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Ultrasound efficacy in determining the presence of renal calculi in Amara city

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Abstract

In recent years, ultrasonography (US) has become a popular alternative to computerized tomography (CT) for renal calculi, which is the gold standard. The US is easy to use and cheaper. This study compares ultrasonography to CT scans, which are considered the most accurate method for detecting kidney stones, their size, and their position. A cross-sectional urology outpatient clinic study was done. In the study, 52 patients aged 19–81 with flank pain were suspected of having renal stones. After demographic data, a thorough history, a routine abdominal exam, and laboratory tests, patients had abdominal ultrasounds to confirm renal stones. If the results were positive, the stone size, position, hydronephrosis, and severity were documented. Following that, the patients were instructed to do a very low-dose native CT scan of the pelvis and abdomen to duplicate the information obtained from the US stone assessment. The original author, a five-year radiologist, reviewed both techniques. The US and CT have a kappa score of 0.338, indicating a fair agreement on stone location. To clarify, the US was insensitive in the middle and upper calyx and missed seven stones, 13.46% of the total. The kappa value between the US and CT for hydronephrosis severity was 0.401, indicating some agreement. The ultrasound missed hydronephrosis in 11 of 18 cases (61.11%). Hydronephrosis in severe and moderate instances is most insensitively diagnosed by ultrasonography. US and CT stone size estimates were highly accurate (ICC > 0.9).

Keywords: Ultrasonography, Renal calculi, Kidney stones

Introduction:

A significant percentage of the world's population is affected by nephrolithiasis. This condition is the most prevalent renal system and urinary tract disorder. Crystals or aggregates originate in the kidney and move through the genitourinary system (1-3). Calculi usually form in the renal cavity and pass through the urethral meatus without pain. Larger calculi may require surgery. The majority of nephrolithiasis patients had calcium oxalate stones, with a smaller proportion of calcium phosphate (4,5). The other main kidney stones are cystine, uric acid, and struvite. A patient may have calcium oxalate and uric acid crystalline stones (6). Familial and individual stone production histories are kidney stone risk factors (7). Inadequate fluid consumption is associated with diabetes, obesity, gout, hypertension, and other urinary and nutritional consider as risk factors for kidney stone formation. Colicky abdominal, flank, or pelvic pain, which accounts for most acute kidney stone presentations, dysuria, hematuria, fever, nausea, and vomiting may be detected incidentally during an abdominal scan (8-11). Genetics, geography, and socioeconomic class affect the occurrence and composition of these stones worldwide. Years ago, many researchers

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found these stones in underdeveloped countries. Kidney stones are between 5% to 19.1% prevalent in West Asia, Southeast Asia, South Asia, South Korea, and Japan, according to a meta-analysis. These Asian regions are referred described as a "stone belt" by researchers (12,13). Asia and more specifically North and East countries display the highest prevalence of kidney stones such as East and North Asia. On the other hand, Saudi Arabia is considered the highest in the Middle East (13, 14). A related study in western Iraq found an increase in kidney stones, but it did not define a prevalence. Low-radiation native A "Computed Tomography Scan" (CT scan) of the abdomen and pelvis is the best way to detect renal stones in nonobese patients. Fifteen. The usual radiation dosage computed tomography scan is preferred for obese people (14-17). CT is estimated to identify kidney stones at almost 95% higher sensitivity than other methods (18-20). Cost and radiation risks limit computed tomography (CT). Charges, costs, refunds, and parties including hospital systems, insurance companies, and consumers can complicate expense discussions. According to Medicare data indicates that the cost of CT scans is approximately double that of renal ultrasounds and one-third that of MRIs. Low-dose CT costs are the same as regular CT (19, 21, 22). Ultrasonography (US) is indicated for detecting nephrolithiasis in pregnant women, children, and without CT scans. In some emergency hospitals, the US can detect kidney stones and hydronephrosis at the bedside, enabling prompt treatment. Ultrasound may replace abdominal and pelvic standard-dose native computed tomography. Radiation exposure from many imaging sessions is reduced for renal stone patients. For nephrolithiasis identification, ultrasound is less reliable and variable than CT (23). Combined ultrasonography sensitivity and specificity are 0.70 (95% CI 0.67-0.73) and 0.75 (95% 0.73-0.78) (24). The most efficient approach for diagnosing kidney stones is the Computed Tomography Scan; however, this study compares ultrasonography to identify, quantify, and locate stones.

Methods

Study Design: An investigational study carried out in an outpatient urology clinic. The participants in the study ranged in age from 19 to 81 years old and were all thought to be suffering from renal calculi due to their symptoms of flank pain. Laboratory testing, a comprehensive medical history, and a standard abdominal examination were all part of the process. Demographic data was also gathered. Patients then had an ultrasound of the abdomen to see how their kidney stones were progressing. The existence or absence of hydronephrosis and the severity of any stones, if any, were recorded, along with their size and location. When the patients' ultrasound results regarding the stones were confirmed, they underwent a low-dose native CT scan of the pelvis and abdomen. With five years of experience, the same radiologist (first author) who was working with a single interpreter evaluated the results of both methods. Beginning on November 1, 2022, and continuing until May 1, 2023, the research took place at Al-Sadr Teaching Hospital in Misan Governorate, which is associated with Misan University's College of Medicine. Every patient who had ultrasonography or CT scanning at the hospital's radiology department gave their informed consent before taking part in the trial.

