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DIAGNOSTIC ACCURACY OF ULTRASOUND IN DETECTING URETERIC CALCULI TAKING COMPUTED TOMOGRAPHY AS STANDARD

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Abstract

Ureteric calculi are important and frequent emergency in medical practice, associated with severe pain due to presence of obstructed stone in ureter. Computed tomography of the kidneys, ureters and bladder (CT-KUB) is the gold standard for renal colic; however, ultrasound (US) can be used safely in place of CT-KUB. This study includes 170 patients selected by non-probability consecutive sampling technique. Detailed medical history of each patient was obtained, followed by clinical evaluation of patients. Ultrasound and computed tomography (CT) of kidney ureter and bladder (KUB) of each patient was performed by consultant radiologist for identification of ureteric calculi. Out of 170 patients recruited, n=95 (56%) patients were male and n=75 (44%) were female. Ureteric calculi diagnosed in 107 (62.9%) patients on the basis of computed tomography (CT) and in 91 (53.5%) patients on the basis of ultrasound (US). Sensitivity (Sn), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy (DA) of ultrasound was 67.29%, 69.84%, 79.12%, 55.70% and 68.24%, respectively by taking computed tomography as gold standard. Ultrasound is sensitive, specific and economical in detection of ureteric calculi. The diagnostic accuracy of ultrasonography in detection of ureteric calculi is acceptable and hence it may serve as an alternative in case of unavailability or contraindication to computed tomography.

Keywords: Ureteric calculi, pain, computed tomography, ultrasound

Introduction:

Ureteric calculi are important and frequent emergency in medical practice, associated with severe pain due to presence of obstructed stone in ureter [1, 2]. It is a solid, pebble-like piece of material that can form in a kidney when minerals in the urine are too high, resulting in pain, urine flow blockage, and long-term kidney problems in case of inappropriate management. When a kidney stone passes down into ureter, it may turn into ureteric calculi [2, 3]. Presence of stone in kidney is not considered as medical emergency but stone in ureter is considered as medical emergency that requires rapid diagnosis and management [4]. Prevalence of ureteric calculi is 5-12% and recurrence rate 50.0% [5, 6].

The classical clinical signs and symptoms associate with ureteric calculi are; acute, severe, loin pain radiates to groin, nausea, vomiting, hematuria, dysuria, and fever [7, 8]. These sign and symptoms frequently overlapped with different other diseases such as appendicitis, pyelonephritis, diverticulitis, etc. Therefore, radiology plays a vital role in appropriate diagnosis so that patients can be appropriately managed [8, 9].

Computed tomography (CT) of kidney ureter and bladder (KUB) is used as a gold standard for diagnosis of ureteric calculi because it is fast, easy to perform, detect extra urological diseases and no need of IV contrast. But at the same time, CT-KUB is expensive and exposes the patients to ionizing radiation, raising health care costs [10]. Ultrasound (US) is more commonly performed imaging technique that is safer, rapid, inexpensive, and repeatable technique that helps in identification of ureteric calculi as compared to CT scan [10, 11]. Different studies were conducted on ureteric calculi management throughout the world. A study on detection of urolithiasis by US was conducted by Nery DR, et al. reported the 53.1% prevalence of ureter stones, sensitivity 63.0%, and specificity 61.3% [12]. Another study on urolithiasis was conducted by Ryu HY, et al. who reported the 59.3% prevalence of ureter stones [13]. A study by Faiq SM, et al. reported the sensitivity and specificity of CT scan 100.0% and 100.0%, and US 52.6% and 76.0% respectively [7].

The rationale of the study is to find out a safe, rapid, inexpensive, and repeatable diagnostic modality for diagnosis in patients suspected for ureteric calculi in local population. As large number of population in Pakistan are suffering from ureteric calculi and belong to poor socioeconomic strata of population, so are unable to beer the expenditures of CT scan. Therefore, study will be helpful in finding out the diagnostic accuracy of US in comparison to CT scan that will be helpful for recommending US as a first line of investigation tool to investigate the persons with suspected ureteric calculi. The study will be helpful in adding the diagnostic accuracy of ultrasound in ureteric calculi patients in existing literature and will help in using the ultrasound as replacement of computed tomography as a gold standard.

