DOI: https://doi.org/10.54393/pjhs.v7i6.3912

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 7, Issue 06 (June 2026)

Original Article

OPEN ACCESS

Diagnostic Accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) in Differentiating Benign and Malignant Causes of Obstructive Jaundice Using Histopathology as the Reference Standard

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ARTICLE INFO

Keywords:
Obstructive Jaundice, Magnetic Resonance Cholangiopancreatography, Biliary Obstruction, Histopathology, Diagnostic Accuracy

How to Cite:
Begum, T., Orakzai, Z. J., Khan, L., Noureen, S., Baig, H., & Azam, N. (2026). Diagnostic Accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) in Differentiating Benign and Malignant Causes of Obstructive Jaundice Using Histopathology as the Reference Standard: MRCP in Benign and Malignant Causes of Obstructive Jaundice Using Histopathology . Pakistan Journal of Health Sciences, 7(6), 69-74. https://doi.org/10.54393/pjhs.v7i6.3912

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Received Date: 30th January, 2026
1st Revision Received: 2nd March, 2026
Acceptance Date: 16th March, 2026
Published Date: 30th June, 2026

ABSTRACT

Obstructive jaundice requires accurate differentiation between benign and malignant causes to guide management and prognosis. Magnetic resonance cholangiopancreatography (MRCP) is increasingly used as a non-invasive diagnostic modality; however, local evidence comparing MRCP findings with histopathology remains limited. **Objectives:** To evaluate the diagnostic accuracy of MRCP in differentiating benign from malignant obstructive jaundice using histopathology as the reference standard. **Methods:** This retrospective cross-sectional study included 103 patients with obstructive jaundice who underwent MRCP followed by histopathological confirmation between June and December 2025. Biochemical parameters and imaging findings were analyzed. Sensitivity, specificity, predictive values, overall accuracy, and area under the receiver operating characteristic curve (AUC) were calculated. **Results:** Histopathology confirmed 54 (52.4%) benign and 49 (47.6%) malignant cases. Total bilirubin, direct bilirubin, ALT, AST, ALP, and CA 19-9 levels were significantly higher in malignant cases (all $p<0.001$), while duration of jaundice, GGT, and stricture length showed no significant difference ($p>0.005$). MRCP demonstrated a sensitivity of 95.9%, specificity of 96.3%, positive predictive value of 95.9%, negative predictive value of 96.3%, and overall accuracy of 96.1%. ROC analysis showed excellent diagnostic performance (AUC = 0.961; 95% CI: 0.918–1.000; $p<0.001$). **Conclusions:** MRCP demonstrates excellent diagnostic accuracy in differentiating malignant from benign obstructive jaundice and serves as a reliable non-invasive imaging modality for clinical decision-making

INTRODUCTION

Obstructive jaundice is a common clinical condition encountered in hepatobiliary practice and results from mechanical obstruction of the biliary tract, leading to impaired bile flow and conjugated hyperbilirubinemia [1]. Globally, obstructive jaundice accounts for a significant proportion of hepatobiliary admissions, with malignant causes reported in approximately 40–60% of adult cases, particularly in patients above 50 years of age [2]. The etiology ranges from benign conditions such as choledocholithiasis, benign strictures, and chronic pancreatitis to malignant diseases, including cholangiocarcinoma, ampullary carcinoma, and pancreatic carcinoma [3]. Differentiating benign from malignant obstruction is crucial because management strategies, surgical planning, and prognosis differ markedly between the two groups [4]. Biochemical assessment and imaging studies form the cornerstone of evaluation [5]. Serum biomarkers, including total and direct bilirubin, alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), transaminases (ALT, AST), and

