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***Research Article (Open Access)***

# EVALUATION OF THE ULTRASOUND ACCURACY IN DETECTING RENAL STONES

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## ABSTRACT
*Introduction:* Ultrasonography is an attainable, cheap imaging modality that uses sound waves rather than electromagnetic waves. This study aimed to determine the ability of ultrasound in detection of renal stone.
*Method***:** A retrospective study was performed from December 2019 to March 2020 at Taif hospitals (King Abdul-Aziz Specialist, King Faisal Specialist and pediatric hospital). The study included data from 56 patients who were chosen for renal stone based on the history of renal colic and acute flank pain. They were referred for ultrasound. The focus of this study was on stone sizing, sensitivity, and specificity. Patients' data were reviewed from the picture archiving and communication system program. The analysis was done by utilizing statistical package for the social sciences (SPSS).
*Result***:** Stone is more common in male rather than in female due to difference in life styles, there is similar difference in stone size and site. Stones are more common in 49-60 years of age and at the left kidney. The most common symptoms appeared on patients were flank pain by (53%), 23% of cases appears as Hydronephrotic and 76% appeared as normal, the most cases had shadow (93 %).
*Conclusion***:** The accuracy of ultrasound to detect renal stone depends on the size of stone and radiologist skills technique.

***Keywords:*** *Renal stone, Ultrasound, Specificity*



## INTRODUCTION
Ultrasound is one of the safest medical imaging methods because it is free from radiological hazards (Brenner & Hall, 2007). The use of ultrasound specifically for kidney stones dates back to 1961 when Schlegel and colleagues first reported on intraoperative amplitude (A)-mode ultrasonography for renal calculi (Schlegel *et al.,* 1961). The location and nature of kidney stones contribute to determining the appropriate imaging technique used to detect them (Rabenou, 2007). Calcium makes up the largest proportion of kidney stones, while there are other components with a lower percentage (Curhan *et al.,* 2009). The incidence of urine stones worldwide is very small, less than 3%, with a significant prevalence among white males (Menon *et al.,* 1998). Approximately 50 percent of patients with previous urinary calculi have a recurrence within 10 years (Uribarri, 1989). US could be used in place of CT for the initial diagnosis of acute kidney stone events (Brisbane *et al.,* 2016).
The commonness of renal calculi differs depending on race, sex, age and geographic location; however, stone formers can be of any age and can develop multiple stones at a time. A lot of diagnoses and treatments are made annually and the total cost was calculated to be over $2B in 2000, which was 50% higher than the cost in 1994 (Curhan, 2007).
The most commonly used technology for kidney stone diagnosis is X-ray computerized tomography (CT). CT is expensive and exposes the patient to ionizing radiation that may increase patients' risk of developing cancer later in life (Curhan, 2007).

Recently, a Doppler studies sonography artifact called the 'Twinkling Artifact (TA)' has been reported to improve the sensitivity of ultrasound for stone detection. The TA is described as rapid color alerting on hard objects such as kidney stones; however, due to the inconstancy of the TA, it has not been adopted clinically for the diagnosis of kidney stones (Curhan, 2007).
This study will have significant importance in improving the quality of the renal stone diagnosis. Also, to deliver perfect evidence not available with standard imaging methods by using ultrasound.

## MATERIALS AND METHODS

The retrospective study was performed from December 2019 to March 2020 in 56 patients with different ages, who presented with renal colic and acute flank pain. The study was conducted at King Abdul-Aziz Specialist Hospital, King Faisal Specialist hospital and pediatric hospital. The study included only those patients who underwent the renal US. US imaging was conducted using different ultrasound machines (Philips, GE, and Siemens) and a 3.5-5 MHz curvilinear probe. Subjects underwent imaging of one or both kidneys based upon stone location by a single sonographer. Since the focus of this study was on stone sizing, sensitivity, and specificity. Variables such as patient age and gender, principal presenting complaints, stone size, etiology of stone, and findings of the Radiologists, was documented.

