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Original Research Article

Detection of the Renal Calculus by Twinkling Artifact in Color Doppler Ultrasonography

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Abstract: ***Introduction:*** Renal calculus is a solid mass of crystals that may block the urinary tract. Calcium and oxalate combine to create the majority of these crystals. These kidney stones pass via the urinary system to leave the body. Most stones may not certainly cause any symptoms or signs until they start moving toward the ureter. For detecting kidney stones twinkling artifact in Color Doppler Ultrasonography (CDU) is a useful sensitive instrument. The twinkling artifact's effect is highly dependent on machine settings and is probably created by phase (or clock) jitter. When illuminating specific rough reflecting surfaces during color Doppler imaging, this phenomenon is frequently seen. It appears as a distinct point of alternating colors that may or may not have a comet tail associated with it. ***Aim of the Study:*** The aim of the study was to detect renal calculous twinkling artifacts in color Doppler ultrasonography. ***Methods:*** This prospective clinical study was conducted at the Department of Radiology and Imaging in BIRDEM General Hospital, Dhaka, to detect the twinkling artifact in color Doppler ultrasonogram in the defection of renal calculus. 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. A consecutive selection method was followed for the selection of the participants. ***Result:*** This study was detected for the twinkling artifact in color Doppler ultrasonography. All the subjects were selected for the study by purposive sampling method. The findings derived from the data analysis are presented as tabular or figure format where necessary. Out of the total 54 patients, 35 (64.82%) were male and 19 (35.18%) were female. The mean age of the patients was (SD) ± 13.42 years their age ranged from 31 to 64 years. Diagnostic accuracy of Doppler twinkling artifact was found to be 95.83% with specificity, sensitivity, positive predictive value, and negative predictive value of 90.90%, 100%, 92.85%, and 100%, respectively. ***Conclusion:*** The findings of the present study can be concluded that the presence of a twinkling artifact in the 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 colour Doppler ultrasonogram.

Keywords: Artifact, Urinary, Stones, Color-Doppler, Ultrasonogram.

INTRODUCTION

Renal Calculus is a solid mass of crystals that may block the urinary tract. Calcium and oxalate combine to create the majority of these crystals. These kidney stones pass via the urinary system to leave the body. Most stones may not certainly cause any symptoms or signs until they start moving toward the ureter. For detecting kidney stones twinkling artifact in Color Doppler Ultrasonography is a useful sensitive instrument. 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

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phase jitter within the Doppler circuitry of the US machine, is commonly observed at color Doppler imaging when insolating certain rough reflective surfaces. It appears as a discrete focus of alternating colors with or without an associated color comet-tail artifact [1]. It is possible that this finding can be used to increase the sensitivity and specificity of US in the diagnosis of nephrolithiasis. Twinkling artifact in the setting of nephrolithiasis is associated with an increased contrast-to-noise ratio when compared with posterior acoustic shadowing, another finding that has been attributed to renal calculi on gray-scale sonographic images. The twinkling artifact appears to be unaffected by poor focusing of the ultrasound beam and is likely frequency-independent. Conversely, this artifact is likely to be at least partly dependent on several US parameters, including color-write priority, gray-scale gain, and pulse repetition frequency [2, 3]. To date, only a few studies have been performed to assess the clinical importance of the renal color Doppler twinkling artifact in humans. In these prior investigations, researchers used abdominal radiography, excretory urography, or gray-scale sonography as the reference standard. The purpose of our study was to retrospectively determine how well sonographic color Doppler twinkling artifact within the kidneys depicts nephrolithiasis by using unenhanced computed tomography (CT) as the reference standard [4]. A Doppler mode in clinical diagnostic ultrasound detects motion, particularly blood flow, and displays the moving blood as red or blue on the imager's screen. For some unknown reason, when a stationary kidney stone is imaged in Doppler mode, the stone is displayed as a rain blow of colors, which makes the stone readily apparent. Something about the presence of the stone tricks the machine into displaying the color, which is an artifact because the color does not represent true motion. Because twinkling is an artifact, its appearance can be intermittent and unreliable. The unreliability is exacerbated because of the variability of ultrasound imager proprietary technologies. We are focused on how to understand the artifact and make it a useful tool to detect and treat kidney stones with lithotripsy [5]. A twinkling artifact has also been observed in color Doppler sonography of the orbit behind strongly reflecting surfaces; recognition of this artifact is important to avoid misinterpreting it as abnormal blood flow caused by a pathologic lesion. 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 flow within the tissue [6]. 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. A plain abdominal radiograph (KUB) is useful approximately 75-90% of urinary stones are radio-opaque but the radiolucent stone is often missed. A study by Olsen *et al.*, revealed a sensitivity of 32% - 57% for the US (grayscale) in the detection of nephrolithiasis when compared with an unenhanced CT scan. In this study, the researchers concluded that the US (grayscale) is of limited value in the detection of nephrolithiasis [7, 8]. So, this present study was carried out to evaluate twinkling artifacts as a diagnostic tool for the detection of renal stones.

