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Original article

Diagnostic Role of Magnetic Resonance Cholangiopancreatography in Evaluation of Obstructive Jaundice

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ABSTRACT

The diagnostic utility of Magnetic Resonance Cholangiopancreatography (MRCP) has expanded substantially, establishing it as a preeminent, noninvasive primary imaging modality for the evaluation of obstructive jaundice. This investigation sought to determine the diagnostic utility of Magnetic Resonance Cholangiopancreatography (MRCP) in patients presenting with obstructive jaundice. Central to this inquiry was the precise measurement of the modality's sensitivity and specificity for differentiating between neoplastic conditions and benign biliary obstructions. The study population consisted of 50 subjects with a mean age of 58.7 years (range: 23–90 years). Demographic profiling indicated that individuals aged 60 and above constituted approximately 50% of the cohort, with female patients constituted the majority. In terms of diagnostic yield, MRCP exhibited a high degree of fidelity when identifying choledocholithiasis; the technique yielded a diagnostic accuracy of 97.73%, accompanied by a sensitivity of 97.37% and a perfect specificity of 100%. The associated positive and negative predictive values (PPV and NPV) were calculated at 100% and 85.71%, respectively. Furthermore, the capacity of MRCP to identify malignant etiologies was absolute; the modality reached a 100% threshold for sensitivity, specificity, accuracy, and both predictive metrics.

Introduction

Pathophysiology and clinical presentation of obstructive jaundice, characterized by a mechanical impediment within the biliary drainage network, serves as a clinical manifestation of an underlying pathological process rather than a standalone disease [1]. The clinical presentation varies significantly based on the primary etiology, ranging from acute symptomatic episodes to a gradual, painless progression [2]. From a surgical perspective, this condition is defined by the disrupted transport of conjugated bilirubin from the hepatic parenchyma to the intestinal lumen [3].

Prompt clinical investigation is essential for the precise identification of the etiology, as unresolved biliary obstruction may lead to irreversible complications, most notably secondary biliary cirrhosis [4]. A diverse array of diagnostic imaging techniques is utilized to evaluate the integrity of the biliary system, including ultrasonography (US), endoscopic ultrasound (EUS), computed tomography (CT), magnetic resonance imaging (MRI), and magnetic resonance cholangiopancreatography (MRCP) [5].

Obstruction within the biliary network, whether originating from intrinsic pathologies or extrinsic compression, may manifest at any anatomical site and culminate in obstructive jaundice [6]. The etiological landscape of this condition is multifaceted, encompassing congenital malformations such as choledochal cysts and inflammatory processes like chronic pancreatitis or choledocholithiasis. Furthermore, neoplastic developments—most notably cholangiocarcinoma and gallbladder carcinoma—alongside strictures resulting from iatrogenic or traumatic injury, represent significant causative factors.

The pathophysiological state of patients presenting with obstructive jaundice is characterized by a heightened vulnerability to diverse systemic impairments. These include nutritional imbalances, infectious sequelae, cardiovascular dysfunction, and acute renal insufficiency. Moreover, the insidious progression of acute complications, such as hypovolemia, coagulopathy, and septicemia, serves to substantially elevate both morbidity and mortality rates within this population [7].

Evidence indicates that individuals with biliary obstruction face a disproportionately higher risk of adverse postoperative outcomes when compared to non-jaundiced cohorts [8-9]. These secondary complications are primarily comprised of renal disorders, hemorrhage, and impaired wound healing. Additionally, septic events—including the development of abscesses, biliary leakage, and cholangitis—remain a significant concern in the surgical management of these patients [9].

In many developing regions, the therapeutic outlook for patients with obstructive jaundice is often suboptimal. This trend is primarily attributed to the limited accessibility of sophisticated diagnostic imaging and advanced therapeutic infrastructure across the majority of medical facilities [10].

