International Journal of Community Medicine and Public Health
Pathan H et al. Int J Community Med Public Health. 2021 Jul;8(7):3269-3272
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040
DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20212576

Original Research Article

Diagnostic accuracy of renal calculi on ultrasonography taking computed tomography as gold standard

Hina Pathan[1]*, M. Kashif Shazlee[2], Junaid Iqbal[1], Ashraf A. Ali[3], Kamran Hameed[1], M. Saad Ahmed[1]

[1]Department of Radiology, Dr. Ziauddin Hospital, Karachi, Pakistan
[2]Department of Radiology, Indus Hospital, Karachi, Pakistan
[3]Department of Radiology, NICH, Karachi, Pakistan

Received: 28 April 2021
Accepted: 28 May 2021

***Correspondence:**
Dr. Hina Pathan,
E-mail: hn_pathan@yahoo.com

ABSTRACT

Background: Ultrasonography is a useful modality to diagnose stones and to confirm the occurrence of complications of other renal pathology, so it is important to understand these characteristic findings and other diseases that mimic them. In addition, other imaging modalities such as computed tomography (CT) can be recommended if the clinical or radiological diagnosis is ambiguous.
Methods: A group of 325 patients with clinical suspicion of renal calculi were included in this study. Out of these 325 patients 179 (55.0%) were male and 146 (44.9%) were female. All these patients underwent ultrasonography (USG) examination. Final diagnosis was based on CT findings which was done subsequently.
Results: The total number of patients comprising the study were 325 who underwent ultrasound examination. After USG and CT scan was done to confirm the diagnosis. Out of 325 patients, 201 patients were confirmed having renal calculi on USG analysis and remaining 103 patients were true negative.
Conclusions: The study proves that USG is highly accurate in diagnosing and characterizing renal calculi. USG also guides in defining exact location as well as aids in deciding the medical or surgical approach to be used.

Keywords: Ultrasonography, Renal calculi, Lumbar pain, Computed tomography

INTRODUCTION

Nephrolithiasis can involve all age groups and its diagnosis is essential because patient should use special management for a long time. Ultrasound (US) is a safe rapid access for diagnosis of most calculi larger than 5 mm but US accuracy decreases in smaller stone due to many misleading bright as non-calculus echoes.[1] Renal calculi has its highest prevalence in men aged 20-40 years. Between 1% and 15% of people globally, are affected by kidney stones at some point in their life.[2] In 2013, 49 million cases occurred resulting in about 15,000 deaths.[3,4] In females, the incidence rate is higher in the late 20s, decreases by age 50, and remains relatively constant thereafter.[5] US reliably demonstrates stones >5 mm size, but smaller stones, up to 40%, are commonly not detected. Computed tomography (CT) is commonly used for detection and is excellent. The sensitivity of US for detecting renal calculi has been reported to as high as 96% compared with that of abdominal radiography and conventional tomography.[6] However the true sensitivity of US for renal calculi may be substantially less, given evidence that radiography is less sensitive than previously thought. Renal and ureteral stones are common problems in primary care practice and affect approximately 10% of the population. Renal colic is a typical symptom of urolithiasis and frequently leads to emergency department (ED) visits.[7,8]

An American study showed that the use of CT scans for evaluation of flank pain in the ED significantly increased

(from 19.6% to 45.5%) between 2000 and 2008, while the use of US remained stable (from 5.6% to 6.9%). During that period, the proportion of patients who were diagnosed with a kidney stone remained stable at approximately 20% of those evaluated for flank pain. CT demonstrates renal stones more accurately than plain radiography, sonography, and excretory urography. Currently, CT is the preferred modality for evaluating patients with urinary colic.[9,10]

Previous research indicates that CT is more accurate than US for the diagnosis of small renal calculi, however, it is associated with escalating health care costs and radiation exposure, in particular cumulative doses of radiation in patients who need repeat imaging (e.g. kidney stone formers). Because of the increased lifetime risk of cancer related to the radiation from CT scans, their use as initial diagnosis of nephrolithiasis is not recommended for pregnant women and young children. US is not associated with radiation, however it is less sensitive than CT in detecting stones in kidneys or ureters.

