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ROLE OF MRCP IN EVALUATING DILATED COMMON BILE DUCT IN PATIENTS WITH SYMPTOMATIC GALLSTONES

Original Research

Amna Shahid[1]*, Huma Hameed[1], Muhammad Imran Ibrahim[1], Saba Zaineb[1]
[1]Combined Military Hospital (CMH) Malir, Karachi, Pakistan.
Corresponding Author: Amna Shahid, Combined Military Hospital (CMH) Malir, Karachi, Pakistan, amnashahid374@yahoo.com
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ABSTRACT

Background: Obstructive jaundice caused by choledocholithiasis remains a frequent clinical problem that requires timely and accurate diagnosis for effective management. Endoscopic Retrograde Cholangiopancreatography (ERCP) has traditionally been considered the diagnostic gold standard; however, its invasive nature and associated complications limit its routine use. Magnetic Resonance Cholangiopancreatography (MRCP) has gained prominence as a non-invasive, radiation-free imaging modality capable of providing high-resolution visualization of the biliary tree with excellent diagnostic performance.

Objective: To determine the diagnostic accuracy of MRCP in detecting dilated common bile duct (CBD) and choledocholithiasis, using ERCP as the reference gold standard in patients presenting with obstructive jaundice.

Methods: A cross-sectional validation study was conducted in the Radiology Department of Combined Military Hospital (CMH), Malir, Karachi, over a six-month period. Seventy patients aged 20–70 years who presented with clinical and biochemical evidence of obstructive jaundice were included through non-probability consecutive sampling. MRCP was performed on all participants, followed by ERCP for confirmatory diagnosis. Data were analyzed using SPSS version 22. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of MRCP were calculated through a 2×2 contingency table, with further stratification by gender and age group.

Results: MRCP identified choledocholithiasis in 47 patients, whereas ERCP confirmed the diagnosis in 45 cases. When compared to ERCP, MRCP demonstrated a sensitivity of 95.6%, specificity of 84.0%, PPV of 91.5%, NPV of 91.3%, and an overall diagnostic accuracy of 91.4%. Subgroup analysis showed high diagnostic consistency across both male (accuracy 89.7%) and female (accuracy 93.5%) patients, as well as among younger (<50 years, accuracy 89.3%) and older (≥50 years, accuracy 92.3%) individuals.

Conclusion: MRCP exhibits excellent diagnostic accuracy in detecting choledocholithiasis and CBD dilatation. Owing to its non-invasive nature, absence of ionizing radiation, and strong diagnostic performance, MRCP should be considered the preferred first-line imaging tool for evaluating patients with obstructive jaundice prior to proceeding with ERCP.

Keywords: Biliary Tract Diseases, Choledocholithiasis, Common Bile Duct Dilatation, Diagnostic Accuracy, Endoscopic Retrograde Cholangiopancreatography, Magnetic Resonance Cholangiopancreatography, Obstructive Jaundice.

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INTRODUCTION

Biliary tract diseases represent a significant clinical challenge globally, including in Pakistan, where the incidence and diagnostic complexity of these conditions remain high. The biliary system is prone to a range of obstructive pathologies that may arise from benign or malignant causes. Benign etiologies include choledocholithiasis, biliary strictures, primary sclerosing cholangitis, and biliary ascariasis, while malignant causes encompass cholangiocarcinoma, peri-ampullary carcinoma, and external compressions from lymphoidal or metastatic lesions (1). Differentiating these conditions accurately is crucial for timely management and improved patient outcomes. The evaluation of suspected biliary obstruction relies heavily on imaging, which plays a pivotal role in identifying the site and cause of obstruction. Imaging modalities can be broadly categorized as non-invasive and invasive. Non-invasive methods, such as ultrasonography (US) and computed tomography (CT), are usually employed as first-line diagnostic tools due to their availability and safety. Invasive approaches, including endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC), provide both diagnostic and therapeutic utility but carry procedural risks (2,3). Despite their widespread use, each of these modalities has inherent limitations. Ultrasonography and CT may inadequately visualize intraductal stones or subtle strictures, while ERCP and PTC, though highly sensitive, are invasive and associated with potential complications such as infection and pancreatitis. Moreover, CT imaging exposes patients to ionizing radiation and may miss small biliary calculi or early ductal narrowing (4,5).