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The clinical trajectory and associated rates of mortality and morbidity in cases of biliary obstruction are inherently dictated by the underlying etiology [10-11]. Despite substantial advancements in preoperative diagnostic accuracy and the refinement of postoperative care protocols, contemporary research suggests that obstructive jaundice continues to pose a significant risk of adverse clinical outcomes [11-12].
Consequently, the identification and thorough understanding of the specific determinants driving increased morbidity and mortality are essential. Elucidating these factors allows for the development of more targeted management strategies, which are critical for enhancing patient survival and improving overall clinical recovery [12].
Magnetic resonance cholangiopancreatography (MRCP) is a specialized radiographic technique designed to visualize the pancreaticobiliary system. The resulting diagnostic images demonstrate a high degree of fidelity, comparable to the visualizations achieved through more invasive modalities, most notably endoscopic retrograde cholangiopancreatography (ERCP) [13]. A primary clinical advantage of MRCP is its non-reliance on exogenous contrast media, rendering it a superior alternative for patient populations where computed tomography (CT) is contraindicated. This specifically includes individuals with a documented history of atopy or known hypersensitivity to iodine-based contrast agents [13]. Because MRCP is inherently non-invasive and does not require contrast administration, it serves as an optimal diagnostic solution for these high-risk cohorts.[13]. The widespread adoption of MRCP among radiologists and clinicians is driven by its established diagnostic precision and excellent safety profile. Furthermore, the non-invasive nature of the procedure ensures high levels of patient tolerance and compliance, distinguishing it as a cornerstone of modern hepatobiliary imaging [13].
Historically, magnetic resonance cholangiopancreatography (MRCP) was utilized primarily as a secondary diagnostic tool for evaluating obstructive jaundice. During this period, the primary investigative standards were centered on more invasive procedures, specifically percutaneous transhepatic cholangiography and endoscopic retrograde cholangiopancreatography (ERCP) [14]. However, over the preceding decades, the clinical utility of MRCP has undergone a significant transformation, with its diagnostic prominence expanding substantially within the field of hepatobiliary imaging [14].
Current clinical evidence now positions MRCP as a diagnostic equivalent to ERCP in identifying the underlying etiology of various pancreatic and biliary tree pathologies [15-22]. A critical differentiator between these two modalities is the superior safety profile of MRCP; it facilitates a comprehensive, noninvasive visualization of the biliary anatomy without necessitating the administration of exogenous contrast media, thereby mitigating the risks associated with more invasive radiographic interventions [23].

Methods

Between January and September 2023, a prospective investigation was carried out involving a cohort of 50 subjects. Participants were recruited from the Albaida Medical Center and the Tyba Imaging Center, both located in Albaida, Libya. The inclusion criteria focused on individuals presenting with clinical indications of obstructive jaundice, for whom Magnetic Resonance Cholangiopancreatography (MRCP) was indicated for further diagnostic evaluation. The diagnostic protocol for the enrolled participants was multifaceted. Initial assessments included the documentation of comprehensive medical histories alongside rigorous physical examinations. Baseline diagnostic data were further supplemented by abdominal ultrasonography and a battery of laboratory analyses, specifically targeting liver function tests (LFT). Subsequently, all subjects underwent MRCP imaging.
To ensure the specificity of the study population, stringent exclusion criteria were applied. Patients were ineligible for participation if they exhibited any general contraindications to Magnetic Resonance Imaging (MRI). Furthermore, individuals diagnosed with jaundice of hepatic or pre-hepatic origin were excluded from the analysis to maintain focus on post-hepatic obstructive etiologies.
Adherence to established medical ethical guidelines was strictly maintained throughout this study. Prior to participation, all individuals were fully apprised of the imaging procedures, and formal informed consent was secured. For specific clinical cases requiring further clarification, supplementary evaluations using Multidetector Computed Tomography (MDCT) and/or Endoscopic Retrograde Cholangiopancreatography (ERCP) were integrated into the diagnostic workflow.
Data acquisition was executed utilizing a 1.5 Tesla whole-body magnetic resonance system (Philips Achieva 1.5T, Best, Netherlands). Following the precise anatomical positioning of each subject, initial scout images were obtained via flash T1-weighted localizers in both the coronal and axial orientations. The comprehensive MRCP acquisition framework integrated a multifaceted array of specialized sequences. T1-weighted morphological assessment was executed utilizing an axial MPRAGE sequence (TR/TE: 1530/322 ms; average: 2; flip angle: 150°). For T2-weighted evaluation, HASTE acquisitions were obtained across both the coronal (TR/TE: 1100/120 ms; average: 1; flip angle: 150°) and transverse (TR/TE: 1100/119 ms) planes to ensure multiplanar visualization. Furthermore, high-resolution three-dimensional (3D) volumetry was

