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ASSESSMENT OF DIAGNOSTIC ACCURACY OF TRANS-ABDOMINAL ULTRASOUND IN DIAGNOSIS OF CHOLEDOCHOLITHIASIS KEEPING MAGNETIC RESONANCE CHOLANGIO-PANCREATOGRAPHY AS GOLD-STANDARD

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Abstract

Objectives: *To assess the diagnostic accuracy of TAUS in detecting choledocholithiasis, using MRCP as the gold standard.*

Methodology: *The study conducted at Radiology and Imaging Department, Al-Noor Diagnostic Center, Lahore, Pakistan during the period May 2, 2024 to November 2, 2024. This cross-sectional study included 248 patients aged 18–85 years presenting with clinical suspicion of choledocholithiasis. TAUS and MRCP findings were compared. Diagnostic accuracy was calculated using MRCP as the reference.*

Results: *Among 248 patients, 62.5% were female and 56.5% were below 50 years. TAUS detected choledocholithiasis in 20.2% cases, while MRCP confirmed it in 28.6%. TAUS showed a sensitivity of 54.9%, specificity of 93.8%, positive predictive value of 78%, negative predictive value of 83.8%, and overall diagnostic accuracy of 82.7%. Detection was notably lower in small or distal stones.*

Conclusion: *TAUS demonstrates high specificity and reasonable diagnostic accuracy for detecting choledocholithiasis and should be employed as the first-line investigation, especially in low-resource settings. When TAUS results are inconclusive, MRCP should be pursued. Structured imaging protocols and trained operators may further enhance TAUS performance.*

INTRODUCTION:

Choledocholithiasis is the presence of stone in the bile ducts. These stones can either pass down from the gallbladder or can form within the bile duct primarily.1 15 -17 % of the patients with gallstones are at the risk of developing choledocholithiasis.2-3 Patients with choledocholithiasis may present with right upper quadrant colicky pain and abnormal liver function tests (elevated bilirubin and alkaline phosphatase levels)4 however, patients may be asymptomatic as well.[5]

Multiple imaging modalities are used for the diagnosis of suspected choledocholithiasis. Trans-abdominal ultrasound is usually the first imaging modality used because of its vast availability, non-invasiveness, cost-effectiveness, and non-ionizing

technique.[1,6] Computed tomography uses ionizing radiation and is unable to detect non-calcified stones which makes it an unreliable study for diagnosing CBD stones.[5] MRCP is a non-ionizing technique, non-invasive technique and the use of multi-planar reconstruction makes it a gold-standard technique. However, MRCP is expensive and puts a psychological and financial burden on the patient and their family as well as a burden on hospital resources.[5]

According to different studies, the diagnostic accuracy of ultrasound for choledocholithiasis varies from 76%[1,3] to 87 %[7] with sensitivity being in range of 76 %[3] to 96%[7] and specificity from 80 %[7] to 81 %.[3] The rationale of this study is the limited data availability regarding the accuracy of trans-abdominal ultrasound in detection of choledocholithiasis. An accurate and early diagnosis is mandatory to proceed to proper management via Endoscopic retrograde cholangiopancreatography[8] or open surgery[7] and hence, to prevent serious complications like ascending cholangitis and pancreatitis.

The significance of selecting this topic is to determine whether trans-abdominal ultrasound can be used as an accurate method for diagnosis of choledocholithiasis or not and to gather the local data to establish the guidelines for the appropriate use of imaging modalities.

Methodology

This cross-sectional study was conducted at the Department of Radiology, Al-Noor Institute of Radiology / Al-Noor Diagnostic Centre, Shadman, Lahore, over a period of six months following the approval of the research synopsis by the institutional review board and ethical committee. The primary objective was to evaluate the diagnostic accuracy of trans-abdominal ultrasound in detecting choledocholithiasis, using magnetic resonance cholangiopancreatography (MRCP) as the gold standard.

A total of 248 patients were enrolled using non-probability purposive sampling. The sample size was calculated using the WHO sample size calculator, based on an anticipated sensitivity of 76%, specificity of 80%, a prevalence of 17%, 13% margin of error, and a 95% confidence interval.

Patients aged 20 to 85 years of both genders, presenting with clinical suspicion of choledocholithiasis—characterized by colicky right upper quadrant abdominal pain and deranged liver function tests—were included as per operational definitions. Exclusion criteria comprised patients with congenital biliary tract anomalies, other benign or malignant hepatobiliary conditions (e.g., liver tumors, gallbladder carcinoma, periampullary tumors), and those with MRI-incompatible devices such as aneurysmal clips, cochlear implants, pacemakers, or prosthetic heart valves.

After obtaining informed consent, patient demographic data, clinical history, and examination findings were documented. Trans-abdominal ultrasound was performed using a curvilinear probe (1–5 MHz) with axial, subcostal, and intercostal scanning approaches. The common bile duct was evaluated in its entirety from the porta hepatis to the head of the pancreas for the presence of intraductal hyperechoic, shadowing calculi. Initial assessments were carried out by radiology residents and subsequently confirmed by senior radiologists to ensure diagnostic reliability.

