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Original Research Article

Diagnostic Accuracy of Transabdominal Ultrasound in the Detection of Choledocholithiasis, Keeping Magnetic Resonance Cholangiopancreatography (MRCP) as the Gold Standard

Shaista Shoukat[1], Omaimah Siddiqui[1*], Atiqa Hasan[1], Dua Zainab[2], Muneeba Rafique[2], Ayesha Bibi[1]

[1]Department of Radiology, JPMC, Karachi, Pakistan
[2]Department of Radiology, SMBBIT, Karachi, Pakistan
**Corresponding author`s email address:* omaimasid@gmail.com

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Abstract: *Choledocholithiasis is a common cause of obstructive jaundice and biliary sepsis. Transabdominal ultrasound (TAUS) is widely used as a first-line investigation; however, its ability to detect common bile duct (CBD) stones varies. This study assessed the diagnostic accuracy of TAUS for detecting choledocholithiasis, using magnetic resonance cholangiopancreatography (MRCP) as the gold standard.* ***Objective:*** *To determine the diagnostic accuracy of transabdominal ultrasound in the detection of choledocholithiasis, taking MRCP as the reference standard.* ***Methods:*** *A cross-sectional diagnostic accuracy study was conducted on 100 patients with clinical suspicion of choledocholithiasis from November 15, 2024, to May/ 15, 2025. All participants underwent TAUS followed by MRCP. MRCP findings were taken as the gold standard for the presence or absence of CBD stones. A 2×2 contingency table was constructed, and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of TAUS were calculated. ROC curve analysis was also performed.* ***Results:*** *The mean age was 44.59 ± 14.59 years; 60% were female and 40% male. Jaundice was present in 47%, fever in 17%, and RUQ pain in 78%. Mean total bilirubin was 3.85 ± 2.66 mg/dL, ALP 246.86 ± 123.4 IU/L, and CBD diameter on ultrasound 7.26 ± 2.08 mm. MRCP detected choledocholithiasis in 40% (n=40). TAUS identified 23 true positives, 56 true negatives, 4 false positives, and 17 false negatives, yielding a sensitivity 57.5%, a specificity 93.3%, a PPV 85.2%, an NPV 76.7%, and an overall accuracy 79%. ROC analysis demonstrated an AUC of 0.755 (P < 0.0001), indicating acceptable discriminative performance.* ***Conclusion:*** *TAUS demonstrated high specificity but only moderate sensitivity for detecting choledocholithiasis compared with MRCP. A positive TAUS result reliably confirmed CBD stones, but a negative TAUS did not exclude disease; therefore, MRCP should be considered in patients with persistent clinical or biochemical suspicion despite negative or equivocal ultrasound findings.*

Keywords: Choledocholithiasis; Transabdominal ultrasound; MRCP; Diagnostic accuracy; Common bile duct stones; ROC curve.

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Introduction

Choledocholithiasis (common bile duct [CBD] stones) is a frequent and clinically important complication of gallstone disease that can cause obstructive jaundice, acute cholangitis, and pancreatitis, often requiring urgent biliary decompression and stone extraction. In population studies, gallstones are common, and CBD stones may occur in up to ~20% of patients with cholelithiasis, particularly in those presenting with biliary symptoms and abnormal liver biochemistry. (1) Because endoscopic retrograde cholangiopancreatography (ERCP) is both diagnostic and therapeutic but invasive, contemporary pathways emphasize confirming CBD stones before ERCP, where feasible, to reduce avoidable procedure-related harm. The American Society for Gastrointestinal Endoscopy (ASGE) guideline notes ERCP is associated with adverse events in approximately 6%–15% of cases, supporting selective use based on pre-test probability and noninvasive imaging. (2,3, 6)

Transabdominal ultrasound (TAUS) is widely available, inexpensive, and typically the first-line imaging test in suspected biliary obstruction (4). However, TAUS performance for direct stone visualization varies with bowel gas, obesity, stone size, and operator dependence; therefore, indirect signs such as CBD and intrahepatic ductal dilatation are also used. In a Pakistani cohort (J Ayub Med Coll Abbottabad, 2019), TAUS sensitivity and specificity for direct visualization of CBD calculi were 76.2% and 81.3%, respectively, highlighting moderate sensitivity even in experienced hands. (3) Other literature has reported markedly lower sensitivities (e.g., ~20%–40%) in some settings, reflecting case-mix and technical factors, while specificity is often higher when a stone is confidently seen. (6,7)

