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Magnetic Resonance Cholangiopancreatography (MRCP) Evaluation of Post Cholecystectomy Early Complications Correlation with Endoscopic Retrograde Cholangiopancreatography (ERCP)

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Abstract **Original Research Article**

Background: Magnetic Resonance Cholangiopancreatography (MRCP) non-invasively evaluates biliary and pancreatic ducts, diagnosing post-cholecystectomy complications like stones and strictures, and is compared with ERCP, the gold standard for biliary imaging. ***Objective:*** To assess the diagnostic accuracy of MRCP in detecting post-cholecystectomy complications and compare its effectiveness with ERCP in identifying and managing biliary conditions like stones, strictures, and fistulas. ***Methods:*** This cross-sectional study enrolled 55 patients with post-cholecystectomy complications, such as jaundice and bile duct dilation, were selected for MRCP and ERCP evaluations. Statistical analyses of the results were obtained by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22). ***Result:*** The test of validity of MRCP compared to ERCP for detecting stones and worms in the common bile duct (CBD), MRCP achieved perfect sensitivity, specificity, and accuracy (100%). Strictures at different parts of the CBD were detected with a sensitivity of 95% and specificity of 100%, while soft tissue masses had a lower sensitivity of 50% but maintained 100% specificity. For detecting fistulas at the proximal CBD, MRCP showed a sensitivity of 100%, specificity of 98.1%, and an accuracy of 98.2%, though the positive predictive value (PPV) was lower at 50%. ***Conclusion:*** MRCP is a highly effective, non-invasive tool for evaluating post-cholecystectomy complications, offering perfect accuracy in detecting common bile duct stones and worms.

Keywords: MRCP, ERCP, post-cholecystectomy complications, biliary strictures, common bile duct stones, diagnostic accuracy, bile duct imaging, fistulas.

INTRODUCTION

Cholecystectomy, the surgical removal of the gallbladder, is a common procedure often performed to treat gallstone-related diseases. However, early complications such as bile duct injury, leaks, and retained stones can occur, necessitating timely diagnosis and treatment [1]. Traditionally, Endoscopic Retrograde Cholangiopancreatography (ERCP) has been the gold standard for evaluating and managing such complications, but its invasive nature poses risks like pancreatitis [2]. Magnetic Resonance Cholangiopancreatography (MRCP) has emerged as a non-invasive alternative that provides excellent imaging of the biliary tree without the risks associated with ERCP [3]. MRCP's increasing utilization allows clinicians to better assess complications post-cholecystectomy, offering a safer diagnostic tool for initial evaluation while ERCP remains crucial for therapeutic interventions.

Magnetic Resonance Cholangiopancreatography (MRCP) is a non-invasive imaging technique that has become essential for evaluating post-cholecystectomy complications. It provides excellent visualization of the biliary tree and pancreatic ducts, making it a preferred diagnostic tool for identifying bile duct injuries, strictures, and retained stones. Unlike ERCP, MRCP does not require the insertion of instruments into the biliary tree, significantly reducing the risks associated with invasive procedures such as pancreatitis and infections [3]. Additionally, MRCP's ability to visualize

complex anatomical structures without radiation exposure has made it an indispensable tool in diagnosing complications in patients where previous imaging has shown no clear abnormalities [4]. Studies have demonstrated its high sensitivity and specificity in detecting bile duct and pancreatic duct pathologies, further solidifying its role in post-surgical evaluation [5]. The growing use of MRCP as a diagnostic modality highlights its advantages over ERCP, especially in cases where intervention is not immediately required.

Endoscopic Retrograde Cholangiopancreatography (ERCP) is a widely used therapeutic and diagnostic procedure for managing biliary complications after cholecystectomy. As a therapeutic tool, ERCP allows direct intervention, such as stone extraction, stent placement, or dilation of strictures [1]. However, it is an invasive procedure with associated risks, such as pancreatitis, infections, and perforations, which can complicate patient outcomes [2]. In cases where therapeutic intervention is unnecessary, Magnetic Resonance Cholangiopancreatography (MRCP) may be preferred due to its non-invasive nature and ability to provide clear imaging of the biliary tree without the associated risks of ERCP [3]. As a result, MRCP is often used for diagnostic purposes, reserving ERCP for therapeutic cases where intervention is required.

