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The role of magnetic resonance cholangiopancreatography in evaluation of etiological spectrum of obstructive jaundice

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ABSTRACT

Background: Jaundice is a commonly encountered problem in society. Discrimination between obstructive and non-obstructive causes is important to imply surgical intervention in cases of obstructive jaundice whereas medical management in non-obstructive jaundice. Nowadays diagnostic endoscopic retrograde cholangiopancreatography (ERCP) may be replaced by Magnetic resonance cholangiopancreatography (MRCP) as it has high level of resolution and reliability. We studied the role of MRCP in obstructive jaundice to evaluate its etiological spectrums and radiological findings.

Aim: To evaluate the role of MRCP in the determination of aetiologies in obstructive jaundice, to assess degree and level of biliary obstruction and to correlate MRCP findings with post surgical follow-ups / ERCP/ histopathology.

Materials and Methods: Total sixty-eight patients with a clinical diagnosis of obstructive jaundice referred for MRCP were included in our study. We correlated MRCP findings with the final diagnosis made by post-surgical follow-up / ERCP/ histopathology as a gold standard.

Results: For benign lesions, overall sensitivity of MRCP was 97.73%, specificity was 95.83% with an accuracy of 97.06%. MRCP had 94.74% sensitivity, 93.88% specificity, 94.12% accuracy in the diagnosis of choledocholithiasis, and 66.67% sensitivity, 98.39% specificity, and 95.59% accuracy in the diagnosis of benign strictures. For malignant lesions, accuracy, sensitivity, and specificity of MRCP were 97.06%, 95.83%, and 97.73%.

Conclusion: MRCP is a highly reliable, accurate, non-invasive imaging technique and has a high sensitivity for the evaluation of aetiologies of obstructive jaundice.

1. Introduction

"Jaundice" is derived from the French word JAUNE, which means "yellow." Bilirubin, a yellow-orange bile pigment, causes a yellowish colouring of the skin, sclera, and mucous membranes.[1] Jaundice is classified as either obstructive (surgical) or nonobstructive (medical). It's essential to differentiate between obstructive and nonobstructive jaundice because nonobstructive jaundice can be treated medically, whereas obstructive jaundice requires surgery. In the preoperative examination of patients with obstructive jaundice, magnetic resonance cholangiopancreatography (MRCP) is an important non-invasive imaging technique.[2] MRCP has proven to be a reliable tool in the evaluation of biliary and pancreatic duct obstruction since its first clinical application by Wallener et al in 1991.[3] It was initially regarded as a second-level examination in the diagnostic workup of obstructive jaundice, following percutaneous transhepatic cholangiography and endoscopic retrograde cholangiopancreatography (ERCP), which were considered

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as first-level investigations. This imaging technology has seen a tremendous increase in its diagnostic relevance in the diagnosis of obstructive jaundice during the last few decades. For the diagnosis of obstructive jaundice, MRCP is presently the method of choice. It's non-invasive and doesn't use any radiation and it's essential in the diagnosis and therapeutic surgical planning of obstructive jaundice.[4] Endoscopic retrograde cholangiopancreatography offers the benefit of being both diagnostic and therapeutic, but it also has the risk of complications such as cholangitis, biliary leakage, pancreatitis, haemorrhage, and inadequate opacification.[5,6] The images are created using heavily T2-weighted fat suppressed sequences in which the static fluid is hyperintense and the background signal is suppressed. Sonography and computed tomography (CT) is the most often utilised imaging modalities for examining the biliary tree and pancreas currently recommended. Direct opacification of the biliary tree or pancreatic duct is frequently required for diagnostic or surgical planning in a considerable proportion of patients, especially when choledocholithiasis, inflammatory stenosis, a postoperative stricture, or even in many cases of malignant blockage is present. In these circumstances, strongly T2-weighted images can be utilised to outline the biliary tree and pancreatic duct without the use of any intravenous contrast media, and it can even delineate the system close to the obstruction. As a result, MRCP outperforms ultrasonography and contrast-enhanced CT.

