Original Research Article

Role of Magnetic Resonance Cholangiopancreatography (MRCP) in Evaluation of Pancreaticobiliary Pathologies and Correlation with Ultrasound Findings

Lovely Kaushal[1], Swati Goyal[2] and Arunima Suresh[3*]

[1]Professor and HOD, [2]Associate Professor, [3]Resident Doctor, Department of Radiodiagnosis, Gandhi Medical College and Associated Hamidia Hospital, Bhopal, Madhya Pradesh, India

Abstract

Background- In this prospective study, we evaluated the role of magnetic resonance cholangiopancreatography (MRCP) as an imaging modality for identification and characterization of various pancreaticobiliary pathologies & to correlate MRCP findings with ultrasound (USG) findings.

Methodology-This study was carried out as an observational study in Department of Radiodiagnosis, GMC Bhopal, for a study period of 20 months on patients suspected with pancreaticobiliary pathologies reporting for ultrasound examination. MRCP was performed following Ultrasound imaging (USG) with subsequent comparison of findings.

Results- The sensitivity, specificity and diagnostic accuracy of ultrasound in detection of CBD dilatation were 86.21%. 100% and 92% respectively. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of ultrasound in detection of intrahepatic biliary radicle (IHBR) dilatation was 81.97%. 97.44%. 98.04%. 77.55% and 88% respectively. The sensitivity of USG for identification of benign lesions was 93.55% whereas that for malignant lesions was 96.15%. Overall, diagnostic accuracy of USG for identification of benign and malignant lesions was 84% and 87% respectively.

Conclusion- Although abdominal ultrasound continues to serve as a screening tool for detection of pancreaticobiliary pathologies and allows for differentiation between surgical and non-surgical causes of obstructive jaundice, the in-depth characterization of lesions as provided by magnetic resonance imaging (MRI) with MRCP suggests that it serves as an indispensable adjunct to endoscopic retrograde cholangiopancreatography (ERCP). MRCP with MRI serves as an accurate and non-invasive, non-ionizing imaging method for evaluation of biliary anatomy and pathology especially in cases of obese patients where ultrasound results are compromised.

Keywords: MRCP, pancreaticobiliary pathologies, USG, diagnostic accuracy

1. Introduction

Obstructive jaundice is one of the commonest forms of pancreaticobiliary pathology with frequent causes being choledocholithiasis and pancreaticobiliary malignancies. The clinical specifics with the lab tests can precisely recognize up to 90% cases of extrahepatic obstruction changes [1].

* **Arunima Suresh**, Resident Doctor, Department of Radiodiagnosis, Gandhi Medical College and Associated Hamidia Hospital, Bhopal
E-mail: arunima51094@gmail.com
ORCID ID: 0000-0000-0000-0000

In obstructive jaundice it is imperative to employ early diagnostic imaging to elucidate the precise etiology in order to prevent the pathological changes [e.g., Secondary biliary cirrhosis] which occur when the obstruction remains unrelieved. In this prospective study, we evaluated the role of magnetic resonance cholangiopancreatography (MRCP) as non-invasive imaging modality for detection and characterization of various pancreaticobiliary diseases & to correlate MRCP findings with ultrasound findings.

2. Methodology

The present study was conducted as an observational study in Department of Radiodiagnosis, GMC Bhopal,

during the study period of 20 months, from January 2020 to August 2021 on 100 patients suspected with pancreatic and biliary pathologies. All patients suspected with pancreaticobiliary pathologies, referred to Department of Radio diagnosis, Gandhi Medical College and Hamidia Hospital Bhopal for ultrasound examination were included whereas patients with cardiac pacemaker, cerebral aneurysm clips, ocular or cochlear implants and ocular foreign bodies, claustrophobia, or heart valve disease or prosthesis were excluded from the study.

After obtaining ethical clearance from Institute's ethical committee, all the patients fulfilling the above-mentioned inclusion criteria were enrolled and written consent was obtained. Socio-demographic details such as age, gender was obtained from all the study participants and entered in questionnaire. Detailed history regarding their illness, its duration, family history, past surgical history was obtained. Further USG and appropriate MRI sequences and multiplanar imaging were performed for every patient.

