical diagnostic ultrasound uses a Doppler mode to detect motion, especially blood flow and shows the moving blood as red or blue on the imager's screen. Our main goal is to comprehend the

artifact and turn it into a valuable tool for lithotripsy kidney stone detection and treatment. [2] Detection of a color mosaic should always prompt further spectral Doppler analysis particularly if therapeutic decisions hinge on criteria based on the presence of blood circulation inside the tissue.[3] The clinical importance of understanding the twinkling artifact is that it helps the identification of renal calculi and foreign bodies with ease because of the presence of color behind them, especially small-sized calculi, which may be missed in the absence of an acoustic shadowing on grayscale imaging. An abdominal radiograph (KUB) is useful approximately 75-90% of urinary stones are radio-opaque but the radiolucent stone is often missed. A study by Ulusen et al revealed a sensitivity of 32% - 57% for (grayscale) in the detection of nephrolithiasis when compared with an unenhanced CT scan. [4] In this study, the researchers concluded that (the gray scale) is of limited value in the detection of nephrolithiasis. [5,4] So, this present study was the observation ofdiagnostic accuracy, specificity, and predictive values of twinkling artifacts in color Doppler ultrasonograms.

II. Objective

General Objective

- To evaluate the twinkling artifact in color Doppler ultrasonogram as a diagnostic tool for the detection of kidney stones.

III. Methods

This prospective clinical study was conducted at the Department of Radiology and Imaging to find out the diagnosis accuracy, specificity, and predictive values of twinkling artifacts in color Doppler ultrasonograms. The study period was one year, starting from 1st July 2013 to 30th June 2014. A total number of 59 clinically suspected subjects were selected by purposive sampling method. Among 59 subjects, 5 patients refused to take part after enrolling in the study. Hence, ultimately 54 subjects were included in the study. Before the commencement of the study, ethical review committee clearance was taken. Clinically suspected cases of renal stone or scheduled for CT scan of the KUB region were selected on basis of inclusion criteria. Those subjects with exclusion criteria were not selected. US studies included in this study were obtained with the following machines: SimensSonoline Antares or MedisonSonoace 800 live & Hitachi Aloka Machine with a multifrequency curvilinear transducer of 2-5 MHz. Data were collected in pre-designed structured data collection sheets. The data collected from the primary source starts from the clinical history, CT scan, and Doppler ultrasonographic findings. The collected data were processed and analyzed using SPSS software. The results were presented in tables, figures, diagrams, etc.

Inclusion Criteria

- Clinically suspected cases of renal stone were referred for USG and scheduled for a CT scan of the KUB region. Patients who had given consent to participate in the study.

Exclusion Criteria

- Unwillingness to participate in the study.

IV. Results

Age in years	**No.**	**%**
31-39	13	24.07
40-49	24	44.44
50-59	11	20.37
60 -64	06	11.12
Mean ± SD	*43.50 ± 13.42*	
Max.–Min.	*31 - 64*	

Table 1: Age distribution of the study subjects

Among the participant's cases, the mean age was 43.50 years with a standard deviation of the mean (SD) ± 13.42 years, and their age ranged from 31 to 64 years. The majority of the study subjects (44.44%) were from the 41-49 years age group.