DOI: https://doi.org/10.54393/pjhs.v7i6.3912

tumor marker CA 19-9, are commonly used in clinical practice [6]. Elevated CA 19-9 levels have been associated with biliary malignancy; however, false elevation may occur in benign obstructive and inflammatory conditions, limiting its specificity. Therefore, no single biochemical marker can reliably distinguish malignant from benign obstruction. Ultrasonography is often the first-line imaging modality, but its diagnostic accuracy is limited by operator dependency and suboptimal visualization of distal bile ducts [7]. Endoscopic retrograde cholangiopancreatography (ERCP) has traditionally served both diagnostic and therapeutic roles, but carries procedure-related risks such as pancreatitis and cholangitis [8]. Magnetic resonance cholangiopancreatography (MRCP) has emerged as a non-invasive imaging modality that provides high-resolution visualization of the biliary and pancreatic ducts without contrast injection or instrumentation [8, 9]. Several studies have reported high sensitivity and specificity of MRCP in differentiating malignant from benign biliary strictures; however, variability in diagnostic performance has been observed across different populations and healthcare settings [10, 11]. In resource-limited environments, access to advanced diagnostic modalities may be constrained, making accurate non-invasive tools even more critical. Histopathology remains the definitive method for confirming malignancy [12]. It was hypothesized that MRCP demonstrates high diagnostic accuracy in differentiating malignant from benign obstructive jaundice when compared with histopathology as the reference standard.

Despite increasing use of MRCP, there is limited local evidence directly correlating MRCP findings with histopathological outcomes in patients with obstructive jaundice. Furthermore, the combined diagnostic value of MRCP alongside routinely available biochemical parameters has not been adequately explored in our setting. This represents an important research gap. Therefore, the present study aimed to evaluate the diagnostic performance of MRCP by determining its sensitivity, specificity, predictive values, overall accuracy, and area under the ROC curve, and to correlate imaging findings with biochemical parameters and final histopathological diagnosis.

METHODS

In this retrospective cross-sectional study, patients were assessed between June and December 2025 in the Department of Radiology, MTI Bacha Khan Medical College and Mardan Medical Complex, Mardan, Pakistan. The study aimed to determine the diagnostic performance of magnetic resonance cholangiopancreatography (MRCP) in distinguishing between benign and malignant causes of obstructive jaundice using histopathology as the reference (gold) standard. The study included all patients who underwent MRCP for evaluation of obstructive jaundice and subsequently had histopathological confirmation within the study period. The study received ethical approval from the Ethical Review Board of MTI Bacha Khan Medical College, Mardan (Ref No. 937/BKMC; dated 14th January 2026), prior to data extraction and analysis and was conducted in accordance with the Declaration of Helsinki. Written informed consent had been obtained from all patients at the time of hospital admission and before undergoing radiological and surgical procedures, and this was documented in their medical records. Although the present analysis was retrospective, patient confidentiality was strictly maintained, and all data were anonymized before statistical analysis. The sample size was calculated using the World Health Organization (WHO) sample size calculator for diagnostic test evaluation. Assuming an expected sensitivity of MRCP of 90% [9], a confidence level of 95%, and an absolute precision of 5%, the minimum required sample size was estimated to be 92 patients. To compensate for incomplete records and improve the precision of diagnostic estimates, a total of 103 patients were included in the final analysis. Consecutive sampling was employed. Adult patients aged 18 years and above with clinical and biochemical features suggestive of obstructive jaundice who underwent MRCP followed by histopathological confirmation were included in the study. Patients with incomplete biochemical records, absence of histopathological confirmation, prior biliary reconstructive surgery altering normal anatomy, or poor-quality MRCP images were excluded. MRCP was performed using a 1.5 Tesla high-field MRI scanner following a standardized hepatobiliary imaging protocol. Axial and coronal heavily T2-weighted sequences were acquired to optimally visualize the biliary tree and pancreatic ductal system. Imaging parameters, including slice thickness and field of view, were kept uniform for all patients to ensure consistency. All MRCP images were independently evaluated by two consultant radiologists with more than five years of experience in hepatobiliary imaging who were blinded to the histopathological findings, and any discrepancies were resolved by consensus to enhance reliability. The radiological parameters documented included the level of obstruction (intrahepatic or extrahepatic), distal common bile duct involvement, hilar involvement, degree of biliary dilatation, morphology of stricture, presence of abrupt cut-off, mass lesion, pancreatic head mass, lymphadenopathy, vascular invasion, gallstones, and stricture length. The degree of biliary dilatation was categorized as mild, moderate, or severe based on duct diameter measurements. Stricture length was measured in millimeters on coronal reformatted