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achieved through a heavily T2-weighted SPACE sequence, which incorporated respiratory triggering to minimize motion artifacts (TR/TE: 1600/622 ms; average: 1; flip angle: 180°). To facilitate a comprehensive 3D visualization of the pancreaticobiliary anatomy, 3D reconstructions using thick-slab Maximum Intensity Projection (MIP) were generated. Furthermore, T2-weighted RARE thick-slab sequences (TR/TE:4500/752 ms; average: 1; flip angle: 180°) were acquired with a 50 mm slice thickness at varying positive and negative angulations relative to the pancreatic duct. Following the primary acquisition, high-definition multiplanar reformations (MPR) were generated across the axial, sagittal, and coronal orthogonal planes with a 1 mm slice thickness.
To optimize the visualization of the biliary tree and pancreatic ducts, these reconstructions were further augmented by the inclusion of 15 mm coronal thick-slab maximum intensity projection (MIP) images. Following the acquisition phase, two independent radiologists performed the image reporting. The definitive MRI diagnoses were then cross-referenced and correlated with the available cytological or histopathological outcomes to determine diagnostic accuracy.

Statistical Analysis
Quantitative data processing was executed utilizing the SPSS software package. Descriptive statistics, specifically frequencies and percentages, were calculated for the entire range of study variables. To ensure clarity in data representation, findings were synthesized into structured tables, where numerical values are expressed as both absolute counts and their corresponding percentages.

Results
Between January 2023 and September 2023, a total of 50 patients (31 female,19 male) were evaluated. The age for the total sample ranged from 23 years to 90 years, with a range of around 67 years and a mean age of 58.7 years (Table 1).

Table 1. Distribution of sex of patients according to age group (Pearson Chi-Square = 0.088)

Gender	Less than 40 years	41-60 years	More than 60 years
Female	9	7	15
Male	1	8	10

The main complaint of these patients was abdominal pain (41 patients), then vomiting (32 patients), and yellowish discoloration of skin and/or sclera (27 Patients). Around 22 patients in our study group were diabetic, while 28 patients were non diabetic; 17 of 50 patients underwent cholecystectomy (Table 2).

Table 2. The correlation between cholecystectomy and diabetes (Pearson Chi-Square = 0.083)

Cholecystectomy	Diabetic patient	
	Yes	No
Yes	9	8
No	13	20

All study participants underwent MRCP evaluation. Our findings identified choledocholithiasis as the predominant benign etiology of obstructive jaundice, affecting 37 patients. The clinical distribution of these cases was as follows: 16 patients presented with concurrent cholecystolithiasis and common bile duct (CBD) stones, 14 exhibited isolated CBD stones, 5 were diagnosed with gallbladder stones (GBS), and 2 manifested occluded stents due to CBD lithiasis. Comprehensive percentage distributions are detailed in (Table 3 and Figure 1). Furthermore, the spectrum of benign biliary obstruction included post-operative adhesions, choledochal cysts (Figure 3), and chronic pancreatitis. Conversely, malignant transformations—specifically ampullary carcinoma, pancreatic head adenocarcinoma (Figure 4), and hilar cholangiocarcinoma—were identified in a limited subset of 7 patients.

