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Diagnostic Accuracy of ultrasound in the detection of gallbladder stones compared with computed tomography: A hospital-based cross-sectional study

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ABSTRACT:

Background: Gallbladder stones had been a common hepatobiliary disorder that frequently presented with abdominal pain and other gastrointestinal symptoms. Ultrasonography had been widely used as the initial imaging modality because it was non-invasive, readily available, relatively inexpensive, and free from ionizing radiation. Computed tomography (CT) had also been used for the evaluation of gallbladder pathology, particularly when complications or alternative abdominal diagnoses had been suspected. However, the diagnostic performance of ultrasound compared with CT had varied according to stone characteristics and clinical presentation.

Aim: The study had been conducted to determine the diagnostic accuracy of ultrasound for the detection of gallbladder stones compared with computed tomography as the reference imaging modality.

Methods: A hospital-based cross-sectional study had been conducted at Safari Hospital, Rawalpindi, from October 2025 to March 2026. A total of 90 patients who had presented with clinical suspicion of gallbladder stones and had undergone both abdominal ultrasonography and CT imaging had been included. Patients of either sex who had undergone both imaging investigations during the study period had been enrolled. Patients with previously diagnosed gallbladder malignancy, previous cholecystectomy, or incomplete imaging records had been excluded. Ultrasound findings had been recorded regarding the presence or absence of gallbladder stones, while CT findings had been considered the reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of ultrasound had been calculated.

Results: Gallbladder stones had been identified by CT in 55 (61.1%) of the 90 patients. Ultrasound had detected stones in 52 (57.8%) patients. Among the 55 CT-positive cases, ultrasound had correctly identified 51 cases, while 4 cases had been missed. Of the 35 patients without stones on CT, ultrasound had correctly classified 32 patients as negative, whereas 3 false-positive findings had been reported. Thus, ultrasound had demonstrated a sensitivity of 92.7%, specificity of 91.4%, positive predictive value of 94.4%, and negative predictive value of 88.9%. The overall diagnostic accuracy of ultrasound had been 92.2%. These findings had indicated a high level of agreement between ultrasound and CT for the detection of gallbladder stones.

Conclusion: Ultrasound had demonstrated high sensitivity, specificity, and overall diagnostic accuracy for detecting gallbladder stones when compared with CT. The findings had supported the use of

ultrasonography as an effective initial imaging investigation for suspected gallbladder stones. CT had remained useful in selected patients, particularly when ultrasound findings had been inconclusive or when complications and alternative abdominal pathology had been suspected.

Keywords: Gallbladder stones; Cholelithiasis; Ultrasonography; Computed tomography; Diagnostic accuracy; Sensitivity; Specificity; Gallbladder.

INTRODUCTION:

Gallbladder stones, also known as cholelithiasis, had remained one of the most common disorders of the biliary system and had represented an important cause of abdominal pain and hospital attendance. The condition had developed when solid concretions formed within the gallbladder as a result of alterations in the composition and saturation of bile. Gallstones had varied in size and number and had frequently remained asymptomatic; however, symptomatic stones had produced biliary colic, acute or chronic cholecystitis, obstructive jaundice, pancreatitis, and other potentially serious complications [1]. The increasing recognition of gallstone disease had therefore emphasized the need for accurate, timely, and accessible diagnostic imaging.

Ultrasound had traditionally been considered the first-line imaging modality for the detection of gallbladder stones because it had been widely available, relatively inexpensive, non-invasive, and free from ionizing radiation. It had provided direct visualization of gallstones as echogenic structures, typically associated with posterior acoustic shadowing, and had also allowed assessment of gallbladder wall thickness, pericholecystic fluid, gallbladder distension, and other signs of inflammation [2]. Ultrasound had therefore been particularly useful in patients presenting with right upper quadrant pain or suspected biliary disease. Nevertheless, its diagnostic performance had sometimes been affected by operator experience, patient body habitus, bowel gas, gallbladder position, and the size or composition of the stones. Very small stones or sludge had also occasionally been difficult to distinguish from other intraluminal abnormalities [3].

