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Comparison of Common Bile Duct Dilatation at the Porta Hepatis in Patients with Obstructive Jaundice on Ultrasonography and Magnetic Resonance Pancreatography

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ABSTRACT

Obstructive jaundice is a frequent clinical issue that, in most cases, is related to choledocholithiasis, strictures, or malignant lesions. **Objective:** To compare the level of diagnostic accuracy of USG to that of MRCP in identifying CBD dilatation. **Methods:** There were 165 patients with clinical suspicion of obstructive jaundice, who were enrolled in six months between 1st July 2024 and 31st December 2024. MRCP was used as the reference standard to assess the diagnostic performance of USG. Calculations were made on sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and likelihood ratios. The Receiver Operating Characteristic (ROC) analysis was conducted, and age, gender, BMI, and symptom duration were determined post-stratification to assess diagnostic accuracy. **Results:** The average age of the participants was 52 years, and 57.6% were men. MRCP was positive in 60.6% of patients with CBD, and USG was positive in 54.5% of patients. USG proved to have a sensitivity of 85.0, specificity of 92.3, and PPV of 94.4 and NPV of 80.0, and a general diagnostic accuracy of 87.9 compared with MRCP. **Conclusions:** USG offers high specificity and accuracy of diagnosis of CBD dilatation and should be used as a primary imaging tool. MRCP is to be used in cases of inconclusive or negative USG when there is high clinical suspicion.

INTRODUCTION

Obstructive jaundice is a typical clinical manifestation that develops because of mechanical obstruction of bile flow anywhere in the biliary tree. It is linked to life-threatening conditions such as cholangitis, pancreatitis, and progressive liver dysfunction, and timely and accurate diagnosis is vital [1]. Hepatobiliary diseases are significant healthcare system burdens in the world, and early imaging is essential to inform therapeutic decisions [2, 3]. Transabdominal ultrasonography (US) is still the initial imaging modality of choice in patients with suspected biliary obstruction. It is cheap, very common, non-invasive, and free of ionizing radiation. The common bile duct (CBD) is easy to see anterior to the portal vein at the porta hepatis, and sonographic measurement of CBD dilatation is usually done at this landmark [4]. The upper normal limit of the common bile duct diameter is thought to be 6 to 7 mm in adults, although it may increase with age or after cholecystectomy [5, 6]. Although it is useful, ultrasound has significant drawbacks, with distal bile ducts and the pancreatic head being frequently obscured by bowel gas or

body habitus, which decreases the accuracy of diagnostics [7]. Magnetic resonance cholangiopancreatography (MRCP) is the most sensitive, non-invasive imaging modality for assessing the biliary tree [8]. It gives multiplanar visualization, which has a high contrast resolution, and the level and cause of obstruction are effectively detected. MRCP has reported sensitivity of between 85% and 98% with specificity of over 90%; hence, it is a good substitute for invasive diagnostic tests like the ERCP [9, 10]. The results of comparative studies indicate that MRCP is better than ultrasound in the localization and etiology of obstruction, especially in choledocholithiasis and malignant strictures [11, 12].

Although extensive studies have been conducted to compare ultrasound and MRCP in the diagnosis of obstructive jaundice, very minimal research has been carried out on the CBD diameter measurement at the porta hepatis, which is a significant anatomical landmark in detecting obstruction at a very early stage. By establishing this correlation, not only will the reliability of ultrasound in the initial screening be validated, but the time when MRCP should be a priority will be established to maximize diagnostic algorithm and resource use. The purpose of the present study was to compare the common bile duct dilatation measured at the porta hepatis on ultrasonography (US) to magnetic resonance cholangiopancreatography (MRI) in patients with obstructive jaundice.