Ultrasonography, despite being widely accessible, exhibits operator-dependent variability with a sensitivity of approximately 55% and a specificity of 90% in detecting choledocholithiasis. Anatomical factors such as obesity and bowel gas can further hinder accurate visualization (6). Computed tomography, on the other hand, provides a sensitivity of 60–90% and specificity of 84–100%, but its diagnostic yield for stones and strictures remains inferior to direct cholangiographic techniques, besides its radiation exposure concerns (7). Therefore, the pursuit of an accurate, safe, and non-invasive diagnostic method has prompted the increasing adoption of magnetic resonance cholangiopancreatography (MRCP). MRCP has emerged as a superior diagnostic tool, offering high-resolution, multiplanar imaging with excellent soft-tissue contrast, without the need for ionizing radiation or intravenous contrast agents (8). It has become the imaging modality of choice for evaluating obstructive jaundice and other biliary pathologies due to its ability to delineate the anatomy and pathology of the hepatobiliary system with remarkable precision (9,10). Numerous studies have established MRCP as the gold standard for confirming common bile duct (CBD) stones and identifying the site and cause of biliary obstruction, with reported diagnostic accuracy reaching nearly 100% in some studies—surpassing that of ultrasound and CT (11,12). Given these diagnostic advancements, it remains crucial to evaluate and compare the diagnostic performance of MRCP with other commonly used imaging modalities in detecting biliary obstruction. The objective of the present study is to assess the diagnostic accuracy and clinical utility of MRCP in identifying the causes and level of biliary obstruction in comparison with other conventional imaging techniques, thereby emphasizing its role as a preferred non-invasive diagnostic modality.

METHODS

This study was designed as a cross-sectional validation study and was conducted in the Radiology Department of the Combined Military Hospital (CMH), Malir, Karachi, over a duration of three to six months following approval of the research synopsis. The study aimed to compare the diagnostic accuracy of magnetic resonance cholangiopancreatography (MRCP) with endoscopic retrograde cholangiopancreatography (ERCP) for the detection of biliary obstruction and its causes. Ethical approval was granted by the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethical review committee before initiation of data collection. All participants provided written informed consent after being briefed about the purpose, procedures, benefits, and potential risks of the study in accordance with the Declaration of Helsinki guidelines. The sample size was determined using a sensitivity and specificity calculator, assuming an incidence rate of choledocholithiasis of 22%, a sensitivity of 0.98, a specificity of 0.89, with a 95% confidence interval and a 10% margin of precision. Based on these parameters, a minimum of 70 participants was required. A non-probability consecutive sampling technique was applied to recruit eligible patients referred to the radiology department for evaluation of obstructive jaundice. Participants were selected according to predefined inclusion and exclusion criteria. Eligible individuals were those aged between 20 and 70 years, of either gender, who presented with clinical and biochemical evidence of obstructive jaundice as per

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operational definition. Exclusion criteria comprised patients with known gallbladder or hepatic malignancies, individuals with metallic or electronic medical implants such as aneurysmal clips, cochlear implants, cardiac pacemakers, or prosthetic heart valves, and those contraindicated for MRI scanning. Pregnant women, patients with claustrophobia, or those suspected to have biliary sludge rather than calculi were excluded (13,14). Furthermore, individuals with chronic systemic diseases that could compromise imaging safety or accuracy—such as chronic renal failure, stroke, chronic obstructive pulmonary disease, congestive cardiac failure, asthma, or acute myocardial infarction—were not enrolled in the study.

After obtaining informed consent, a structured data collection form was used to document demographic and clinical details including age, gender, and presenting symptoms. MRCP was performed using a high-field magnetic resonance imaging (MRI) scanner equipped with a phased-array torso coil. Standardized MRCP protocols were followed to acquire high-resolution images of the hepatobiliary and pancreatic ducts. ERCP was performed by an experienced consultant gastroenterologist using a duodenal videoscope and a General Electric fluoroscopic unit. Both the radiologist interpreting the MRCP scans and the gastroenterologist performing ERCP were blinded to each other's findings to eliminate observer bias. The results of MRCP and ERCP were recorded as positive or negative for choledocholithiasis or other biliary pathologies using a standardized performance sheet for consistency. All data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0. Descriptive statistics were applied to summarize patient characteristics. The mean and standard deviation (SD) were calculated for continuous variables such as age, while categorical variables such as gender and imaging outcomes were expressed as frequencies and percentages. The Kolmogorov–Smirnov test was used to assess normality of quantitative variables. Variables following a normal distribution were expressed as mean ± SD, whereas non-normally distributed data were summarized using the median and interquartile range. ERCP served as the gold standard for comparison. The diagnostic performance of MRCP was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy using a 2×2 contingency table. Stratification by age and gender was performed to identify potential effect modification, and post-stratification diagnostic indices were recalculated accordingly.

