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COMPARISON OF MAGNETIC RESONANCE CHOLANGIOPANCREATOGRAPHY AND ULTRASOUND IN DIAGNOSIS OF BILIARY OBSTRUCTION

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ABSTRACT
INTRODUCTION
The expanding spectrum of therapeutic options for patients with obstructive jaundice makes it necessary for the radiologist to precisely assess the underlying aetiology, exact location, level and extent of the disease.[1] Biliary tree diseases are common worldwide. The causes of biliary obstruction may be intraluminal like choledocholithiasis, haemobilia, parasites or may be extraluminal like chronic pancreatitis, ampullary stenosis, lymph node or vascular compression or may be benign like post-surgical stricture, primary sclerosing cholangitis, AIDS cholangiopathy or it may be malignant like cholangiocarcinoma, carcinoma head of pancreas, duodenal or ampullary carcinoma, metastatic disease. It may also be due to congenital anomalies like biliary atresia, choledochal cyst or Caroli's disease.[2]

In evaluation of patients with suspected biliary obstructive disease, a variety of imaging modalities are available such as Ultrasonography, Computed Tomography, Magnetic Resonance cholangiopancreatography, Endoscopic Retrograde Cholangiopancreatography and Percutaneous Transhepatic Cholangiography.[3] Magnetic Resonance Cholangiopancreatography (MRCP) is a relatively newer, non- invasive, radiation free modality for visualization of biliary system. It is mainly useful in patients with contraindication to invasive modality like Endoscopic Retrograde Cholangiopancreatography (ERCP).[4]

Ultrasonography has always been considered as the first choice of imaging modality in cases of biliary obstructive disease since it is easily available, non-invasive, radiation free and low cost.[5]

Though it is a very useful modality to visualize the common hepatic and proximal common bile duct, it does have limitations in visualizing distal common bile duct and pancreas due to obscuration by overlying bowel gas in 30-50% cases and the image quality may be compromised in obese patients.[6]

Magnetic Resonance Cholangiopancreatography (MRCP) has advantages of being non-invasive, cheaper as compared to ERCP, free of ionizing radiation, painless, less operator dependent, no contrast requirement, gives a better visualization of ducts proximal to obstruction and when combined with conventional T1W and T2W sequences, allows detection of extraductal disease.[7]

The basic principle of Magnetic Resonance Cholangiopancreatography is that body fluids like bile and pancreatic secretions have a high signal intensity on heavily T2W magnetic resonance sequences which appear white while the background tissue appears dark due to low signal intensity.[8]

Modified Fast Spin Echo (FSE) sequences like Rapid Acquisition with Rapid Enhancement sequence (RARE) and Half Fourier acquisition single shot turbo spin echo (HASTE) are ideally used in combination for MRCP which takes only 10 minutes of imaging time while providing improved quality of image.[9]

Magnetic Resonance Imaging plays a vital role in prompt diagnosis of pancreatico- biliary tract. With advancements in higher strength magnetic field and newer pulse sequences, Magnetic Resonance Cholangiopancreatography (MRCP) with its higher resolution, better contrast, rapidity, non-invasive nature and multiplanar capability is proving to be the investigation of choice in patients with pancreatico-biliary diseases.[10]

MATERIAL AND METHODS

A total 50 patients who underwent ultrasonography and MRCP imaging during a period of 2 years were randomly considered for the study. These patients were prospectively subjected for MRCP after a routine ultrasonography of abdomen and pelvis. This was a prospective, comparative and cross-sectional study. Institute Ethics Committee Clearance will be obtained before start of study. The study was conducted on patients of age group (0 - 75 years), of either sex, referred to the Department of Radio diagnosis and Imaging, DR. D. Y. Medical College, Hospital & Research Centre Pimpri, Pune. A written informed consent was taken for every patient before performing the ultrasonography and MRCP study. All ultrasonography studies were performed on Aloka Prosound Alpha 6 and the MRI studies were performed on SIEMENS MAGNETOM AVANTO 1.5 Tesla MR System.

All patients clinically suspected of biliary obstruction by pathologies like choledocholithiasis, choledochal cysts, biliary strictures, carcinoma of biliary tress, cholangiopathies, carcinoma of gall bladder was included in this study. Patients having history of past surgeries, post-ERCP status, cardiac Pacemaker, cochlear implant, metallic foreign body metallic orthopaedic hardware, pregnancy and severe claustrophobia were excluded from this study.

Patients were instructed to fast for 6 hours prior to study in order to reduce the fluid secretions within the stomach and duodenum, reduce bowel peristalsis and promote gallbladder distension.

MRCP was performed using phase array body coil. First an axial 2D breath-hold HASTE sequence was performed. Two breath-hold acquisitions were obtained so that entire liver up to duodenal ampulla was visualised.

Following this, a 3D respiratory-triggered heavily T2 weighted FSE sequence was taken in coronal plane. The imaging plane was selected from the initial axial T2WI, with one acquisition aligned to common bile duct in the head of pancreas and second acquisition aligned to pancreatic duct at approximately 90 degrees to the first imaging plane. Respiratory triggering was achieved with use of a navigator sequence than an MR pre-pulse to monitor respiratory motion.