Table 3. Correlation between the nature of the lesion and age group (Pearson Chi-Square = 4.3)

Age of the patient	Nature of lesion	
	Benign	Malignant
Less than 40 years	10	0
41-60 years	14	1
More than 60 years	19	6

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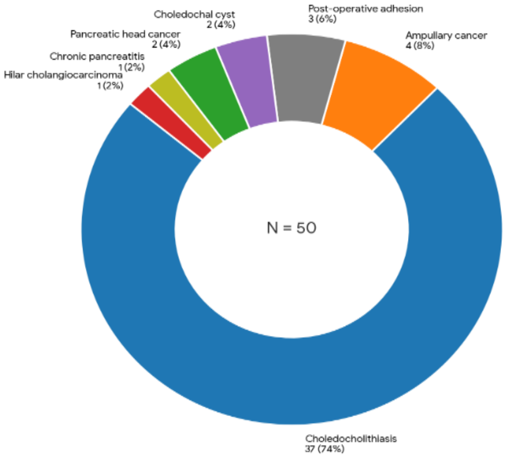

Figure 1. the percentage of causes of obstructive jaundice in a group study according to MRCP diagnosis

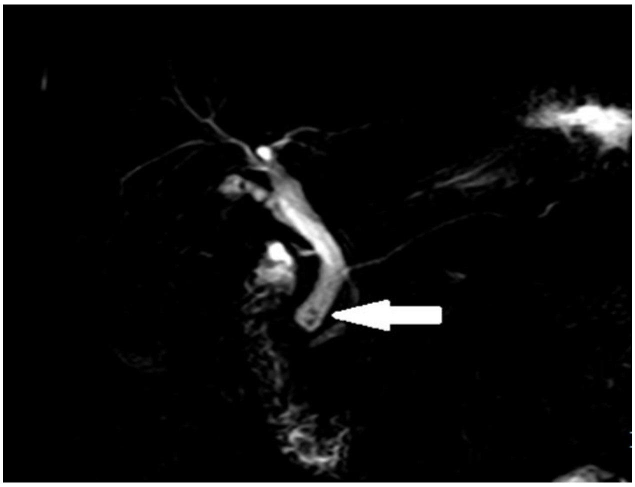

Figure 2. MRCP showed a normal diameter of CBD after cholecystectomy with 2 small stones around 2 mm in diameter seen in the distal part, diagnosed as retained CBD stones

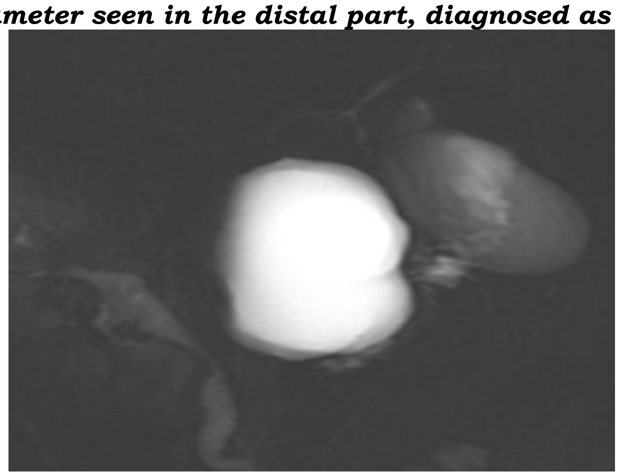

Figure 3. MRCP showed a cylindrical-shaped dilatation of the entire extrahepatic CBD, diagnosed as a Choledochal cyst type 1A according to Todani's classification.

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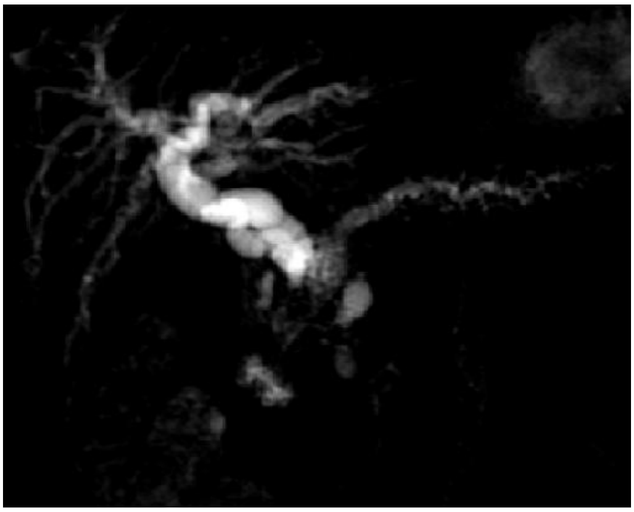