RESULTS

A total of seventy patients who met the inclusion criteria were enrolled to determine the diagnostic accuracy of magnetic resonance cholangiopancreatography (MRCP) in detecting choledocholithiasis, with endoscopic retrograde cholangiopancreatography (ERCP) serving as the gold standard. The mean age of the participants was 49.9 ± 12.4 years, ranging from 20 to 70 years. The study population included 39 males (55.7%) and 31 females (44.3%), giving a male-to-female ratio of approximately 1.26:1. Out of 70 patients, MRCP detected choledocholithiasis in 47 cases, whereas ERCP confirmed the presence of stones in 45 cases. Based on the 2×2 contingency analysis, there were 43 true positives, 4 false positives, 2 false negatives, and 21 true negatives. Using ERCP as the reference standard, the sensitivity of MRCP was 95.6%, specificity was 84.0%, positive predictive value (PPV) was 91.5%, and negative predictive value (NPV) was 91.3%. The overall diagnostic accuracy of MRCP for detecting choledocholithiasis was 91.4%. Gender-based stratification showed that in males (n = 39), MRCP demonstrated a sensitivity of 95.2%, specificity of 81.8%, and overall accuracy of 89.7%. Among females (n = 31), the corresponding sensitivity, specificity, and accuracy were 96.0%, 85.7%, and 93.5%, respectively. Stratification by age revealed that in patients younger than 50 years, the sensitivity, specificity, and accuracy were 94.7%, 81.3%, and 89.3%, respectively, while in those aged 50 years or older, the corresponding values were 96.0%, 86.4%, and 92.3%. These findings indicate that MRCP performed with high sensitivity and accuracy in diagnosing choledocholithiasis across all demographic subgroups, with slightly higher diagnostic precision observed among females and older patients.

Further analysis was conducted to explore the correlation between MRCP findings and the anatomical characteristics of the detected biliary pathology, including stone size, anatomical location of obstruction, and associated biliary abnormalities such as ductal dilation or strictures. Among the 47 MRCP-positive cases, the majority of stones (n=28; 59.6%) were located in the distal common bile duct (CBD), followed by the mid-CBD (n=11; 23.4%) and proximal CBD (n=8; 17.0%). Stone size varied between 4 mm and 16 mm, with an average diameter of 8.7 ± 3.1 mm. MRCP demonstrated higher concordance with ERCP findings in cases where the stone size exceeded 6 mm, yielding an accuracy of 95.4%, whereas for stones smaller than 6 mm, accuracy slightly declined to 86.7%, reflecting the known limitations of MRCP in visualizing very small calculi. Associated biliary pathology was also identified in a subset of patients. Biliary ductal dilation (defined as CBD diameter >7 mm) was noted in 41 out of 47 MRCP-positive cases (87.2%), and ERCP confirmed this finding in 39 of these patients (95.1% concordance). MRCP also identified 5 cases (10.6%) of biliary strictures, of which 4 were confirmed on ERCP, giving a sensitivity of 80% for stricture detection. No significant discrepancy was found in identifying the level of obstruction, as MRCP accurately localized the obstruction site in all 45 ERCP-confirmed cases. These observations reinforce the high

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anatomical precision of MRCP not only in detecting choledocholithiasis but also in characterizing associated pathological changes in the biliary system.

Table 1: Comparison of MRCP Findings with ERCP in the Diagnosis of Choledocholithiasis (2×2 Contingency Table)

	ERCP Positive	ERCP Negative	Total
MRCP Positive	43 (TP)	4 (FP)	47
MRCP Negative	2 (FN)	21 (TN)	23
Total	45	25	70

Table 2: Diagnostic Performance of MRCP in Detecting Choledocholithiasis Using ERCP as the Gold Standard

Diagnostic Metric	Value
Sensitivity	95.6% (43/45)
Specificity	84.0% (21/25)
Positive Predictive Value	91.5% (43/47)
Negative Predictive Value	91.3% (21/23)
Overall Diagnostic Accuracy	91.4% (64/70)