The ultrasound examination was carried out on USG machine available in our department, using a low frequency curvilinear transducer after explaining them the procedure. Further MRCP examination was performed ap per a standard protocol. Magnetic resonance cholangiopancreatography (MRCP) is a form of non-invasive cross sectional imaging technique for biliary system, providing high resolution images of biliary tract. higher signal intensity of fluids on on heavily T2-weighted magnetic resonance sequences (i.e., they appear bright), against a background of tissues which appeared dark (i.e., low signal) is the basic principle behind MRCP. MRCP was performed on the 1.5T MRI available in department of radiodiagnosis, Hamidia hospital using a phased-array body coil post six hours fasting prior to the examination. This reduced the gastroduodenal secretions; bowel peristalsis and also optimal distension of gallbladder was obtained. Heavily T2-weighted sequences were performed using fast spin echo or single shot fast spin echo software with a torso phased array coil. Single-shot fast spin-echo (BASG) is a newer and more rapid MRCP sequence that was performed in a single breath hold, thereby significantly reducing motion artifacts and increasing image quality.

2.1 Statistical analysis

Data was compiled using MS Excel and analysed using IBM SPSS software version 20. Descriptive and inferential statistics was applied. Data were grouped, presented as frequency and percentage.

3. Results

The present study was conducted on a total of 100 patients with suspected pancreaticobiliary pathologies. In this study, patients belonged to age group ranging from 24 -85years, the youngest patient being 24 years

old who was diagnosed with choledochal cyst and oldest patient was 85 years old who was diagnosed with gall bladder (GB) carcinoma. The dominant age group was 51- 60 years. The ratio of females: males was 1:1.1 with only a marginal increase in the number of males. Additionally in the benign category, there were a greater number of females (33%), while in the malignant subgroup included a greater number of males (23%).

In our study maximum number of patients presented with abdominal pain (95%) followed by vomiting (60%) and icterus (59%) while loss of appetite was seen in 52% of patients. 10 out of 100 patients had surgical history of previous cholecystectomy (Table-1&2).

Biliary obstruction was observed in 25% cases on ultrasound and 32% cases on MRCP. USG and MRCP detected benign pathology in majority of cases. Among benign causes, Cholelithiasis was identified in 37.1% and 25.8% cases respectively on USG and MRCP whereas cholelithiasis and choledocholithiasis were observed in 8.6% cases on USG and 24% cases on MRCP. Cholangiocarcinoma was the most frequent malignant lesion observed in USG as well as MRCP as depicted in above table-2.

The sensitivity, specificity and diagnostic accuracy of ultrasound in detection of CBD dilatation was 86.21%. 100% and 92% respectively. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of ultrasound in detection of IHBR dilatation was 81.97%. 97.44%. 98.04%. 77.55% and 88% respectively.

Table 1- Distribution according to USG and MRCP findings

USG findings		USG		MRCP		
		N	%	n	%	
Level of Obstruction	Hepatic	15	15.0	18	18.0	
	Pancreatic	25	25.0	32	32.0	
	Suprapancreatic	19	19.0	16	16.0	
Diagnosis	Benign	70	70.0	62	62.0	
	Malignant	26	26.0	37	37.0	
	Normal Study	4	4.0	1	1.0	

4. Discussion

In the diagnosis of patients suspected with biliary or pancreatic pathologies a timely diagnosis plays a significant role in the planning of treatment. Meticulous understanding of each of the techniques in hand is required in order to work up an accurate diagnostic protocol. In our study, we have included 100 patients suspected with various pancreaticobiliary pathologies. Transabdominal USG was performed on all of the patients and subsequently MRCP was performed.