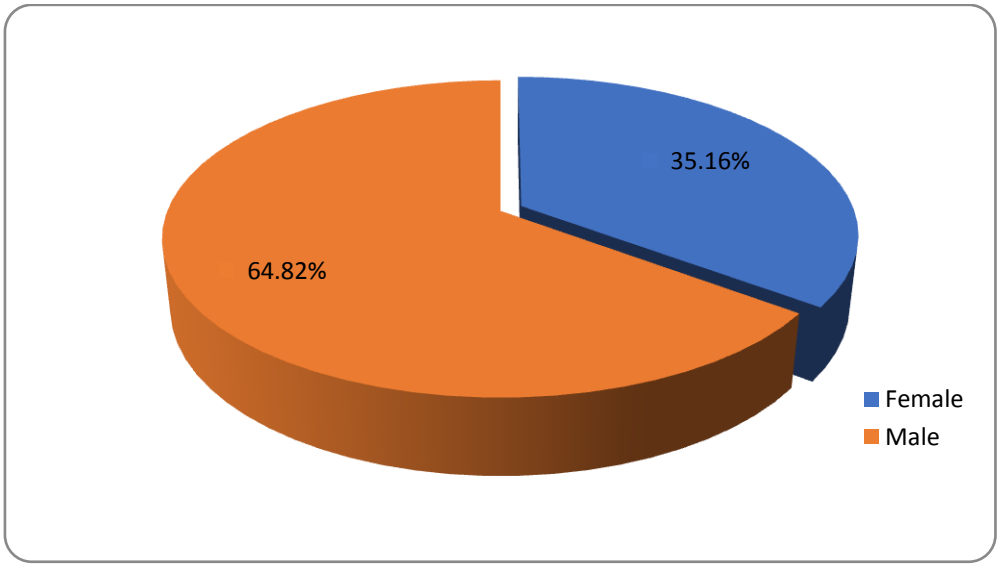

Figure 01: Pie diagram showing the gender distribution of the study subjects.

Among the study subjects, 35 (64.82%) were male and 19 (35.18%) were female.

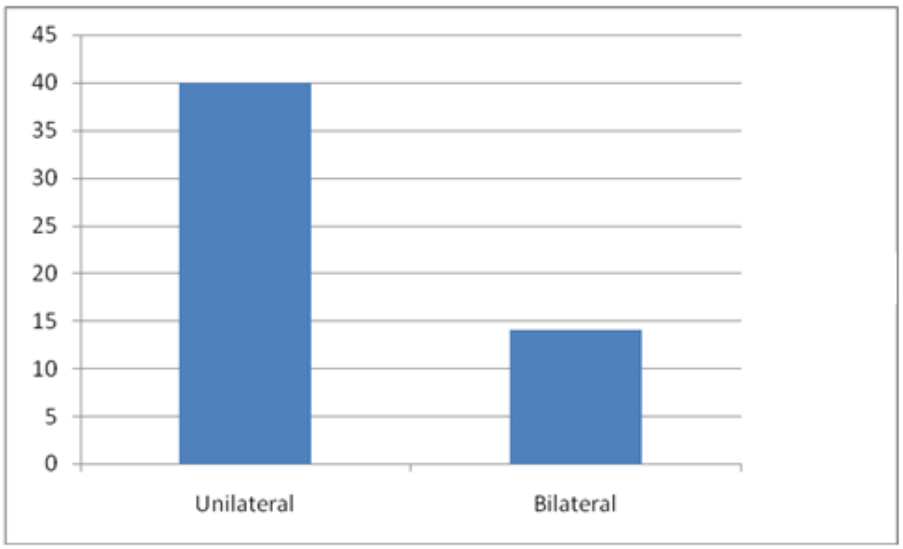

Figure 02: Bar diagram showing the number of echogenic structures in the kidney of the study subjects.

Among 54 subjects, echogenic structures were unilateral in 40 (74.07%) cases and bilateral in 14 (25.92%) cases.