Magnetic resonance cholangiopancreatography (MRCP) is a noninvasive modality with strong diagnostic performance for assessing the biliary tree. It is frequently used as a "reference" imaging test, with ERCP reserved for therapy. Reported MRCP sensitivity and specificity for choledocholithiasis commonly fall in broad ranges (sensitivity ~50%–100%, specificity ~83%–100%) depending on study design and reference standards. (5) In a prospective observational study from Rawalpindi (PAFMJ; 134 patients; ERCP as gold standard), ultrasound indicated stones in 78.2% while MRCP diagnosed stones in 92%; overall diagnostic accuracy was 70.5% for USG versus 92.4% for MRCP, emphasizing MRCP's higher yield when clinical suspicion remains high after a negative or equivocal ultrasound. (1) Another recent regional report similarly found ultrasound to be less sensitive than MRCP (ultrasound sensitivity 43%, specificity 100%; MRCP sensitivity 99%, specificity 94%, with ERCP as reference), again supporting MRCP as a robust confirmatory test in intermediate-risk patients. (4)

Given local resource constraints, TAUS remains pivotal for triage, but uncertainty persists regarding its true diagnostic accuracy compared with MRCP in symptomatic patients. Quantifying TAUS sensitivity, specificity, predictive values, and accuracy using MRCP as the comparator can refine imaging algorithms and reduce unnecessary ERCPs, hospitalizations, and complications. (8-10)

Objective: To determine the diagnostic accuracy of transabdominal ultrasound for the detection of choledocholithiasis, using MRCP as the gold standard.

Methodology

A cross-sectional diagnostic accuracy study was conducted in the radiology department of JPMC, Karachi, with a study period between 15th November 2024 and 15 May 2025. Adult patients presenting with clinical suspicion of choledocholithiasis (e.g., right upper quadrant pain, jaundice, and/or deranged liver function tests suggestive of cholestasis) were enrolled using consecutive sampling until the target sample size of 100 was achieved. Patients with prior biliary surgery altering anatomy (except cholecystectomy without biliary-enteric anastomosis), known biliary malignancy, contraindications to MRI (e.g., non-MRI compatible implants, severe claustrophobia), pregnancy, or incomplete imaging were excluded. All included participants underwent transabdominal ultrasound performed by an experienced radiologist using a standardized protocol assessing CBD diameter, intrahepatic biliary dilatation, and direct visualization of intraductal echogenic foci with acoustic shadowing. MRCP was performed within a short predefined interval after TAUS using standard hepatobiliary sequences, and MRCP reports were interpreted by a radiologist blinded to the TAUS result. MRCP evidence of CBD stones (signal voids/filling defects within the duct) defined disease-positive status. TAUS was classified as positive or negative for choledocholithiasis based on direct visualization of the stone (and, where applicable, predefined supportive criteria). A 2×2 contingency table was constructed (TAUS vs MRCP), and sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated with 95% confidence intervals. Categorical variables (e.g., sex, symptom flags, TAUS/MRCP positivity) were summarized as frequencies and percentages, while continuous variables (e.g., age, CBD diameter, bilirubin, ALP) were summarized as mean ± standard deviation. Data were analyzed using standard statistical software.

Results

In this study, 100 participants were evaluated, with a mean age of 44.59 ± 14.59 years. Females constituted the majority of the sample (60%, n=60), while males accounted for 40% (n=40). Regarding clinical presentation, jaundice was present in 47% (n=47) of patients, right upper quadrant (RUQ) pain in 78% (n=78), and fever in 17% (n=17). The mean total bilirubin level was 3.85 ± 2.66 mg/dL, the mean alkaline phosphatase (ALP) was 246.86 ± 123.4 IU/L, and the mean CBD diameter on transabdominal ultrasound was 7.26 ± 2.08 mm.

On diagnostic comparison of transabdominal ultrasound (TAUS) against MRCP (gold standard), TAUS correctly identified choledocholithiasis in 23 cases (true positives) and correctly ruled it out in 56 cases (true negatives). There were 4 false-positive and 17 false-negative results. Overall, MRCP detected choledocholithiasis in 40% (n=40) of participants, while 60% (n=60) were MRCP negative. Based on these findings, TAUS demonstrated a sensitivity of 57.5% and a specificity of 93.3%. The positive predictive value (PPV) was 85.2%, the negative predictive value (NPV) was 76.7%, and the overall diagnostic accuracy of TAUS was 79%.