Table 2- Distribution according to USG and MRCP findings

		USG		MRCP	
		N	%	n	%
Benign Diagnosis	Acute Pancreatitis	10	14.2	10	16.1
	Choledocholithiasis	11	15.7	8	12.9
	Cholelithiasis	26	37.1	16	25.8
	Cholelithiasis and Choledocholithiasis	6	8.6	15	24.2
	Chronic Pancreatitis	2	2.9	2	3.2
	Gb Sludge	1	1.4	1	1.0
	Choledochal cyst	0	0	4	6.5
	Other Benign Conditions	2	2.9	0	0
	Stricture	9	12.8	6	9.7
	Congenital Variant	3	4.2	0	0
Malignant	Cholangiocarcinoma	8	30.8	12	32.4
	Neoplastic GB Mass	6	23.1	8	21.6
	Other Malignant Conditions	3	11.5	1	2.7
	Pancreatic Mass	4	15.4	5	13.5
	Periampullary Carcinoma	4	15.4	7	18.9
	Extrinsic compression by lymphnodes	0	0	1	2.7
	Stricture	1	3.8	3	8.1

The advent of MRCP has dramatically helped with the diagnosis of pancreaticobiliary pathologies & its institution by Wallner et al in 1991[2] is considered one of the distinguished developments in the field of modern radiology. The highly accurate cholangiographic imaging thereby achieved is comparable to that of direct cholangiography with additional benefit of patient comfort & safety associated with USG. Upadhyay et. al. [3] in their study found a sensitivity of 94.44%, specificity of 81.81%, positive predictive value of 89.47%, and negative predictive value of 90% for detection of malignancy. MRCP is a promising non-invasive diagnostic tool in cases of obstructive jaundice [4].

Magnetic resonance cholangiopancreatography (MRCP) employs high resolution heavily T2-weighted sequences which amplify the signal from static fluid in the biliary and pancreatic ducts[10] & generates multiple images which are reconstructed in order to build a three-dimensional image of the bile ducts. This inherent ability helps to excellently characterise the underlying pathology in most of the cases has made it the modality of choice and an essential method for evaluation in pre-op setting for patients diagnosed with obstructive jaundice undergoing surgery [5].

Table 3- Diagnostic accuracy of USG for detection of ductal dilatation

USG		MRCP		P value
		Dilated	Non dilated	
CBD	Dilated	50	0	0.001
	Non dilated	8	42	
IHBR	Dilated	50	1	0.001
	Non dilated	11	38	

Table 4- Diagnostic accuracy of USG for identification of benign and malignant lesions

	Benign lesions		Malignant lesions	
	%	95% CI	%	95% CI
Sensitivity	93.55%	84.30% to 98.21%	96.15%	80.36% to 99.90%
Specificity	68.42%	51.35% to 82.50%	83.78%	73.39% to 91.33%
Positive Likelihood Ratio	2.96	1.85 to 4.75	5.93	3.51 to 10.01
Negative Likelihood Ratio	0.09	0.04 to 0.25	0.05	0.01 to 0.31
Disease prevalence (*)	62.00%	51.75% to 71.52%	26.00%	17.74% to 35.73%
Positive Predictive Value (*)	82.86%	75.08% to 88.58%	67.57%	55.24% to 77.86%
Negative Predictive Value (*)	86.67%	71.09% to 94.50%	98.41%	90.05% to 99.77%
Accuracy (*)	84.00%	75.32% to 90.57%	87.00%	78.80% to 92.89%

Out of 100 patients included in our study, one patient was reported as normal on MRCP, while benign conditions constituted 62 (62%) and malignant lesions 37% respectively. Out of them ultrasound was able to correctly identify 26 cases as malignant, however eight of the malignant cases were reported as benign on ultrasound which can be ascribed to the difficulty in differentiating the aetiology of stricture disease and spurious reporting as choledocholithiasis in cases of intraductal polypoidal mass within distal common bile duct (CBD).

This is in conformity with the study by Bhatt et. al. [6] who reported a diagnostic accuracy of 88% in ultrasound against 98% of MRCP for diagnosis of benign & malignant diseases. In our study, the most common benign aetiology encountered was cholelithiasis (25.8%), while the most frequent benign cause of biliary obstruction was cholelithiasis in association with choledocholithiasis (24.2%) followed by choledocholithiasis (12.9%), as observed in study by Karki et. al. [7] and it is possibly because choledocholithiasis cases are commonly secondary to passage of stones from the gallbladder into the CBD while primary choledocholithiasis is infrequently encountered and includes de novo formation of stones within the common bile duct.