A study conducted from the Department of Radiology, University of New Mexico School of Medicine showed that the sensitivity and specificity of US for any renal calculi were 44% (95% CI: 35%, 53%) and 98% (95% CI: 95%, 100%), respectively. The positive predictive value was 88% (95% CI: 82%, 94%), and the negative predictive value was 81% (95% CI: 74%, 88%). Another study conducted by George established that looking at the ability of US alone to detect at least 1 stone, the authors found the modality had a sensitivity of 78.9% and specificity of 83.7%.[11]

As there is variation in the results of above mentioned two studies conducted in two different population groups and to my best knowledge there is no local data available for establishing sensitivity and specificity of renal calculi on ultrasonography my study will therefore help in determining the significance of USG in making an earlier diagnosis of renal calculi in our population and comparing its accuracy with CT that would be helpful in early and effective starting of treatment which will reduce the morbidity and mortality and will offer the patients better prognosis regarding survival and quality of life.

METHODS

From December 2018 to May 2019, a cross sectional study was done, in department of Diagnostic Radiology of Dr. Ziauddin University Hospital, Karachi. Patients in the age group of 20-60 years presenting with all or any of the following symptoms: acute lumbar pain, gross hematuria or having (+++) red cells on urine detail report, patient of either gender, fever, nausea, vomiting and flank pain persisting for 2 weeks-2 months were included in the study. Patient already known case of renal calculi, patient not giving consent for CT scan, if recommended after ultrasonography, pregnant female patients were excluded from the study.

Data collection procedure

All patients with suspected renal calculi, presenting clinically with acute lumbar pain, gross or microscopic hematuria will be referred to the radiology department of Dr. Ziauddin Hospital for USG. Purpose and procedure of study will be explained after taking an informed consent. USG will be performed on Toshiba Xario 200 scanner. US of kidneys will be performed in longitudinal and axial planes with patient lying in supine and decubitus position by a senior radiologist with a minimum of three years of experience using 6.5 MHz frequency probe.

After performing US of the patients and being diagnosed as having renal calculi or with negative US, the patient will go for CT scan, which will then confirm our US findings. Final diagnosis will be "yes" or "no" depending on whether CT scan shows presence or absence of renal calculi. All relevant features including patient's name, age, registration number, date, duration of symptoms, US and CT scan findings will be recorded on performa by the researcher.

Data analysis

Statistical analysis was done using statistical package for the social sciences (SPSS) windows package version 16. Descriptive statistics, frequency and percentage was computed for presentation of qualitative variables like gender, symptoms, USG and CT findings. Age of patient and duration of symptoms was presented by mean and standard deviation (SD) and a table was constructed. Sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of US was determined by taking CT as gold standard. Stratification was done with respect to age, gender, symptoms and duration of symptoms to control the effect modifier, post-stratification diagnostic accuracy was computed.

RESULTS

During the six months period from December 2018 to May 2019, 339 patients turned up for USG with clinical suspicion of renal calculi. Majority of the patients were males with average age between 20-60 years and a mean of 35 years. Out of these, fourteen patients were excluded from the study because seven were already diagnosed for renal calculi, three were pregnant females and rest of the four did not give consent for CT pyelogram. Therefore, the final number of patients comprising the study were 325 who underwent CT pyelogram examination. Out of these 325 patients. 179 patients were male (55.0%) and 146 were female (44.9%).

After USG, CT pyelogram, was done to confirm the diagnosis. Correct assessment of renal calculi was made in 206 patients on USG out of these 05 patients were negative on CT. Incorrect assessment was made in 119 patients out of these 103 were true negative and 16 were false negative.

Table 1: Sensitivity and specificity of renal calculi on US and CT.