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MRCP images using electronic calipers available in the radiology workstation software. Measurements were taken from the proximal to distal margins of luminal narrowing along the bile duct axis. Predefined radiological criteria were used to classify lesions as benign or malignant. Features suggestive of malignancy included irregular or asymmetric strictures, abrupt cut-off, associated mass lesion, lymphadenopathy, vascular invasion, and marked upstream biliary dilatation, whereas smooth tapered strictures without invasive features were categorized as benign. Clinical and biochemical data were retrieved from hospital records. The laboratory parameters analyzed included total bilirubin (mg/dL), direct bilirubin (mg/dL), alanine aminotransferase (ALT, U/L), aspartate aminotransferase (AST, U/L), alkaline phosphatase (ALP, U/L), gamma-glutamyl transferase (GGT, U/L), and carbohydrate antigen 19-9 (CA 19-9, U/mL). Venous blood samples were collected under aseptic conditions at the time of initial clinical presentation before any surgical or endoscopic intervention. Serum bilirubin, ALT, AST, ALP, and GGT levels were measured using an automated clinical chemistry analyzer based on standardized enzymatic colorimetric methods in the hospital laboratory. CA 19-9 levels were determined using a chemiluminescent immunoassay technique. All measurements were performed according to manufacturer guidelines and internal laboratory quality control protocols, and results were recorded in standard international units. The definitive reference standard was histopathological diagnosis obtained from biopsy or surgical specimens. All tissue samples were processed in the Department of Pathology using standard hematoxylin and eosin staining techniques and examined by consultant pathologists. Cases were categorized as benign or malignant based on microscopic evaluation, and specific histopathological diagnoses were documented. MRCP findings were compared with histopathological results to determine true-positive, true-negative, false-positive, and false-negative outcomes.

Data were entered and analyzed using SPSS version 25.0. The Shapiro-Wilk test was applied to assess the normality of quantitative variables. Variables with normal distribution were presented as mean ± standard deviation, whereas non-normally distributed variables were presented as median and interquartile range. Independent samples t-test or Mann–Whitney U test was used to compare benign and malignant groups, as appropriate. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated using standard 2×2 contingency tables. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the discriminative ability of MRCP, and the area under the curve (AUC) with 95% confidence interval was reported. A p-value of less than 0.005 was considered statistically significant.

RESULTS

A total of 103 patients with obstructive jaundice were included in the study. The mean age was 55.63 ± 15.93 years (range 28–82 years), and the mean duration of jaundice was 6.47 ± 3.67 weeks. Males constituted 53.4% of the study population. Pruritus, abdominal pain, weight loss, and fever were reported in 53.4%, 55.3%, 50.5%, and 51.5% of patients, respectively. Diabetes mellitus and hypertension were present in 49.5% and 54.4% of cases (Table 1).

Table 1: Baseline Characteristics of Patients (n=103)

Variables	Mean ± SD / n (%)
Age (Years)	55.63 ± 15.93
Duration of Jaundice (Weeks)	6.47 ± 3.67
Male Gender	55 (53.4%)
Pruritus	55 (53.4%)
Weight Loss	52 (50.5%)
Abdominal Pain	57 (55.3%)
Fever	53 (51.5%)
Diabetes Mellitus	51 (49.5%)
Hypertension	56 (54.4%)

Histopathological examination classified 54 (52.4%) cases as benign and 49 (47.6%) as malignant. There was no statistically significant difference in age between benign and malignant groups (p=0.883). Duration of jaundice, GGT levels, and stricture length also did not differ significantly (p>0.05). However, total bilirubin, direct bilirubin, ALT, AST, ALP, and CA 19-9 levels were significantly elevated in patients with malignant obstruction compared to benign cases (all p<0.001), indicating more severe cholestatic and hepatocellular injury in malignant disease (Table 2).

Table 2: Comparison of Clinical and Biochemical Variables by Histopathology

Variables	Benign (n=54)	Malignan (n=49)	p-value
Age (years), Mean ± SD	55.85 ± 16.50	55.39 ± 15.45	0.883†
Duration (weeks), Median (IQR)	6.5 (7.0%)	6.0 (7.0%)	0.979‡
Total Bilirubin (mg/dL)	6.25 (4.08%)	13.10 (4.40%)	<0.001‡
Direct Bilirubin (mg/dL)	3.75 (2.45%)	9.20 (3.10%)	<0.001‡
ALT (U/L)	97.5 (39.5%)	164.0 (44.5%)	<0.001‡
AST (U/L)	97.5 (47.25%)	143.0 (48.5%)	<0.001‡
ALP (U/L)	348.0 (160.5%)	676.0 (218.5%)	<0.001‡
GGT (U/L)	222.0 (136.5%)	230.0 (121.5%)	0.577‡
CA 19-9 (U/mL)	83.5 (43.5%)	451.0 (428.5%)	<0.001‡
Stricture Length (mm)	22.5 (19.0%)	22.0 (16.5%)	0.399‡

