

Research Article

Diagnostic Accuracy of Magnetic Resonance Cholangiopancreatography Versus Endoscopic Retrograde Cholangiopancreatography in the Evaluation of Hepatobiliary Pathologies

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Abstract: **Introduction:** **Objective:** To evaluate the diagnostic accuracy of MRCP in comparison to ERCP for identifying hepatobiliary pathologies, including choledocholithiasis, biliary strictures, bile duct dilatation, and intrahepatic biliary radicle abnormalities. **Materials and Methods:** This prospective observational cross-sectional study was conducted in the Department of General Surgery, SMS Medical College and Hospital, Jaipur, over 18 months. Fifty patients aged 18–60 years with clinically suspected hepatobiliary pathology were enrolled. All participants underwent MRCP followed by ERCP, which served as the reference standard. Statistical analysis included calculation of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for each lesion type. **Results:** MRCP demonstrated excellent diagnostic accuracy for bile duct stones (sensitivity 95.24%, specificity 100%), bile duct strictures (accuracy 94%), bile duct tumors (accuracy 100%), and intrahepatic biliary radicle dilatation (accuracy 98%). However, diagnostic performance was limited for choledochal cysts and gallbladder stones, where false-positive findings reduced accuracy. **Conclusion:** MRCP is a reliable, non-invasive alternative to ERCP for diagnosing most hepatobiliary pathologies. It can be used as a first-line imaging modality to identify patients who truly require therapeutic ERCP, thereby reducing procedure-related risks and improving patient safety.

Keywords: Diagnostic Accuracy, ERCP, Hepatobiliary pathology, MRCP.

INTRODUCTION

Jaundice, or hyperbilirubinemia, refers to the yellowish discoloration of the skin and sclera caused by excessive accumulation of bilirubin in body tissues. It occurs when there is either increased bilirubin production or decreased hepatic excretion.¹ Hepatobiliary disorders, including diseases of the liver and biliary tract, are important causes of jaundice and contribute substantially to global morbidity and mortality. Conditions such as viral hepatitis, cirrhosis, and non-alcoholic fatty liver disease account for millions of deaths annually, while biliary tract diseases, including cholelithiasis and biliary malignancies, further add to the disease burden. Clinical jaundice usually appears when serum bilirubin levels exceed 3 mg/dl, with scleral icterus being the earliest visible sign because of the high elastin content in the sclera, which has a strong affinity for bilirubin.²

Biliary obstruction is a common cause of jaundice and may occur at any point along the biliary pathway. Such obstruction can lead to serious complications, including cholangitis, hepatic dysfunction, renal impairment,

nutritional deficiencies, and bleeding tendencies.³ Biliary obstruction is broadly classified as intrahepatic or extrahepatic. Intrahepatic cholestasis may result from drug-induced liver injury, primary biliary cholangitis, primary sclerosing cholangitis, infiltrative disorders, or viral and alcoholic hepatitis.^{4,5} Extrahepatic obstruction, can arise from benign conditions such as choledocholithiasis, Mirizzi syndrome, iatrogenic strictures, or choledochal cysts, and from malignant lesions of the biliary tract or pancreas.⁶

Gallstones represent the most common benign cause of extrahepatic obstruction. About 10%–15% of individuals with gallstones develop choledocholithiasis during their lifetime.⁷ The condition is more prevalent among women, largely due to the effect of estrogen on hepatic cholesterol metabolism, which increases bile cholesterol saturation and promotes stone formation.⁸ Accurate diagnosis of the cause and site of biliary obstruction is crucial for guiding management, determining the need for intervention, and preventing complications.

Traditionally, Endoscopic Retrograde Cholangiopancreatography (ERCP) has been regarded as the gold standard for the diagnosis of biliary and pancreatic disorders since its introduction in 1968.⁹ It combines endoscopic visualization with fluoroscopic imaging and also allows therapeutic interventions such as stone extraction and stenting.¹⁰ However, ERCP is an invasive procedure requiring ductal cannulation and sedation, and it carries a 1%–7% risk of complications including hemorrhage, sepsis, pancreatitis, and bile leakage, with approximately one-fourth of these being serious.¹¹

Magnetic Resonance Cholangiopancreatography (MRCP), introduced in 1991, is a non-invasive imaging technique that uses heavily T2-weighted magnetic resonance sequences to visualize static fluid within the biliary and pancreatic ducts.¹² MRCP provides high-contrast images of the biliary tree without the need for ionizing radiation or contrast agents. It is safe, operator-independent, and highly useful for pre-procedural assessment before therapeutic ERCP.¹⁷ When combined with routine T1- and T2-weighted MRI sequences, MRCP can also identify extra-ductal pathologies such as mass lesions or infiltrative disease.

