

COMPARATIVE ASSESSMENT OF UROLITHIASIS DETECTION BY ULTRASOUND AND X-RAY OF KIDNEY, URETER AND BLADDER AMONG ADULT PATIENTS AT IRFAN GENERAL HOSPITAL PESHAWAR

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Abstract

In the current study the aim of study was to compare the stone detection rate and stone size distribution between Ultrasound KUB and Plain X-ray KUB radiography in adult patients with suspected urolithiasis who were presented to Irfan General Hospital, (IGH), Peshawar. Fifteen hundred adult patients with clinical suspicion of urolithiasis were included in this cross-

sectional comparative study over six-month period. The patients were divided into two parallel diagnostic groups of 75 patients in each group who were evaluated with Plain X-ray KUB and Ultrasound KUB, respectively. Data regarding demography, clinical history, stones, stone size (<5 mm, 5–10 mm, >10 mm), and anatomical location were documented and analyzed in SPSS version 22. One hundred and fourteen patients (76.0%) had urinary stones detected. Calculi were detected by ultrasound KUB in 63 (84.0%) patients and by X-ray KUB in 51 (68.0%) patients. There was a statistically significant difference in the rate of stone detection between imaging modality (5.263, $p = 0.0225$). Among all detected stones across both modalities ($n = 114$), 47 (31.3%) were <5 mm, 42 (28.0%) were 5–

10 mm, and 25 (16.7%) were >10 mm. There was no statistically significant difference between the two modalities in stone-size distribution ($\chi^2 = 0.237$, $p = 0.888$). The most frequent anatomical site (22.0%) was ureteric calculi, followed by calyces (19.3%), renal pelvis (17.3%) and urinary bladder (17.3%). The ability of ultrasound KUB to detect stones was found to be significantly superior to Plain X-ray KUB in urolithiasis suspected patients. Due to its non- Ultrasound KUB is recommended as the first imaging modality to use if able to do so in resource-limited clinical settings.

INTRODUCTION

Urolithiasis, also known as kidney stone disease, is a common urological disorder characterized by the formation of mineral crystals within the urinary tract. Its increasing incidence is associated with dietary changes, sedentary lifestyles, obesity, inadequate fluid intake, and metabolic disorders such as diabetes mellitus. Patients commonly present with severe flank pain, hematuria, dysuria, nausea, and urinary obstruction. If left untreated, the condition may lead to recurrent urinary tract infections, hydronephrosis, chronic kidney disease, and renal failure (Syahputra, 2025; Park et al., 2024; Arshad et al., 2026; Hameed et al., 2021). Kidney stone formation involves urinary supersaturation, crystallization, Randall's plaques, hormonal influences, microbial activity, and immune responses (Aleem et al., 2020). The growing burden of urolithiasis highlights the importance of early and accurate diagnosis to prevent complications and guide appropriate treatment (Weng et al., 2020; Aslam et al., 2020). Several imaging modalities are available for diagnosing renal and ureteric calculi, including ultrasonography (USG), plain X-ray of the kidneys, ureters, and bladder (X-ray KUB), computed tomography (CT), and magnetic resonance imaging. Non-contrast CT KUB is considered the gold standard because of its high sensitivity and specificity, accurate stone localization, and ability to assess stone size and density (Kumar, 2020; Shoaib et al., 2020). However, its high cost and radiation exposure may limit routine use, particularly in resource-constrained settings (Arshad et al., 2026). USG is a non-invasive, relatively inexpensive, radiation-free modality commonly used as an initial investigation, particularly in pregnant women and children. Stones typically appear as echogenic foci with posterior acoustic shadowing. However, USG may miss small stones and ureteric calculi because of bowel gas, overlying structures, and limitations in visualizing parts of the ureter (Ather et al., 2004; Siriwardana and Abey Suriya, n.d.). X-ray KUB is also widely available and inexpensive, but its ability to detect small or radiolucent stones is limited. Although radiation exposure from X-ray KUB is relatively low, it remains an important consideration during repeated examinations (Kandasamy et al., 2024). Furthermore, the likelihood of spontaneous stone passage decreases as stone size increases, emphasizing the importance of accurate assessment (Memon et al., 2021).