Materials and methods:

This cross-sectional study was conducted at Radiology department of Liaquat University of Medical and Health Sciences (LUM&HS) Jamshoro from September, 2020 to March, 2021.

Sample size

The sample size calculation was done by using online sample size calculator for sensitivity and specificity, using Nery DR, et al. [12]. The sampling technique was consecutive sampling.

Inclusion criteria

Patients of any gender having 18-70 years of age and having ureteric calculi were included in this study.

Exclusion criteria

Diagnosed patients or at higher risk of acute cholecystitis, appendicitis, aortic aneurysm, and bowel disorders, were not included in the study.

Data collection

Detailed medical history of each patient including name, gender, age, duration of symptoms, pain, nausea, vomiting, fever, gross hematuria, and dysuria was obtained. Ultrasound of kidney ureter and bladder (KUB) of each patient was performed by consultant radiologist (having 3-5 years of experience) at radiology department for identification of ureteric calculi, computed tomography of kidney ureter and bladder (KUB) of each patient was performed by trained CT technician (having 3-5 years of experience) and interpreted by consultant radiologist (having 3-5 years of experience). All the data was recorded in proforma by researcher.

Statistical analysis

After collection of data the analyses were conducted by using Statistical Package for Social Science (SPSS) software, Version 22 and Excel, 2017. Mean and standard deviation was calculated for quantitative variables like age and duration of symptoms. Frequency and percentages were computed for qualitative variables like gender, age in groups, pain, nausea, vomiting, fever, gross hematuria, dysuria ureteric calculi (present or absent) on CT and US. Two by two table was constructed for sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy for US taking CT scan as gold standard. Effect modifier like gender, age, nausea, vomiting, fever, gross hematuria and dysuria were addressed through stratification. Post stratification a 2 by 2 table was used to calculate sensitivity, specificity, negative predictive value, positive predictive value and diagnostic accuracy of ultrasound in the detection of ureteric calculi.

Results:

In current study 170 patients were included who fulfill the inclusion criteria of the study.

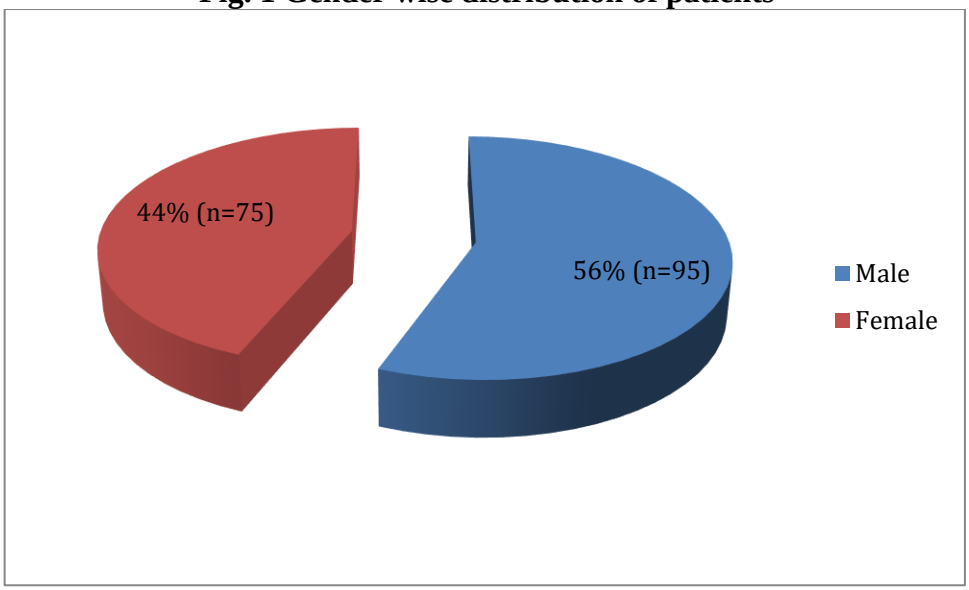
In table 1 descriptive statistics of continuous variable of duration of symptoms (in days) was done, where mean and standard deviation of duration of symptoms was 8.7 ± 6.0 (1-20) days.