2. Aim and Objective

To assess the significance of MRCP in determining the wide range of etiologies, assessing the level as well as the severity of biliary tract blockage in patients with obstructive jaundice. To evaluate how accurate MRCP is at diagnosing obstructive jaundice.

3. Materials and Methods

The ethical committee at our college approved the proposal for the study. Our study comprised a total of sixty-eight individuals suffering from obstructive jaundice from all age groups and both sexes. Our study patient had to be clinically diagnosed with obstructive jaundice and referred to the Department of Radio Diagnosis for additional study. Patients who were unable to have an MRI owing to claustrophobia, pregnancy, or other factors were excluded from the study. The MRCP was performed using GE Sigma HDxt 1.5 Tesla MRI Machine by Wipro GE healthcare Pvt Ltd., in the Department of Radio Diagnosis and Imaging Science, Jorhat Medical College and Hospital, Jorhat in 2020-2021. Prior to the assessment, all of the patients were told to fast overnight. Prior to the examination, all metallic items were removed and inspected using a metal detector.

MRCP protocols: 3 plane localizer was taken after proper positioning of the patient. The MRCP protocol consisted of Axial T2 FS BH, Axial T2 BH, Axial T1 FS BH, Axial T1 BH, Axial T2 SSFSE Rtr, Cor FS BH, Cor FS BH, Cor SSFE Rtr, Thick slab MRCP-BH, Axial 2D FIESTA FS-BH, A 3D image (thick maximum intensity projection [MIP]) was reconstructed to visualize the biliary and pancreatic duct in a 3D view.

The following parameters like level of blockage, bile duct calculi, CBD status, degree of dilatation of intrahepatic biliary radicles, gall bladder pathology (size, wall, stones, etc.) were factors considered.

In the case of malignant lesions, dilatation of the pancreatic duct, pancreatic atrophy, calcifications, and pseudocysts, presence of masses, invasion of viscera, fascial planes, and metastasis were investigated. Findings were correlated with the final diagnosis made by post-surgical follow ups/ ERCP/ histopathology as the gold standard. The data were recorded in a proforma and statistical analysis were done using Statistical Package for the Social Sciences (SPSS).

4. Results

In our study, a total of 68 patients are included, with 28 (41%) being males and 40 (59%) being females. Obstructive jaundice was more common in women, with a male to female ratio of 1:1.42.

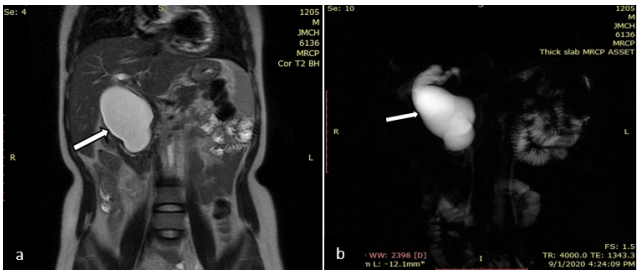


Fig. 1: T2-weighted coronal; **a:** and thick slab MRCP; **b:** Reveals dilated CBD all throughout its course (thick white arrow), consistent with type IA Choledochal cyst.

The causes of obstructive jaundice are divided into benign and malignant causes, where we found 44 cases (65%) as benign etiology while 24 cases (35%) as malignant etiology of obstruction.Graph 2

In our study, out of total 44 benign causes, choledocholithiasis (21 cases-30.9%) was the most common reason of obstruction, followed by benign stricture (5 cases-7.4%). [Table 1]

Out of total 24 malignant causes of obstruction, periampullary carcinoma was the commonest cause accounting for 8 cases (11.7%) followed by cholangiocarcinoma and carcinoma gallbladder infiltrating into biliary system [Table 2].