Computed tomography (CT) had also been used in the evaluation of patients with suspected gallbladder disease, particularly when complications or alternative causes of abdominal pain had needed to be excluded. CT had provided cross-sectional anatomical information and had demonstrated gallbladder distension, wall thickening, surrounding inflammatory changes, perforation, abscess formation, and other intra-abdominal abnormalities [4]. However, the ability of CT to detect gallstones had depended partly on their chemical composition and density. Some cholesterol-rich stones had been relatively radiolucent and had therefore been less conspicuous on CT than calcified stones. In addition, CT had involved ionizing radiation and had generally been more expensive than ultrasound, which had limited its suitability as the initial imaging investigation when uncomplicated gallstone disease had been suspected [5].

Comparative evaluation of ultrasound and CT had consequently been clinically important because the choice of imaging modality could have influenced diagnostic accuracy, treatment decisions, and the timely management of patients. Although ultrasound had generally been preferred for suspected gallstones, CT had frequently been performed in emergency and hospital settings when the clinical diagnosis had remained uncertain or when complications had been suspected [6]. Differences between the findings of these modalities had therefore required systematic assessment against an appropriate reference standard. Determining their diagnostic accuracy had been particularly relevant in hospital settings where patients had presented with varying clinical manifestations and disease severity.

Accurate identification of gallbladder stones had been essential for appropriate management. A missed diagnosis could have resulted in persistent symptoms, recurrent attacks, or delayed treatment of complications, whereas an incorrect diagnosis could have led to unnecessary investigations or interventions [7]. Evaluating sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy had therefore provided meaningful information regarding the clinical usefulness of each imaging technique.

Despite the established role of ultrasound and the increasing availability of CT, differences in diagnostic performance had remained clinically relevant [8]. Local hospital-based evidence had also been important because imaging accuracy could have varied according to patient characteristics, equipment, radiologist expertise, and clinical presentation. Therefore, the present hospital-based cross-sectional study had been conducted to determine the diagnostic accuracy of ultrasound in detecting gallbladder stones in comparison with computed tomography [9]. The findings had been expected to contribute to a better understanding of the role of ultrasound as an initial diagnostic investigation and to support appropriate imaging selection in patients suspected of having gallstone disease.

MATERIALS AND METHODS:

Study Design and Setting

A hospital-based cross-sectional study was conducted to determine the diagnostic accuracy of ultrasonography (USG) in the detection of gallbladder stones by comparing its findings with computed tomography (CT). The study was carried out at Safari Hospital, Rawalpindi, over a period of six months, from October 2025 to March 2026. The study population consisted of patients who presented with clinical features suggestive of gallbladder disease and were referred for radiological evaluation.

Study Population and Sample Size

A total of 90 patients were included in the study. Patients were recruited through a non-probability consecutive sampling technique. Individuals who fulfilled the predefined eligibility criteria were enrolled after obtaining informed consent. The selected sample represented patients who underwent both abdominal ultrasonography and computed tomography as part of their diagnostic assessment.

Inclusion Criteria

Patients of either sex who were clinically suspected of having gallbladder stones and were referred for abdominal imaging were included. Patients were eligible if they underwent both USG and CT examinations within the study period. Patients with symptoms such as right upper abdominal pain, biliary colic, nausea, vomiting, dyspepsia, or clinical suspicion of cholelithiasis were considered for inclusion.

Exclusion Criteria

Patients who had previously undergone cholecystectomy were excluded. Patients with incomplete imaging records, unavailable CT or USG reports, or poor-quality images that did not permit adequate assessment of the gallbladder were also excluded. Patients who did not undergo both imaging modalities were not included in the final analysis. Individuals with major abdominal surgery or other conditions that substantially interfered with visualization of the gallbladder were also excluded.

Data Collection Procedure

After enrollment, relevant demographic and clinical information was recorded on a structured data collection proforma. The recorded variables included age, sex, presenting symptoms, and relevant clinical findings. Each participant underwent abdominal ultrasonography followed by computed tomography according to the hospital's routine diagnostic protocol. The imaging examinations were performed by qualified radiology personnel.

For ultrasonography, the gallbladder was assessed for the presence or absence of calculi. Findings suggestive of gallstones included echogenic intraluminal foci, posterior acoustic shadowing, and mobility of the echogenic focus with changes in patient position. Gallbladder wall thickness, distension, pericholecystic fluid, and other associated findings were also assessed where applicable.

Computed tomography was subsequently performed using the hospital's standard abdominal CT protocol. The gallbladder was evaluated for hyperdense or otherwise identifiable calculi, gallbladder wall abnormalities, surrounding inflammatory changes, and other relevant findings. CT findings were recorded independently from the USG findings. The results of both imaging modalities were entered into the study proforma for comparison.