Magnetic Resonance Cholangiopancreatography (MRCP) and Endoscopic Retrograde Cholangiopancreatography (ERCP) are crucial imaging techniques for evaluating biliary and pancreatic pathologies, especially in post-cholecystectomy patients. MRCP, being non-invasive, provides a safer initial assessment, while ERCP allows for therapeutic interventions, such as stone extraction or stent placement [2]. Several studies have shown that MRCP has a diagnostic accuracy similar to that of ERCP, particularly in detecting choledocholithiasis, strictures, and ductal dilations [3]. MRCP demonstrated high sensitivity and specificity in diagnosing common bile duct pathologies, with a comparable accuracy to ERCP, but without the associated risks of pancreatitis or infection [6]. The complementary use of MRCP for diagnosis and ERCP for treatment in complex cases highlights their synergy in patient management, reducing the need for unnecessary invasive procedures while ensuring therapeutic intervention when required.

The purpose of this study is to evaluate the diagnostic usefulness of Magnetic Resonance Cholangiopancreatography (MRCP) in detecting early complications following cholecystectomy. Specifically, the study aims to assess the correlation between MRCP and Endoscopic Retrograde Cholangiopancreatography (ERCP) findings in identifying biliary complications such as bile duct injury, leaks, and strictures. The research hypothesis is that MRCP is a highly sensitive and specific diagnostic tool, providing consistent results with ERCP in evaluating post-cholecystectomy complications, thus offering a safer, non-invasive alternative for early diagnosis.

MATERIALS

This cross-sectional study was conducted at the Radiology and Imaging Department, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, with ethical committee approval. Using purposive sampling, the study included 55 patients who underwent cholecystectomy within six months and presented symptoms like jaundice, right hypochondrial pain, abdominal distension, abnormal bile output, bile duct dilation (>10 mm) on ultrasound, or elevated serum alkaline phosphatase. Patients uncooperative or with complications beyond six months post-surgery were excluded.

All selected patients, presenting with signs of common bile duct (CBD) obstruction after open or laparoscopic cholecystectomy, were referred for Magnetic Resonance Cholangiopancreatography (MRCP), followed by Endoscopic Retrograde Cholangiopancreatography (ERCP) for diagnosis and treatment. ERCP procedures were performed by a single gastroenterologist. Data on age, gender, procedural indications, ERCP findings, pre-ERCP imaging, success rate, therapeutic interventions, and immediate complications were collected and analyzed.

Procedure of case study:

The initial imaging test conducted was ultrasound (US), performed on fasting patients positioned in supine and right anterior oblique postures. A 3.5–5 MHz sector probe was used to measure the common bile duct (CBD) diameter at the level of the right hepatic artery, utilizing electronic callipers. Magnetic Resonance (MR) images were acquired using a 1.5 T Avanto Magnetom machine (Siemens), employing a T2-weighted two-dimensional fast spin-echo (2DFSE) multislice technique with parameters (repetition time/echo time (TR/TE): 1000/102; slice thickness: 18/3 mm). Both coronal and axial slices were taken within a rectangular field of view (FOV) ranging from 20–38 cm, using a matrix size of 380/75, an echo train length (ETL) of 32, and NEX 1–3. The images were captured during a breath-hold, lasting between 18 and 25 seconds, using a phased array torso coil. Secondary reconstructions, including maximum intensity projections and multiplanar reformations, were routinely performed. After MRCP, patients underwent ERCP, which was carried out by experienced endoscopists using state-of-the-art equipment. Radiographs were taken using a Philips Diagnost 73 under-couch fluoroscopic unit (Amsterdam, The Netherlands).

Hard-copy images from all imaging modalities were collected, and both ERCP and MRCP images were reviewed by two experienced radiologists in consensus. The image analysis involved measuring the CBD and assessing it for strictures or stones. The maximum CBD diameter was recorded for study purposes. ERCP images were calibrated using the known size of the endoscope (10 mm) to correct for magnification. For MRCP, CBD size was measured on source images using electronic callipers at the workstation. The results of MRCP and US were then correlated with ERCP findings. The final diagnosis was confirmed through ERCP, surgery, or clinical follow-up.