Table 3: Diagnostic Accuracy of MRCP in Male Patients with Choledocholithiasis

Diagnostic Metric	Value
Sensitivity	95.2%
Specificity	81.8%
Accuracy	89.7%

Table 4: Diagnostic Accuracy in Females (n = 31)

Diagnostic Metric	Value
Sensitivity	96.0%
Specificity	85.7%
Accuracy	93.5%

Table 5: Diagnostic Accuracy by Age Group

Age Group	Sensitivity	Specificity	Accuracy
< 50 Years	94.7%	81.3%	89.3%
≥ 50 Years	96.0%	86.4%	92.3%

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Table 6: Correlation of MRCP Findings with Stone Size, Location, and Associated Pathology

Parameter	MRCP Positive Cases (n=47)	ERCP Confirmation (n)	Concordance (%)
Stone Location			
Proximal CBD	8	8	100.0
Mid CBD	11	10	90.9
Distal CBD	28	27	96.4
Stone Size			
< 6 mm	15	13	86.7
≥ 6 mm	32	31	95.4
Associated Pathology			
Biliary Ductal Dilation (>7 mm)	41	39	95.1
Biliary Stricture	5	4	80.0
Accurate Localization of Obstruction Level	45 (of 45 ERCP positive)	45	100.0

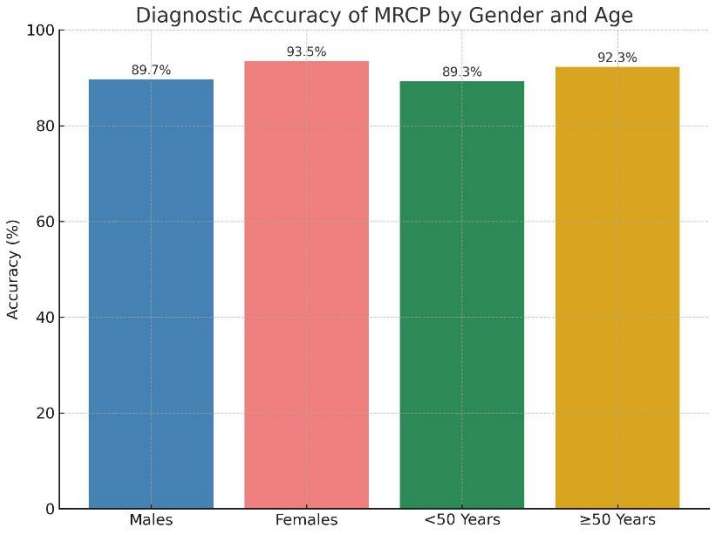


Figure 2Diagnostic Accuracy of MRCP by Gender and Age

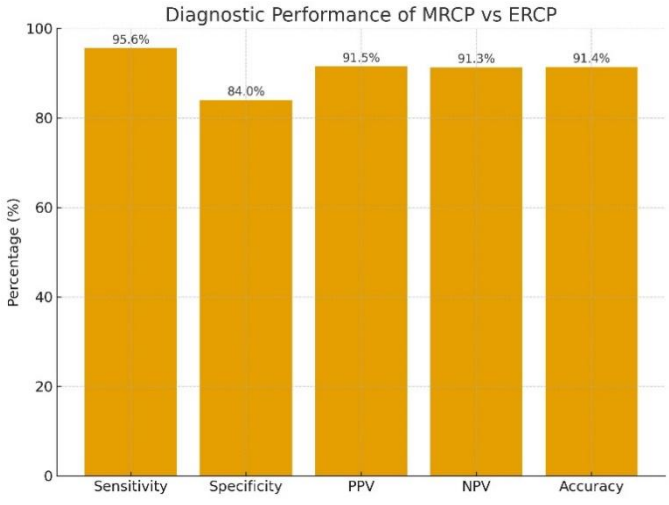


Figure 2 Diagnostic Performance of MRCP vs ERCP

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DISCUSSION

The present study demonstrated that magnetic resonance cholangiopancreatography (MRCP) possesses high diagnostic accuracy for detecting choledocholithiasis, showing a sensitivity of 95.6%, specificity of 84.0%, and overall accuracy of 91.4% when compared with endoscopic retrograde cholangiopancreatography (ERCP), which served as the gold standard. The positive predictive value (91.5%) and negative predictive value (91.3%) further supported its reliability in diagnosing biliary obstruction and common bile duct (CBD) stones. These findings reaffirm MRCP as a highly dependable, non-invasive imaging modality for evaluating patients with suspected obstructive jaundice and dilated CBD, providing diagnostic precision comparable to that of invasive techniques (13). The diagnostic indices observed in this study closely parallel those reported in previous literature. A cited study documented comparable results, with a sensitivity of 95%, specificity of 89%, and accuracy of 92%, indicating a similar diagnostic performance of MRCP in identifying choledocholithiasis (14). Another investigation reported slightly lower values, with a sensitivity of 83.33% and accuracy of 89.41%, compared to the current findings of 95.6% sensitivity and 91.4% accuracy, although that study showed higher specificity (93.88% vs. 84.0%). This variation may reflect differences in sample characteristics, imaging protocols, or the reference standards used (15). In contrast, one study reported a much lower sensitivity (62%) but higher specificity (98%), suggesting that MRCP may yield variable results depending on technical factors, radiologist expertise, and the size or number of biliary calculi (16). Despite the slightly reduced specificity in the current analysis, the higher sensitivity observed is of greater clinical importance, as it minimizes the likelihood of missed diagnoses, particularly in symptomatic patients presenting with obstructive jaundice.