In our study we observed that cholelithiasis was detected by USG in 31 out of 32 cases while in one case gall bladder found to be contracted at the time of ultrasound examination and the patient was diagnosed with a micro cholecystolithiasis on MRCP. The dilatation of central and peripheral IHBR was noted in 51 cases (90%) on USG while in 60 cases on MRCP. Ultrasound correctly detected dilatation of CBD in 46 of 58 cases as detected by MRCP which is in accordance with study conducted by Kaur et. al. [8] who also reported that ultrasound was able to detect IHBR dilatation in 90% of the cases and dilatation of CBD in 50% cases as compared to 86% cases detected on MRCP. They further reported that there was

obscuration of distal CBD in 84% cases. Ultrasound was unable to detect ductal dilatation due to reasons including obscuration of CBD & MPD in cases of excessive bowel gases, operator inefficiency in case of obese patients and partly due to the fact that definition of "normal limits" of CBD dilation is also a matter of discussion as suggested "normal limits" varies extensively, ranging from 5 to 11 mm because diameter of CBD might increase with age and following cholecystectomy [9].

We observed that choledocholithiasis was diagnosed in 23 cases on MRCP, of which only 17 were diagnosed on ultrasound accurately primarily because of bowel gases and also accounting to the technical difficulty observed in cases of choledocholithiasis in non-dilated ducts which is in compliance with the study by Kurian et al. [10] They also reported that diagnostic accuracy of ultrasound for choledocholithiasis as 25% which was also emphasized by Norero et. al. [11] Although ultrasound can detect peripancreatic acute fluid collections, the main drawback lies in the failure of detection of necrosis. Henceforth limiting its role to the detection of cholelithiasis and choledocholithiasis and identification of fluid collections in the peritoneum, retroperitoneum, and pleural spaces in cases of acute pancreatitis. Stricture disease accounted for nine of 100 cases as diagnosed on MRCP out of which six were categorized as benign and three as malignant. However, ultrasound was unable to ascertain the stricture aetiology as malignant in two cases and one was falsely diagnosed as calculi in distal CBD. Additionally, two cases of periampullary carcinoma and extrahepatic distal cholangiocarcinoma were also erroneously diagnosed as stricture on ultrasound. MRCP clearly demonstrated the length of the stricture with further differentiation of stricture into malignant and benign based on the morphology of the stricture. This is in accordance with the prospective study conducted by Rathore at. Al. [12] on 50 patients who reported a 100% diagnostic accuracy of MRCP in identification of stricture.

Amongst the malignant pathologies noted in our study the most common cause was cholangiocarcinoma which is comparable to the study conducted by Kurian et. al. [10] Cholangiocarcinoma was reported in eight cases on ultrasound out of 12 cases reported on MRCP. MRI with MRCP further helped in delineating the extent of the lesion thus helping in staging. This is in accordance with the study conducted by Kurian et al in which the authors reported diagnostic accuracy for detection of cholangiocarcinoma on ultrasound was 83% & 100% on MRCP whereas Singh et. al. [13] reported a diagnostic accuracy of 96% & 98% on ultrasound & MRCP respectively.

Eight patients were diagnosed with gall bladder carcinoma on MRCP, of which ultrasound accurately identified the six cases while was unable to diagnose the focal nodular thickening in the fundal region, in case of contracted GB and another case of exophytic GB mass with hepatic infiltration was reported as intrahepatic

cholangiocarcinoma on ultrasound. On the other hand, MRCP was able to detect even subtle local spread in liver in case of infiltrative lesions and thus helped in pre-surgical staging. Henceforth it can be concluded that ultrasound can be used as a preliminary imaging tool although is not accurate in determining the staging in case of carcinoma gall bladder. Certain limitations exist in our study. Extensive bowel gas in few cases negatively affected the visualization of the periampullary and peripancreatic region leading to misinterpretation and missing of the potential causes of obstructive jaundice on ultrasound.