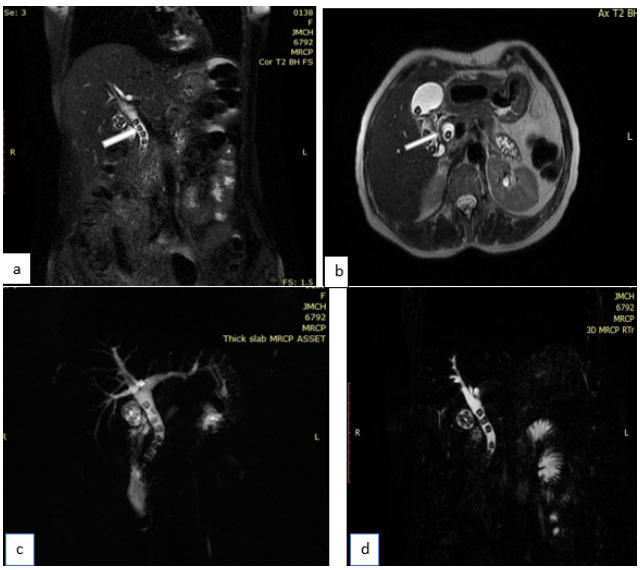


Fig. 2: Coronal T2 FS BH; **a**: and axial; **b**: images showing multiple intraluminal hypointense foci suggestive of calculi in the CBD (thick white arrow) causing upstream dilatation of CBD and IHBRs. Thick slab; **c**: and 3D MRCP; **d**: Images reveal multiple calculi in supra and intrapancreatic CBD resulting in obstructive biliopathy.

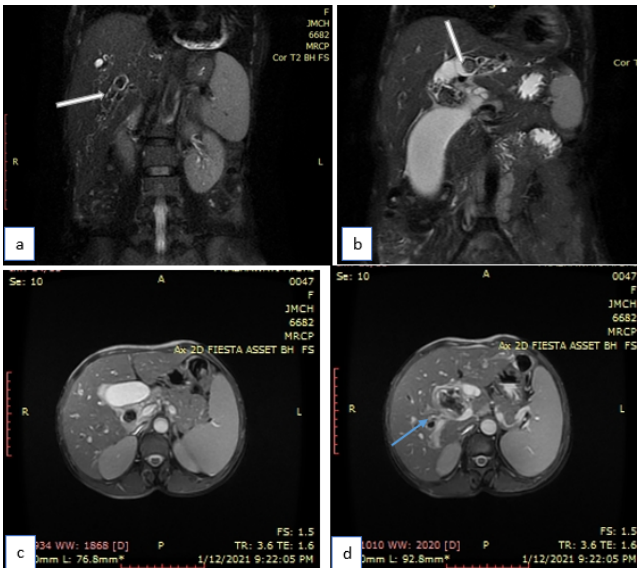


Fig. 3: T2W coronal images; **a**: and **b**: Showing calculi in the right, left sectoral and peripheral hepatic ducts (thick white arrow) with dilatation of IHBRs. Calculus also seen in the cystic duct. Axial 2D FIESTA; **c**: and **d**: Images showing dilatation of CBD with multiple calculi within (thin blue line).

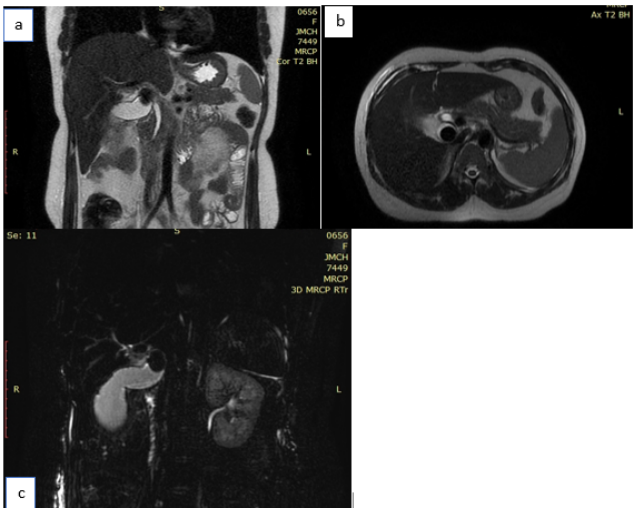


Fig. 4: T2W coronal **a:** axial; **b:** and 3D MRCP; **c:** Images reveal an impacted T2 hypointense GB neck calculus causing Mirizzi syndrome.