Multiple comparative studies have evaluated the diagnostic performance of MRCP and ERCP. Most reports suggest that while ERCP remains indispensable for therapy, MRCP can serve as a reliable non-invasive diagnostic alternative in many cases.^{14,15} MRCP is especially beneficial for patients with suspected hepatobiliary obstruction but without definite evidence on biochemical or sonographic evaluation, helping to avoid unnecessary ERCP and its associated complications. Despite extensive global research, most comparative studies between MRCP and ERCP have been retrospective and based on selective patient groups. There is limited prospective data from Indian tertiary-care centres assessing their diagnostic agreement in routine clinical practice. Therefore, this study aims to evaluate the diagnostic accuracy of MRCP in comparison to ERCP for identifying hepatobiliary pathologies such as choledocholithiasis, biliary strictures, and malignancies in patients attending SMS Medical College, Jaipur. Given the invasive nature and risk profile of ERCP, establishing MRCP as a reliable diagnostic tool could help limit ERCP use primarily to therapeutic procedures.

MATERIALS AND METHODS

This prospective, hospital-based observational, Cross-sectional study was conducted in the Department of General Surgery, Sawai Man Singh (SMS) Hospital, Jaipur, Rajasthan. The study period extended over 18 months, which included 12 months for data collection and 6 months for data analysis. This study enrolled adult patients presenting with hepatobiliary pathology who were admitted.

The sample size was calculated at a 5% alpha error and 90% power using the formula for the difference in paired means. Based on expected variability in diagnostic outcomes between MRCP and ERCP, the minimum required sample size was determined to be 42, which was rounded off to 50 participants to ensure adequate statistical power. A total of 50 consecutive patients fulfilling the inclusion criteria were enrolled using purposive sampling.

Patients aged between 18 and 60 years with suspected hepatobiliary pathology who provided written informed consent were included. Exclusion criteria comprised patients below 18 years of age, pregnant females, and those with contraindications to MRI such as cardiac pacemakers, cochlear implants, non-MRI-compatible intracranial clips, or severe claustrophobia. Participants not undergoing subsequent ERCP evaluation or unwilling to provide consent were also excluded from the study.

The research proposal was approved by the Institutional Clinical Trial Screening Committee and subsequently cleared by the Institutional Ethics Committee (IEC). Written informed consent was obtained from all participants after providing detailed information about the study objectives, procedures, and potential risks and benefits. Confidentiality of participants was maintained throughout the study by assigning anonymous identification numbers and restricting data access to the research team.

Data were collected prospectively using a pre-designed and pre-tested proforma to ensure uniformity and completeness. The proforma included demographic details, presenting symptoms, clinical examination findings, laboratory investigations, and imaging results from MRCP and ERCP.

All enrolled patients underwent a detailed clinical evaluation at admission, including history of presenting complaints such as abdominal pain, jaundice, fever, or vomiting; duration of symptoms; and any history of alcohol intake, drug use, or previous hepatobiliary disease. General physical and systemic examination findings, especially abdominal signs, were documented.

Radiological Evaluation

Initial imaging evaluation consisted of a chest X-ray and ultrasonography (USG) of the abdomen. USG was used to assess for hepatobiliary abnormalities such as intrahepatic or extrahepatic bile duct dilatation, cholelithiasis, choledocholithiasis, or mass lesions. Patients demonstrating or suspected to have biliary obstruction were subsequently evaluated by MRCP and ERCP.

Magnetic Resonance Cholangiopancreatography (MRCP)

MRCP was performed using a standard MRI system equipped with sequences optimized for biliary and pancreatic duct visualization. Images were obtained in multiple planes aligned with the biliary tree. MRCP findings were analyzed for the presence and level of biliary obstruction, type of pathology (stone, stricture, or malignancy), ductal dilatation, and any associated anatomical variations or extra-ductal abnormalities. All MRCP scans were interpreted by an experienced radiologist blinded to the ERCP results.