ROC curve analysis further supported the test's diagnostic performance, with an area under the curve (AUC) of 0.755, indicating acceptable discriminative ability of TAUS in detecting choledocholithiasis when MRCP was used as the reference standard. This diagnostic performance was statistically significant with $P < 0.0001$.

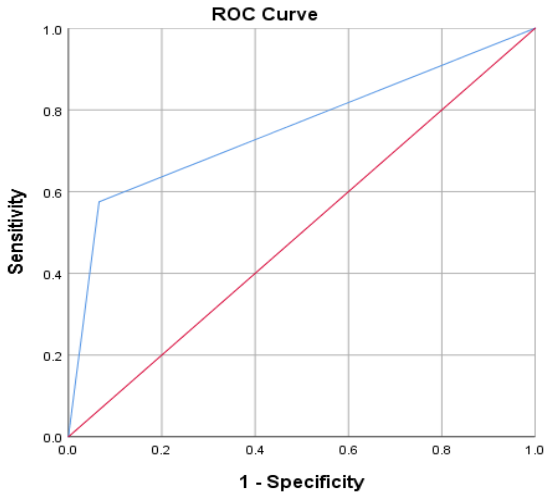

Figure 1: ROC curve analysis with AUC=0.755 and P<0.0001

Table 1: Demographic and clinical variables

Variables	Mean and Frequency
Age (years)	44.59±14.59
Gender	
Male	40 (40%)
Female	60 (60%)
Symptoms	
Jaundice	47 (47%)
Fever	17 (17%)
Total bilirubin (mg/dL)	3.85±2.66
ALP (IU/L)	246.86±123.4
CBD diameter (mm/US)	7.26±2.08
RUQ Pain	78 (78%)

Table 2: 2x2 contingency tables and accuracy metrics

	MRCP positive	MRCP negative	Total
TAUS positive	23	4	27
TAUS negative	17	56	73
Total	40	60	100
Sensitivity	57.5		
Specificity	93.3		
PPV	85.2		
NPV	76.7		
Accuracy	79		

Discussion

In the present study, transabdominal ultrasound (TAUS) demonstrated moderate sensitivity (57.5%) but high specificity (93.3%) for detecting choledocholithiasis, with a PPV of 85.2%, an NPV of 76.7%, and an overall accuracy of 79%. This pattern—good "rule-in" ability when TAUS is positive but limited "rule-out" ability when TAUS is negative—is consistent with the known technical limitations of TAUS for direct CBD stone visualization, particularly in the distal duct where bowel gas and body habitus frequently obscure the field.

Historically, TAUS has shown variable sensitivity for choledocholithiasis. Early prospective work by Gross et al. reported a sensitivity of only 25% (with a negative predictive value of around 73%) when ultrasound findings were compared with cholangiographic or operative standards, emphasizing that a negative ultrasound does not reliably exclude stones. (11) Similarly, Stott et al. found ultrasound to be highly accurate for detecting CBD dilatation but much less accurate for detecting ductal stones directly, with a sensitivity 36% and a specificity 98%. (12) These foundational studies help explain the false-negative burden in our dataset (17%)—a clinically relevant issue because missed CBD stones can lead to persistent obstruction, cholangitis, or pancreatitis.

More contemporary studies show improved TAUS performance in selected populations and specialized centers, yet sensitivity remains inconsistent. Varghese et al., using direct cholangiography as the diagnostic standard, reported ultrasound sensitivity 38% and specificity 100% for choledocholithiasis, while MRCP achieved 91% sensitivity and 98% specificity. (13) Compared with our results, specificity is similar (reflecting that clearly visualized stones are usually true stones). At the same time, our sensitivity exceeds 38%. Still, it remains only moderate, likely because ultrasound detection depends heavily on stone size, ductal location, sonographer expertise, and the proportion of distal CBD stones.