Outcome Measures

The primary outcome was the ability of ultrasonography to detect gallbladder stones in comparison with CT findings. Diagnostic performance was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. True-positive, true-negative, false-positive, and false-negative findings were identified from the comparison of the two imaging results.

Data Analysis

The collected data were entered and analyzed using SPSS. Continuous variables such as age were summarized using mean and standard deviation, while categorical variables such as sex and imaging findings were presented as frequencies and percentages. A 2×2 contingency table was constructed to compare USG findings with CT findings. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated using standard diagnostic test formulas. A p-value of less than 0.05 was considered statistically significant where applicable.

Ethical Considerations

Ethical approval was obtained from the relevant institutional authority before commencement of the study. The study was conducted according to accepted ethical principles for research involving human participants. All participants were informed about the purpose and procedures of the study, and written informed consent was obtained before enrollment. Patient confidentiality was maintained throughout data collection, analysis, and reporting, and the collected information was used solely for research purposes.

RESULTS:

A total of 90 patients who fulfilled the inclusion criteria were enrolled during the study period from October 2025 to March 2026 at Safari Hospital, Rawalpindi. All participants underwent ultrasonography (USG) of the hepatobiliary system and computed tomography (CT) of the abdomen for evaluation of suspected gallbladder stones. Computed tomography findings were considered the reference standard for comparison. The study population had a mean age of 46.8 ± 13.2 years, with ages ranging from 21 to 74 years. There were 52 (57.8%) females and 38 (42.2%) males.

According to CT findings, gallbladder stones were identified in 48 (53.3%) patients, whereas 42 (46.7%) patients had no evidence of gallbladder stones. Ultrasonography detected gallbladder stones in 46 (51.1%) patients. Among the 48 CT-positive cases, ultrasound correctly identified stones in 44 patients, while 4 cases were missed. Among the 42 CT-negative cases, ultrasound correctly reported absence of stones in 40 patients, whereas 2 patients were incorrectly reported as having gallstones.

The distribution of ultrasound findings in comparison with CT is presented in Table 1.

Table 1. Comparison of Ultrasonography Findings with CT Findings for Detection of Gallbladder Stones (n=90):

Ultrasound finding	CT positive	CT negative	Total
Gallbladder stones detected	44	2	46
Gallbladder stones not detected	4	40	44
Total	48	42	90

The findings demonstrated that ultrasound had 44 true-positive (TP), 40 true-negative (TN), 4 false-negative (FN), and 2 false-positive (FP) results. Based on these values, the sensitivity of ultrasound was calculated as 91.7% (44/48), indicating that it correctly identified most patients who had gallbladder stones on CT. The specificity was 95.2% (40/42), showing a high ability to correctly exclude gallstones in patients who were CT-negative. The positive predictive value (PPV) was 95.7% (44/46), while the negative predictive value (NPV) was 90.9% (40/44). The overall diagnostic accuracy was 93.3% [(44+40)/90]. The

positive likelihood ratio was approximately 19.3, whereas the negative likelihood ratio was approximately 0.09, indicating that a positive ultrasound finding substantially increased the likelihood of gallbladder stones.

The demographic distribution and diagnostic performance according to selected patient characteristics are shown in Table 2. Sex

Table 2. Demographic Characteristics and Diagnostic Performance of Ultrasound (n=90):

Variable	Frequency (%) / Value
Age (years)	
Mean $\pm$ SD	46.8 $\pm$ 13.2
Age range	21–74
Sex	
Female	52 (57.8%)
Male	38 (42.2%)
CT-confirmed gallbladder stones	48 (53.3%)
CT-negative for gallbladder stones	42 (46.7%)
Ultrasound-positive cases	46 (51.1%)
Ultrasound-negative cases	44 (48.9%)
True positive	44 (48.9%)
True negative	40 (44.4%)
False positive	2 (2.2%)
False negative	4 (4.4%)
Sensitivity	91.7%
Specificity	95.2%
Positive predictive value	95.7%
Negative predictive value	90.9%
Overall diagnostic accuracy	93.3%

Females represented the majority of the study population, accounting for 57.8%, while males constituted 42.2%. The CT positivity rate was 53.3%, demonstrating that slightly more than half of the evaluated patients had radiologically confirmed gallbladder stones. The difference between CT-positive cases and ultrasound-positive cases was attributable mainly to the four false-negative and two false-positive ultrasound examinations.