METHODS

This cross-sectional validation study was conducted at PAEC General Hospital, Islamabad, for six months from 1st July 2024 to 31st December 2024. The ethical approval was obtained from the Institutional Ethical Committee (IEC) of PAEC General Hospital, Approval no: PGHI-IRB (DMe)-RCD-06-092. A sample size of 165 patients was calculated using a sensitivity and specificity calculator, based on an expected sensitivity of 85%, specificity of 79%, prevalence of 78.0%, desired precision of 10%, and a confidence level of 95% [2, 9]. Patients were recruited using a non-probability consecutive sampling technique. All patients presenting with clinical signs and symptoms of obstructive jaundice, such as right hypochondrial pain, upper abdominal pain, fever, and malaise, along with raised total serum bilirubin levels greater than 1.2 mg/dl, were considered eligible. Adults of both genders aged between 30 and 70 years were included. Patients with a history of cholecystectomy or other abdominal surgical interventions, pregnant women, and those with contraindications to MRI, such as claustrophobia, metallic implants, dental and cochlear devices, cardiac pacemakers, or aneurysmal clips, were excluded from the study. Patients meeting the inclusion criteria who presented to the Department of Outpatient Services or the Department of Emergency were enrolled in the study. The participants were informed about the study protocol, and informed consent was obtained along with a brief clinical history, including the procedures of ultrasonography and MRCP. In the case of ultrasonography, patients were positioned in the supine or left lateral position to enable an improved view of the hepatobiliary system. Following the coupling of gel, a transducer was placed on the right upper abdomen, and the liver, gallbladder, and bile ducts were real-time visualized. The presence of stones or masses, the common bile duct (CBD) diameter, wall characteristics, and differentiation between vascular and biliary structures were observed, and Doppler was applied. In adults, a CBD of more than 6 mm was regarded as dilated. Magnetic resonance cholangiopancreatography (MRCP) was done with the patient lying supinely in the MRI scanner, where abdominal coils were used. T2-weighted sequences were acquired to emphasize fluid-filled structures to give clear images of the biliary tree and pancreatic ducts. Coronal and axial images provided close anatomical detail, whereas other sequences blocked the fat signal and enhanced the ductal visualization. Obstructive jaundice was characterized as a high level of serum bilirubin (more than 2.5 mg/dL) in which there is predominance of direct bilirubin, which is usually characterized by yellowish skin and sclera, dark urine, and pale stool. The test under evaluation was ultrasonography, and the reference standard of diagnosis was MRCP. To assess diagnostic performance, sensitivity was the capacity of ultrasound to identify genuine cases of CBD dilatation, and specificity was used to identify the potential to eliminate non-cases. Positive predictive value (PPV) was used to denote the percentage of true positives of ultrasound positives, and negative predictive value (NPV) was used to denote the percentage of true negatives of ultrasound negatives. True positives, false positives, true negatives, and false negatives were all determined in terms of comparison with MRCP. Data entry and analysis were done using SPSS version 23.0. Quantitative data, or the body mass index, common bile duct size, age, and lab results, were expressed using mean and standard deviation. Qualitative variables like chief complaints, gender, duration of symptoms, and outcomes were presented, such as frequencies and percentages. A 2 x 2 contingency table was developed on MRCP as the reference; the sensitivity, specificity, positive predictive value, negative predictive value, and the overall diagnostic value of the ultrasonography were established. Diagnostic performance of ultrasonography was evaluated against MRCP by the Receiver Operating Characteristic (ROC) curve, and the area under the curve (AUC) was used as a

summary measure of the overall test performance. A CBD diameter cut-off of 6 mm was used to define dilatation on ultrasonography to generate the ROC curve and the AUC. The stratification was adjusted for the effect modifiers age, gender, BMI, and duration of symptoms. A p-value ≤0.05 was taken to be significant.

R E S U L T S

The BMI of the study participants was 27.5 ± 4.2 kg/m2 with a mean age of 52.0 ± 10.0. Out of 165 respondents, 57.6 percent were males and 42.4% were females. Jaundice (90.9%) was the most frequent presenting complaint, followed by abdominal pain (72.7%), dark-colored urine (54.5%), pruritus (27.3%), and pale bowel movements (18.2%). In terms of symptom duration, 18.2% had had the symptoms for less than one week, 48.5% less than four weeks, and 33.3% had a longer duration. The MRCP gold standard in this study indicated that 60.6% of participants had common bile duct dilatation, with 39.4% having no dilatation. In ultrasound, 54.5% of the patients showed dilatation, and 45.5% did not have any evidence of dilatation (Table 1).

Table 1: Demographics and Clinical Features and Imaging Findings of the Study Participants (n=165)

Variables	n (%)
Age	
Mean ± SD (Years)	52.0 ± 10.0
Gender	
Male	95 (57.6%)
Female	70 (42.4%)
BMI	
Mean ± SD (kg/m^2)	27.5 ± 4.2
Chief complaint	
Jaundice	150 (90.9%)
Abdominal Pain	120 (72.7%)
Pruritus	45 (27.3%)
Dark Urine	90 (54.5%)
Pale Stools	30 (18.2%)
Duration	
< 1 Week	30 (18.2%)
1–4 Weeks	80 (48.5%)
> 4 Weeks	55 (33.3%)
MRCP (Gold Standard)	
CBD Dilatation	100 (60.6%)
No CBD Dilatation	65 (39.4%)
Ultrasound	
CBD Dilatation	90 (54.5%)
No CBD Dilatation	75 (45.5%)

The laboratory analysis revealed that there were high levels of bilirubin and matching liver dysfunction tests, such as transaminases, alkaline phosphatase, and gamma-glutamyl transferase, which are in agreement with

obstruction of the biliary system. Hematological evaluation showed that some patients had mild anemia, and the white blood cell count, as well as the platelet count, mostly fell within the expected clinical levels (Table 2).