Analytical procedures

Ultrasound techniques: A greyscale US (VolusonTM E6 GE HealthCare Technologies Inc., United States of America Chicago, Illinois) with a curved surface transducer operating at 3–5 MHz was utilized. All of the echogenic foci that were observed in the renal pelvis or calyces on ultrasound were determined to be stones in the urinary system. This is because a little stone might not generate an acoustic shadow. Some secondary symptoms of obstruction were also observed; nevertheless, the only thing that was regarded to be confirmed was the direct observation of the stone.

CT-Scan Method

A CT/multi-slice helical CT scanner (Siemens SOMATOM Sensation 64/Siemens Healthiness, Germany, Erlangen) was utilized to acquire the CT images. KVp 130 and mAS 200–250 were the adjustments that were made to the exposure factors. We made sure the stander steps for taking the images were followed. To determine the maximal stone diameter and the polar location within the kidney, the investigator conducted an independent assessment of the results of the CT scan. In the process of reviewing CT scans, both the coronal and axial planes were examined, and the biggest diameter was utilized. Furthermore, the presence of hydronephrosis, renal tumors, cysts, and anatomic anomalies were also documented in the patient's medical history. The largest stone was then selected to compare its findings with those obtained from Ultrasonography imaging.

Data analysis:

The Shapiro–Wilk test is a test of normality that was utilized in all of the analyses that were carried out using SPSS version 24.1 and GraphPad Prism version 10. A paired t-test was utilized to evaluate the differences between the various radiological modalities.

Results:

There was a total of 700 individuals who were hospitalized to the hospital during the time of the study; Out of all samples, only 52 met our criteria. In detail, the ultrasound and computed scan apply to all the select cohere and the step is critical for diagnosis.With a kappa score of 0.338, the US and the CT were in reasonable agreement when it came to pinpointing the stone's exact location. In terms of particular, the US missed seven stones (13.46% of the total) that could be located. Due to its tendency to diagnose one out of every five instances that are diagnosed by CT, the United States tends to down-diagnose in the upper calyx. Because it confirms 12 out of 3 instances found by CT, the US has a propensity to overdiagnose in the middle calyx. Since it diagnoses fourteen out of twenty-three instances that are diagnosed by CT, the United States tends to down-diagnose in the lower calyx. Because it diagnoses 18 out of 21 instances in the pelvis that are diagnosed by CT, the United States tends to down-diagnose. According to Table 2, the results showed that Ultrasonography is not a good choice for detecting middle and upper calyx.

The kappa score for assessing the severity of hydronephrosis between Ultrasonography and CT was 0.401, indicating a moderate level of agreement between the two methods. Additionally, Ultrasonography failed to identify hydronephrosis in 11 of 18 instances, representing 61.11 percent of the total. Ultrasonography exhibited a propensity for over-diagnosis, identifying 16 out of 16 instances of mild hydronephrosis, while it demonstrated a tendency for under-diagnosis by recognizing only 6 out of 10 cases of moderate hydronephrosis. Additionally, it displayed an inclination for over-diagnosis by detecting 15 out of 8 cases of severe hydronephrosis. Further details are available in the subsequent paragraphs. Table 3 illustrates that Ultrasonography is the least sensitive method for diagnosing severe and moderate hydronephrosis.

According to Table 4 and Figure 1, there was a high degree of reliability between the US and CT in terms of assessing stone size. This was demonstrated by the fact that the ICC exceeds 0.9.

Table 1: The details for sex and stone localization.

Variable	Value
Number	52
Age (y), mean ± SD	47.85 ± 15.0
Sex, no (%)	
Female	25 (48.1%)
Male	27 (51.9%)
Kidney side, no (%)	
Left	27 (51.9%)
Right	25 (48.1%)

Table 2: shows the radiological modalities of the location of the stones.

Variables		Computerized tomography				Total
		Upper Calyx	**Middle Calyx**	**Lower Calyx**	**Pelvis**	
US	**None**	3	0	4	0	7
	Upper Calyx	1	0	0	0	1
	Middle Calyx	1	2	4	5	12
	Lower Calyx	0	0	11	3	14
	Pelvis	0	1	4	13	18
Total		5	3	23	21	52
Kappa = 0.338, p-value <0.001						

Table 3: Using radiological modalities to detect hydronephrosis severity.