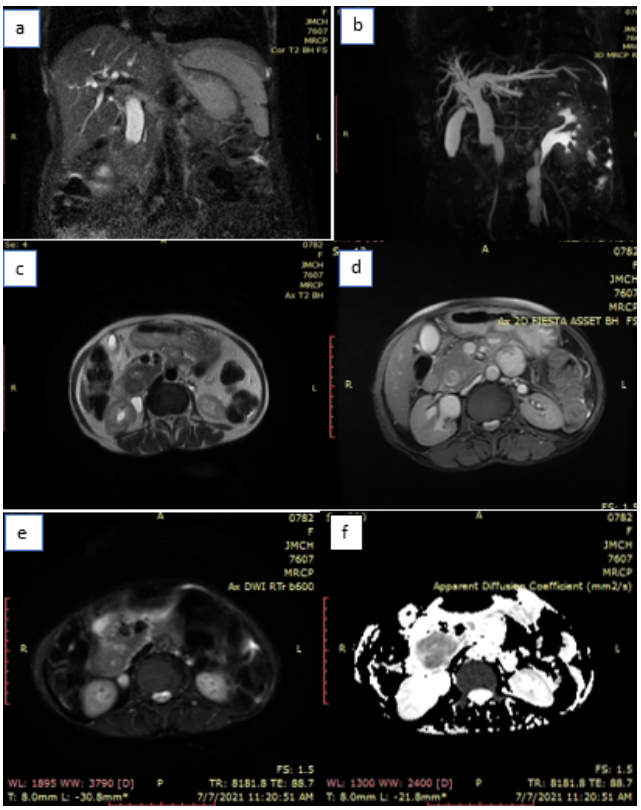


Fig. 5: Coronal T2W; **a**: and 3D MRCP; **b**: Images showing dilated CBD with distal abrupt narrowing, another axial T2W; **c**: and axial 2D FIESTA; **d**: Images showing a poorly subtle iso to hyperintense intraductal lesion in the distal 3rd of the CBD which is showing restricted diffusion on DWI & ADC; **e & f**: and mild post contrast enhancement (image not given).—Intraductal cholangiocarcinoma of distal CBD was confirmed in ERCP guided biopsy.

