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ORIGINAL ARTICLE

Ureteric colic diagnosis by plain radiography and ultrasound by taking CT-KUB as Gold Standard.

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ABSTRACT… Objective: To assess the sensitivity and specificity of ultrasound, plain radiography, and CT for diagnosing ureteral colic in individuals with acute flank pain. **Study Design:** Cross-sectional Research. **Setting:** Department of Radiology, PAF Hospital, Islamabad, Pakistan. **Period:** August 2022 to Janury 2023. **Methods:** The study included 150 individuals with an average age of 40.68 years. Pre-procedural imaging modalities included plain radiography (X-ray KUB), ultrasound (U/S), and CT. **Results:** Ureteral stones were confirmed in all 150 cases. CT demonstrated 100% sensitivity and specificity. X-ray KUB had a sensitivity of 90%, while ultrasound had a sensitivity of 74%. Some stones were missed by ultrasound due to interference from intestinal gases, and a few were not identified on X-ray KUB. **Conclusion:** All three modalities successfully diagnosed ureteral stones. While CT is the most accurate diagnostic tool, X-ray KUB and ultrasound can be considered as alternatives, especially in settings requiring lower radiation exposure.

Key words: Ultrasonography (U/S), Computed Tomography (CT), Plain Radiography, Kidney Ureter Bladder (KUB), CT KUB, Ureteric Colic

INTRODUCTION

Ureteric colic is a type of distress caused by a clogged stone in the ureter. Ureteric colic is caused by calculi obstructing the urinary system at the thinnest anatomical locations of the ureter: the pelviureteric juncture (PUJ), around the pelvic border at the passage of the iliac arteries, and the vesicoureteric junction (VUJ).[1,2] When urine becomes fully saturated with salts and ions like calcium oxalate, struvite (ammonium magnesium phosphate), uric acid, and cysteine then calculi develop. They range in sizes from tiny 'gravel-like' stones to massive staghorn calculi. The stones normally start in the kidneys and then migrate into the urinary tract, where they might get caught in small ducts, such as bladder stones, ureteric stones and kidney stones. It can be quite serious and requires immediate medical attention.[3]

Ureteric colic is characterized by acute discomfort in the loin (flank). The area of the pain may be relevant, but it is not a reliable indicator of the stone's presence inside the urinary system. Symptoms of bladder irritation may appear as the stone reaches the vesicoureteric junction. The acute pain extends from the frontal part of the abdomen to the inguinal region. It can also spread to the testicle in men and the labia in women. Ureteric colic occurs when a stone enters the ureter. Hematuria, sickness, vomiting, urination pain, urinary obstruction, abdominal cramps, and cold are the most prevalent signs of urinary stones, according to different publications, and they are the most common reasons to get clinical treatment.[4]

The literature evidence proposed in the prevalent research has confirmed that a urinary tract stone affects 5–12% of the community at some point in their lives, with incidence rates approaching 50%. According to Rodger et al., ureteric colic is a frequent ailment that affects one out of every 1,000 persons each year.

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Women are more susceptible at a relatively young age, with peak onset in their late twenties.[5]

Ureteric calculi are rather common, developing in about 12% of males and 7% of women over their lifespan. Most individuals are between the ages of 30 and 60, with the highest prevalence between the ages of 35 and 45. It is rare for calculus to manifest itself after the age of 50.[6] Long-term blockage and infections caused by the stone disease can result in kidney failure. To avoid problems and maintain kidney functioning, timely correct diagnosis and cure of stone formation are crucial.

Using CT-KUB as the gold standard, the design of this fundamental research work will play a significant contribution to ureteric colic diagnosis using plain radiography and ultrasound. The specificity and sensitivity of diagnostic techniques will be the subject of this research. In this research, quantitative metrics and statistical analysis will be used to evaluate the diagnostic effectiveness of plain radiography and ultrasounds in the diagnosis of ureteric colic, with computed tomography (CT-KUB) as a potential gold standard of imaging that could lead to better therapy.

METHODS

The cross-sectional research was carried out over three months from August 2022 to January 2023. The data collection and the whole procedure were performed in the radiology department of the PAF hospital in Islamabad, Pakistan.

The consent and ethical approval were acquired from the PAF institutional board (ERC/PAF-030 on 28/07/2022) before the planning and execution of the research work. The investigation was conducted under the ethical guidelines for conducting the primary clinical investigation. Written informed consent was obtained before the inclusion of patients with ureteric colic. Obtaining written informed consent was substantively important to guarantee that patients were treated according to their wishes.