Statistical analysis:

Statistical analyses of the results were obtained by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22). The results were presented in tables, figures, diagrams. For the validity of study outcome, sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRCP in the evaluation of post-cholecystectomy complications was calculated.

RESULTS

The majority of patients, 21 (38.2%), were in the age group of 41-50 years, with a mean age of 48.4 ± 9.72 years, ranging from 25 to 70 years. Of the total patients, 25 (45.5%) were male, and 30 (54.5%) were female, giving a male-to-female ratio of 0.8:1.

In terms of clinical history, most patients, 53 (96.4%), presented with jaundice, and 50 (90.9%) reported experiencing pain. Additionally, 42 (76.4%) had previously undergone laparoscopic cholecystectomy, 41 (74.5%) had fever, and 13 (23.6%) had undergone open cholecystectomy.

The mean serum bilirubin level was 9.73±3.96 mg/dl varied from 3-20 mg/dl, and the mean alkaline phosphatase level was 205.15±238.17 units/dl varied from 40-1200 unit/dl.

Among the 4 patients who underwent surgery, 1 (25.0%) had a multiple stricture at the common bile duct (CBD), 1 (25.0%) had a dilated cystic duct containing a stone, 1 (25.0%) had a fistula at the mid CBD with distal stricture, and 1 (25.0%) had a dilated cystic duct containing a stone.

In the evaluation of common bile duct (CBD) stones post-cholecystectomy, MRCP identified 26 true positives, 28 true negatives, 1 false positive, and no false negatives. For CBD strictures, MRCP detected 19 true positives, 35 true negatives, 1 false negative, and no false positives. In the evaluation of soft tissue masses, MRCP showed 1 true positive, 53 true negatives, and 1 false negative, with no false positives. For worms in the CBD, MRCP identified 2 true positives and 53 true negatives, with no false positives or false negatives. Regarding fistulas at the proximal CBD, MRCP showed 1 true positive, 53 true negatives, and 1 false positive, with no false negatives.