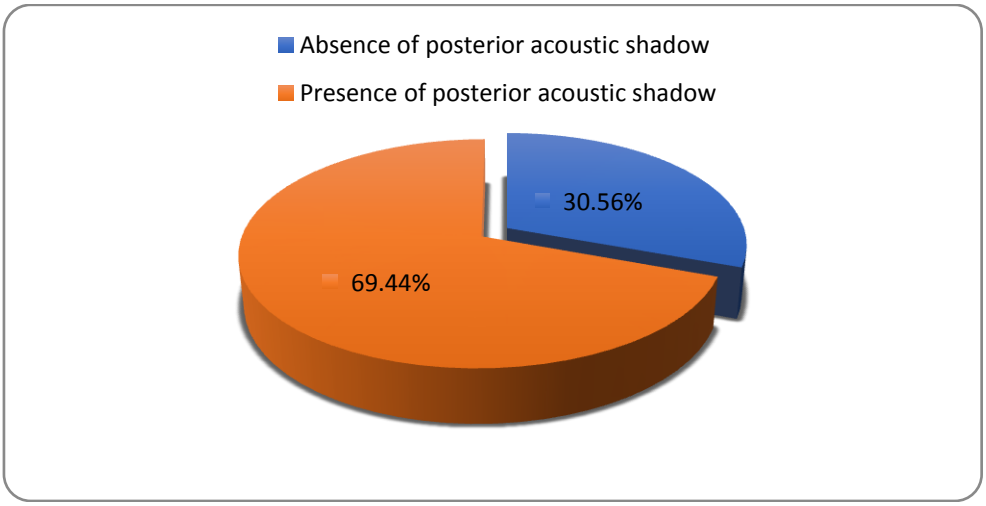

Figure 03: Pie diagram showing the presence of posterior acoustic shadow in suspected renal stone

Among 72 suspected stones 50 (69.44%) had posterior acoustic shadow and the rest 22 (30.56%) had no posterior acoustic shadow.

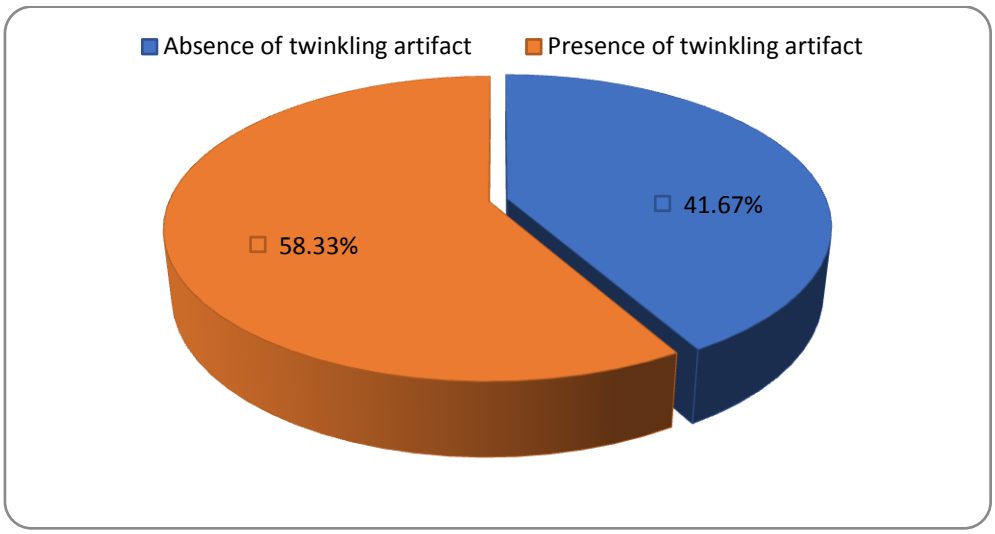

Figure 04: Pie diagram showing the number of echogenic structures in the kidney of the study subjects

Among 72 suspected stones, 42 (58.33%) had twinkling artifacts, and the rest 30 (41.67%) had no twinkling artifacts.

Table 2: Doppler sonographic twinkling artifact of the renal stone and its correlation with unenhanced CT scan

Doppler sonography revealed a twinkling artifact	**Unenhanced CT scan Renal stone**		**Total**
	Present	**Absent**	
Present	39 (TP)	03 (FP)	42
Absent	00 (FN)	30 (TN)	30
Total	39	33	72

Among those 72 twinkling artifacts-producing structures 39 were confirmed as renal stones. Out of 42 cases in which a twinkling artifact was present, the CT scan was positive in 39 and negative in only 3 cases, and in the rest 30 did not show the artifact.

Table 3: Diagnostic accuracy of Doppler sonographic twinkling artifact for detection of renal stone compared with unenhanced CT scan.