OBJECTIVE

General Objective

- To find out the diagnostic usefulness of gray scale sonography and twinkling artifact in color Doppler ultrasonogram in the detection of renal calculus by considering non-contrast CT as the gold standard.
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Specific Objectives

- To detect the renal calculus by color Doppler ultrasonography using twinkling artefact.

METHODS

This prospective clinical study was conducted at the Department of Radiology and Imaging, BIRDEM General Hospital, Dhaka, to detect the twinkling artifact in color Doppler ultrasonogram in the defection of renal calculus. 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: Simens Sonoline Antares or Medison Sonoace 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

- Patients who had unwillingness to participate in the study.

RESULTS

Table 1: **Age distribution of the study subjects**

Age in year	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	

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.

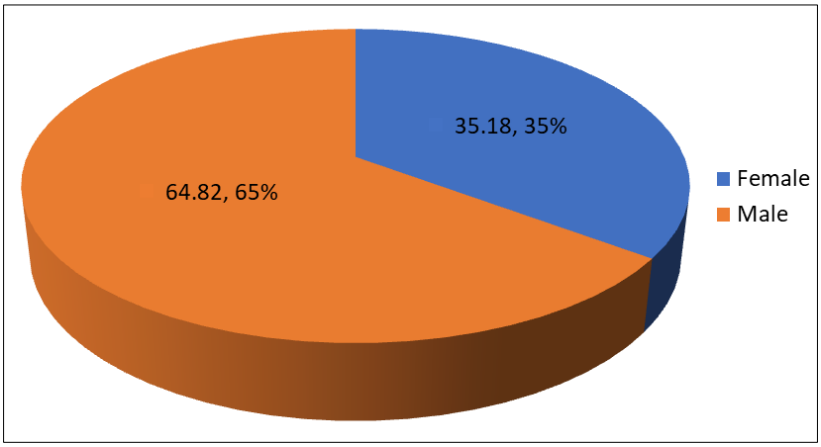

Figure 01: Pie diagram showing the gender distribution of the study subjects

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

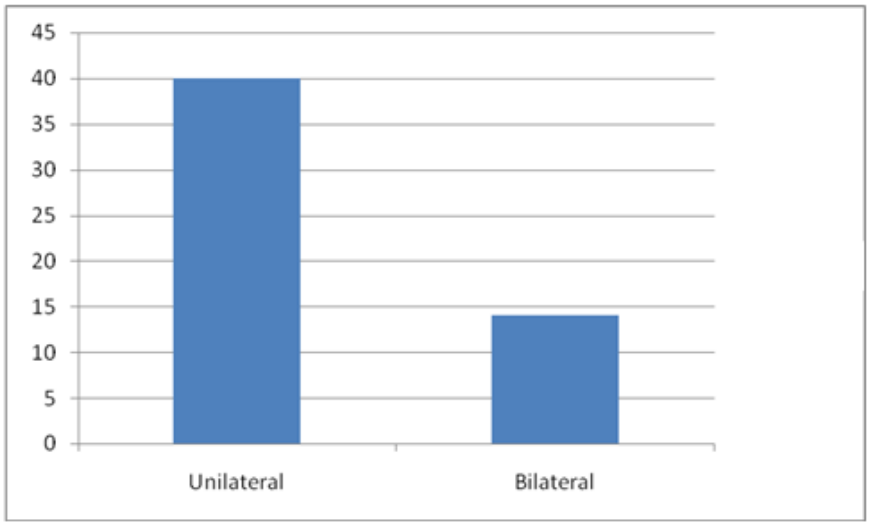

Figure 02: Bar diagram showing the number of echogenic structures in the kidney of the study subjects.

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

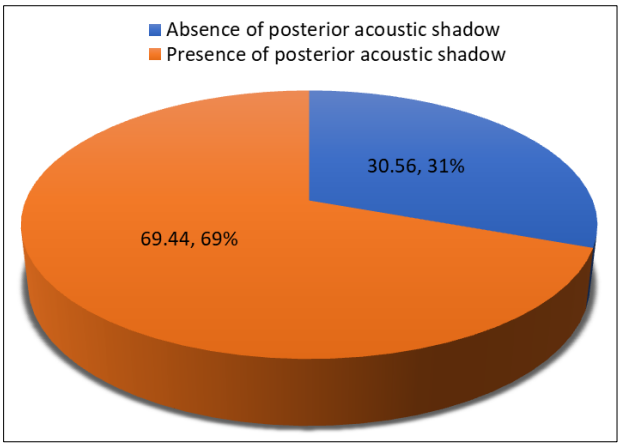

Figure 03: **Pie diagram showing the presence of posterior acoustic shadow in suspected renal stone**

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

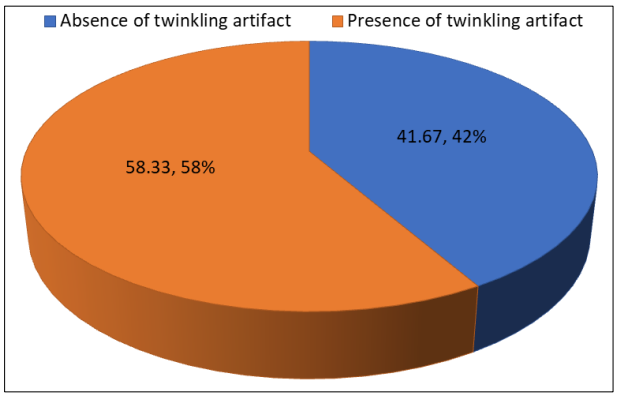

Figure 04: **Pie diagram showing the number of echogenic structures in the kidney of the study subjects**

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%.