All enrolled patients then underwent MRCP on a Siemens MAGNETOM 1.5 Tesla MRI scanner using a standardized protocol. The MRCP findings were interpreted by the study supervisor, blinded to ultrasound results, and findings were documented according to the defined criteria for choledocholithiasis.

Data were recorded in a structured proforma. Statistical analysis was performed using SPSS version 25.0. Mean and standard deviation were calculated for quantitative variables such as age, while frequencies and percentages were reported for qualitative variables. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of trans-abdominal ultrasound were calculated in comparison to MRCP. The chi-square test was applied, and a p-value ≤ 0.05 was considered statistically significant. Data were stratified by age and gender, and diagnostic performance was recalculated post-stratification to assess any effect modifiers.

RESULTS:

Table 1: Frequency Distribution of Study Variables

This table presents the categorical distribution of the study population. The age group 18–50 years comprised the majority of the sample, accounting for 56.5% (n = 140), while 43.5% (n = 108) were aged 51–85 years. A larger proportion of the study participants were female (62.5%, n = 155) compared to males (37.5%, n = 93). Ultrasound (US) identified choledocholithiasis in 20.2% of patients (n = 50), whereas magnetic resonance cholangiopancreatography (MRCP), the gold standard, detected choledocholithiasis in 28.6% (n = 71). In terms of diagnostic classification, 15.7% were true positives (TP), 66.9% true negatives (TN), 4.4% false positives (FP), and 12.9% false negatives (FN).

Table 1: Frequency Distribution of Study Variables

Variable	Group	Frequency (n)	Percent (%)
Age Group	18-50	140	56.5
	51-85	108	43.5
Gender	Male	93	37.5
	Female	155	62.5
Choledocholithiasis on US	Yes	50	20.2
	No	198	79.8
Choledocholithiasis on MRCP	Yes	71	28.6
	No	177	71.4
Diagnostic Result	TP	39	15.7
	TN	166	66.9
	FP	11	4.4
	FN	32	12.9

Table 2: Descriptive Statistics for Quantitative Variables

The mean age of the patients was 47.27 years with a standard deviation of 16.57, based on a sample of 248 individuals. Among those who had calculi identified, the mean common bile duct (CBD) diameter was 9.74 mm (SD ±4.20) in 74 patients. The average size of the calculus was 6.14 mm (SD ±3.41), measured in 70 patients. These values provide an understanding of the age distribution and anatomical characteristics related to biliary pathology in the study population.

Table 2: Descriptive Statistics for Quantitative Variables

Variable	Mean	Standard Deviation	N
Age (years)	47.27	16.57	248
CBD Diameter (mm)	9.74	4.20	74
Average Calculus Size (mm)	6.14	3.41	70

Table 3: Overall Diagnostic Accuracy of Ultrasound Compared to MRCP

Ultrasound demonstrated an overall diagnostic accuracy of 82.7% when compared with MRCP. The sensitivity of ultrasound for detecting choledocholithiasis was 54.9%, indicating moderate ability to identify true positive cases. However, the specificity was high at 93.8%, reflecting a strong capacity to correctly identify true negatives. The positive predictive value (PPV) was 78.0%, and the negative predictive value (NPV) was 83.8%, suggesting that ultrasound is more reliable in ruling out disease than confirming its presence.

Table 3: Overall Diagnostic Accuracy of Ultrasound Compared to MRCP

Metric	Value (%)
Sensitivity (%)	54.9
Specificity (%)	93.8
PPV (%)	78.0
NPV (%)	83.8
Accuracy (%)	82.7

Table 4: Diagnostic Result by Age Group

When stratified by age, the younger group (18–50 years) had a higher proportion of true negatives (72.9%) and equal proportions of true positives and false negatives (12.1% each). False positives were minimal at 2.9%. In contrast, the older group (51–85 years) exhibited a slightly higher rate of true positives (20.4%) and false positives (6.5%), with true negatives at 59.3% and false negatives at 13.9%. The association between diagnostic outcomes and age group was not statistically significant (p = 0.100).

Table 4: Diagnostic Result by Age Group

Age Group	TP	TN	FP	FN	Total	Pearson Chi-Square
18-50	17 (12.1%)	102 (72.9%)	4 (2.9%)	17 (12.1%)	140	0.100
51-85	22 (20.4%)	64 (59.3%)	7 (6.5%)	15 (13.9%)	108	

Table 5: Diagnostic Result by Gender

Diagnostic performance was also analyzed by gender. Among males, 15.1% were true positives, and 66.7% were true negatives, while females had a slightly higher true positive rate of 16.1% and a similar true negative rate of 67.1%. False positive and false negative rates were nearly equal across both genders. The Pearson Chi-Square test indicated no significant association between diagnostic results and gender (p = 0.980), suggesting that ultrasound accuracy is consistent across male and female patients.