### *Data Analysis*

Data were initially summarized into means, standard deviations (SD); mean ±SD and percentages in a form of comparison tables and graphs. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 20 for windows and (P-value) was used for significance. The level of significance of the above-mentioned tests were set at $p<0.05$.

### *Limitation*

Ultrasonography has specific limitations. First, the technique is both operator and equipment-dependent, particularly with regard to the demonstration of acoustic shadowing. Second, it may not be possible to detect stones that are smaller than 5 mm. Third, other structures in the renal hilum, such as calcified arteries, may appear as echogenic foci with acoustic shadowing.

## RESULTS

**Table 1: Distribution of age groups among gender**

| Age of patients | Gender of patients | | Total |
|---|---|---|---|
| | Male | Female | |
| 1 - 12 | 4 | 1 | 5 |
| 13 -24 | 1 | 2 | 3 |
| 25 -36 | 6 | 3 | 9 |
| 37 -48 | 4 | 5 | 9 |
| 49 - 60 | 11 | 6 | 17 |
| 61 - 72 | 3 | 5 | 8 |
| 73- 84 | 5 | 0 | 5 |
| Total | 34 | 22 | 56 |

Their ages ranged from 1 to 81 years. with mean age and standard deviation (SD) of 46.04 ± 19.9 years. In the population of males, 11 subjects were in the age set (49-60) years was largest of the male population. The age group (13-24) years were the smallest of the male population.

In female population, 6 subjects were in the age set (49-60) years were largest of the population, in the age set (73-84) years there wasn't population.

**Gender of patients**


figure shown 34 (61%) males 22 (39%) female.

**Table 2: Site of stone and Size of stone**

| Site of stone | Size of stone | | | Total |
|---|---|---|---|---|
| | 1 - 5 mm | 6 - 10 mm | >10 mm | |
| Right Kidney | 3 | 9 | 10 | 22 |
| Left Kidney | 3 | 15 | 6 | 24 |
| Both kidneys | 5 | 2 | 3 | 10 |
| Total | 11 | 26 | 19 | 56 |

The table shown site and various sizes of stone. 22 cases found in right kidney; 3 between (1-5 mm) ,9 between (6-10 mm) and 10 were (>10 mm). In the left kidney there were 24 cases; 3 between (1-5 mm) ,15 between (6-10 mm) and 6 were (>10 mm).In both kidney 10 cases, 5 between (1-5 mm) ,2 between (6-10 mm) and 3 were (>10 mm)

**Table 3: Site of stone and Kidney status**

| Site of stone | Kidney status | | Total |
|---|---|---|---|
| | Normal | Hydronrphrotic | |
| Right Kidney | 15 | 7 | 22 |
| Left Kidney | 19 | 5 | 24 |
| Both kidneys | 9 | 1 | 10 |
| Total | 43 | 13 | 56 |

In this study shown kidney status it was 43 case appear normal, 15 cases in right kidney and 19 in left kidney and 9 in Both kidneys and 13 appear with Hydronrphrotic 7 cases in right kidney and 5 in left

kidney and 1 in both kidneys.

**Table 4: Number of stones and Size of stone**

| Number of stones | Size of stone | | | Total |
|---|---|---|---|---|
| | 1 - 5 mm | 6 - 10 mm | >10 mm | |
| Single | 9 | 16 | 12 | 37 |
| Multiple | 2 | 10 | 7 | 19 |
| Total | 11 | 26 | 19 | 56 |

The Single stone found in 37 cases include 9 between (1-5 mm) ,16 between (6-10 mm) and 12 (>10 mm). Multiple stone found 19 cases include 2 between (1-5 mm), 10 between (6-10 mm) and 7 (>10 mm)

**Table 5: History of patients**

| History | Frequency | Percent |
|---|---|---|
| Flank pain | 30 | 53.6 |
| BPH | 3 | 5.4 |
| Follow up | 11 | 19.6 |
| Other | 12 | 21.4 |
| Total | 56 | 100.0 |

Of the 56 patients under study,30 cases (53.6%) came with flank pain and 11 cases (19.6%) came for follow up. 3 cases (5.4%) had BPH (Benign prostatic hyperplasia) and 12 cases came with other symptoms.

