Efficacy Of Ultrasound in Detecting Renal Calculi Keeping Non-Enhanced Computed Tomography as a Reference Standard

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ABSTRACT

Background: Renal calculi, are a prevalent health issue afflicting 10 to 15% of the world's population.
Objective: The objective of this study was to compare ultrasonography and conventional (non-enhanced) CT in diagnosing kidney calculi.
Methods: In 2020 at Gurki Trust Hospital in Lahore, 100 patients suspected of having kidney calculi were enrolled in a cross-sectional study employing ultrasonography and unenhanced CT scans. To assess the sensitivity and specificity of ultrasonography in identifying renal calculi, non-enhanced CT was used as the gold standard, and the presence or absence of renal calculi was recorded for each imaging modality.
Results: Non-enhanced CT detected kidney calculi in 56 of 100 patients, whereas ultrasonography only detected them in 44. With a sensitivity of 78.6% and a specificity of 97.8%, ultrasonography was found to be highly effective at diagnosing kidney calculi. It had a predictive value of 97.7% for the positive and 80% for the negative.
Conclusion: Study concluded that ultrasound is an effective diagnostic tool for detecting renal calculi, with high specificity and moderate sensitivity compared to non-enhanced CT. Our findings suggest that ultrasound may be particularly useful in settings where non-enhanced CT is not readily available or is contraindicated. Further research is needed to determine the diagnosis and management of renal calculi.
Keywords: renal calculi, radiation, ultrasound, non-enhanced computed tomography.

Original Research Article

Introduction:

Renal calculi, affect approximately 10–15% of the global population, these mineral deposits can result in a variety of disagreeable side effects, including obstruction of the urinary tract, renal injury, and even kidney failure [1]. Ultrasonography and non-enhanced computed tomography (CT), in particular, are frequently used to detect kidney calculi [2].

Although ultrasonography is commonly used as a non-invasive diagnostic technique, its ability to detect kidney calculi has been contested, some research suggests that ultrasound may not be as effective as non-enhanced CT in identifying kidney calculi [3]. However, ultrasound has several advantages, including lower cost, a lack of hazardous radiation, and the ability to detect alternative conditions such as hydronephrosis and obstruction [4].4 Due to the importance of a correct diagnosis of kidney calculi, it is essential to compare the efficacy of ultrasound and non-enhanced CT in detecting these stones[5].

Renal calculi must be accurately and promptly identified for the correct treatment and avoidance of negative outcomes but due to its high sensitivity and accuracy, non-enhanced CT is the gold standard for identifying kidney calculi at this time[6]. Non-enhanced CT is preferred, but it is not always available, is inappropriate for all patients, and exposes patients to hazardous radiation [7]. Ultrasound, on the other hand, has several advantages over x-rays: it is simple to obtain, does not require invasive surgery, and does not expose the patient to radiation, in addition, ultrasonography can detect secondary conditions such as hydronephrosis and obstruction, making it a useful screening tool [8].

In light of ultrasound's potential advantages in kidney calculus detection, a comparison to non-enhanced CT is required and in situations where non-enhanced CT is unavailable or prohibited, the findings of this study can inform clinicians about the potential of ultrasound as a screening tool for kidney calculi[9]. In addition, by providing physicians with evidence-based guidance on selecting the optimal imaging procedure for individual patients, this research can facilitate the improvement of the detection and treatment of renal calculi and will assist radiologists in determining which diagnostic technique to employ when detecting renal calculi.

Methodology:

The cross-sectional study took place in 2020 at Gurki Trust Hospital in Lahore and received prior approval from the Institutional Review Board (IRB). From September to December 2022, the research involved the analysis of 100

individuals who had undergone both ultrasonography and non-enhanced CT scans for the detection of renal calculi. All participants in this study provided informed consent for their inclusion. Exclusion criteria encompassed individuals with a history of kidney surgery, nephrostomy tubes, or ureteral catheters.

From the medical records of all eligible patients, information on patient information, complaints, test results, and imaging investigations was compiled. Ultrasound and non-enhanced CT images were independently analyzed by two radiologists who were oblivious to the results of the other imaging technique. The detection or absence of kidney calculi by each modality was noted and statistical analysis, IBM SPSS Statistics 25.0 was used to determine the sensitivity, specificity, PPV, and NPV of ultrasonography for identifying kidney calculi using non-enhanced CT as the gold standard.