Variables		Computerized tomography				Total
		none	**mild**	**Moderate**	**Severe**	
US	**None**	11	5	1	1	18
	Mild	4	8	3	1	16
	Moderate	0	3	2	5	10
	Severe	0	0	0	8	8
Total		15	16	6	15	52
Kappa = 0.401, p-value <0.001						

Table 4: evaluation of radiological stone size agreement

US	CT	p-value ^{a}	ICC	p-value ^{b}
1.5 (0.8 – 2.5)	2.4 (1.53 – 3.38)	0.002	0.925	<0.001

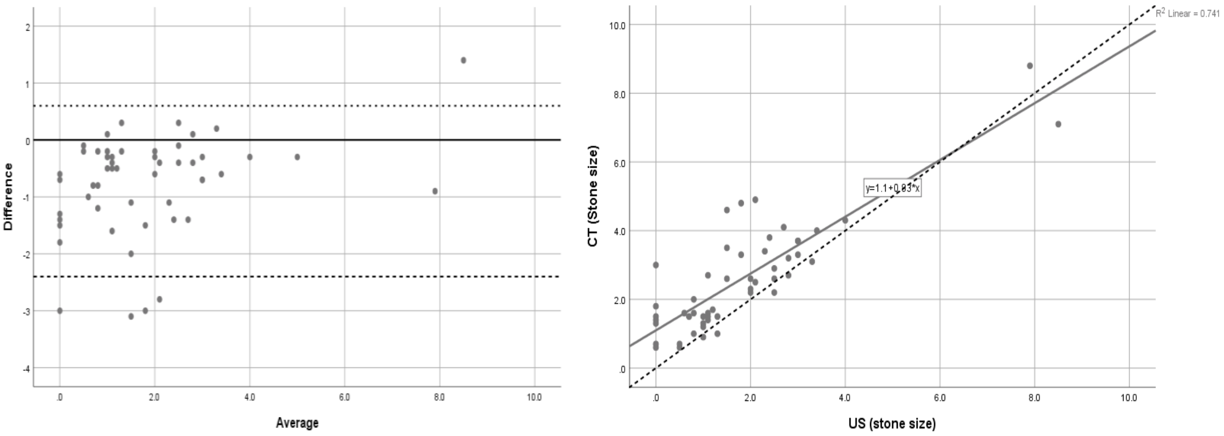

Figure 1: Truncated Violin plot, Bland-Altman analysis, and correlation plot of stone size by radiological modalities are the three types of plots that are used.

Discussion:

Ultrasonography is a frequent urinary tract imaging method. Its noninvasiveness and safety make this imaging technique superior to others. These benefits come from avoiding radiation and injecting contrast agents. For children and pregnant women suspected of urolithiasis, renal ultrasonography (US) is generally the first test (25). Cost-effectiveness, image quality, and accessibility are other benefits. This method has drawbacks for renal calculi imaging. Ultrasonography (US) sensitivities for renal calculi range from 12% to 93%, according to the literature. Additional research revealed that ureteral colic sensitivity was increased by 77% to 79% by ultrasound (US) and kidney-ureter-bladder X-ray (KUB) (26). However, the US is known for its difficulty detecting mid-ureter calculi. (27-30) found that ultrasonography (US) had only 13% sensitivity for stones smaller than 3 mm. As a result of an unclear stone boundary, ultrasound (US) has the potential to be an inaccurate measurement of the size of renal or ureteral calculi. (31-33). This overestimation may alter patient management decisions. This study showed that ultrasound stone size determination was more reliable than computed tomography, with a low tendency to underestimate stone size (34-36). According to Bland-Altman's study, smaller stones are underestimated more. Ultrasound (US) has moderate agreement with other modalities, especially in evaluating stone size, making it less useful for stone localization and hydronephrosis (37,38). Ultrasound is poor at identifying severe and moderate hydronephrosis and middle and upper calyx stones. Compared to CT scans, ultrasound (US) exams have lower sensitivity and specificity for the percentage of stones that can be identified ranging from 24% to 70% and from 88% to 94.4%, respectively. When it comes to stones that are 5 millimeters or smaller, US imaging frequently errs by 3.3 millimeters. The size of the stone can change the surgical approach and spontaneous transit that are most effective. Thus, clinical decision-making relies on this vital information. In management, stone size-based decisions lead to 22% wrong advice (39). Improved stone recognition and size precision are the main barriers to US imaging's mainstream use. Unenhanced helical computed tomography is best for urinary calculi diagnosis (40). CT scans are more sensitive than radiography and intravenous urography at detecting renal and ureteral calculi. The results of a comprehensive review of the scholarly literature indicate that CT scans can diagnose acute ureteral colic one hundred percent of the time, while IVU 37-40 64% of the time. CT scans are now the norm for acute flank pain evaluation, replacing IVU (41). To estimate stone size, transverse and craniocaudal measures were compared on 61 stones with a diameter of one centimeter. Analyses were performed on KUB and CT images. Concerning transverse dimensions, the CT scans and the KUB were identical. The CT scans revealed a craniocaudal overestimation of 1.4 millimeters in comparison to the KUB (42).

Author Contributions

The study design and performed experiments were done by Husam Al-hraishawi and Saud Kadhim Abbas. In addition, both authors analyzed the data and wrote the manuscript.

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Conflict of interest: NIL

Ethical approval:

At the end of October 2022, the "Al-Sadr Teaching Hospital" ethics committee gave its approval to the research project, which was given the code S2022-18.

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