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. Spectral analyses show a typically rectangular time/velocity wave diagram, and an uncomfortably high-pitched audio signal saturates the echo system. The twinkling can be detected in the calcified areas of various tissues and is usually interpreted as an artifact [9, 10]. Refer its origin to the abnormalities in the processing of echo signals coming from irregular and hyper-echogenic surfaces. The intensity of the sign is strongly affected by the mechanic index related to the acoustic power output, whereas it is not dependent on the variation of the wall motion color filter or the pulse repetition frequency. However, a higher value of the pulse repetition frequency ameliorates the visibility of the artifact by reducing the noise deriving from blood flow signals. Moreover, twinkling is differentiated from the blood flow signal for its peculiar aspect of mixed color bands parallel to the ultrasound beam independent of arterial pulses [11]. Although it was first described some years ago, the diagnostic value of twinkling in renal lithiasis is generally unacknowledged. This is possible because of the lack of suitable comparative studies using a standard reference technique, such as spiral computed tomography which, however, is expensive and not always available, exposes patients to a substantial amount of X-radiation, and is considered unjustified or even unethical in the absence of concomitant kidney function impairment. Furthermore, the twinkling effect can be seen in a high percentage of clinically asymptomatic humans [12]. Renal stone causes infection and obstruction, loss of kidney function, azotemia, and hydronephrosis. In ultrasonography, both renal pelvis fat and stone give a bright shadow. So, it became difficult to differentiate between stone and others. Gray scale ultrasound is widely used but is not strong stones echo, posterior shadowing is not an obvious or silent film, especially diameters less than 5mm small kidney stones diagnosis is difficult [13]. Color Doppler can differentiate renal stone by the presence of a twinkling artifact. In this study, we will find out the presence of twinkling artifacts in Doppler ultrasonogram as a useful tool for the diagnosis of renal calculus using non-contrast computed tomography (CT) as a gold standard. This cross- sectional study took place in the Department of Radiology and Imaging, BIRDEM General Hospital, 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 current study, gray-scale suspected renal stones showed twinkling artifacts in the majority of cases. A study [4] determined color Doppler twinkling artifacts could be considered an additional diagnostic sonographic feature of urinary stones. They observed that color Doppler twinkling artifacts from urinary stones occurred frequently and might be considered an additional sonographic feature of urinary stones. Recently [14], stated that the twinkling sign was positive in 177 out of 206 lithiases (86 %) visible on CT, while the grayscale was positive in 98 out of 206 lithiases (47.6%) and doubtful positive in 71 out of 206 lithiases (31%). The twinkling sign was positive in 100% of absolutely positive and doubtful positive lithiasis on B-mode, and in 8 out of 31 lithiases not visible on B-mode. 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 the negative predictive value. The overall accuracy of the Doppler sonographic twinkling artifact for renal stone was 95.83% [15]. Another study observed the addition of renal color-Doppler ultrasonography in the setting of acute renal colic improves the sensitivity of conventional sonography and found that the Sensitivity and specificity of CDU were 100 and 100%, respectively compared with enhanced CT. Kielar *et al.*, (2012) observed that the positive predictive value (PPV) of the twinkling artifact for identifying calculi was 94%, and the sensitivity was 83% when compared with non-enhanced CT. In a retrospective study [2], correlated sonographic color Doppler twinkling artifact within the kidneys with unenhanced computed tomography (CT) in the detection of nephrolithiasis and found that the presence of sonographic renal twinkling artifact, in general, had a 78% (95% confidence interval: 0.66, 0.90) positive predictive value for nephrolithiasis anywhere in the kidneys at CT. The true-positive rate of twinkling artifacts for confirmed calculi at CT was 49% (73 of 148 twinkling foci), while the false-positive rate was 51% (75 of 148 twinkling foci). The overall sensitivity of twinkling artifact for the detection of specific individual renal calculi observed at CT was 55% (95% confidence interval: 0.47, 0.64). A recent study [15] 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.

CONCLUSION

From the findings of the present study, it can be concluded that the presence of a twinkling artifact in the Colour Doppler ultrasonogram. To reach a consensus regarding the color Doppler twinkling artifact in the assessment of renal calculus. It is encouraged to conduct cross-sectional research with larger sample sizes and a focus on interobserver variability.

FUNDING

No funding sources.

CONFLICT OF INTEREST

None declared.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

RECOMMENDATION

Ultrasonography is a relatively cheap, available, painless, and no radiation-hazardous imaging tool. It can be used in a patient with renal colic for the assessment of nephrolithiasis. The presence of a twinkling artifact in the color Doppler ultrasonogram was a useful finding for diagnosis which may help the concern 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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