Parameter	Value (in %)
Specificity	90.90
Sensitivity	100
Positive predictive value	92.85
Negative predictive value	100
Accuracy	95.83

Among the participant's cases, the specificity and sensitivity of Doppler sonographic twinkling artifact for renal stone were 90.90% and 100% respectively. Positive predictive value 92.85%. 100% was a negative predictive value. The overall accuracy of the Doppler sonographic twinkling artifact for renal stone is 95.83%.

V. Discussion

The twinkling in color Doppler images is created by a rapidly changing series of colored horizontal bars that appear beyond the reflex surfaces, assuming a triangular shape when highly evident.Various tissues' calcified regions can exhibit twinkling, which is typically viewed as an artifact. [6,7] Moreover, twinkling is clearly differentiated from the blood flow signal for its peculiar aspect of mixed color bands parallel to the ultrasound beam independent of arterial pulses. [8] In this study, we will find out the diagnosis accuracy, specificity, and predictive values of twinkling artifacts in color Doppler ultrasonograms. This cross-sectional study took place in the Department of Radiology and Imaging, BIRDEM, Dhaka for one year. The sampling technique was purposive and the sample size was 54. The findings of the study are discussed on basis of related previous studies concerning the objectives of the study. Doppler ultrasound is available in Bangladesh from the secondary to tertiary level of health care. If radiologists carefully examined the twinkling artifact in echogenic structures in kidneys it will be easier for decision-making and definitive diagnosis of renal stone when the stone does not give a posterior acoustic shadow. In the present study, all the renal stones which produced twinkling artifacts were confirmed by an unenhanced CT scan. Among 103 echogenic structures, 42 had twinkling artifacts. Among those 42 twinkling artifacts-producing structures 39 were confirmed as renal stones. Considering unenhanced CT scan report as a gold standard test, the specificity and sensitivity of Doppler sonographic twinkling artifact for renal stone were 90.90% and 100% respectively. The positive predictive value was 92.85%. 100% was a negative predictive value. The overall accuracy of the Doppler sonographic twinkling artifact for renal stone was 95.83%. [9] Another study observed when there is acute renal colic, adding a renal color-Doppler ultrasound increases the sensitivity of standard sonography. and found that the sensitivity and specificity of CDU were 100 and 100%, respectively compared with enhanced CT. [10] Another author observed that the twinkling artifact's positive predictive value (PPV) for diagnosing calculi was 94%, while its sensitivity was 83%. when compared with non-enhanced CT. In a retrospective study,[11] correlated nephrolithiasis is detected via sonographic color Doppler twinkling artifacts on unenhanced computed tomography scans of the kidneys. and found that nephrolithiasis anywhere in the kidneys at CT exhibited a 78% (95% confidence interval 0.66, 0.90) positive predictive value for the presence of sonographic renal twinkling artifact in general.In contrast to the false positive rate, which was 51%, the true positive rate for the twinkling artifact for confirmed calculi at it was 49% for 73 of 148 twinkling foci. A recent study [12] detected sensitivity and specificity were 90 % and 100 %, respectively. The positive predictive value was 100 % and the negative 67 %. The accuracy was 92 %.

Limitations of The Study

The study was conducted in a single hospital with small sample size. So, the results may not represent the whole community.

VI. Conclusion

According to the results of the current study, the presence of the twinkling artifact in a color Doppler ultrasonogram was a helpful finding for the diagnosis of renal calculus, and this Twinkling artifact had good diagnostic value when grayscale sonography was used in conjunction with a color Doppler ultrasonogram.

VII. Recommendation

Ultrasonography is a relatively cheap, available, painless, and non-radiation-hazardous imaging tool. It can be used in the patient with renal colic for assessment of nephrolithiasis. The presence of twinkling artifacts in the color Doppler ultrasonogram was a useful finding for diagnosis which may help the concerned physicians

and urologists to take appropriate measures for treating and following up with the patients. However, further study can be undertaken by including a large number of study subjects involving multiple centers.

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