Table.1 Duration of symptoms in patients

Variable	N	Min.	Max.	Mean	Std. Deviation
Duration of Symptoms (Days)	170	1	20	8.7	6.0

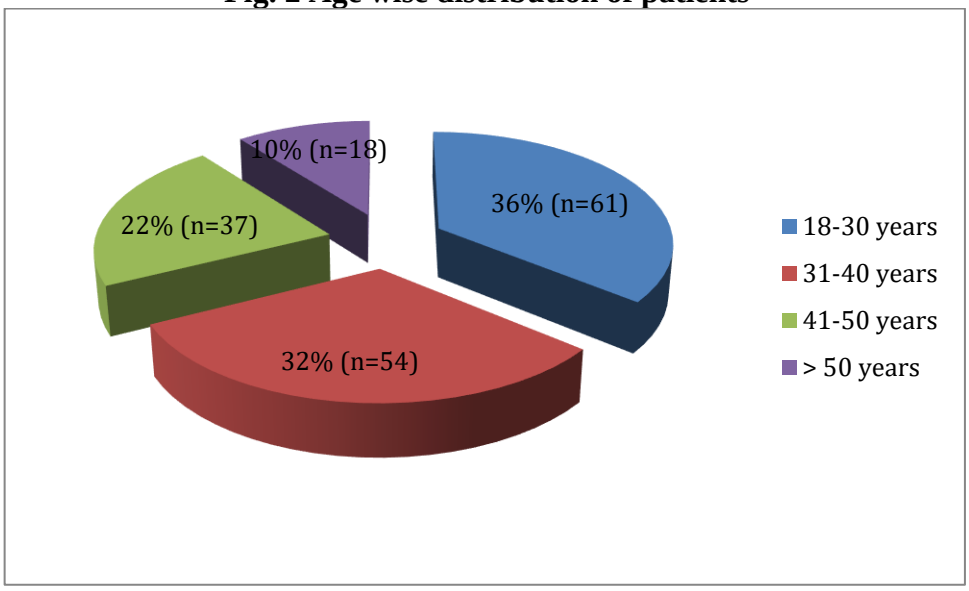
The distribution of gender was done; in this study 56% (n=95) patients were male and 44% (n=75) were female. Male patients were more affected with disease as compared to female patients (Fig. 1).

Fig. 1 Gender wise distribution of patients



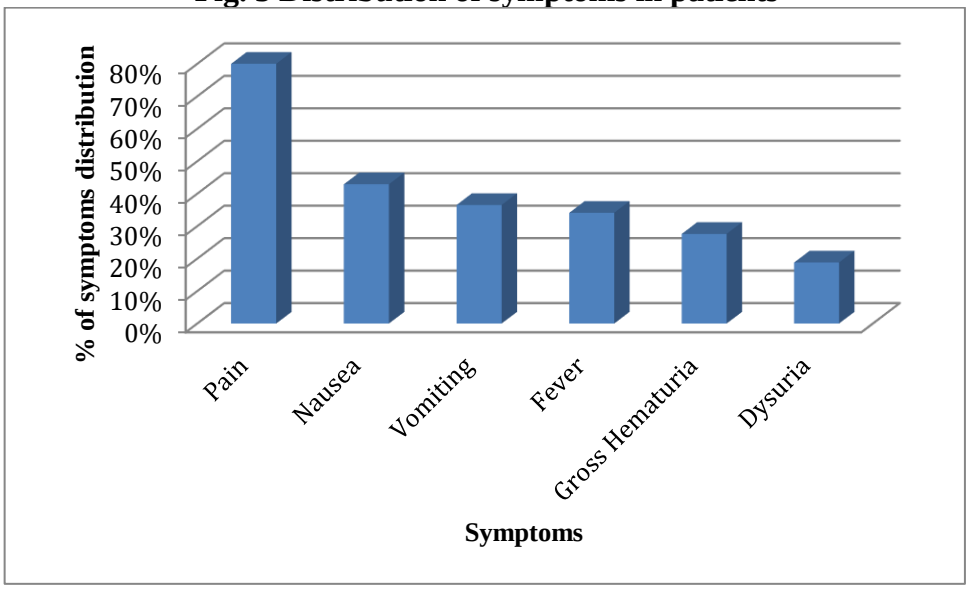
In Fig. 2 distribution of age in groups was done; in this study enrolled patients were grouped as; in 18-30 years n=61 (36%) patients, in 31-40 years n=54 (32%) patients, in 41-50 years n=37 (22%) patients and in > 50 years n=18 (11%) patients.