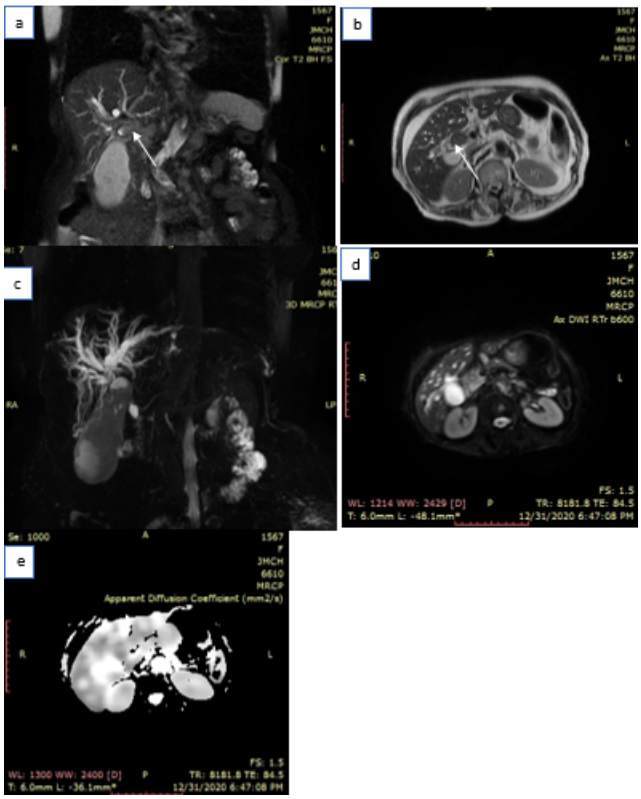
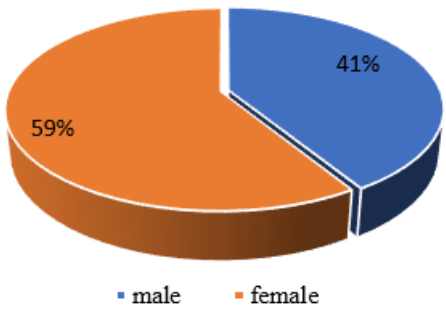
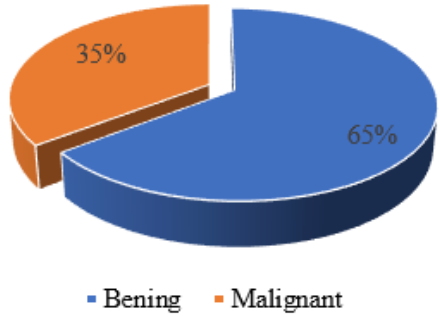


Fig. 6: T2W **a**: Coronal; **b**: axial images reveal hypointense mass lesion (thin white arrow) involving primary confluence resulting in biliary obstruction. 3D MRCP image; **c**: showing dilatation of right and left sectoral ducts with dilatations of IHBRs. The lesion showed restricted diffusion on DWI & ADC; **d & e**:. Histopathology confirmed the diagnosis of cholangiocarcinoma (Klatskin tumour).



Graph 1: Showing female preponderance.



Graph 2: Showing benign causes of obstructive jaundice are more common than malignant causes.

Table 1: Distribution of various benign causes of obstruction

Benign pathology	Number of patients	Percentage
Choledocholithiasis	21	30.9
Benign strictures	5	7.4
Pancreatitis	3	4.4
Sclerosing cholangitis	2	2.9
Postsurgical stricture	3	4.4
Portal biliopathy	1	1.5
Mirizzi's syndrome	2	2.9
Sludge	3	4.4
Choledochal cyst	2	2.9
Biliary ascariasis	2	2.9
Total	44	65

Table 2: Distribution of various malignant causes of obstruction

Malignant diagnosis	Number of patients	Percentage
Periampullary carcinoma	8	11.7
Cholangiocarcinoma	6	8.8
Gallbladder Carcinoma	6	8.8
Klatskin tumour	3	4.4
Metastatic deposit	1	1.5
Total	24	35

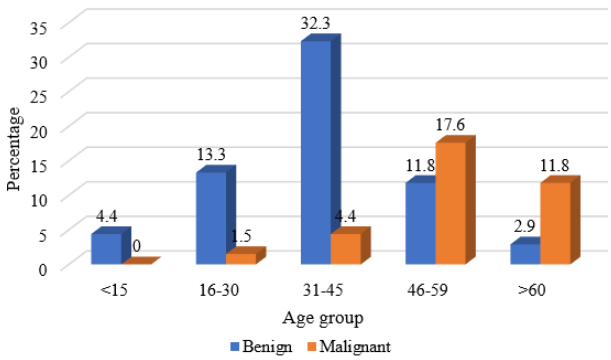
The patient's age ranged varied from 11 to 80yrs old, with a mean age of 52.6±11 years. The majority of patients under the age of 50 years presented with benign lesions, whereas the elderly age group had the highest number of malignant causes (beyond 50 years of age). Graph 3 illustrates that at extremes of age, there are considerable differences in benign and malignant causes. An increase in age groups has an inverse association with benign causes, but a direct relationship with malignant causes.