† Independent t-test. ‡ Mann–Whitney U test

MRCP identified extrahepatic obstruction in 59.2% of cases and intrahepatic obstruction in 40.8%. Distal

DOI: https://doi.org/10.54393/pjhs.v7i6.3912

common bile duct involvement was observed in 53.4% and hilar involvement in 42.7% of patients. Moderate biliary dilatation was the most common pattern (42.7%), followed by mild (30.1%) and severe (27.2%). Irregular strictures and abrupt cut-off were observed in 53.4% and 54.4% of cases, respectively. A mass lesion was detected in 38.8% of patients. Pancreatic head mass, lymphadenopathy, and vascular invasion were present in 47.6%, 53.4%, and 49.5% of patients, respectively. The mean stricture length was 21.47 ± 10.70 mm (Table 3).

Table 3: MRCP Imaging Characteristics (n=103)

Variables	n (%) / Mean ± SD
Extrahepatic Obstruction	61 (59.2%)
Intrahepatic Obstruction	42 (40.8%)
Distal CBD Involvement	55 (53.4%)
Hilar Involvement	44 (42.7%)
Moderate Dilatation	44 (42.7%)
Irregular Stricture	55 (53.4%)
Abrupt Cut-Off	56 (54.4%)
Mass Lesion Detected	40 (38.8%)
Pancreatic Head Mass	49 (47.6%)
Lymphadenopathy	55 (53.4%)
Vascular Invasion	51 (49.5%)
Gallstones	53 (51.5%)
Stricture Length (mm)	21.47 ± 10.70

Definitive histopathological diagnosis revealed 54 (52.4%) benign and 49 (47.6%) malignant cases. Among benign causes, benign stricture was most frequent (21.4%), followed by chronic pancreatitis (17.5%) and choledocholithiasis (13.6%). Among malignant etiologies, cholangiocarcinoma was the most common (19.4%), followed by ampullary carcinoma (16.5%) and pancreatic carcinoma (11.7%) (Table 4).

Table 4: Histopathological Spectrum (n=103)

Category	Diagnosis	n (%)
Benign	Benign Stricture	22 (21.4%)
	Chronic Pancreatitis	18 (17.5%)
	Choledocholithiasis	14 (13.6%)
Malignant	Cholangiocarcinoma	20 (19.4%)
	Ampullary Carcinoma	17 (16.5%)
	Pancreatic Carcinoma	12 (11.7%)

Using histopathology as the reference standard, MRCP correctly identified 47 true-positive and 52 true-negative cases, with 2 false-positive and 2 false-negative results. MRCP demonstrated a sensitivity of 95.9% and specificity of 96.3% in differentiating malignant from benign obstruction. The positive predictive value and negative predictive value were 95.9% and 96.3%, respectively. The overall diagnostic accuracy was 96.1%. Receiver operating characteristic (ROC) curve analysis further confirmed excellent diagnostic performance, with an area under the curve (AUC) of 0.961 (95% CI: 0.918–1.000; p<0.001) (Table 5).

Table 5: Diagnostic Performance of MRCP Compared with Histopathology

Parameters	Value
True positive	47
True negative	52
False positive	2
False negative	2
Sensitivity	95.9%
Specificity	96.3%
PPV	95.9%
NPV	96.3%
Accuracy	96.1%
AUC (95% CI)	0.961 (0.918–1.000)

ROC curve of MRCP for differentiating malignant from benign obstructive jaundice using histopathology as a reference standard. Receiver operating characteristic (ROC) curve of MRCP for differentiating malignant from benign obstructive jaundice using histopathology as the gold standard. The area under the curve (AUC) was 0.961 (95% CI: 0.918–1.000; p<0.001), indicating excellent diagnostic performance (Figure 1).