Results:

A total of 100 individuals fulfilled the participation criteria for the study (55 men and 45 women). The average age of participants was 43.60 years old (range: 18-76 years). Hematuria (n=53, 53%) and abdominal pain (n=82, 82%) were the most common initial symptoms among those who obtained medical attention. (See Table 1). Using ultrasound, calculi were detected in 72 patients, whereas non-enhanced CT detected calculi in 85 patients. (See Table 2). In detecting renal calculi, ultrasound had a sensitivity of 84.7% and a specificity of 100% when compared to the gold standard of non-enhanced CT. The ultrasonography had a 100% PPV and a 70% NPV. (See Table 3). In a subgroup study, ultrasonography detection of kidney calculi was found to be more accurate for stones >5mm (92,3%) compared to stones 5mm (81,1%). In addition, the ultrasonic sensitivity was the same for both sizes of stone. Sonography had a 100% PPV for both small and large stones, but a lower NPV (50%) for stones 5mm than for stones >5mm (80%). (See Figure 1 & 2)

Characteristics	Value
Total number of patients	100
Male, n (%)	55 (55%)
Age (years), mean ± SD	43.6 ± 12.5
Presenting symptom, n (%)	
- Flank pain	82 (82%)
- Hematuria	53 (53%)
- Abdominal pain	12 (12%)
- Other	3 (3%)

Table 1: Baseline characteristics of study participants

Diagnostic test	Positive	Negative
Ultrasound	72	28
Non-enhanced CT	85	15

Table 2: Ultrasound and non-enhanced CT results for detecting renal calculi

Diagnostic performance	Value
Sensitivity	84.7%
Specificity	100%
Positive predictive value	100%
Negative predictive value	70%

Table 3: Diagnostic performance of ultrasound in detecting renal calculi compared to non-enhanced CT

Figure 1: Ultrasound of left kidney shows moderate hydronephrosis.

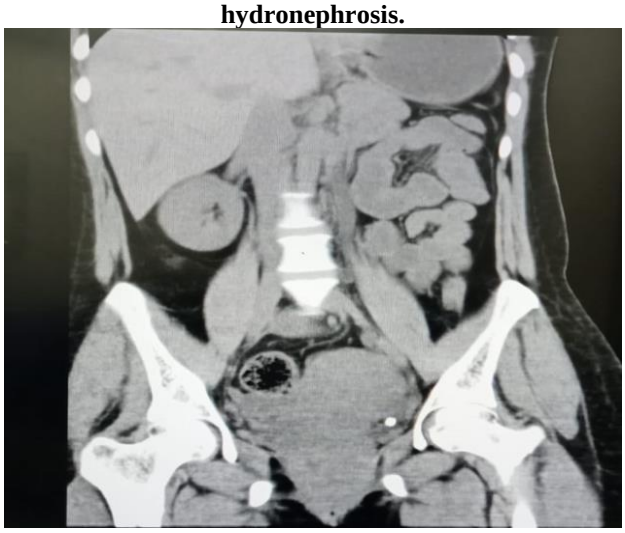

Figure 2: Coronal CT image Stone is seen in VUJ.

Discussion:

Prompt and accurate identification of kidney calculi is required for effective treatment and to reduce the risk of adverse effects [10]. Due to its high sensitivity and accuracy, non-enhanced CT is the gold standard for identifying kidney calculi at this time.11 Non-enhanced CT is preferred, but it is not always available, is not appropriate for all patients, and exposes patients to hazardous radiation [11]. Ultrasound, on the other hand, has several advantages over x-rays: it is simple to obtain, does not require invasive surgery, and does not expose the patient to radiation, in addition, ultrasonography can detect secondary conditions such as hydronephrosis and obstruction, making it a useful screening tool[12].

Study discovered that ultrasound, in comparison to non-enhanced CT, the current gold standard, had a sensitivity of 84.7% and a specificity of 100% for identifying kidney calculi. Due to its high precision, ultrasound appears to be a reliable instrument for determining whether or not kidney calculi are present [14]. Ultrasound may be less effective at detecting small stones than unenhanced CT because its accuracy is inferior[15]. However, a subgroup study revealed that ultrasound has a higher sensitivity for larger stones (>5mm), suggesting that it may be useful for identifying larger stones.

Previous research on the ability of ultrasound to detect kidney calculi has yielded similar results to our own. Maryam et al. found the diagnosis rate to be 67.83%, the PPV to be 79.66%,

the NPV to be 55.36 %, and the sensitivity to be 65% [16]. According to the study by Aqsa Rao et al., 121 individuals were examined, and our findings are in complete agreement with theirs. 82 (67.2%) of the group's 121 individuals were female, while 39 (32.8%) were male. 60 patients (40.6%) did not have ureteric calculi based on ultrasonographic findings, while 61 patients (50.4%) did. Even though ureteric calculi have been reported (90.9%), CT only detected them in 11% of individuals. ($p<0.05$). Accuracy for transabdominal ultrasound was 58.68%, sensitivity was 58.62%, specificity was 56.76%, PPV was 51.52%, and NPV was 63.64% [17].

One of the benefits of our research is the use of non-enhanced CT as the reference standard, which is currently the gold standard for identifying kidney calculi. Additionally, we increased the transferability of our findings by evaluating ultrasound's ability to detect kidney calculi in a clinical setting. However, our investigation is not without faults. Our results may not be pertinent to a larger population because our sample size is so small. Our research was limited in its applicability because it was conducted at a single institution.

Conclusion:

Study concluded that ultrasound is an effective diagnostic tool for detecting renal calculi, with a high specificity and moderate sensitivity compared to non-enhanced CT. Our findings suggest that ultrasound may be particularly useful in settings where non-enhanced CT is not readily available or is contraindicated. Further research is needed to determine the diagnosis and management of renal calculi.

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