Table 2: Laboratory Findings of the Study Participants (n=165)

Laboratory Findings	Mean ± SD
Total Bilirubin (mg/dL)	6.8 ± 3.4
Direct Bilirubin (mg/dL)	4.9 ± 2.6
ALT (U/L)	78 ± 60
AST (U/L)	65 ± 50
ALP (U/L)	320 ± 150
GGT (U/L)	210 ± 120
Hemoglobin (g/dL)	11.8 ± 1.6
WBC (×10^3/mm^3)	9.5 ± 3.2
Platelets (×10^3/mm^3)	220 ± 60

Comparison of the results of ultrasonography and MRCP as the gold standard demonstrates that the majority of the cases of common bile duct dilatation on the MRCP were also identified in the ultrasound. Cohen's kappa was calculated from the 2×2 table to assess agreement between ultrasound and MRCP, yielding a value of 0.77, indicating substantial concordance between the two modalities. Of the total, 85 were true positives, 60 were true negatives, 15 cases were missed as false negatives, and 5 were over-reported as false positives (Table 3).

Table 3: Comparison of MRCP Findings with UGS (n=165)

MRCP	USG		Total
	Positive	Negative	
Positive (CBD Dilated)	85 (TP)	15 (FN)	100
Negative (No CBD Dilatation)	5 (FP)	60 (TN)	65
Total	90	75	165

The ultrasonography showed high specificity and positive predictive value, which means that a dilatation detected by sonography has a high probability of being confirmed in MRCP. The negative predictive value and sensitivity were somewhat lower, indicating the possibility of missed cases in some patients. In general, the quality of diagnoses was good, and all the measures were supported by a 95% confidence to obtain precision and enhance interpretability. Moreover, the AUC under the ROC curve was 0.93 (95% CI: 0.88-0.97) (Table 4).

Table 4: Diagnostic Performance of USG Using MRCP as the Gold Standard

Measurements	Values	95% Confidence Interval (CI)
Sensitivity	85.0%	76.0–91.0%
Specificity	92.3%	83.0–97.0%
Positive Predictive Value (PPV)	94.4%	86.0–98.0%
Negative Predictive Value (NPV)	80.0%	69.0–88.0%
Overall Accuracy	87.9%	81.0–93.0%

The diagnostic accuracy of USG was not significantly

different after post-stratification by age groups (p=0.125) or genders (p=0.455). Nevertheless, a substantial difference was also evident regarding BMI, with a decrease in the diagnostic performance of patients with obesity (BMI ≥30 kg/m2) relative to the normal/overweight patients (p=0.044). Likewise, duration of symptoms also played a role in the accuracy of the diagnosis, with lower accuracy among those whose symptoms had a short time frame of one week compared with those whose symptoms had a longer duration (p=0.032) (Table 5).

Table 5: Post-Stratification Diagnostic Performance of USG (n = 165)

Stratum (n)	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value
Age				
< 50 Years (n=70)	86.0%	90.0%	87.1%	0.125
≥ 50 Years (n=95)	84.5%	93.0%	88.4%	
Gender				
Male (n=95)	85.3%	91.6%	88.4%	0.455
Female (n=70)	84.6%	93.3%	87.1%	
BMI				
< 25 kg/m^2 (n=45)	90.0%	95.0%	92.2%	
25–29.9 kg/m^2 (n=80)	85.0%	92.0%	88.8%	0.044*
≥ 30 kg/m^2 (n=40)	75.0%	85.0%	80.0%	
Duration of Symptoms				
< 1 Week (n=30)	78.0%	86.0%	82.0%	
1–4 Weeks (n=80)	87.5%	93.0%	90.0%	0.032*
> 4 Weeks (n=55)	85.0%	92.0%	88.2%	