Figure 4. MRCP showed dilated IHBR, dilated CBD, and dilated pancreatic duct (double duct sign). There are no filling defects within the biliary tree to suggest calculi, and the patient was diagnosed with pancreatic head carcinoma

Discussion

A variety of causes can lead to surgical obstructive jaundice, such as the obstruction of the biliary tree with gallstones, strictures, malignancy, or primary causes such as cholangiocarcinoma, carcinoma of the gall bladder, ampullary carcinoma, and carcinoma head of pancreas, or secondary causes such as liver metastasis and congenital causes such as choledochal cyst [24,25]. Patients with obstructive jaundice usually complain of abdominal pain, jaundice, itching, vomiting, or fever. In some patients, depending upon the cause presented with weight loss or clay-colored stool. The treatment and prognosis rely on the etiology and level of biliary obstruction [26]. An invasive and non-invasive imaging procedure commonly used to detect the accurate cause and level of obstruction includes transabdominal ultrasound, computed tomography (CT), magnetic resonance cholangiopancreatography (MRCP), percutaneous transhepatic cholangiography (PTC), endoscopic ultrasound (EUS), endoscopic retrograde cholangiopancreatography (ERCP), and radionuclide imaging [27,28]. Our study is carried out to detect the role of MRCP in the diagnosis of obstructive jaundice, determine its specificity and sensitivity in differentiation between benign and malignant obstructive jaundice. Magnetic Resonance Cholangiopancreatography (MRCP) is currently established as the premier non-invasive modality for biliary imaging, offering critical diagnostic precision that facilitates surgical intervention planning.

Despite its clinical efficacy, the technique is constrained by high operational costs, prolonged acquisition times, and limited accessibility relative to Multidetector Computed Tomography (MDCT) [29]. However, MRCP has largely superseded invasive alternatives—specifically Endoscopic Retrograde Cholangiopancreatography (ERCP) and Percutaneous Transhepatic Cholangiography (PTC)—which were historically utilized as primary diagnostic tools [30]. The current prospective analysis involved 50 patients referred for the diagnostic evaluation of obstructive jaundice via MRCP. Within this cohort, a female predominance was observed, accounting for 62% of the total (n=31). This demographic distribution aligns with prior epidemiological findings reported in Ghana [31] and Tanzania [32]. This gender-based disparity is likely attributable to the higher prevalence of choledocholithiasis among female populations, which remains a primary etiological risk factor for the development of obstructive jaundice. Within the sampled cohort, participant ages spanned from 23 to 90 years, yielding a mean age of 58.7 years.

The demographic was predominantly composed of individuals exceeding 60 years of age, representing approximately 50% of the total population. These findings largely correlate with the data presented by Gameradin et al. [33], which identified the 45–75 and 75–95 age brackets as the primary demographics for obstructive jaundice. The positive correlation between advancing age and the incidence of biliary obstruction is frequently attributed to immunological decline, which facilitates the development of both neoplastic masses and cholelithiasis [34]. Co-morbidities were notably prevalent, with diabetes mellitus identified in 44% (n = 22) of the subjects. This observation aligns with established literature suggesting a robust association between diabetic metabolic profiles and biliary tree pathologies, specifically an elevated risk for gallbladder carcinoma and choledocholithiasis [35]. The physiological basis for this link may reside in compromised gallbladder motility and subsequent biliary stasis, which predispose patients to localized infections and secondary structural alterations [36]. Regarding surgical history, 34% (n = 17) of the study group had previously undergone cholecystectomy. Post-cholecystectomy obstructive jaundice is a