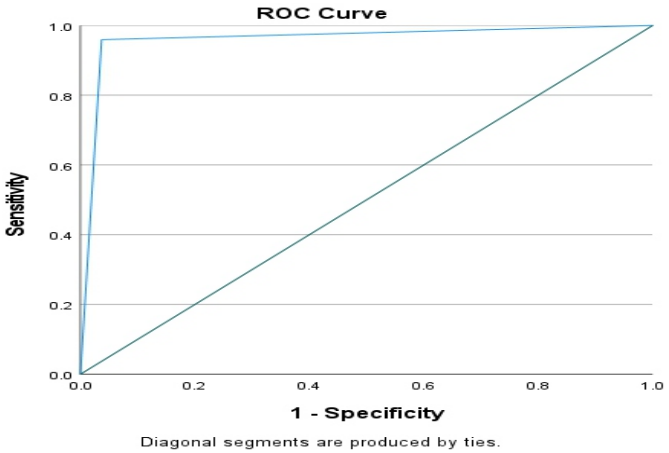

Figure 1: ROC Curve of MRCP for Differentiating Malignant from Benign Obstructive Jaundice Using Histopathology as Reference Standard

DISCUSSION

Obstructive jaundice remains a clinically challenging condition in which early differentiation between benign and malignant etiologies is essential for appropriate management and prognosis. Current international guidelines recommend a structured diagnostic approach integrating biochemical evaluation with high-quality cross-sectional imaging before proceeding to invasive procedures [13-15]. In this context, MRCP has gained recognition as a reliable non-invasive modality for the evaluation of biliary obstruction. In the present study, MRCP demonstrated excellent diagnostic performance, with a sensitivity of 95.9%, specificity of 96.3%, overall

DOI: https://doi.org/10.54393/pjhs.v7i6.3912

accuracy of 96.1%, and an AUC of 0.961 when compared with histopathology. These findings are consistent with recent regional and international studies reporting sensitivity ranging from 90% to 96% and specificity exceeding 90% in differentiating malignant from benign biliary obstruction [16, 17]. The high AUC observed in this study further confirms the strong discriminative ability of MRCP in clinical practice. Radiological patterns observed in malignant cases, including irregular strictures, abrupt cut-off, associated mass lesion, lymphadenopathy, and vascular invasion, align with established imaging characteristics of biliary malignancy described in contemporary literature [18, 19]. Extrahepatic and distal common bile duct involvement was frequently observed in malignant cases, which corresponds with known distribution patterns of cholangiocarcinoma and pancreatic malignancies. These findings reinforce the reliability of morphological criteria in MRCP-based assessment. Biochemical parameters also showed significant differences between benign and malignant groups. Elevated total and direct bilirubin, transaminases, ALP, and CA 19-9 levels were associated with malignant obstruction. The significant elevation of CA 19-9 in malignant cases is consistent with recent evidence supporting its adjunctive role in cholangiocarcinoma and pancreatic cancer diagnosis [19, 20]. However, as reported in previous studies, CA 19-9 lacks absolute specificity due to false elevation in benign cholestatic and inflammatory conditions, limiting its independent diagnostic utility. In the present study, MRCP demonstrated superior discriminative performance compared with individual biochemical markers, supporting its role as the primary non-invasive diagnostic modality. A major strength of this study is the use of histopathology as the reference standard, minimizing diagnostic misclassification. The nearly balanced distribution of benign and malignant cases enhances the reliability of sensitivity and specificity estimates. Furthermore, ROC curve analysis adds robust statistical validation to the reported diagnostic performance.

Nevertheless, certain limitations must be acknowledged. The study was conducted at a single tertiary care center, which may limit generalizability. A small number of false-positive and false-negative cases were observed, likely due to overlapping imaging features between inflammatory strictures and malignancy. Advanced imaging modalities such as PET/MRI or diffusion-weighted imaging were not evaluated and may further refine diagnostic pathways in future research. Multicenter studies with larger sample sizes and standardized reporting criteria are recommended to validate these findings. Overall, the findings support current guideline recommendations positioning MRCP as a first-line imaging modality in the evaluation of obstructive jaundice. Its high sensitivity, specificity, and negative predictive value make it an effective non-invasive gatekeeper investigation before invasive diagnostic procedures such as ERCP or surgical exploration, particularly in resource-constrained settings.

CONCLUSIONS

MRCP demonstrated excellent diagnostic accuracy in differentiating benign from malignant causes of obstructive jaundice when compared with histopathology as the reference standard. With high sensitivity, specificity, predictive values, and strong ROC performance, MRCP represents a reliable non-invasive imaging modality that supports accurate clinical decision-making and may reduce unnecessary invasive procedures.

Authors' Contribution

Conceptualization: TB
Methodology: LK
Formal analysis: TB, HB,
Writing and Drafting: TB, ZJO, LK, SN, HB, NA
Review and Editing: TB, ZJO, LK, SN, HB, NA

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.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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