Sensitivity and specificity	Ultrasonography		Computed tomography	
	Male	Female	Male	Female
True +ve	111 +ve	90 +ve	111 +ve	90 +ve
True –ve	56 -ve	47 -ve	56 -ve	47 -v e
False +ve	3 +ve	2 +ve	-ve	-ve
False –ve	9 –ve	7 –ve	+ve	+ve

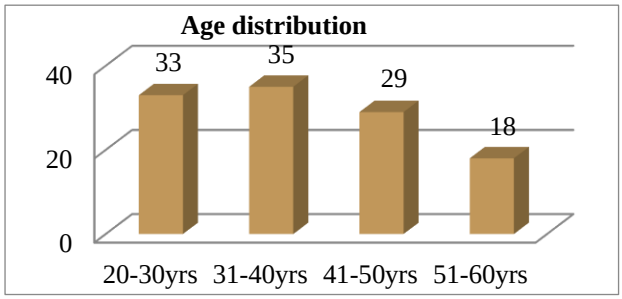

Figure 1: Age distribution chart.

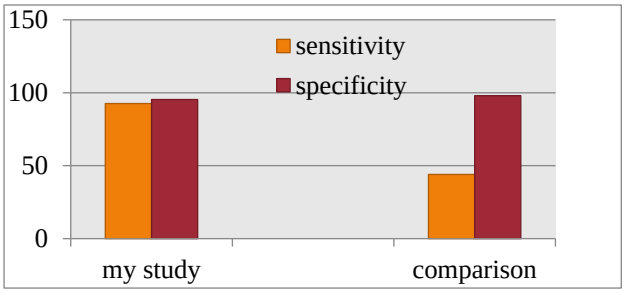

Figure 2: Comparison with the study from University of New Mexico, School of Medicine, Department of Radiology.

Table 2: Stratification of USG in detecting renal calculi according to gender.

Gender	Renal calculus on US (%)	
	No renal calculus (%)	Renal calculus (%)
Female	54 (36.9)	92 (63.0)
Male	65 (36.3)	114 (63.3)
Total	119	206

Table 3: Stratification of USG in detecting renal calculi according to age.

Age group	Diagnosis	
	No renal calculus	Renal calculus
20-30	30 (25.2)	42 (20.3)
31-40	38 (31.9)	66 (32.0)
41-50	28 (23.5)	56 (27.1)
51-60	23 (19.3)	42 (20.3)
Total	119	206

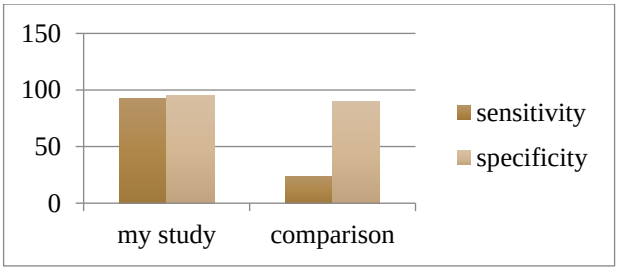

Figure 3: Comparison with study by Fowler.

DISCUSSION

Renal calculi is a common disease with increasing prevalence worldwide and a lifetime estimated recurrence risk of over 50%. Imaging plays a serious role in the preliminary diagnosis, follow up and urological management of urinary tract stone disease. USG, plain radiography, and CT are currently used to evaluate renal and ureteric calculi. USG is recommended as the initial imaging modality in patients with renal colic and suspected renal and ureteric calculi.[12,13] US has no risk of radiation, is reproducible and inexpensive, and the outcome is not significantly different for patients with suspected calculi undergoing initial US exam compared to patients undergoing initial CT exam.

This study was a cross-sectional study of 325 patients clinically suspected for renal calculi. After a detailed history, clinical examination and consent, the patients were subjected to US examination.

The study included men and women of age group 20-60 years who presented in ER with clinical signs and symptoms of ureteric calculi and were referred to our department by the urologists, emergency physicians or surgeons.

Most of the patients who came with sign and symptoms of renal calculi were between 20-60 years of age group.

In the study, lumbar pain is the main symptoms recognized for renal calculi.

The study also concluded that most of the patients present with symptoms of renal calculus within duration of 2-3 days.

Visualization of echogenic focus with posterior acoustic shadowing in kidney and hydronephrosis were the two most frequent US findings observed in this study.