Evidence suggests that combining USG with X-ray KUB can improve the detection and follow-up of ureteric calculi where CT is unavailable or unsuitable (Ravishankar et al., 2020). Therefore, this study aims to compare the detection of renal stones using USG and X-ray KUB among patients presenting to Irfan General Hospital, Peshawar, to evaluate their diagnostic usefulness in a resource-limited clinical setting.

Material and Methodology:

A cross-sectional study was conducted at Irfan General Hospital (IGH), Peshawar, to assess the detection of renal stones using ultrasound and X-ray examinations. A non-probability convenience sampling technique was used to recruit 150 patients, with 75 participants in each group, based on patient availability and the study duration. Adults aged 18 years and above presenting with symptoms suggestive of renal stones, such as flank pain, hematuria, or dysuria, were included. Patients with chronic kidney disease, renal failure, previous renal transplantation or other renal surgeries, contraindications to imaging, incomplete medical records, or unwillingness to participate were excluded. Ethical approval was obtained from the research committees of Sarhad Institute of Allied Health Sciences (SIAHS) and IGH, and informed consent was obtained from all participants before data collection. Data was collected using a self-developed questionnaire covering demographic characteristics, clinical symptoms, and ultrasound and X-ray findings. The collected data were analyzed using SPSS version 22 and presented as frequencies and percentages. The chi-square test was used to assess associations between stone detection and imaging modalities, with a p-value of less than 0.05 considered statistically significant.

Result:

Age wise Distribution of Participants

The study entitled “Comparative Assessment of Urolithesis Detection by Ultrasound KUB and X-ray KUB among Adult Patients” included 150 participants (75 for each group). Mean age of study participants was (42.41 ± 17.062 SD) as shown in Figure 4.1.