The cases without shadow were 4 (7%) and cases with shadow were 52 (93%)

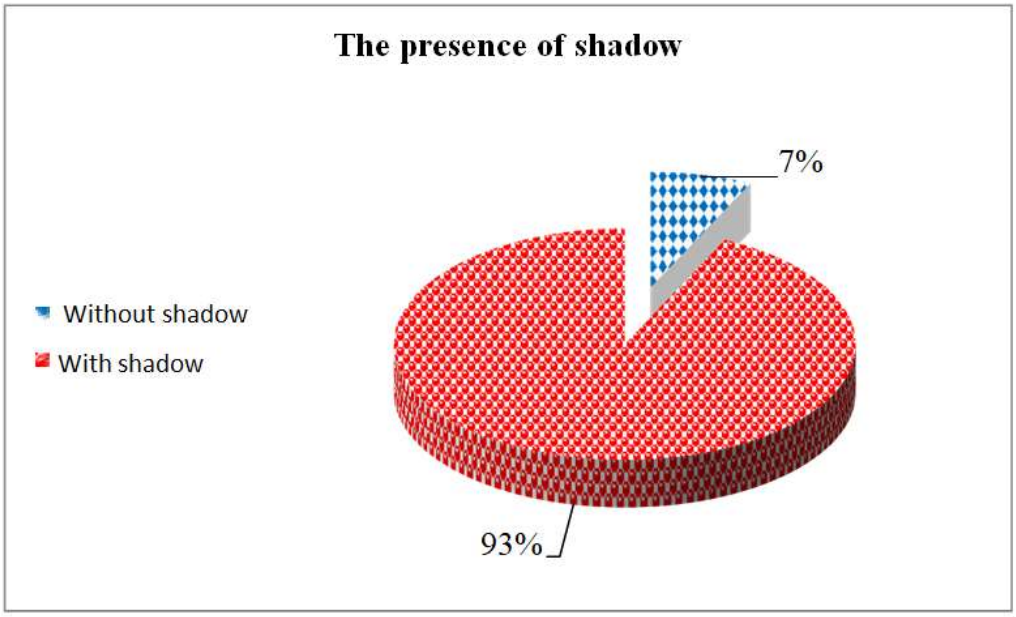


**Figure 2: The presence of shadow**

**Table 6: Chi square test of effect of some factors on appearance of shadow**

| Risk | Chi -Square | p-value |
|---|---|---|
| Site of stone | .569 | >0.05 |
| Size of stone | 2.282 | <0.05 |
| Number of stones | 3.241 | <0.05 |

Chi-Square test showed a highly significant difference in size of stone and number of stones ($p < 0.05$ for all parameters) and non-significant difference in site of stone.

## DISCUSSION

Ultrasound is a common modality used to examine kidney stones (Kanno *et al.*, 2014). The present project detected that the proportion of male patients was more than female patients (34 samples out of the 56 samples were male). This outcome was in concordant with Johnson *et al.*, (1979) who reported that male cases are more repeated than the female cases with percentages 69.6% and 30.4% respectively. The current survey found that the largest age group was 49-60 years old, and least age group was 13-24 years old. This finding was supported by Mousa *et al.*, (2020) who told that the mean age of patients was 49.26 years and the standard deviation was 23.82 years. By contrast to this study Johnson *et al.*, (1979) reported that the age group with the largest number of records was 30-39 years and the age group with the lowest number of records was 10-19 years. The analysis showed that 24 out of the 56 samples were in the left kidney and 22 were in the right kidney with percentages of 43% and 39% respectively. This result does not correspond to studies by Ulusan *et al.*, (2007) who showed that the percentages of the occurrence of the renal stones in the left and the right kidneys were 32-39% and 52-57% respectively. The current research found that most of the stones were in the range of 6-10 mm, and the least number of records were in the range of 1-5 mm. furthermore, the study noticed that out of the 56 samples 43 kidneys were normal whereas 13 kidneys with hydronephrosis with percentages of 76.8% and 23.2% respectively. This finding not agree with Riddell *et al.*, (2014) who revealed that out of 125 samples only 27 kidneys were normal and 98 kidneys with hydronephrosis with percentages 21.6% and 78.4% respectively. This study found that the shadow appeared in 52 (93%) out of 56 samples. This finding was in agreement with Verhagen *et al.*, (2019) who stated that large renal calculi had posterior acoustic shadow.