A total of 150 individuals with intense flank pain were assigned for ureteric Colic imaging. Out of 150 individuals, there were 115 males and 35 females, with an average age of 40.68 years for both men and women. The range of age was from 10 to 65 years. For acute flank pain, all individuals are transferred to the radiology department from the emergency room for urinary tract CT KUB, ultrasonography, and plain radiography. In this research, all patients who reported to the hospital with the symptoms of ureteric colic throughout the duration of the research and met the inclusion conditions were enrolled after the further screening. Patients with established pelvic pathology, pregnant women, individuals who declined to grant permission, and uncooperative patients (psychiatric patients) were all excluded from the research. The goal of the study was explained to all patients, and formal informed consent was obtained. A medical health assessment was conducted.

Following the phase of choosing patients for the collection of data needed, consultant radiologists were brought in to do ultrasounds to evaluate the ureteric colic. All participants with a full urinary bladder underwent transabdominal ultrasonography with esaote MyLabSix ultrasound scanner. Both the axial and frontal planes were used to image the kidneys.

After ultrasonography, patients were screened with computed tomography (KUB) using the Acquilion multislice (64) CT scanner. The outcomes of the computed tomography imaging were all confirmed by an expert radiologist. A helical CT scanner was used to obtain all CT scans without the use of oral or IV contrast material. Traditional film or digital images were used to acquire a plain radiograph of the KUB. With the patient in the supine posture, a single anteroposterior image of the whole urinary system was accomplished. The outcomes of every imaging procedure were saved in excel spreadsheets and clinically created reports, allowing us to keep a close eye on and critically analyze the results of each kind of imaging method used to determine the occurrence and development of ureteric colic.

The data was analyzed with a SPSS version 26. The gender, CT recordings, and USG data

were all analyzed in a categorized manner. The data was displayed as percentage and frequency. Performa was used to gather the data. The specificity and sensitivity was calculated using 2 X 2 table taking CT scan as gold standard. The CT findings were estimated independently by the two observers.

RESULTS

Out of 150 individuals, 115 males and 35 females with an average age of 40.68 years for both men and women. The range of age was from 10 to 65 years. 59.33% (N=89) of the patients belonged to the 26-45 years of age group. The frequency of age groups and percentages of patients in the particular age group is shown in Table-I.

All 150 patients screened positive for ureteric colic using the CT KUB gold standard imaging technique. None of the patients showed a negative result for ureteric colic which means that the sensitivity and specificity of CT KUB were 100%. When using CT KUB as the gold standard, 111 patients (74%) were true positive on ultrasound imaging. In the case of ureteric colic, ultrasonography had a sensitivity of 74%, while plain X-ray (KUB) radiography had a sensitivity of 90% (Table-II).

Study Variables	Age Group	Frequency	Percentage
Age (Years)	10-25	N= 13	8.67
	26-45	N= 89	59.33
	45-65	N=48	32
	Total	150	100
Gender	Male	N=115	76.67%
	Female	N=35	23.33%

Table-I. Demographic details and age distribution of the patients in groups

Modality Name	Sensitivity	Specificity
Ultrasonography	74%	79%
Plain Radiography	90%	94%

Table-II. Sensitivity and Specificity of Ultrasonography and Plain Radiography to diagnose ureteric colic, taking Computed Tomography as a gold standard

DISCUSSION

The critical assessment of the literature presented that the diagnostic location, patient body morphology, expense, and ionizing radiation sensitivity all play a role in determining the best imaging technique for ureteric colic. The diagnosis made with the imaging technology may aid the care provider in determining the fundamental factors of the inflammation, the rate at which it progresses, and the effects it has on the related organs and systems.[7] There are a variety of imaging techniques accessible, however, they are presently confined to plain radiography, CT, ultrasonography, and kidney ureter bladder imaging (KUB). The optimum imaging technique is selected based on specificity and sensitivity, benefits, drawbacks, and expenses.

The research carried out by Masarani and Dinneen showed that in the assessment of severe flank pain, X-Ray has a sensitivity of 45–60%. Identifying ureteric stones might be challenging due to the presence of intestinal gas or feces. Furthermore, a KUB is unable to detect radiolucent stones (10–20%), restricting the efficacy of plain radiography.[8] According to previous research, KUB radiography was 57 percent sensitive and 76 percent specific in research.[9]

In many cases, nevertheless, a KUB may be sufficient for determining the size, morphology, and position of urinary calculi. Large radiopaque calculi can be detected on a plain abdomen (KUB) film. Tiny calculi and radiolucent stones, on the other hand, may go undiagnosed.[10] Blockage and fluid accumulation is difficult to diagnose. The plain film with ultrasonography is employed in certain centers for limited dose preliminary investigation for particular patient categories. When a stone is seen on an abdominal x-ray or CT scanogram, the plain film might be used as a follow-up.