Fig 1a: In a Histo-pathologically proven case of cholangiocarcinoma, transabdominal ultrasound image showing a relatively well defined iso to hyperechoic mass expanding and fillingthe CBD in perihilar location, with indentation over the portal vein at the hilum.

Fig1b: For the same case, BASG coronal sequence showing a fairly defined T2isointense lesion at biliary confluence and proximal CBD, seen extending into distal part of left hepatic duct causing upstream dilation of bilateral central and peripheral IHBR (Left > right) with over distension of GB.

Fig 2a: Ultrasound axial image demonstrates an echogenic focus casting posterior acoustic shadow noted within the lumen of gall bladder; however, GB wall thickness appears normal and no evidence of pericholecystic collection noted,suggestive of cholelithiasis.
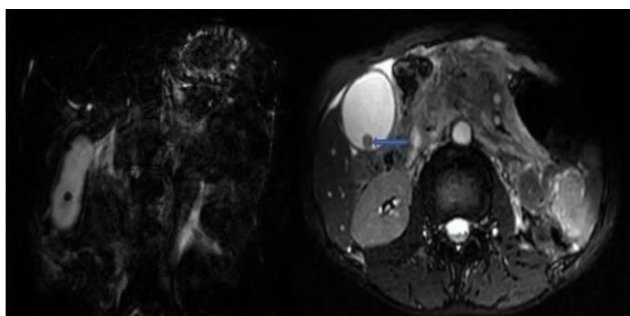

Fig 2b: 3D MRCP sequence and T2 axial sequence demonstrate correspondingwell defined intraluminal T2 hypointense filling defect within gall bladder, suggestive of cholelithiasis.
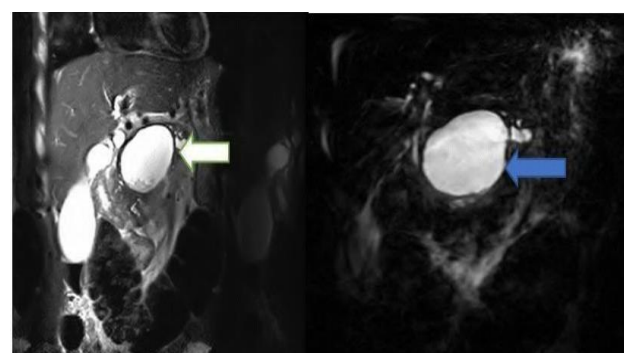

Fig 3a: 2D MRCP demonstrate fusiform dilation of the extrahepatic bile duct, consistent with type I choledochal cyst.

Fig 3b: Ultrasound axial image shows fusiform dilation of the extrahepatic bile duct, suggestive of type I choledochal cyst.

Fig 4a: T2 coronal BH & 3D MRCP sequence show a well-defined T2 hyperintense cystic lesion with a T2 hypointense wall, and fluid -fluid levels suggestive of debris in relation to body of pancreas- likely pseudo cyst of pancreas. No definite evidence of communication
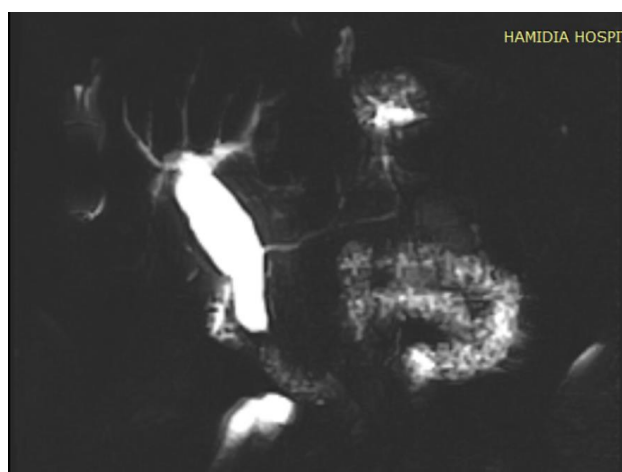

Fig 4B: corresponding USG axial image of abdomen demonstrates a well-defined anechoic cystic lesion in the epigastric region showing intraluminal debris within.