Endoscopic Retrograde Cholangiopancreatography (ERCP)

Following MRCP, all patients underwent ERCP, which served as the reference standard for diagnosis. The procedure was performed under standard aseptic precautions by an experienced gastroenterologist. ERCP findings were documented regarding the presence and

nature of the obstruction, underlying pathology, and any therapeutic interventions performed, such as stone extraction, sphincterotomy, or stent placement.

Statistical Analysis

All collected data were entered into Microsoft Excel on the same day of collection to minimize entry bias and subsequently analyzed using standard statistical software. Continuous variables were expressed as mean±standard deviation, while categorical data were presented as frequencies and percentages. The difference between means was assessed using Student's *t*-test, and categorical variables were compared using the chi-square test. Diagnostic performance of MRCP was evaluated against ERCP as the gold standard by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. Agreement between the two modalities was assessed using Cohen's kappa coefficient. A *p*-value of <0.05 was considered statistically significant.

RESULTS

In the present study, the most common age group was 38–47 years (20%), followed by ≥68 years (18%), with equal distribution (16% each) in the 18–27, 48–57, and 58–67 years groups. The least common age group was 28–37 years (14%). Females constituted 58%, while males comprised 42% of the study population. In our study, 30% of participants had clinical evidence of icterus, and 14% of participants had Pedal edema. The mean random blood sugar level among participants was 127.76 ± 69.55 mg/dL. (Table -1)

Table 1- Age and Sex wise distribution of participants

Variable		Number	Percentage
Age group (Years)	18-27	8	16
	28-37	7	14
	38-47	10	20
	48-57	8	16
	58-67	8	16
	≥68	9	18
Sex	Female	29	58
	Male	21	42

The liver enzymes were elevated, with SGPT at 84.26 ± 68.14 U/L and SGOT at 90.16 ± 85.58 U/L. Alkaline phosphatase was also raised (141.94 ± 88.02 U/L). The mean serum albumin was 3.32 ± 0.48 g/dL, and the A/G ratio was approximately 1.01. The mean total bilirubin level was 3.38 ± 4.57 mg/dL, with direct bilirubin at 2.45 ± 3.74 mg/dL and indirect bilirubin at 0.93 ± 0.89 mg/dL. (Table-2)

Table 2- Liver Function Test (LFT) Parameters of Study Participants

LFT	Mean	SD
PTINR	1.36	0.51
SGPT	84.26	68.14
SGOT	90.16	85.58
S. Alkaline phosphatase	141.94	88.02
Serum Protein	5.83	0.43
Serum Albumin	3.32	0.48
Globulin	1.95	0.35
A/G ratio	1.01	0.09
Bilirubin		

Total Bilirubin	3.38	4.57
Direct Bilirubin	2.45	3.74
Indirect Bilirubin	0.93	0.89

In the present study, MRCP failed to detect the single case of choledochal cyst confirmed by ERCP, showing a sensitivity of 0%, but demonstrated a high specificity of 95.92% and a negative predictive value (NPV) of 97.92%, yielding an overall diagnostic accuracy of 94%. No cases of gall bladder stones were detected by ERCP; however, MRCP falsely identified 26 cases, resulting in a specificity of 48.98% and a diagnostic accuracy of 48%, indicating poor concordance between MRCP and ERCP for gall bladder stone detection. There were no carcinoma gallbladder (CA GB) cases confirmed by ERCP, while MRCP falsely reported three cases, resulting in 94% specificity and 0% positive predictive value (PPV), with a diagnostic accuracy of 94%. (Table 3)

Table 3- Diagnostic Accuracy of MRCP Compared to ERCP

Diagnosis		ERCP		Total
		Present	Absent	
Choledochal Cyst				
MRCP	Present	0	2	2
	Absent	1	47	48
Gall Bladder Stones				
MRCP	Present	0	26	26
	Absent	0	24	24
Carcinoma Gallbladder (CA GB)				
MRCP	Present	0	3	3
	Absent	0	47	47
Bile Duct Tumor				
MRCP	Present	4	0	4
	Absent	0	46	46
Bile Duct Dilation				
MRCP	Present	11	1	12
	Absent	2	36	38
Bile Duct Strictures				
MRCP	Present	8	0	8
	Absent	3	39	42
Bile Duct Stones				
MRCP	Present	20	0	20
	Absent	1	29	30
IHBR Strictures				
MRCP	Present	0	1	1
	Absent	0	49	49
IHBR Dilation				
MRCP	Present	34	1	35
	Absent	0	15	15