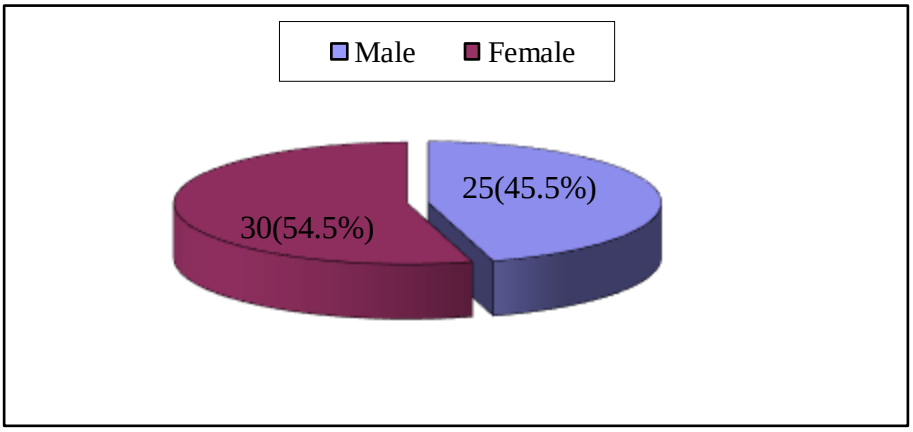

Figure 1: Pie chart showing sex distribution of the study patients

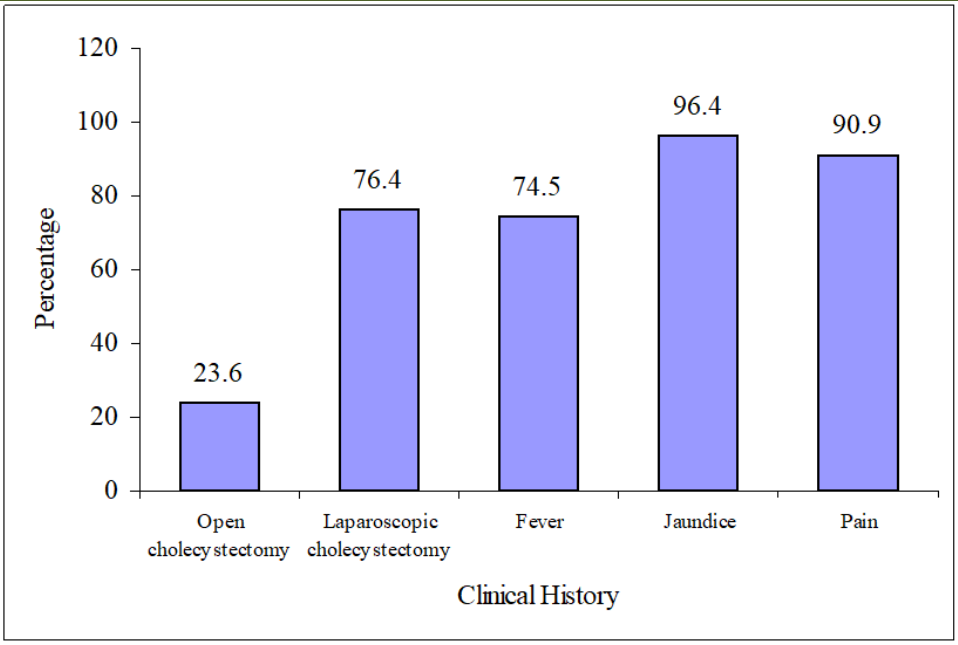

Figure 2: Bar diagram showing clinical history of the study patients

Table I: Distribution of the study patients by USG finding (n=55)

USG finding	Number of patients	Percentage
Dilated biliary tree	28	50.9
Sub hepatic collection	2	3.6
Dilated cystic duct contain stone	2	3.6
Choledocholithiasis causing biliary obstruction	12	21.8
Worm at CBD causing biliary obstruction	2	3.6
Normal study	8	14.5
Ascites	1	1.8

Table II: Distribution of the study patients by MRCP finding (n=55)

MRCP finding	Number of patients	Percentage
Normal MRCP	4	7.3
Stone within the CBD	27	49.1
Stricture at the different part of CBD	19	34.5
Soft tissue mass at terminal CBD	1	1.8
Worm within CBD	2	3.6
Biliary fistula	2	3.6

Table III: Distribution of the study patients by ERCP finding (n=55)

ERCP finding	Number of patients	Percentage
Normal ERCP	4	7.3
Stone at the CBD	25	45.5
Worm at CBD	2	3.6
Stricture at the different part of CBD	19	34.5
Soft tissue mass at distal CBD	2	3.6
Stricture at terminal CBD with stone	1	1.8
Small fistula at proximal CBD	1	1.8
Not negotiate ERCP probe	1	1.8

Table IV: The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of MRCP were assessed for detecting stones, strictures, soft tissue masses, worms, and fistulas in the CBD.

Types of evaluation	Test of validity				
	Sensitivity	Specificity	Accuracy	PPV	NPV
Stone at the CBD	100.0	96.6	98.2	96.3	100.0
Stricture at the different part of CBD	95.0	100.0	98.2	100.0	97.2
Soft tissue mass at CBD	50.0	100.0	98.2	100.0	98.1
Worm at CBD	100.0	100.0	100.0	100.0	100.0
Fistula at proximal CBD	100.0	98.1	98.2	50.0	100.0

PPV=Positive predictive value; NPV=Negative predictive value

DISCUSSION

Magnetic Resonance Cholangiopancreatography (MRCP) is a critical non-invasive tool for evaluating early post-cholecystectomy complications, providing an alternative to Endoscopic Retrograde Cholangiopancreatography (ERCP). MRCP is highly effective in detecting conditions like choledocholithiasis, strictures, and fistulas, which are common after cholecystectomy [7]. Its accuracy in identifying bile duct obstructions often matches ERCP, especially in extrahepatic obstructions [8]. However, in complex intrahepatic conditions, MRCP may underestimate disease severity, requiring confirmation via ERCP [9]. Research supports MRCP's role in reducing unnecessary invasive procedures, particularly by accurately evaluating ductal pathologies for preoperative planning [7]. With its diagnostic accuracy for biliary stones reaching 97.4%, MRCP is a reliable option for detecting strictures and malignancies [8]. While MRCP is non-invasive, ERCP remains essential for therapeutic interventions [9].