Table 5: Diagnostic Result by Gender

Gender	TP	TN	FP	FN	Total	Pearson Chi-Square
Male	14 (15.1%)	62 (66.7%)	4 (4.3%)	13 (14.0%)	93	0.980
Female	25 (16.1%)	104 (67.1%)	7 (4.5%)	19 (12.3%)	155	

DISCUSSION

Choledocholithiasis represents a critical clinical condition due to its potential complications, including obstructive jaundice, cholangitis, and pancreatitis. Early and accurate diagnosis is essential to guide timely intervention and reduce morbidity. While MRCP serves as the non-invasive gold standard, TAUS remains the initial imaging modality of choice in many healthcare setups due to its accessibility, cost-effectiveness, and non-invasiveness. Our study was conducted to evaluate the diagnostic accuracy of TAUS in detecting choledocholithiasis using MRCP as the gold standard.

The demographic profile in our study revealed a higher prevalence of choledocholithiasis among females (62.5%) compared to males (37.5%), consistent with prior studies. Iqbal et al[9] and Abdulwahid et al[10] also reported female predominance, attributing it to hormonal influences and anatomical variations such as slower gallbladder emptying in women. Additionally, a majority of our study population (56.5%) was under 50 years of age, in contrast to some prior studies that reported a peak incidence in older individuals. This age distribution may reflect regional dietary patterns and genetic predispositions, although further investigation is warranted.

In terms of diagnostic accuracy, our results demonstrated that TAUS had a sensitivity of 54.9%, specificity of 93.8%, positive predictive value of 78%, and negative predictive value of 83.8%, using MRCP as the gold standard. These findings are closely aligned with Qamar et al[11] who reported comparable sensitivity and specificity values for TAUS in detecting CBD stones. This supports TAUS as a reliable preliminary diagnostic tool, particularly in resource-limited settings.

One major contributor to the limited sensitivity of TAUS is its difficulty in detecting small or distally located stones, often missed due to overlapping bowel gas or suboptimal acoustic windows. Mendoza et al[12] and Khan SA[13] have emphasized that EUS and MRCP demonstrate superior visualization in such cases, significantly improving detection rates for microlithiasis or impacted distal CBD stones.

Furthermore, operator experience and equipment quality play vital roles in TAUS accuracy. Lemuel et al[14] found that obesity, bowel gas interference, and aged ultrasound machines markedly reduce image quality and diagnostic yield. Bhatti et al[15] similarly noted that misdiagnosis is more likely when scanning protocols are not standardized or radiologists lack adequate experience. These findings underscore the need for operator training and quality assurance in ultrasound practices.

Despite its limitations, TAUS offers a practical advantage in the diagnostic work-up of choledocholithiasis. Vikram et al[16] and Lem et al[17] highlighted that although EUS and MRCP have higher diagnostic accuracies, TAUS remains indispensable as a first-line screening tool due to its wide availability and non-invasiveness. Our results further confirm that in settings where MRCP is inaccessible, TAUS can guide management when combined with clinical judgment and laboratory findings.

Recent literature also supports a stepwise diagnostic model, where TAUS is used initially and more advanced imaging is employed in cases of persistent clinical suspicion or inconclusive results. Both Binnuhaid et al[18] and Oweis et al[19] advocate this tiered approach, promoting resource optimization while maintaining diagnostic. Our findings align well with this model, validating TAUS as an appropriate gatekeeper to more expensive imaging.

Ultimately, the results of our study emphasize the need to integrate TAUS within clinical algorithms for suspected choledocholithiasis, especially in resource-constrained environments. Its diagnostic accuracy, when interpreted in the right clinical context, justifies its continued frontline use. Moreover, enhancements in operator training, equipment modernization, and structured imaging protocols could further elevate its reliability and clinical impact.

Based on our findings and supported by the literature, we recommend the continued use of TAUS as the initial imaging modality in patients with suspected choledocholithiasis. Clinicians should consider patient factors such as age, gender, and clinical presentation when interpreting ultrasound results. Negative or inconclusive TAUS findings should prompt further evaluation with MRCP or EUS, particularly in patients with high clinical suspicion. Regular skill enhancement workshops for radiologists and standardized scanning protocols should be prioritized to improve diagnostic outcomes.

Policy-wise, a tiered diagnostic approach should be encouraged: initial screening by TAUS, followed by MRCP or EUS when clinically warranted. This pathway ensures rational use of resources, early identification of biliary stones, and minimized delay in treatment. In settings with limited access to MRCP, proper training and standardized protocols for TAUS can substantially improve diagnostic yield.

This study was limited to a single tertiary care center, which may affect generalizability to other settings. Furthermore, TAUS findings were not stratified by radiologist experience, which could influence diagnostic accuracy. Inter-observer variability was not assessed. Future multi-center studies with larger populations and inclusion of additional imaging modalities like EUS could provide more comprehensive insights.

CONCLUSION:

Transabdominal ultrasound (TAUS) remains a practical and valuable first-line modality in the

diagnostic work-up of choledocholithiasis. Although its sensitivity is moderate, its high specificity, accessibility, and non-invasiveness justify its frontline role, especially in resource-constrained settings. Integration of TAUS into structured diagnostic algorithms will continue to play a pivotal role in timely identification and management of biliary stones.

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