Fig. 2 Age wise distribution of patients



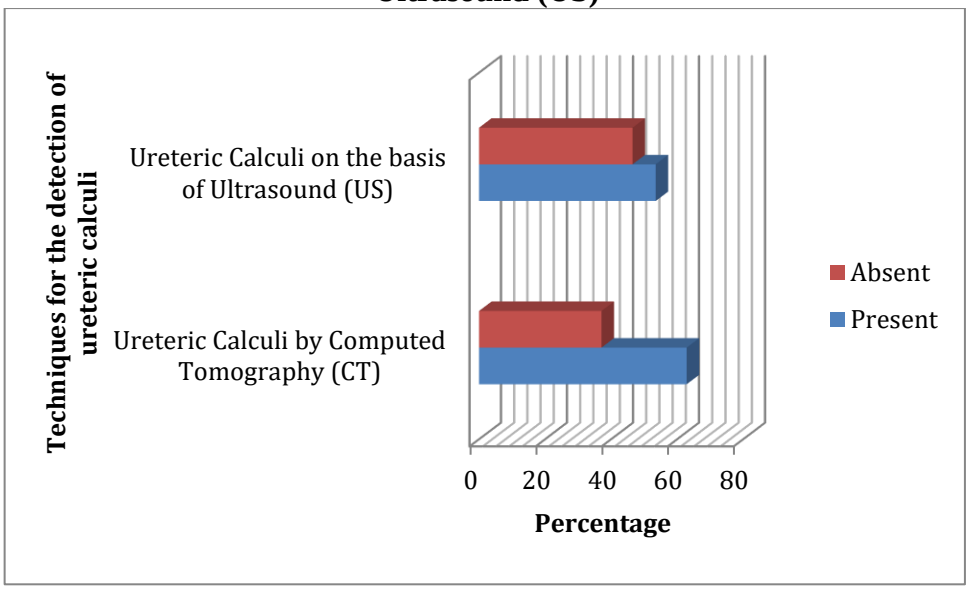
The distribution of pain n=136 (80.0%), nausea n=73 (42.9%), vomiting n=62 (36.5%), fever n=58 (34.1%), Gross hematuria n=47 (27.6%) and dysuria n=32 (18.8%) was noticed, respectively in (n) patients (Fig. 3).

Fig. 3 Distribution of symptoms in patients



The comparison of distribution of ureteric calculi diagnosis on the bases of computed tomography (CT) and of ultrasound (US) were present in n=107 (62.9%) patients and n=91 (53.5%) patients, respectively (Fig.4).

Fig. 4 Distribution of Ureteric Calculi on the bases of Computed Tomography (CT) and Ultrasound (US)



In table 14, sensitivity and specificity 2×2 table of ultrasound was done by taking computed tomography as a gold standard in diagnosis of ureteric calculi. In this table patients were categorized as; True Positive (TP) n=72 (42.4%) patients, False Positive (FP) n=19 (11.2%) patients, False Negative (FN) n= 35 (20.6%) patients and True Negative (TN) n=44 (25.9%) patients.

Table. 2 Sensitivity and specificity 2×2 table for ultrasound.

	GOLD STANDARD	
	Positive	**Negative**
Positive	True Positive (TP)	False Positive (FP)
Negative	False Negative (FN)	True Negative (TN)

ULTRASOUND	**COMPUTED TOMOGRAPHY**	
	Positive	**Negative**
Positive	72 (42.4%)	19 (11.2%)
Negative	35 (20.6%)	44 (25.9%)

In table 15, sensitivity (Sn), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy (DA) of ultrasound was distributed. Sn, Sp, PPV, NPV and DA of ultrasound was 67.29%, 69.84%, 79.12%, 55.70% and 68.24% respectively, calculated by using standard formulas.