The intrapancreatic/distal CBD was the most common location of benign blockages in our study (20 cases). We found that malignant lesions were mostly involving both CHD and primary confluence (7 cases) levels.

Table 3: Detection of the level of obstruction:

Table 3: MRCP case distribution according to level of obstruction

Level of obstruction	Benign		Malignant	
	Number	Percentage	Number	Percentage
Intrapancreatic Common bile duct /Distal CBD	15	75	5	25
Suprapancreatic CBD/Mid CBD	10	76.9	3	33.1
Proximal CBD.	6	54.5	5	45.5
Diffuse biliary involvement	4	80	1	20
CHD and primary confluence	4	36.3	7	63.6
RHD, LHD, secondary confluence, and segmental ducts	3	60	2	40
CHD	2	66.6	1	33.3
Total	44		24	



Graph 3: Age-wise distributions of benign and malignant lesions.

In our study, MRCP accurately diagnosed forty-three cases with benign pathologies and twenty-three cases with malignant pathologies. For benign lesions, MRCP had an overall sensitivity of 97.73 %, a specificity of 95.83 %, and an accuracy of 97.06 %. For malignant lesions, it had an overall sensitivity of 95.83%; specificity of 97.73% and an accuracy of 97.06% [Table 4].

5. Discussion

In both medical and surgical practices, jaundice is a common problem. Its etiology can often be predicted clinically, but confirmation usually requires biochemical and radiological imaging studies. The major aims of any imaging modality in obstructive jaundice are to determine the presence of obstruction, the location, extent, and likely etiology.

On the basis of clinical and biochemical data, we included 68 patients who were suspected of having obstructive jaundice in our study. We observed that MRCP was 100% accurate in detecting ductal dilatation & level of obstruction, and 97% accurate in identifying the cause of obstruction. The results of our study are equivalent to the study done by Al–Obaidi et al.[7]

There are 40 (59 %) females and 28 (41 %) males in our study, showing a female preponderance. This finding is in accordance with a study done by Gameraddin et al,[8] who found that females are more likely than males to suffer from obstructive jaundice.

In our study, the youngest patient was an 11yrs girl with a choledochal cyst, and the oldest one was an 80yrs old man with cholangiocarcinoma. The majority of benign lesions were found under the age of 50, while the majority of malignant lesions were found beyond 50. Patients with benign etiology had a mean age of 41±10 years, while those with malignant lesions had a mean age of 59±13 years which is consistent with Hasan DI et al.[9]study.

The benign cause of obstruction accounted for 65% (44/68), whereas the malignant cause accounted for 35% (24/68), which is in contradiction to the study done by Siddique et al,[10] where the majority of patients (56.66%) showed malignant causes of obstructing jaundice and benign causes were 43.33%.

Choledocholithiasis is the most common cause of obstruction in our study (30.9%), followed by periampullary carcinoma (11.7%). Mubarak Ali et al[11] and Manohar Singh Rathore et al[12] reported similar observations in their studies. However, V Upadhyaya et al[13] and Rajneesh Madhok et al[14] observed that pancreaticobiliary tumors were the most common etiology. We found some discrepancies with a few literature about benign and malignant causes of obstructive jaundice, which we believe is age related.

Choledocholithiasis was the most common benign cause of obstructive jaundice. On MRCP, 18 of the 21 cases of choledocholithiasis were accurately diagnosed. Three patients were misdiagnosed as choledocholithiasis on MRCP, and one was subsequently shown to have sludge on ERCP, one to have stones, and one to have stricture co-existing with stone on ERCP. As a result, MRCP had an overall sensitivity of 97.74%, a specificity of 93.88%, and an accuracy of 94.12 % for diagnosing choledocholithiasis. Our findings are in line with those of Laokpessi et al[15] and Soto et al[16]who demonstrated a sensitivity of 94% and a

Table 4: Sensitivity and specificity of MRCP for various benign and malignant conditions.