***Conflicts of interest statement and funding:***
The authors have no conflicts of interest to disclose

## REFERENCES

**Brenner DJ and Hall EJ (2007).** Computed Tomography — An Increasing Source of Radiation Exposure. *New England Journal of Medicine*. **357**(22) 2277–84.

**Brisbane W, Bailey MR, Sorensen MD (2016).** An overview of kidney stone imaging techniques. *Nature Reviews Urology* **13**(11) 654–62

**Curhan GC, Aronson MD, Preminger GM (2009).** Diagnosis and acute management of suspected nephrolithiasis in adults. UpToDate. *https://www.uptodate.com/contents/diagnosis-and-acute-management-of-suspected-nephrolithiasis-in-adults?source=search_result&search=nephrolithiasis%20adult&selectedTitle=1~150#H2698242. Accessed on: February 15, 2021.*

**Curhan GC (2007).** Epidemiology of Stone Disease. *Urology Journal of Clinical North America,* **3**(34) 287–93.

**Johnson CM, Wilson DM, Ofallon WM, Malek RS and Kurland LT (1979).** Renal stone epidemiology: A 25-year study in Rochester, Minnesota. *Kidney International* **16**(5) 624–31.

**Kanno T, Kubota M, Sakamoto H, Nishiyama R, Okada T, Higashi Y *et al.*, (2014).** The Efficacy of

Ultrasonography for the Detection of Renal Stone. *Urology*, **84**(2) 285– 8.

**Menon M, Parulkar BG, Drach GW (1998).** Urinary lithiasis: etiology, diagnosis, and medical management. *In:* Walsh PC, Retik AB, Vaughan ED Jr, Wein AJ, eds. Campbell's Urology. 37th ed. Philadelphia, Pa: WB Saunders Co, 2680.

**Mousa TE, Ahmed ME, Gar-elnabi MM (2020).** Classification of Renal Stone Types during Ultrasound using Texture Analysis Technique. *International Journal Dental and Medical Sciences Research (IJDMSR).* **4**(1) 23–8.

**Rabenou RA (2007).** Radiology tests used for kidney stones. In: Patient guide to kidney stone diagnosis, treatment and prevention [website]. *New York: New York University.*

**Riddell J, Case A, Wopat R, Beckham S, Lucas M, Mcclung C *et al.*, (2014).** Sensitivity of Emergency Bedside Ultrasound to Detect Hydronephrosis in Patients with Computed Tomography-proven Stones. *Western Journal of Emergency Medicine*, **15**(1) 96– 100.

**Schlegel J, Diggdon P, Cuellar J (1961)**. The Use of Ultrasound for Localizing Renal Calculi. *Journal of Urology*, **86**(4) 367–9

**Ulusan S, Koc Z, Tokmak N (2007).** Accuracy of sonography for detecting renal stone: Comparison with CT. *Journal of Clinical Ultrasound,* **35**(5) 256–61.

**Uribarri J (1989).** The First Kidney Stone. *Annals of Internal Medicine,* **111**(12) 1006.

**Verhagen MV, Watson TA, Hickson M, Smeulders N and Humphries PD (2019).** Acoustic shadowing in pediatric kidney stone ultrasound: a retrospective study with non-enhanced computed tomography as reference standard. *Pediatric Radiology*, **49**(6) 777–83.