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documented phenomenon occurring in approximately 1–7% of cases. The etiology of such obstruction typically involves iatrogenic biliary strictures, the presence of retained (missed) stones within the common bile duct (CBD), or complications arising from a redundant cystic duct remnant [37]. Regarding clinical manifestations, the predominant symptom identified was upper abdominal pain, observed in 82% of the cohort. This was followed by emesis (64%) and icterus—characterized by the yellowing of the skin and sclera—in 54% of cases. Notably, the presence of jaundice was more frequently detected through biochemical laboratory analysis than through primary patient complaints. These symptomatic trends are consistent with the findings of Saddique et al. [38], whose research similarly identified abdominal pain as the primary presenting complaint in patients diagnosed with obstructive jaundice. In this study, all 50 participants were subjected to MRCP imaging, with results independently verified by two specialist diagnostic radiologists. Etiological analysis revealed that 86% (n = 43) of the obstructions were of benign origin, whereas malignant pathologies were suspected in the remaining 14% (n = 7).

Choledocholithiasis emerged as the most prevalent cause of biliary obstruction, accounting for approximately 74% of the cases. This high incidence aligns with the results reported by Bhutia et al. [39], whose study of 73 patients also confirmed choledocholithiasis as the leading etiology, albeit at a higher frequency of 95.4%. Beyond primary etiologies, secondary benign factors identified in this cohort included post-surgical adhesions (6%), choledochal cysts (4%), and chronic pancreatitis (2%). Conversely, malignant biliary obstructions were predominantly represented by ampullary carcinoma, which affected 8% of the participants. Other neoplastic causes included pancreatic head carcinoma (4%) and hilar cholangiocarcinoma (2%). Clinical follow-up confirmed the initial MRCP findings in nearly all instances, with the exception of a single false-positive result; in this case, a suspected ampullary carcinoma was subsequently identified as a small calculus within the ampulla of Vater during ERCP. Statistical analysis underscored the diagnostic robustness of MRCP for identifying choledocholithiasis, the most frequent cause of obstruction. The modality achieved a sensitivity of 97.37%, a specificity of 100%, and an overall diagnostic accuracy of 97.73%, with positive and negative predictive values (PPV and NPV) reaching 100% and 85.71%, respectively. These figures exhibit a strong correlation with contemporary biliary research. Furthermore, the present study demonstrated diagnostic performance was 100% for the detection of malignant obstructive jaundice. Thesfe performance indicators are consistent with, and occasionally exceed, established benchmarks in the literature. For comparison, Attri et al. [40] documented an overall accuracy of 96% for benign lesions.

Regarding malignancies, their findings indicated sensitivity and specificity levels of 96.5% and 96%, respectively. Specifically, for choledocholithiasis, Attri et al. reported a diagnostic accuracy of 92% and a specificity of 97.3%, further validating the high diagnostic yield observed in this investigation. The diagnostic utility of MRCP in evaluating malignant biliary obstructions is further supported by the findings of Sherpa et al. [41], who identified a sensitivity of 89.50% and a specificity of 93.60%. Their analysis of benign conditions demonstrated comparable reliability, characterized by a sensitivity of 93.60% and a positive predictive value (PPV) of 95.70%. Consistent with these results, Subhi et al. [42] reported an absolute sensitivity (100%) for the identification of choledocholithiasis, alongside a perfect specificity (100%) in the context of malignant pathologies. These metrics are reinforced by the research of Goud et al. [43], which demonstrated a sensitivity of 100% and a comprehensive diagnostic accuracy of 97.2% for both benign and malignant biliary lesions. When viewed collectively, these findings emphasize the clinical reliability of MRCP. The high degree of sensitivity in distinguishing between diverse etiologies of obstructive jaundice confirms the status of MRCP as an essential, non-invasive diagnostic cornerstone for the clinical management of affected patients.

Conclusion

MRCP has a high sensitivity and specificity for the detection of choledocholithiasis, which is considered the commonest cause of obstructive jaundice. In the preoperative assessment of obstructive jaundice, this technique has emerged as an indispensable tool, serving as the preferred modality for the definitive characterization of underlying causative pathologies. By providing precise anatomical localization of the biliary blockage, it significantly refines the diagnostic process and directly informs the subsequent formulation of clinical management strategies.

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Conflicts of Interest

Declare conflicts of interest or state “The authors declare no conflicts of interest.” Authors must identify and declare any personal circumstances or interests that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

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