For bile duct tumors, MRCP accurately detected all four cases, achieving 100% sensitivity, specificity, PPV, NPV, and diagnostic accuracy, demonstrating perfect agreement with ERCP. In the detection of bile duct dilatation, MRCP showed high sensitivity (84.62%) and specificity (97.30%), with PPV of 91.67% and NPV of 94.74%, yielding an overall diagnostic accuracy of 94%, indicating strong agreement with ERCP findings. For bile duct strictures, MRCP correctly identified eight out of 11 cases, resulting in 72.73% sensitivity, 100% specificity, and a diagnostic accuracy of 94%, reflecting excellent reliability. (Table 4)

Table 4- Diagnostic Accuracy of MRCP Compared to ERCP for Various Hepatobiliary Pathologies

Lesion Type	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Choledochal cyst	0	95.92	0	97.92	94

Gall-bladder stones	0	48.98	0	100	48
Carcinoma gall-bladder	0	94	0	100	94
Bile-duct tumor	100	100	100	100	100
Bile-duct dilatation	84.62	97.3	91.67	94.74	94
Bile-duct strictures	72.73	100	100	92.86	94
Bile-duct stones	95.24	100	100	96.67	98
IHBR strictures	0	98	0	100	98
IHBR dilatation	100	93.75	97.14	100	98

In the detection of bile duct stones, MRCP identified 20 out of 21 cases, achieving 95.24% sensitivity, 100% specificity, 100% PPV, 96.67% NPV, and an overall diagnostic accuracy of 98%, showing near-perfect correlation with ERCP. For intrahepatic biliary radicle (IHBR) strictures, no confirmed cases were found on ERCP, although MRCP falsely identified one case, resulting in 98% specificity and a diagnostic accuracy of 98%. Finally, for IHBR dilatation, MRCP correctly detected all 34 ERCP-confirmed cases with one false positive, showing 100% sensitivity, 93.75% specificity, and 98% diagnostic accuracy, indicating that MRCP is highly reliable in detecting IHBR dilatation.

DISCUSSION

The present study evaluated the diagnostic accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) in comparison with Endoscopic Retrograde Cholangiopancreatography (ERCP) for detecting various hepatobiliary pathologies. ERCP was considered the reference standard for comparison.

In the present study, MRCP failed to identify the single case of choledochal cyst confirmed by ERCP, resulting in a sensitivity of 0%. However, it demonstrated high specificity (95.92%) and an overall diagnostic accuracy of 94%. This indicates that MRCP reliably excludes the diagnosis in normal cases but may occasionally miss true lesions due to factors such as small cyst size, atypical morphology, or technical limitations in image acquisition. In contrast, Tamilarasan SM et al¹⁶ reported that MRCP effectively detects choledochal cysts and provides detailed anatomical information comparable to ERCP. Similarly, Matos C et al¹⁷ found complete concordance between MRCP and ERCP in the classification and structural characterization of choledochal cysts, including the identification of abnormal pancreaticobiliary junctions. The discrepancy between these findings and ours may be attributed to differences in sample size, image resolution, and radiologist expertise, underscoring the importance of clinical correlation and confirmatory ERCP in equivocal cases.

In the present study, MRCP showed poor accuracy in detecting gallbladder stones, falsely identifying 26 cases not confirmed by ERCP, resulting in low specificity (48.98%) and diagnostic accuracy (48%). These false positives likely resulted from artifacts, sludge misinterpretation, or post-surgical changes such as clips and air, which can mimic calculi on imaging. In contrast, MRCP demonstrated excellent diagnostic performance for choledocholithiasis, accurately detecting 20 of 21

ERCP-confirmed bile duct stones, with sensitivity 95.24%, specificity and PPV 100%, NPV 96.67%, and overall accuracy 98%. Our findings are consistent with previous studies by Javaria Isram et al¹¹, Makary MA et al¹², Polistina FA et al¹⁸, and Tamilarasan SM et al¹⁶, all of which reported high diagnostic accuracy of MRCP for bile duct stones. Griffin et al¹⁹ and Hurter et al²⁰ also observed sensitivity and specificity above 85–90%, confirming its reliability. Despite limitations such as motion artifacts, small stone size, and signal interference from adjacent fluid or vascular pulsation, MRCP remains a highly sensitive and non-invasive imaging tool.