Sensitivity and specificity of USG in present study is found to be 92.62% and 95.57%, respectively, in diagnosing renal calculi taking CT as gold standard. The positive and negative predictive values were found out to be 97.57% and 86.55%, respectively, while the diagnostic accuracy was calculated as 93.53% (Table 1 and 2). A study conducted from the department of radiology, University of

New Mexico School of Medicine showed that the sensitivity and specificity of US for any renal calculi were 44% (95% CI: 35%, 53%) and 98% (95% CI: 95%, 100%) respectively. The positive predictive value was 88% (95% CI: 82%, 94%), and the negative predictive value was 81% (95% CI: 74%, 88%). Another study conducted by George established that looking at the ability of US alone to detect at least 1 stone, the authors found the modality had a sensitivity of 78.9% and specificity of 83.7%. Factors influencing false positive cases of renal calculi include: there were 05 false positive cases in my study; false positives can, however, occur if other structures such as calcifications or renal sinus fat or vessel are mistaken for renal calculi; and one case that turned out to be false positive was of a 56 years old female who was diagnosed as renal calculus on US which was not found on CT, likely representing a renal sinus fat giving false impression of calculus on US.

CONCLUSION

The study shows that USG is highly accurate in diagnosing and characterizing renal calculi. Use of this rapid, non-invasive and highly accurate examination may decrease delays in appropriate management and also guides in defining the disease extent as well as aids in deciding the medical or surgical approach to be employed. Post stratification result of US in detecting renal calculi according to gender is significant, showing males have predominance over females in carrying renal calculi.

ACKNOWLEDGEMENTS

Authors would like to thank patients, without whom this study wouldn't have had completed.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Khan AN, Craig M, Worrall JA. Sonographic mimics of renal calculi. J Ultrasound Med. 2004;23(10):1361-7.
2. Morgan MS, Pearle MS. Medical management of renal stones. BMJ. 2016;352:52.
3. Vos T, Barber RM, Bell B, Bertozzi-Villa A, Biryukov S, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;386(9995):743-800.
4. Abubakar II, Tillmann T, Banerjee A. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;385(9963):117-71.
5. Lieske JC, De La Vega LP, Slezak JM, et al. Renal stone epidemiology in Rochester, Minnesota: an update. Kidney Int. 2006;69(4):760-4.
6. Smith RC, Verga M, McCarthy S, Rosenfield AT. Diagnosis of acute flank pain: value of unenhanced helical CT. AJR. Am J Roentgenol. 1996;166(1):97-101.
7. Johri N, Cooper B, Robertson W, Choong S, Rickards D, Unwin R. An update and practical guide to renal stone management. Nephron Clin Pract. 2010;116(3):159-71.
8. Teichman JM. Acute renal colic from ureteral calculus. N Engl J Med. 2004;350(7):684-93.
9. Fowler KA, Locken JA, Duchesne JH, Williamson MR. US for detecting renal calculi with nonenhanced CT as a reference standard. Radiology. 2002;222(1):109-13.
10. Ather MH, Jafri AH, Sulaiman MN. Diagnostic accuracy of ultrasonography compared to unenhanced CT for stone and obstruction in patients with renal failure. BMC Med Imaging. 2004;4(1):2.
11. Patlas M, Farkas A, Fisher D, Zaghal I, Hadas-Halpern I. Ultrasound vs CT for the detection of ureteric stones in patients with renal colic. Br J Radiol. 2001;74(886):901-4.
12. Türk C, Petřík A, Sarica K. EAU guidelines on diagnosis and conservative management of urolithiasis. Eur Urol. 2016;69(3):468-74.
13. Nicolau C, Claudon M, Derchi LE. Imaging patients with renal colic—consider ultrasound first. Insights Imaging. 2015;6(4):441-7.

Cite this article as: Pathan H, Shazlee MK, Iqbal J, Ali AA, Hameed K, Ahmed MS. Diagnostic accuracy of renal calculi on ultrasonography taking computed tomography as gold standard. Int J Community Med Public Health 2021;8:3269-72.