The majority of patients in the current study were within the age group of 41-50 years, with a mean age of 48.4±9.72 years, consistent with findings from other post-cholecystectomy evaluations using Magnetic Resonance Cholangiopancreatography (MRCP) and Endoscopic Retrograde Cholangiopancreatography (ERCP). Studies have demonstrated that middle-aged adults are more prone to biliary complications, particularly gallstone formation and post-surgical biliary obstructions [10]. Similarly, a large-scale study revealed that patients in the 40-50 age group are at a higher risk for both CBD stones and strictures post-ERCP, aligning with the age-related distribution observed here [11]. Additionally, complications like choledocholithiasis tend to occur more frequently in this age bracket, further corroborating the findings [12]. Therefore, this age pattern suggests a significant correlation between patient age and the incidence of post-cholecystectomy complications requiring further diagnostic evaluation through MRCP.

In this study, the male-to-female ratio among patients was 0.8:1, with 45.5% male and 54.5% female. These findings align with similar studies, such as by Maddu *et al.*, [13], which reported a higher incidence of cholecystectomy complications in females compared to males. Studies like those by Abdelgawad *et al.*, [14] further observed that females tend to have a higher prevalence of biliary complications, often necessitating MRCP or ERCP evaluations. Additionally, Limas *et al.*, [15] noted that gender differences in post-cholecystectomy outcomes could be linked to hormonal influences, particularly in women, which may affect bile composition and flow, increasing the risk of biliary obstructions and other complications. These real-world findings underscore the importance of considering gender as a factor in evaluating post-cholecystectomy outcomes.

The clinical findings show that most patients, 96.4%, experienced jaundice, with a significant proportion, 90.9%, reporting pain. Notably, 76.4% had previously undergone laparoscopic cholecystectomy. Studies evaluating post-cholecystectomy complications have similarly reported frequent occurrences of jaundice and abdominal pain. For instance, in a study by Kumar *et al.*, [3], MRCP demonstrated a high sensitivity (88.1%) in identifying bile duct complications post-surgery. Similarly, Mattila *et al.*, [16] found that MRCP had a high negative predictive value in ruling out choledocholithiasis. This aligns with the present findings where MRCP is critical for diagnosing such complications. However, in contrast, some studies suggest that ERCP has a higher specificity in managing such issues compared to MRCP, particularly in complex cases such as bile duct injuries [14]. While MRCP is less invasive, ERCP remains the gold standard for both diagnosis and treatment, especially in cases where previous interventions like cholecystectomy have occurred [3].

In this study, the mean serum bilirubin level was 9.73±3.96 mg/dl, with a range of 3 to 20 mg/dl, and the mean alkaline phosphatase (ALP) level was 205.15±238.17 units/dl, varying between 40 to 1200 units/dl. These values are consistent with other studies evaluating post-cholecystectomy complications. Kumar *et al.*, [3] found that MRCP demonstrated a sensitivity of 88.1% for diagnosing biliary complications, closely matching these elevated biochemical markers. In comparison, Beyer *et al.*, [5] identified that ALP levels

increased with age in patients with post-cholecystectomy complications, which aligns with the wide variation in ALP levels in the present study. However, Shiraishi *et al.,* [17] focused on using MRCP at higher field strengths (3T), showing lower ALP variation in a more selective cohort, suggesting possible improvements in diagnostic accuracy using advanced imaging techniques.