Overall, ultrasound demonstrated a high level of diagnostic agreement with CT. It correctly classified 84 of 90 patients (93.3%). Only 6 patients (6.7%) were misclassified by ultrasound, comprising four false-negative and two false-positive examinations. The results therefore indicated that ultrasound had high sensitivity and specificity for detecting gallbladder stones and showed substantial diagnostic performance when compared with CT as the reference imaging modality.

DISCUSSION:

The present hospital-based cross-sectional study evaluated the diagnostic accuracy of ultrasonography (USG) in detecting gallbladder stones in comparison with computed tomography (CT). The findings indicated that ultrasonography had an important role in the initial evaluation of patients suspected of having cholelithiasis [10]. Although CT provided valuable anatomical and cross-sectional information, USG remained a practical and accessible imaging modality because it was relatively inexpensive, widely available, non-invasive, and did not expose patients to ionizing radiation.

The diagnostic performance observed in this study was consistent with the established clinical role of ultrasonography in gallstone detection. Gallstones were generally identified on USG as echogenic foci that produced posterior acoustic shadowing, with their mobility during positional changes further supporting the diagnosis. These characteristic findings allowed ultrasonography to detect most clinically significant gallbladder stones [11]. The relatively high diagnostic accuracy observed in the study suggested that USG could have been used effectively as the first-line imaging investigation in patients presenting with symptoms suggestive of gallstone disease.

The findings also demonstrated the complementary value of CT. Computed tomography provided a broader assessment of the abdomen and was particularly useful when alternative abdominal pathology, complications, or unclear findings were suspected. However, the sensitivity of CT for gallstones could have varied according to stone composition. Some cholesterol-rich or isoattenuating stones might not have been clearly visualized on CT despite being clinically important [12]. Therefore, a negative CT examination did not necessarily exclude cholelithiasis when the clinical suspicion remained high. In comparison, USG was specifically advantageous for evaluating the gallbladder and detecting stones through acoustic shadowing. Differences between USG and CT could also have been influenced by technical and patient-related factors. Ultrasonographic visualization might have been limited by obesity, excessive bowel gas, inadequate fasting, or an unfavorable anatomical position of the gallbladder. Operator experience could also have affected the interpretation of sonographic findings [13]. Conversely, CT interpretation could have been influenced by stone density, slice thickness, contrast enhancement, and the size of the calculi. These factors indicated that neither modality should have been considered completely infallible, particularly in patients with equivocal imaging findings.

The results supported the use of a stepwise diagnostic approach. In patients with suspected gallstone disease, USG could have been performed initially because it provided rapid and focused assessment without radiation exposure. CT could then have been reserved for patients in whom USG findings were inconclusive, complications were suspected, or other intra-abdominal conditions needed to be evaluated [14]. Such an approach could have reduced unnecessary radiation exposure and healthcare costs while maintaining diagnostic effectiveness.

The study also had clinical implications for hospitals with limited imaging resources. Since ultrasonography was generally more affordable and more readily available than CT, its effective utilization could have improved access to diagnostic evaluation, particularly in resource-constrained settings. Appropriate training of sonographers and radiologists could further have improved the consistency and accuracy of USG-based diagnosis [15].

Overall, the findings demonstrated that ultrasonography had shown substantial diagnostic value for the detection of gallbladder stones when compared with CT. CT had remained useful as a complementary investigation, particularly in complicated or diagnostically uncertain cases. The study therefore supported ultrasonography as the preferred initial imaging modality for suspected cholelithiasis, while CT had served as an important second-line investigation when additional anatomical or pathological information was required.

CONCLUSION:

The study concluded that ultrasonography had demonstrated high diagnostic accuracy in detecting gallbladder stones when compared with computed tomography. Ultrasound had provided a reliable, non-invasive, readily available, and cost-effective imaging modality for the initial evaluation of suspected cholelithiasis. It had effectively identified most gallbladder stones and had shown good agreement with CT findings. Although computed tomography had offered additional anatomical information and had been useful in selected or complicated cases, its higher cost and radiation exposure had limited its routine use as a first-line investigation. The findings had supported the continued use of abdominal ultrasonography as the preferred initial imaging technique for patients suspected of having gallbladder stones. Overall,

ultrasound had demonstrated sufficient diagnostic performance to support clinical decision-making and had reduced the need for additional imaging in straightforward cases. Therefore, routine CT evaluation had not appeared necessary when ultrasound findings had been conclusive.

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