Table. 3 Sensitivity (sn), specificity (sp), positive predictive value (ppv), negative predictive value (npv) and diagnostic accuracy (da) of ultrasound

Ultrasound	**RESULT**
Sensitivity (Sn)	67.29%
Specificity (SP)	69.84%
PPV	79.12%
NPV	55.70%
Diagnostic Accuracy (DA)	68.24%

Discussion:

Ureteric calculi is a kidney stone mostly small that normally moves down into the ureter usually composed of undissolved mineral and can easily be stuck in a narrow part of the ureter and becomes

a medical emergency [14]. CT-KUB is the most sensitive investigation for identification of Ureteric calculi. However, it has some weaknesses like limited spatial of resolution, use of ionizing radiation, repeated CT scans can result in a substantial cumulative dose during short-term follow up, etc. [15, 16], whereas ultrasound is used extensively in the examination of patients with suspected uretic calculi and has the advantage of being universally available, fast and easily performed, as well as not employing ionizing radiation [17].

Ultrasound is a safe, rapid, inexpensive and repeatable diagnostic modality for diagnosis in patients suspected for ureteric calculi in case of unavailability or contraindication to computed tomography. Therefore, current study was designed to find out the diagnostic accuracy of US in comparison to CT scan that will be helpful for recommending US as a first line of investigation tool to investigate the persons with suspected ureteric calculi.

In current study diagnostic accuracy of ultrasound was tested by using the computed tomography as a gold standard in diagnosis of ureteric calculi. In current study 170 patients were evaluated, out of which 95 (55.9%) patients were male and 75 (44.1%) were female. Similar Pakistani studies also reported.

The higher prevalence of male and lower prevalence of female such as; Javed M, et al reported the 54.8% male and 45.2% female [18], Ather MH, et al reported the 59.0% male and 41.0% female [19] and Altaf N, et al reported the 64.4% male and 35.6% female [20]. Male patients were more affected with disease as compared to female patients.

In current study mean and standard deviation of age was 36.1 ± 12.5 (18- 70) years. Most of the patients were in age group of 18-30 years with 61 (35.9%) patients followed by age group of 31-40 years with 54 (31.8%) patients, 41-50

years with 37 (21.8%) patients and > 50 years with 18 (10.6%) patients. Shams H, et al. study reported the similar mean age 36.43 ± 10.34 years, with similar patients in different age group; <30 years with 38.2% patients, 31-40 years with 33.3% patients, 41-50 years with 17.6% patients and >50 years with 10.8% patients [21]. Javed M, et al. also reported the similar mean and standard deviation of age i.e., 35.69 ± 5.91 years [18]. Wahab M, et al. also reported the similar mean and standard deviation of age i.e., 36.47± 8.243 years [22]. Younger patients were more affected with disease as compared to elder patients.

In current study ureteric calculi were diagnosed in 107 (62.9%) patients on the basis of computed tomography and in 91 (53.5%) patients on the basis of ultrasound. Similar results of ultrasound and computed tomography were reported by different researchers such as; Javed M, et al. reported that ureteric calculi diagnosed in 62.6% and 51.3% patients on the basis of computed tomography and ultrasound respectively [18]. Altaf N, et al reported that ureteric calculi diagnosed in 71.2% and 34.2% patients on the basis of computed tomography and ultrasound respectively [20]. Wahab M, et al. reported that ureteric calculi diagnosed in 70.0% and 58.8% patients on the basis of computed tomography and ultrasound respectively [22]. Computed tomography was more accurate in detecting ureteric calculi as compared to ultrasound.

In current study sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasound was 67.29%, 69.84%, 79.12%, 55.70% and 68.24% respectively by taking computed tomography as gold standard. Javed M, et al. reported the similar sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasound 65.27%, 72.09%, 79.66%, 55.36% and 67.83% respectively [18]. Wahab M, et al. also reported the similar sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasound 69.64%, 66.6%, 82.92%, 48.48% and 68.75% respectively [22]. Diagnostic accuracy of ultrasound in detection of ureteric calculi is acceptable and can be used in place of computed tomography.

Conclusion:

Ultrasound is sensitive, specific and economical in detection of ureteric calculi. The diagnostic accuracy of ultrasonography in detection of ureteric calculi is acceptable and hence it may serve as an alternative in case of unavailability or contraindication to computed tomography.

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