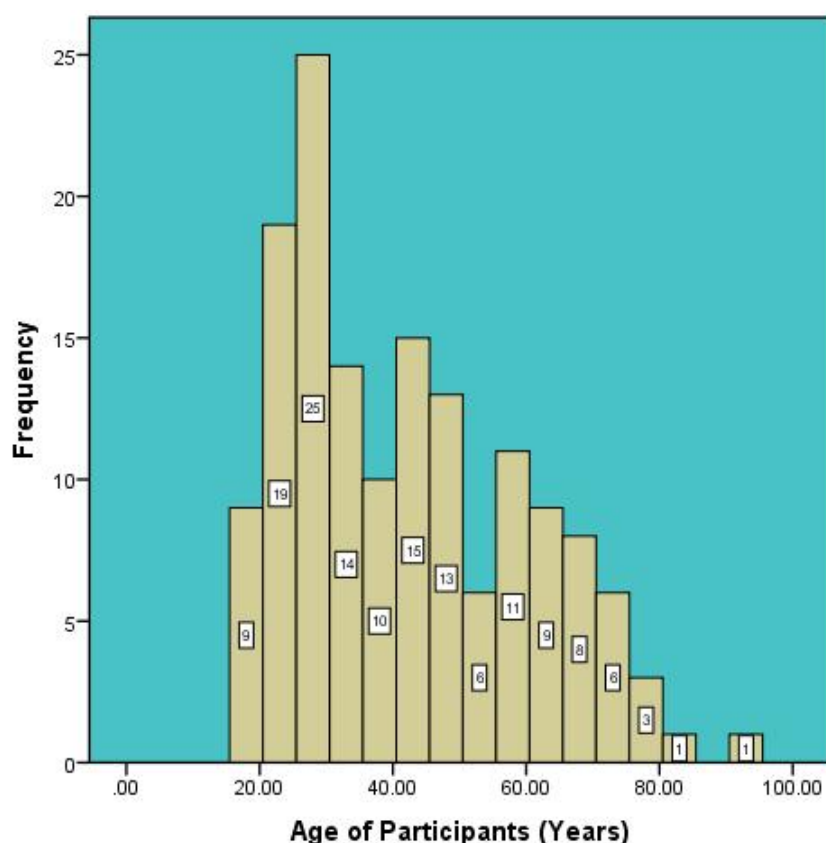
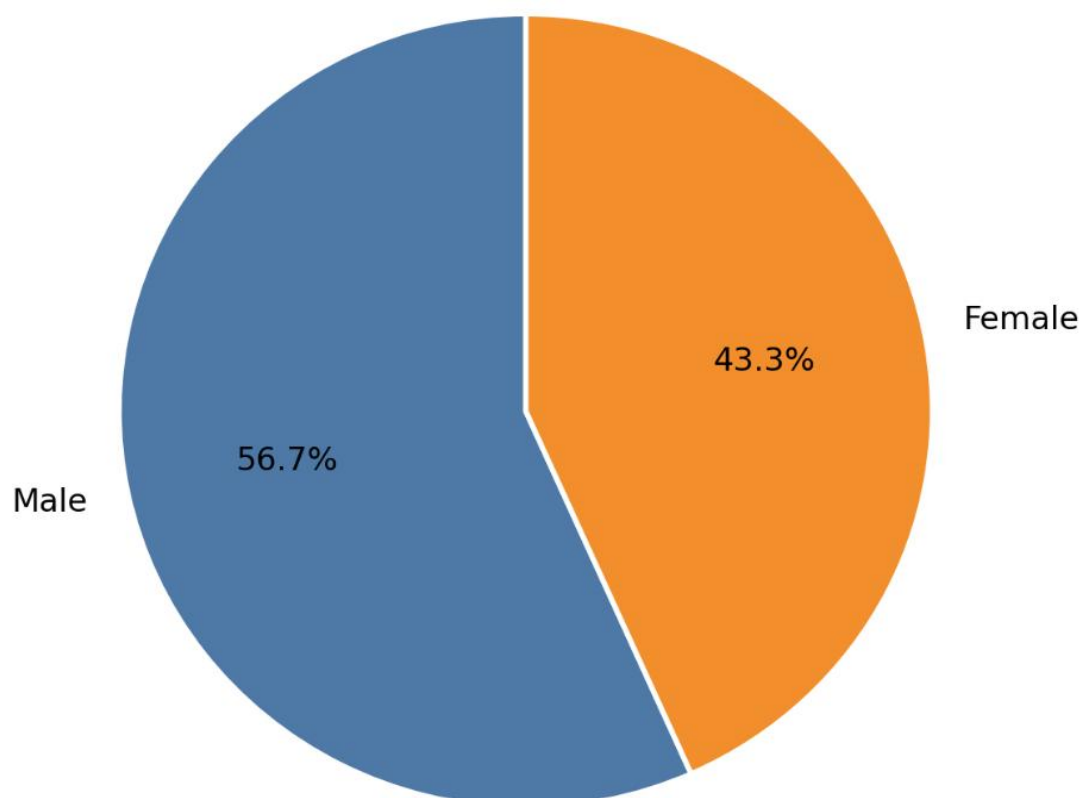


Figure 4.1. Age Distribution of Participants**Gender wise Distribution of Participants**

Among study participants male gender was common n=85 (56.7%) and female gender was n=57 (43.3%) as shown in Table 4.1.

Gender Distribution (N = 150)**Figure 4.2. Gender Wise Distribution of Participants****Clinical Characteristic of Participants**

Among study participants most of the participants n=59 (39.3%) experienced symptoms for a period of 1-4 weeks, followed by n=56 (37.3 %) for period of less than 1 week and n=35 (23.3%) experienced symptoms for greater than 1 month. Moreover, previous history of renal stones most of the participants n= 86 (57.3%) has negative history while n= 64 (42.7) demonstrated positive previous history. Along with that most of participants n=93 (62 %) has no family history of kidney stones while n=57 (38%) has positive family history of kidney stones as shown in Table 4.2.

Clinical Characteristic of Participants

S.NO	Variable		Frequency (F)
1	Duration of Symptoms	Less than 1 Week	56
		1-4 Weeks	59
		Greater than 1 Month	35
2	Previous Medical History of Kidney Stones	YES	64
		NO	86
3	Family History of Kidney Stones	YES	57
		NO	93

Diagnostic Approach & Finding Participants

Among study participants n=150 equal number of participants n=75 (50%) undergoes X-Ray KUB and n= 75 (50%) under Ultrasound KUB to compare the urinary stone detection rate between ultrasound and X-ray KUB radiography. Among the 114 participants in whom urinary stones were detected across both parallel groups (51 in the X-ray group and 63 in the Ultrasound group), overall stone size distribution showed that 47 participants (31.3%) had stones <5 mm, 42 (28.0%) had stones 5–10 mm, and 25 (16.7%) had stones >10 mm as shown in Table 4.3.