Conclusion

MRCP proves to be a superior imaging modality in establishing the diagnosis of obstructive biliary disease and is more likely to detect choledocholithiasis, CBD strictures and malignant pathologies as compared to ultrasound in conditions affecting its performance. Although abdominal ultrasound continues to serve as a screening tool for detection of pancreaticobiliary pathologies and allows for differentiation between surgical and non-surgical causes of obstructive jaundice, the in-depth characterization of lesions as provided by MRI with MRCP suggests that it serves as an indispensable adjunct to ERCP. MRCP with MRI serves as an accurate and non-invasive, non-ionizing imaging method for evaluation of biliary anatomy and pathology especially in cases of obese patients where ultrasound results are compromised. While ultrasound still remains the primary investigative modality of choice in patients suspected with pancreaticobiliary pathology, MRCP with its added advantage of multiplanar reconstruction and high spatial resolution makes it an indispensable imaging technique for biliary imaging.

Funding- NIL

Conflicts of interest- The authors declare that there are no conflicts of interest.

References

[1]. Mercer S, Singh S, Paterson I. Selective MRCP in the management of suspected common bile duct stones. HPB. 2007 Apr 1;9(2):125-30

[2]. Griffin N, Charles-Edwards G, Grant LA. Magnetic resonance cholangiopancreatography: the ABC of MRCP. Insights into imaging. 2012 Feb;3(1):11-21.

[3]. Housset C, Chrétien Y, Debray D, Chignard N. Functions of the Gallbladder. Compr Physiol. 2016;6(3):1549-77.

[4]. Ghimire R, Lohani B, Pradhan S. Accuracy of ultrasonography in evaluation of level and cause of biliary obstruction: a prospective study. Kathmandu University medical journal (KUMJ). 2005;3(1):17-21.

[5]. Vaishali MD, Agarwal AK, Upadhyaya DN, Chauhan VS, Sharma OP, Shukla VK. Magnetic resonance cholangiopancreatography in obstructive jaundice. Journal of clinical gastroenterology. 2004;38(10):887-90.

[6]. Bhatt C, Shah PS, Prajapati HJ, Modi J. Comparison of diagnostic accuracy between USG and MRCP in biliary and pancreatic pathology. Indian Journal of Radiology and Imaging. 2005;15(02):177-81.

[7]. Karki S, Joshi KS, Regmi S, Gurung RB, Malla B. Role of ultrasound as compared with ERCP in patient with obstructive jaundice. Kathmandu University Medical Journal. 2013;11(3):237-40.

[8]. Kaur DA, Malaviya DA, Deepika DD, Kaur DN. Comprehensive evaluation of MRCP versus Ultra Sonography in biliary obstruction. International Journal of Medical Research and Review. 2018;6(3):143–52.

[9]. CostiR, Gnocchi A, DiMario F, Sarli L. Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy. World Journal of Gastroenterology: WJG. 2014 Oct 7;20(37):13382.

[10]. Kurian JM, Ganesh K, John PK, Hegde P, Murthy C, Kumar A. A Comparative Evaluation of USG and MRCP Findings in Biliary and Pancreatic Pathologies. IJCMR. 2017;4(1):212-5

[11]. Norero E, Norero B, Huete A, Pimentel F, Cruz F, Ibáñez L, Martínez J, Jarufe N. Accuracy of magnetic resonance cholangiopancreatography for the diagnosis of common bile duct stones. Revista medica de Chile. 2008;136(5):600-5.

[12]. Rathore MS, Vishakha R, Amit K, Gaurav K, Neeraj G, Jain DK. Comparative study to assess diagnostic reliability of ultrasound and 3T-MRCP in patient of obstructive jaundice. British Journal of Medicine and Medical Research. 2015;8(11):919-30.

[13]. Singh A, Mann HS, Thukral CL, Singh NR. Diagnostic accuracy of MRCP as compared to ultrasound/CT in patients with obstructive jaundice. Journal of clinical and diagnostic research: JCDR. 2014;8(3):103.