Ultrasound imaging is a safe, quick, economical, non-ionizing radiation method that is rapidly replacing CT outside the United States; nevertheless, doctors in the United States are increasingly turning to this technology. Ultrasound imaging has a broad variety of sensitivity and specificity, based on differences in techniques, physical shape, patient population, and standards. The specificity and sensitivity

for detecting ureteral calculi are 45% and 94%, accordingly, and 45% and 88%, respectively, for renal stones, according to a summarized analysis of the literature.[11]

Integrating ultrasonography with KUB radiography can increase sensitivity. Again, there are wide differences, but sensitivity and specificity scores for these pooled investigations range from 58 to 100% and 37 to 100%, respectively.[12] When contrasted to a helical CT scan, ultrasonography sensitivity and specificity of detected stone diseases and other conditions that produce flank pain were rather lower.[13] Ultrasound is non-invasive, devoid of ionizing radiation, readily accessible, and cheap therefore has evolved as a major imaging technique for the assessment of urinary tract calculi. Inter-operator variance and difficulties to diagnose ureteric calculi are potential drawbacks. When x-ray KUB is added to ultrasonography, the sensitivity for ureteric calculi enhances.[14]

Computed tomography is an extremely sensitive imaging method that is medically acknowledged to assess and diagnose organs, according to previous research.[15] The gold standard for detecting ureteric colic is non-contrast CT (CT KUB), with a large percentage (99%) being radio-dense (Arumuham et al., 2019). Stones larger than 1 mm are visible, with helical CT having a specificity of 100%.[16] Imaging the patient in the flat position is preferable because it is easier to determine if a stone is still lodged in the ureterovesical junction or has moved smoothly into the bladder. CT has the maximum sensitivity of all the known techniques for diagnosing kidney stones, with realistic estimations proposing it at 95%. Large stones are rarely missed with CT, but tiny stones (less than 3 mm) may slide between the scanned tissue planes and go undetected. Except for some stones formed by the deposition of protease inhibitor medicines in the urine, mostly all stones can be visualized with CT.

The CT KUB test is the most effective test for detecting ureteric colic. Nevertheless, it has some flaws, such as a low spatial precision, which causes it to anticipate small calculi and stone pieces inaccurately. Minimal-dose procedures expose patients to a low dose, resulting in a lower biological concern. Urinary stones at the PUJ, the VUJ, and the renal pelvis or calyces can all be seen using ultrasonography. Ultrasonography, on the other hand, has a hard time detecting stones between the PUJ and the VUJ.[17]

Undoubtedly, CT is the gold standard test but new evidence suggests that examining patients with ultrasound in the emergency service can assist to prevent CT in more than half of cases, resulting in lower cumulative dose of radiation and fewer problems, pain scores, emergency department visits, and hospital stay.[18] Individuals who have to prevent irradiation, such as pregnant women, may benefit from ultrasound. It can also help in percutaneous nephrostomy tube implantation in septic patients and evaluating for problems like hydronephrosis or pyonephrosis. CT has been the gold standard in the diagnosis of urinary calculi over the last nine years due to its exceptional sensitivity (95-98%) and specificity (96-99%). In contrast to CT scans, the results of the literature study showed that ultrasonography is less accurate in evaluating and diagnosing the existence and magnitude of ureteric colic.[19]

The purpose of this research was to assess the reliability of ultrasonography and plain radiography imaging to the efficacy of CT scan (the gold standard) in determining the occurrence of ureteric colic. To obtain accurate results, the patients of a wide age group of 10 to 65 years old were selected. The majority of patients reported with acute flank pain related to ureteric colic were between the ages of 26 and 45. The results of this research revealed that ultrasonic imaging was 74% effective and sensitive. In comparison, CT scans were 100 percent accurate in detecting the existence of ureteric colic. Plain radiography was shown to be 90% sensitive and effective. These findings suggest that X-ray (KUB) is more accurate and sensitive as compared to ultrasonography. Plain radiography had a sensitivity for diagnosing ureteric colic that was very close to the gold standard of CT KUB. The following is the order of reliability and sensitivity of the three modalities.

CT (KUB) - Gold Standard > Plain Radiography (X-ray KUB) > Ultrasonography

The outcomes of existing literature and research investigations support these findings. According to other research, ultrasounds had a diagnostic accuracy of 74 percent to 78 percent in detecting ureteric colic, comparable to the gold standard CT scan.[20] The results are consistent with evidence from the literature. CT has a higher sensitivity and effectiveness, according to the literature. After CT, X-ray is the most sensitive modality, while ultrasonography is the least sensitive. Therefore, traditional radiological modality such as CT is more commonly performed to clinically test patients with ureteric colic symptoms.