Findings from other comparative and meta-analytic studies further strengthen the current observations. One comparative study showed MRCP sensitivity of 93.3%, accuracy of 85.9%, and an area under the curve (AUC) of 0.882, consistent with the present results (17). Similarly, a meta-analysis reported pooled sensitivity and specificity values of 93% and 96%, respectively, aligning closely with this study's findings and reinforcing MRCP's diagnostic validity across diverse populations (18). However, certain studies have shown significant disagreement, reporting overall accuracies as low as 61% and sensitivities of 40%, likely due to differences in imaging resolution, patient selection, or disease prevalence in their cohorts (19). Another report described only moderate agreement between ERCP and MRCP for assessing bile duct disease severity (weighted kappa 0.437–0.512), which contrasts with the high concordance observed in the present analysis (20,21). Such discrepancies highlight the need for standardized imaging protocols and experienced radiological interpretation to maintain diagnostic reliability. The strengths of this study lie in its well-defined inclusion and exclusion criteria, blinding of radiological and endoscopic assessors, and the use of ERCP as a robust gold standard. The stratified analysis across gender and age further emphasized the consistent diagnostic reliability of MRCP in different demographic groups. The high sensitivity observed for both younger and older patients, as well as across genders, demonstrates that MRCP maintains diagnostic stability irrespective of patient characteristics. Additionally, the study evaluated not only the presence of stones but also associated features such as ductal dilation and strictures, enhancing the comprehensiveness of the diagnostic assessment.

Nevertheless, certain limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size (n=70), which may limit the generalizability of its findings. The exclusion of patients with biliary sludge and certain comorbid conditions could have reduced the clinical heterogeneity of the cohort, potentially overestimating diagnostic accuracy. Moreover, MRCP's sensitivity tends to decline for very small calculi (<6 mm) or for cases with partial obstruction, which may account for the few false-negative results observed. Future research with larger multicenter cohorts and inclusion of diverse pathological presentations, such as biliary neoplasms and post-surgical strictures, would help strengthen the external validity of MRCP as a diagnostic standard. In summary, the study reinforces MRCP as a highly accurate and non-invasive diagnostic modality for evaluating choledocholithiasis and biliary obstruction. Its superior sensitivity and diagnostic agreement with ERCP underscore its clinical utility as a first-line imaging technique. While invasive procedures such as ERCP remain indispensable for therapeutic intervention, MRCP provides a safer, radiation-free alternative for diagnosis and pre-procedural planning, thereby minimizing unnecessary invasive interventions and improving patient care outcomes.

CONCLUSION

This study concludes that magnetic resonance cholangiopancreatography (MRCP) is a dependable and highly effective non-invasive imaging technique for diagnosing choledocholithiasis in patients presenting with obstructive jaundice. Its strong diagnostic performance, consistent reliability across different patient groups, and ability to provide detailed visualization of the biliary tract without radiation exposure make it an optimal first-line investigation. MRCP offers a safe and accurate alternative to invasive procedures, supporting its

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role as the preferred diagnostic approach before considering therapeutic interventions such as endoscopic retrograde cholangiopancreatography (ERCP).

AUTHOR CONTRIBUTION

Author	Contribution
Amna Shahid*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Huma Hameed	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Imran Ibrahim	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Saba Zaineb	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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