Local and regional MRCP-comparator studies have frequently reported higher TAUS sensitivity than seen in our findings. Palwa et al. reported a sensitivity of 96% and a specificity of 80.9% for TAUS versus MRCP, with a diagnostic accuracy of 87.86%. (14) Likewise, Rizvi et al. (n=150) reported ultrasound sensitivity 76.3%, specificity 92.3%, and accuracy 86% with MRCP as reference. (15) The lower sensitivity observed in our study (57.5%) compared to these reports may reflect differences in case mix (e.g., smaller stones), timing of imaging, proportion of distal duct stones, and operational factors such as patient fasting status and bowel gas. Importantly, our high specificity (93.3%) aligns well with that of Rizvi et al. (92.3%), supporting the inference that TAUS positivity is clinically actionable and can appropriately expedite definitive management. (15)

When considering ultrasound as a broader assessment of biliary pathology (not merely stone detection), diagnostic agreement also varies. Samara et al. compared ultrasound with MRCP and found an overall ultrasound accuracy of about 76.1%, with meaningful false-negative and false-positive proportions. (16) This mirrors our overall accuracy of 79% and reinforces that TAUS is useful for triage but should not be the sole determinant in patients with persistent clinical suspicion.

The ROC curve in our results showed an AUC of 0.755 ($P < 0.0001$), indicating acceptable overall discrimination. This is clinically important because ROC performance reflects diagnostic separability beyond a single threshold. One reason ROC performance may be acceptable despite moderate sensitivity is that TAUS likely performs better in patients with supportive features (e.g., duct dilatation, cholestatic labs). In resource-limited settings, De Silva et al. highlighted the utility of CBD diameter measurement as an objective predictor (reporting a threshold with high sensitivity and specificity in their context). (17) In our study, the mean CBD diameter (7.26 ± 2.08 mm) and cholestatic markers (bilirubin 3.85 ± 2.66 mg/dL; ALP 246.86 ± 123.4 IU/L) support the concept that ultrasound's strongest contribution may be risk stratification using indirect signs, rather than direct stone visualization alone.

The consistent finding across studies is that MRCP generally outperforms TAUS for stone detection, particularly for distal CBD stones. Naheed et al. reported ultrasound sensitivity 47.27% versus MRCP sensitivity 78.18%, with MRCP providing better visualization of distal CBD stones. (18) This aligns with the clinical interpretation of our data: the false-negative rate (17%) likely represents stones that were small, distal, or obscured scenarios, where MRCP typically has superior performance.

Finally, it is important to acknowledge that MRCP itself is not perfect. A recent meta-analysis comparing EUS and MRCP reported pooled MRCP sensitivity around 0.85 and specificity around 0.90, indicating that MRCP, while strong, can miss stones, especially tiny or transient stones. (19) Nonetheless, MRCP remains a highly appropriate noninvasive reference in many diagnostic accuracy studies, particularly where ERCP is reserved for therapy. In addition, the relationship between cholestatic labs and imaging findings supports integrated decision-making. Isherwood et al. examined serology and ultrasound parameters in patients undergoing MRCP and emphasized the importance of combining biochemical and imaging indicators rather than relying on ultrasound alone. (20) Taken together, our findings support a pragmatic pathway: a positive TAUS can "rule in" choledocholithiasis with high confidence. At the same time, a negative TAUS should be followed by MRCP (or EUS, where available) in clinically or biochemically suspicious cases, to reduce missed stones and downstream complications.

Conclusion

Transabdominal ultrasound showed moderate sensitivity (57.5%) but high specificity (93.3%) for detecting choledocholithiasis when compared with MRCP. A positive TAUS finding was strongly predictive of CBD stones (PPV 85.2%), making it useful for ruling in disease. However, due to a notable false-negative rate, a negative TAUS could not reliably exclude choledocholithiasis (NPV 76.7%). Therefore, MRCP should be considered in patients with clinically or biochemically suspicious findings and negative or equivocal ultrasound findings.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-MMS-033-24)

Consent for publication
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The authors declared no conflict of interest.

Author Contribution

SS (Professor)
Manuscript drafting, Study Design,
OS (Resident Radiology R4)
Review of Literature, Data entry, Data analysis, and drafting articles.
AH (Resident Radiology R2)
Conception of Study, Development of Research Methodology Design
DZ (Resident Radiology R2)
Study Design, manuscript review, and critical input.
MR (Resident Radiology)
Manuscript drafting, Study Design,
AB (Resident Radiology)

Conception of Study, Development of Research Methodology Design

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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