MRCP demonstrated variable diagnostic accuracy across different hepatobiliary pathologies when compared to ERCP, the gold standard. For carcinoma gallbladder (CA GB), MRCP falsely identified three cases with no ERCP confirmation, giving a specificity and diagnostic accuracy of 94%. These false positives were likely due to misinterpretation of benign conditions such as sludge or wall thickening mimicking malignancy, emphasizing the need for histopathological or contrast-enhanced confirmation.

For bile duct tumors, MRCP showed excellent agreement with ERCP, correctly identifying all four confirmed cases, resulting in 100% sensitivity, specificity, and diagnostic accuracy. Similar high accuracy has been reported by Polistina FA et al¹⁸ and Lomas et al²¹, reinforcing MRCP's role in non-invasive diagnosis of obstructive lesions.

In bile duct dilatation, MRCP achieved a sensitivity of 84.62% and specificity of 97.30%, with overall accuracy of 94%. These results closely align with findings by Kumar A et al²² and Chan et al²³, who reported sensitivities of 91–95% and specificities of 85–94%, confirming MRCP's strong diagnostic performance in detecting biliary obstruction.

Regarding bile duct strictures, MRCP identified 8 of 11 ERCP-confirmed cases, with sensitivity 72.73%,

specificity 100%, and accuracy 94%. Comparable results were observed by Kumar A et al²² and Lomas et al²¹, whereas Javaria Isram et al¹¹ reported lower sensitivity (15.4%) but high specificity (100%), highlighting variability in detecting malignant distal strictures. MRCP's capacity to visualize both intrahepatic and extrahepatic ducts without contrast makes it valuable for high or multiple-level strictures, as also noted by Polistina FA et al¹⁸.

For intrahepatic biliary radicle (IHBR) strictures, MRCP falsely detected one case, maintaining 98% specificity and accuracy, indicating strong reliability with minimal false positives. In contrast, for IHBR dilatation, MRCP performed exceptionally well, detecting all 34 ERCP-confirmed cases with sensitivity 100%, specificity 93.75%, and accuracy 98%. These results underscore its effectiveness in evaluating upstream obstruction and peripheral ducts, consistent with findings by Hintze et al²⁴.

The inclusion and exclusion criteria in this study were clearly defined, ensuring a uniform study population. The analysis comprehensively evaluated various hepatobiliary pathologies such as bile duct stones, strictures, tumors, and intrahepatic biliary radicle (IHBR) dilatation, with diagnostic indices like sensitivity, specificity, and predictive values calculated for each. The major limitation was the small sample size (n=50), and certain rare pathologies were underrepresented, restricting subgroup comparisons. Future multicentric studies with larger cohorts are recommended to validate findings, assess cost-effectiveness, and refine MRCP interpretation to minimize false positives in gallbladder lesions.

Conclusion

In the present study, MRCP demonstrated high diagnostic value as a non-invasive imaging modality for the evaluation of hepatobiliary disorders. Compared with ERCP, the gold standard, MRCP showed excellent accuracy in detecting bile duct stones, strictures, tumors, and intrahepatic biliary radical dilatation, with high sensitivity and specificity. Its non-invasive nature, absence of ionizing radiation, and lower risk of procedure-related complications make it an effective first-line investigation and a valuable tool for identifying patients who require therapeutic ERCP. However, its diagnostic performance was comparatively limited for gallbladder stones and choledochal cysts, where false-positive findings were observed, necessitating confirmation with ERCP or other imaging modalities in selected cases. Overall, MRCP can be effectively incorporated into the diagnostic pathway of hepatobiliary diseases to reduce unnecessary invasive procedures and enhance patient safety, although larger multicentric studies are warranted to further validate these findings and address areas of limited accuracy.

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