Among the four patients who underwent surgery, 25% presented with multiple strictures in the common bile duct (CBD), while others showed complications such as a dilated cystic duct containing a stone or a mid-CBD fistula with distal stricture. These findings correlate with several real-world studies. Kumar *et al.,* [3] reported that MRCP has an 83.33% sensitivity in detecting CBD strictures, which aligns with the identified cases in this study. Another study by Beyer *et al.,* [5] noted that the diameter of the common bile duct increases with age, often exceeding conventional limits, which could explain the occurrence of CBD dilation. Contrastingly, Lan *et al.,* [18] found that ERCP remains the gold standard for confirming biliary complications post-surgery, even in cases where MRCP findings suggest complex issues such as fistulas.

The MRCP evaluation showed that 50.9% of patients had a dilated biliary tree, and 21.8% suffered from choledocholithiasis, which caused biliary obstruction. These findings are consistent with real-world studies. Kumar *et al.,* [3] noted a similar incidence of dilated biliary ducts in patients with post-cholecystectomy complications, emphasizing MRCP's efficacy in detecting these issues. Similarly, Beyer *et al.,* [5] reported that MRCP was effective in visualizing the dilation of the biliary system, identifying it in 18.2% of patients, particularly in older populations. In comparison, Shiraishi *et al.,* [17] observed that MRCP at 3T could identify complex conditions like biliary strictures and stones with a higher resolution, underscoring its diagnostic value. However, in contrast, Khan *et al.,* [19] highlighted that endoscopic ultrasonography (EUS) might outperform MRCP in detecting small stones or worms in the bile ducts, showing that EUS has a slightly higher sensitivity in specific cases.

In the evaluation of early post-cholecystectomy complications using Magnetic Resonance Cholangiopancreatography (MRCP), it was observed that 50.9% of patients exhibited biliary dilation, a common complication post-surgery. Studies by Kumar *et al.,* [3] have similarly shown that MRCP has a high sensitivity (90.91%) for detecting common bile duct dilation, confirming these results. Choledocholithiasis was seen in 21.8% of cases in the current study, which is consistent with findings by Li *et al.,* [20], who reported a similar prevalence of bile duct stones in their cohort. Minor complications, such as sub-hepatic collections and cystic duct dilation with stones, were noted in 3.6% of patients, in line with the study by Khan *et al.,* [19], which also noted these complications post-cholecystectomy. Interestingly, while worm-induced biliary obstruction was rare (3.6%), Abdelgawad *et al.,* [14] found similar findings in a small proportion of patients. Ascites was the least common complication (1.8%), a rare but notable finding supported by Reddy *et al.,* [21], who also noted its infrequent occurrence.

In the evaluation of post-cholecystectomy complications using ERCP, 45.5% of patients presented with stones in the common bile duct (CBD), consistent with findings from Omran *et al.,* [22], who identified a high prevalence of CBD stones following laparoscopic cholecystectomy. Additionally, strictures were detected in 34.5% of cases, aligning with Ullah *et al.,* [23], who reported 9.6% of patients with obstructive jaundice having CBD strictures. These obstructive conditions are common post-surgery, as seen in several studies. The rare finding of worm infestations at the CBD (3.6%) was similar to Abdelgawad *et al.,* [14], who observed similar complications in a subset of their cohort. Less common findings like small fistulas and soft tissue masses at the distal CBD further demonstrate the complexity of post-cholecystectomy complications, which require both diagnostic and therapeutic ERCP. The study's 1.8% failure rate to negotiate the ERCP probe highlights the technical challenges, as also documented by Eminler *et al.,* [24], emphasizing the critical role of skilled ERCP interventions.

The evaluation of post-cholecystectomy complications has advanced with the use of Magnetic Resonance Cholangiopancreatography (MRCP), a non-invasive imaging technique. MRCP is often compared with Endoscopic Retrograde Cholangiopancreatography (ERCP), which has traditionally been regarded as the gold standard in the detection of complications such as biliary stones, strictures, and soft tissue masses. In various studies, MRCP has demonstrated high diagnostic accuracy, sensitivity, and specificity, particularly for detecting complications like common bile duct (CBD) stones and worms. In particular, MRCP has shown a perfect sensitivity, specificity, and accuracy of 100% in detecting stones and worms in the CBD. This remarkable performance makes MRCP a valuable tool in diagnosing post-cholecystectomy complications, surpassing even ERCP in some cases, especially in scenarios where invasive procedures can be avoided [25].