The chi-square test was applied* Statistically significant (p≤0.05) ROC Curve showing the diagnostic performance of USG-measured CBD diameter against MRCP-confirmed dilatation, with an AUC of 0.93, reflecting excellent accuracy (Figure 1).
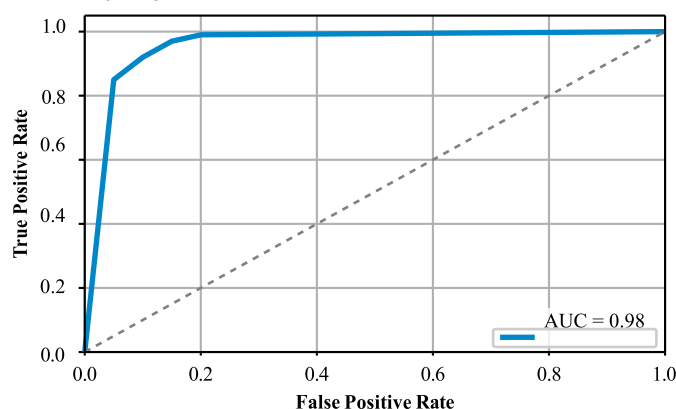

Figure 1: ROC Curve for USG vs MRCP (CBD Dilatation)

DISCUSSION

In the present study cohort of 165 patients, USG showed good diagnostic performance for detecting CBD dilatation when MRCP was used as the reference standard: sensitivity 85.0%, specificity 92.3%, and AUC 0.93. These results place USG in a favorable position compared with several recent reports that evaluated US, MRCP, and other modalities for biliary obstruction. A 2023 single-center study comparing USG and MRCP reported low sensitivity but high specificity for ultrasound in detecting choledocholithiasis, while MRCP showed very high sensitivity and specificity; the authors concluded that MRCP outperformed US, particularly for small or distal stones. Several recent institutional reports and audit-style studies similarly found MRCP to have excellent diagnostic accuracy (often ≥90%) for biliary obstruction and choledocholithiasis, while USG performance was more variable [13, 14]. A 2020 diagnostic efficacy study reported MRCP accuracy near 97% for level and cause of obstruction compared with ultrasound accuracy around 81%, emphasizing MRCP's superior mapping of the biliary tree and cause of obstruction; our USG accuracy (87.9%) lies between those values and likely reflects that our endpoint, CBD dilatation at the porta hepatis, is a sonographic landmark that USG can measure reasonably well in many patients [15]. Other studies have published prospective comparisons showing MRCP sensitivity often above 90% for choledocholithiasis and overall diagnostic accuracy approaching 90%, which supports the role of MRCP as the non-invasive gold standard in many centers [16, 17]. The present study MRCP-based reference standard and the high AUC for USG indicate that ultrasound-measured CBD diameter is a strong discriminator of MRCP-confirmed dilatation, even if ultrasound may miss some cases. Differences in sensitivity between studies appear tied to the prevalence of distal small stones, operator skill, and the specific definition of "positive" [18, 19]. A multicenter analysis has compared MRCP, EUS, and transabdominal ultrasound and showed that MRCP and EUS have superior sensitivity to transabdominal ultrasound for detecting stones and defining the level of obstruction, although specificity is frequently similar across modalities. Where EUS shows higher sensitivity, MRCP remains the preferred non-invasive test for anatomical mapping [13, 20]. Current findings are compatible with this body of evidence; ultrasound demonstrated high specificity and PPV, but NPV was lower (80.0%), indicating that a negative ultrasound could not always exclude MRCP-confirmed dilatation, which mirrors conclusions from recent meta-analyses [21]. This study is limited by its single-center design, operator-dependent ultrasonography, and use of non-probability consecutive sampling, which may introduce selection bias and limit generalizability. Additionally, small distal stones may be missed on ultrasound, and the lack of statistical comparison of continuous CBD measurements between US and MRCP restricts assessment of measurement agreement. Future multicenter studies using standardized imaging protocols should compare continuous CBD

measurements across modalities and incorporate EUS or MRCP to improve diagnostic accuracy.

CONCLUSIONS

Present study showed that ultrasonography offers strong diagnostic accuracy, high specificity, and an excellent positive predictive value for identifying common bile duct dilatation when compared to MRCP, the gold standard. These results demonstrate its value as a dependable, affordable, and easily accessible first-line screening tool, especially in environments with limited resources. Its negative predictive value and poorer sensitivity, however, highlight how crucial it is to confirm negative ultrasonography results with MRCP in patients who have a high level of clinical suspicion.

Authors' Contribution

Conceptualization: SM
Methodology: SM, NS, NK, MIK
Formal analysis: NK, HG
Writing and Drafting: SM, NS, AN, MIK
Review and Editing: SM, NS, NK, MIK, HG, AN

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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