Table.4.2. Cross-Tabulation of Imaging Modalities with Stone Detection Rate

Imaging Modality	Stone Detected, n (%)	Stone Not Detected, n (%)	Total, N (%)
X-ray KUB	51 (68.0%)	24 (32.0%)	75 (100%)
Ultrasound KUB	63 (84.0%)	12 (16.0%)	75 (100%)
Total (Pooled)	114 (76.0%)	36 (24.0%)	150 (100%)

Location of Urinary System Stones

Regarding location of kidney stones in study participants most of the participants n=33 (22%) stone was found in ureter followed by n=29 (19.3%) in calyces, n=26 (17.3%) in renal pelvis and n=26 (17.3%) stones was found in urinary bladder as shown in Figure 4.4.



Figure.4.3. Location of Urinary System Stones

Cross Tabulation of Imaging Modality ×Stone Detection

To compare stone detection rate between two independent groups (X-Ray KUB and Ultrasound KUB) Pearson’s Chi square test was applied. Among study participants urolithesis was detected in n=51 (68 %) and n= 24 (32 %) stone as not detected in patients examined with X-ray KUB. While n=63 (84 %) stones were detected in patients examined with ultrasound KUB and n=12 (16 %) stones were not found. Pearson’s Chi square test demonstrated statistically significant association between imaging modality and stones detection ($X^2=5.263$, $P=0.022$) as shown in Table4.4.

Table4.3. Cross Tabulation of Imaging Modality ×Stone Detection

S.NO	Variable		Urolithesis Frequency		Detectio n Rate	X ²	P Value
			YES	NO			
1	Imaging	X-ray	51	24	68	5.26	0.022

	Modality	KUB				3	
		Ultrasou nd KUB	63	12	84		

Cross Tabulation of Imaging Modality ×Stone Size

To assess stone size distribution of stones detected by each modality Pearson’s chi square test was applied which showed that there is no statistically significant association between imaging modality and stone size category ($X^2 = 0.237$, $P = 0.888$). Among study participants diagnosed with urolithiasis on X-ray KUB, $n = 20$ (39.2%) was less than 5mm in size, $n = 20$ (39.2%) was 5-10mm in size and $n = 11$ (21.6%) was greater than 10mm in size. Moreover, participants diagnosed with urolithiasis on ultrasound KUB $n = 27$ (42.9%) were less than 5mm in size, followed by $n = 22$ (34.9%) was 5-10mm in size while $n = 14$ (22.2%) was greater than 10mm in size as shown in Figure 4.5.

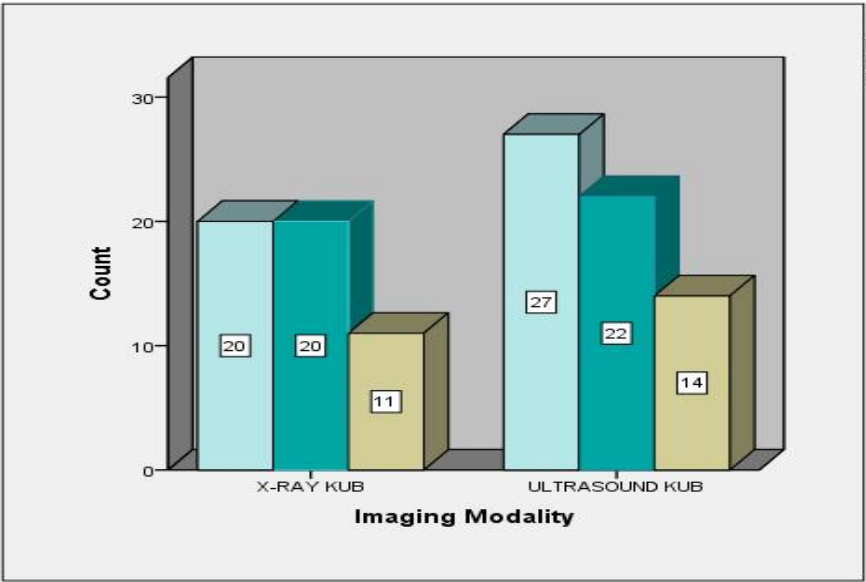


Figure4.4. Cross Tabulation of Imaging Modality ×Stone Size

Discussion:

The mean age of participants in the present study was 42.41 years, indicating that suspected urolithiasis was common among middle-aged adults. This finding is comparable to Khalid et al. (2025), who reported a mean age of 40.68 years among 150 patients presenting with acute flank pain. Similarly, males constituted

56.7% of participants, compared with 43.3% females, consistent with Waqas et al. (2024), who reported male predominance in patients with kidney stones in Khyber Pakhtunkhwa. The mean participant weight was 69.97 ± 15.5 kg. However, direct comparison with BMI-based studies was not possible because BMI categories were not assessed. Zhao et al. (2024) reported an association between obesity and increased nephrolithiasis risk, highlighting the potential relevance of body weight. Regarding symptom duration, 39.3% of participants reported symptoms lasting 1–4 weeks, 37.3% reported symptoms for less than one week, and 23.3% reported symptoms lasting more than one month. Although Chatterjee et al. (2025) investigated radiological characteristics associated with spontaneous passage of mid- and lower-ureteric stones, differences in study objectives prevent direct comparison of symptom duration. Previous kidney stones were reported by 42.7% of participants, while 57.3% had no previous history. Tan et al. (2023) highlighted the clinical importance of recurrent symptomatic nephrolithiasis and its association with deterioration in kidney function. A positive family history was reported by 38.0% of participants, whereas 62.0% reported no family history. In comparison, Karimi et al. (2024) identified older age, male sex, and positive family history, particularly among first-degree relatives, as factors associated with lifetime urolithiasis occurrence. Overall, urinary stones were detected in 76.0% of participants. Stones smaller than 5 mm accounted for 31.3%, those measuring 5–10 mm accounted for 28.0%, and stones larger than 10 mm accounted for 16.7%. Kandasamy et al. (2024) similarly demonstrated limitations in X-ray KUB detection compared with ultra-low-dose CT, particularly for smaller calculi. In the present study, ultrasound KUB detected stones in 63 of 75 participants (84%), whereas X-ray KUB detected stones in 51 of 75 participants (68%). This difference was statistically significant ($\chi^2 = 5.263$, $p = 0.022$). These findings are consistent with Farooq et al. (2023), who reported higher sensitivity for ultrasound than X-ray in patients suspected of urinary calculi. However, Khalid et al. (2025) reported greater sensitivity for X-ray KUB (90%) than ultrasound (74%) using CT KUB as the reference standard. This difference may reflect variations in study populations, stone locations, imaging protocols, and reference standards. Stone-size distribution did not differ significantly between the imaging groups ($\chi^2 = 0.237$, $p = 0.888$). Among X-ray-positive cases, 39.2% of stones were smaller than 5 mm, 39.2% measured 5–10 mm, and 21.6% were larger than 10 mm. Among ultrasound-positive cases, the corresponding proportions were 42.9%, 34.9%, and 22.2%, respectively. Ashraf et al. (2024) reported comparable preoperative stone-size measurements between ultrasound and CT, suggesting that ultrasound can provide useful size estimates when stones are visualized. Nevertheless, the present study assessed categorical size distribution rather than measurement accuracy against CT. Ureteric stones were the most common location (22.0%), followed by calyces (19.3%), renal pelvis (17.3%), and urinary bladder (17.3%). Iwahashi et al. (2024) also emphasized the clinical importance of ureteric stone location and associated hydronephrosis.

Conclusion:

Ultrasound KUB demonstrated a higher stone detection rate than X-ray KUB in this study, with a statistically significant difference ($p = 0.022$), while stone-size

distribution showed no significant association with imaging modality ($p = 0.888$). These findings support the clinical usefulness of ultrasound as an initial imaging modality, particularly in settings where cost, accessibility, and radiation exposure are important considerations. However, because CT KUB was not used as a uniform reference standard, the findings should not be interpreted as establishing the diagnostic sensitivity or specificity of either modality. CT remains important when definitive diagnostic confirmation is clinically required.

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