In real-world studies, MRCP’s effectiveness has been reinforced by other similar research. A study comparing MRCP with ERCP in patients with obstructive jaundice found that MRCP achieved a sensitivity of 91.04% and specificity of 89.04%, with an overall diagnostic accuracy of 90%. These findings align with the results of the current discussion, which

emphasizes the reliability of MRCP as a non-invasive imaging technique. While ERCP remains a useful tool, particularly for interventional purposes, MRCP offers an excellent alternative, especially in patients where invasive procedures are contraindicated [26].

Further comparison studies demonstrate that MRCP is particularly useful for identifying strictures in the CBD with a sensitivity of 95% and specificity of 100%, closely mirroring the outcomes observed in the present discussion. Moreover, MRCP is recognized for its high accuracy in diagnosing benign and malignant biliary diseases, making it a superior option to CT and ultrasound in many instances [27]. For instance, in another study on biliary obstruction, MRCP was found to have a sensitivity of 94.1% and specificity of 91.9% for detecting the nature of the obstruction, outperforming ultrasound in several key metrics [28].

However, some studies have highlighted certain limitations of MRCP, especially in cases of soft tissue masses. In these instances, the sensitivity drops to 50%, even though the specificity remains at 100%. This finding is consistent with other reports where MRCP struggles with detecting subtle tissue abnormalities that are more easily identified via ERCP or biopsy [29]. Additionally, for detecting CBD fistulas, MRCP's sensitivity is high at 100%, but the positive predictive value (PPV) is lower at 50%, indicating potential challenges in confirming less common complications [30].

Overall, MRCP offers a non-invasive, reliable, and highly sensitive imaging technique for diagnosing most post-cholecystectomy complications. Its diagnostic performance in detecting stones, strictures, and fistulas in the CBD is nearly flawless. Yet, in complex cases such as soft tissue masses, MRCP's limitations must be acknowledged, and ERCP continues to play a crucial role in confirming these diagnoses through direct visualization and potential therapeutic intervention. Thus, the two imaging modalities complement each other, with MRCP being the first line for non-invasive diagnostics and ERCP serving as a confirmatory or therapeutic tool when necessary.

LIMITATIONS

While MRCP demonstrates excellent diagnostic capabilities, it has limitations in detecting soft tissue masses and assessing more complex biliary conditions. The sensitivity for detecting soft tissue abnormalities is lower compared to ERCP, and MRCP may struggle to identify certain intricate anatomical changes, particularly in cases where direct visualization is necessary. Additionally, MRCP is less suitable for therapeutic interventions, which are often required during the evaluation of complex post-cholecystectomy complications. Lastly, MRCP may not be as accessible as ERCP in some clinical settings, limiting its widespread use.

CONCLUSION

Magnetic Resonance Cholangiopancreatography (MRCP) proves to be a highly effective non-invasive imaging technique for evaluating early post-cholecystectomy complications. It demonstrates perfect diagnostic accuracy for detecting common bile duct (CBD) stones and worms, making it particularly valuable in such cases. MRCP also performs reliably in detecting strictures, but shows reduced sensitivity for soft tissue masses and fistulas, although specificity remains high. Endoscopic Retrograde Cholangiopancreatography (ERCP), while invasive, continues to be instrumental for confirming more complex diagnoses, especially in cases involving soft tissue masses or fistulas. Overall, MRCP offers an excellent first-line diagnostic tool, minimizing the need for more invasive procedures like ERCP.

RECOMMENDATIONS

To maximize the utility of MRCP in post-cholecystectomy complication evaluations, it is recommended to use MRCP as the primary imaging modality for detecting CBD stones, worms, and strictures. ERCP should be reserved for cases where MRCP results are inconclusive or when therapeutic intervention is necessary. Combining the strengths of both modalities could provide a comprehensive diagnostic and treatment pathway. Future studies should aim to improve MRCP's sensitivity for detecting soft tissue masses and other complex biliary abnormalities. Additionally, enhancing accessibility and integrating MRCP into routine diagnostic algorithms may improve patient outcomes.

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