Causes	TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	Accuracy
Benign	43	1	1	23	97.73	95.83	97.73	95.83	97.06
Malignant	23	1	1	43	95.83	97.73	95.83	97.73	97.06

TN: True negative, TP: True positive, FP: False positive, FN: False negative, NPV: Negative predictive value, PPV: Positive predictive value.

Table 5: MRCP sensitivity and specificity for various benign and malignant conditions.

Causes	On MRCP	Final diagnosis	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Choledocholithiasis	21	19	94.74	93.88	85.71	97.87	94.12
Benign stricture	4	5	66.67	98.39	80.00	96.83	95.59
Pancreatitis	3	4	75.00	100	100	98.46	98.53
Choledochal cyst	2	2	100	100	100	100	100
Sludge	3	3	66.67	98.46	66.67	98.46	97.06
Sclerosing cholangitis	2	3	66.67	100	100	98.48	98.53
Post-surgical stricture	3	3	66.67	98.46	66.67	98.46	97.06
Portal biliopathy	1	1	100	100	100	100	100
Mirizzi syndrome	2	2	100	100	100	100	100
Biliary ascariasis	2	2	100	100	100	100	100
Periampullary carcinoma	8	6	100	96.77	75.00	100	97.06
Cholangiocarcinoma	6	5	80.00	96.83	66.67	98.39	95.59
Carcinoma gallbladder	6	6	100	100	100	100	100
Klatskin tumor	3	3	100	100	100	100	100
Malignant deposit	1	1	100	100	100	100	100

specificity of 100% for identifying biliary calculi on MRCP. MRCP has been proven to have sensitivities of 81–100% and specificities of 85–100% in multiple studies.

MRCP diagnosed 4 of the 5 benign strictures as benign, whereas one case that was first diagnosed as benign due to its morphological characteristics turned out to be malignant. ERCP revealed calculus in the intrapancreatic section of CBD in one instance with inflammatory stricture caused by chronic pancreatitis. On MRCP, one case was misdiagnosed as benign stricture, while ERCP showed stones. For benign strictures, MRCP had an overall sensitivity of 66.67%, a specificity of 98.39%, and an accuracy of 95.59%. Our findings are consistent with that of the study done by Obaidi et al.[17]

In our study, there were 2 cases of choledochal cyst. MRCP correctly diagnosed both cases of choledochal cyst, with 100% sensitivity, specificity, and diagnostic accuracy. Our study showed that MRCP had 100% sensitivity, specificity, and diagnostic accuracy which is in accordance with the study of Suthar et al.[18]

Out of 3 cases of pancreatitis, MRCP diagnosed all cases of pancreatitis. MRCP was reported to have better visibility of the main pancreatic duct dilatation, stating its irregularity, the appropriate etiology of chronic pancreatitis, and concomitant complications such as stricture, distal CBD calculus, and any parasite obstructing both the CBD and the main pancreatic duct.

In our study, we had two cases of primary sclerosing cholangitis, both of which exhibited multiple strictures, bile duct irregularities, and wall thickening on MRCP, but only one case of sclerosing cholangitis was correctly diagnosed. MRCP correctly diagnosed two cases, with sensitivity, specificity, and diagnostic accuracy of 66.67%, 100%, and 98.48%, respectively. Our findings are comparable to those of Angulo et al,[19] who found that MRCP had a diagnostic accuracy of more than 90% in the diagnosis of primary sclerosing.

There were two cases of biliary ascariasis of the liver; both of which were accurately identified by MRCP.