CONCLUSION

In clinical settings, X-ray KUB and U/S have essentially identical clinical outcomes to CT because the stones that go undetected by U/S are usually small and should pass on their own, while some stones go undetected by X-ray KUB are due to incorrect bowel preparation. The selection is made based on the accessibility of each technology and the Radiologist's expertise. The CT will identify more ureteric colic, but with a little effort, a combination of X-ray KUB and U/S will yield equivalent practical outcomes with a reduced X-ray dosage for the patient. The CT should only be used in individuals who have clinical signs of significant colic and a negative U/S and X-ray KUB.

LIMITATIONS

The study had limitations, including its single-center design, small sample size, and exclusion of certain groups like pregnant women and those with pelvic pathology, limiting generalizability. Ultrasound results were operator-dependent, and follow-up data to confirm initial findings were lacking. Radiation exposure from CT scans was not quantified, and specificity of imaging modalities was less emphasized. Future research with larger, multicenter trials and broader patient demographics is needed.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Batura D, Hashemzehi T, Gayed W. **Should contrast CT urography replace non-contrast CT as an investigation for ureteric colic in the emergency department in those aged 65 and over?.** Emergency Radiology. 2018 Dec; 25:621-6.

2. Woodhouse CR, Kirkham A, editors. **Radiology and follow-up of urologic surgery.** John Wiley & Sons. 2017 Aug 30.

3. Finkielstein VA, Goldfarb DS. **Strategies for preventing calcium oxalate stones.** Cmaj. 2006 May 9; 174(10):1407-9.

4. Gandhi A, Hashemzehi T, Batura D. **The management of acute renal colic.** British Journal of Hospital Medicine. 2019 Jan 2; 80(1):C2-6.

5. Rodger F, Roditi G, Aboumarzouk OM. **Diagnostic accuracy of low and ultra-low dose CT for identification of urinary tract stones: A systematic review.** Urologia Internationalis. 2018 Apr 12; 100(4):375-85.

6. Glazer K, Brea IJ, Leslie SW, Vaitla P. **Ureterolithiasis.** InStatPearls [Internet] 2024 Apr 20. StatPearls Publishing.

7. PARMAR G. **Severity assessment of acute pancreatitis using CT severity index and modified CT severity index: Association with clinical outcomes and ranson's criteria.** 2021.

8. Masarani M, Dinneen M. **Ureteric colic: New trends in diagnosis and treatment.** Postgraduate Medical Journal. 2007 Jul; 83(981):469-72.

9. Javed M. **Diagnostic accuracy of trans-abdominal ultrasonography in urolithiasis, keeping CT KUB as gold standard.** Journal of Islamabad Medical & Dental College. 2018 Nov 18; 7(3):204-7.

10. Avni FE, Priso RH, Novo R. **Imaging urolithiasis and their complications.** Imaging Acute Abdomen in Children. 2018:257-65.

11. Ray AA, Ghiculete D, Pace KT, Honey RJ. **Limitations to ultrasound in the detection and measurement of urinary tract calculi.** Urology. 2010 Aug 1; 76(2):295-300.

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

13. Syed Muhammad F, Nazish N, Fatima Batool Z, Adeeb ul Hassan R. **Diagnostic accuracy of ultrasound and X-ray kub in ureteric colic taking CT as gold standard.** 2014; 22-27.

14. Ather MH, Jafri AH, Sulaiman MN. **Diagnostic accuracy of ultrasonography compared to unenhanced CT for stone and obstruction in patients with renal failure.** BMC Medical Imaging. 2004 Dec; 4:1-5.

15. Werge M, Novovic S, Schmidt PN, Gluud LL. **Infection increases mortality in necrotizing pancreatitis: A systematic review and meta-analysis.** Pancreatology. 2016 Sep 1; 16(5):698-707.

16. Hamm M, Knöpfle E, Wartenberg S, Wawroschek F, Weckermann D, Harzmann R. **Low dose unenhanced helical computerized tomography for the evaluation of acute flank pain.** The Journal of Urology. 2002 Apr; 167(4):1687-91.

17. Ferrero A, Takahashi N, Vrtiska TJ, Krambeck AE, Lieske JC, McCollough CH. **Understanding, justifying, and optimizing radiation exposure for CT imaging in nephrourology.** Nature Reviews Urology. 2019 Apr; 16(4):231-44.

18. Brower C, Rehani MM. **Radiation risk issues in recurrent imaging.** The British Journal of Radiology. 2021 Oct 1; 94(1126):20210389.

19. Sommer FG, Jeffrey Jr RB, Rubin GD, Napel S, Rimmer SA, Benford J, et al. **Detection of ureteral calculi in patients with suspected renal colic: value of reformatted noncontrast helical CT.** AJR. American Journal of Roentgenology. 1995 Sep; 165(3):509-13.

20. Ganesan V, De S, Greene D, Torricelli FC, Monga M. **Accuracy of ultrasonography for renal stone detection and size determination: Is it good enough for management decisions?.** BJU International. 2017 Mar; 119(3):464-9.

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