Periampullary carcinoma was the most common malignant etiology among the malignant lesions we identified, followed by cholangiocarcinoma. There were eight cases of periampullary carcinoma in total, with MRCP detecting six of them; one case of groove pancreatitis was misdiagnosed as cancer head of pancreas. Another case with polypoidal intraluminal cholangiocarcinoma involving distal CBD was misdiagnosed as carcinoma of pancreatic head, which was later confirmed as intraluminal cholangiocarcinoma after an ERCP. MRCP showed 100% sensitivity, 96.77% specificity, and 97.06 % diagnostic accuracy. Our findings are comparable to the study of Al-Obaidi et al,[17] who observed that MRCP had 90%, 97.8%, and 95% sensitivity, specificity, and diagnostic accuracy, respectively.

MRCP effectively detected 5 of the 6 cases of cholangiocarcinoma. One instance of benign focal thickening was misdiagnosed as cholangiocarcinoma, when MRCP was unable to diagnose the case, showing a

sensitivity of 80%, specificity of 96.83%, and diagnostic accuracy of 95.59%. Our findings were similar to those of Singh et al,[2] with MRCP sensitivity, specificity, and diagnostic accuracy of 83.33%, 98%, and 100%, respectively. Guibaud et al,[20] and Pavone et al[21] reported similar results, with diagnostic accuracies of 91 to 100%, sensitivities of 80 to 86 %, and specificities of 96 to 98%.

In all three cases of Klatskin tumour, MRCP accurately diagnosed all three. MRCP was 100% accurate in terms of sensitivity, specificity, and accuracy. Our study is in accordance to that of Raguraman et al[22] and Bhatt et al[23] who found 100% accuracy of MRCP.

In all six cases of carcinoma gallbladder with local metastases and involvement of intrahepatic biliary radicles, MRCP was effective in detecting them. In our study, MRCP had 100% sensitivity, specificity, and diagnostic accuracy; findings consistent with those of Bhatt et al.[23] They observed that MRCP alone was 100 percent accurate in detecting gallbladder cancer in their study.

MRCP with an overall sensitivity of 97.73%, specificity of 95.83%, and accuracy of 97.06% for benign lesions, can distinguish benign from malignant lesions. MRCP had a 95.83 % sensitivity, a 97.73% specificity, and a 97.06% accuracy for malignant lesions. Our findings are consistent with those of Amandeep et al[2] who observed that the sensitivity, specificity, and diagnostic accuracy of MRCP for benign lesions were 100%, 95.83%, and 98 %, respectively, whereas the sensitivity, specificity, and diagnostic accuracy of MRCP for malignant lesions were 95.83%, 100%, and 98%, respectively. A study done by Francesco et al[24] reported similar results for benign lesions stating the diagnostic accuracy, sensitivity, and specificity of MRCP to be 78.62%, 16.67%, and 97.29% respectively. Pasanen et al,[25] Sharma and Ahuja,[26] Saluja et al,[27] and Park et al[28] all found similar findings.

6. Limitations

1. Claustrophobia.
2. With the use of MRCP, no therapeutic or interventional operation could be performed.
3. Children, elderly and debilitated patients who can not hold their breath during image acquisition.
4. It requires the patient's cooperation and takes time.

7. Conclusion

According to the findings, MRCP was proven to be a better diagnostic technique in the evaluation of obstructive jaundice which is noninvasive and radiation-free. MRCP is a highly sensitive method for distinguishing between obstructive and nonobstructive causes of jaundice. MRCP also helps the surgeons preoperatively to better understand the anatomy, anatomical variations, level, and extent of obstruction, allowing them to choose more appropriate therapeutic options such as biliary enteric anastomosis. An invasive procedure like ERCP can be avoided as diagnostic procedure because of the excellent diagnostic specificity and accuracy of MRCP. It can even be used in the case of a failed ERCP because it shows the biliary tree proximal and distal to the level of obstruction.

8. Conflict of Interest

There are no conflicts of interest in this article.

9. Source of Funding

None.

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