The navigator was placed over the edge of the diaphragm on the coronal and sagittal localizer and image acquisition was triggered when the position of the diaphragm interface with the lung falls with the pre-specified acceptance window. The patient was asked to breath regularly throughout the acquisition, which takes between 3-5 minutes to acquire. A stack of images was obtained which was continuous and each was of 1.5 mm thickness. As the images were heavily T2-weighted, the pancreatico-biliary tree displayed as high signal intensity while adjacent structures showed low intensity.

From this volume of data, a MIP reformat was generated in coronal and sagittal planes. In addition to MIP reformat, a thick collimation slab was obtained in the coronal and oblique planes. This involved performing a FS HASTE sequence with a slab thickness of 4 cm. It was successful in depicting the entire pancreatico-biliary system. The diagnosis was confirmed on ERCP/ Histopathology/ Surgery. The sensitivity and specificity for USG and MRCP of biliary obstruction was calculated.

OBSERVATIONS AND RESULTS

Table 1: Age wise distribution of cases in study group.

Age group (years)	Number	Percentage
0-10	8	16.0
11-20	1	2.0
21-30	7	14.0
31-40	12	24.0
41-50	9	18.0
51-60	5	10.0
61-70	6	12.0
> 70	2	4.0
Total	50	100

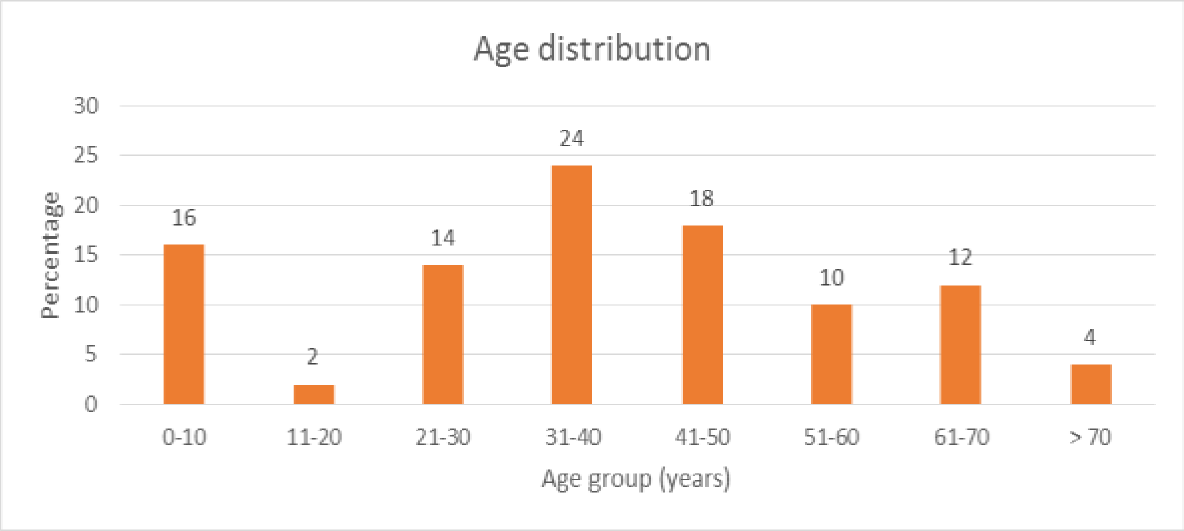

Figure 1: Age wise distribution of cases in study group.

The most common age group involved in our study was between 30 – 50 with a Mean (SD) age was 39 (±19) years.

Table 2: Sex wise distribution of cases in study group.

Gender	Number	Percentage
Male	23	46.0
Female	27	54.0
Total	50	100

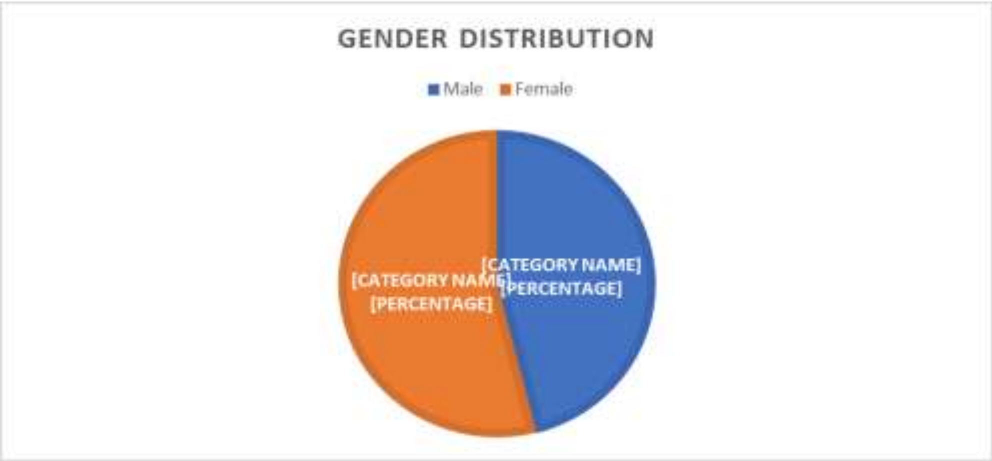

Figure 2: Sex wise distribution of cases in study group.

In Our study there was a female predominance. 54 % were females and 46% were males (Fig-2).

Table 3: Distribution of various biliary diseases diagnosed on USG and MRCP.

Diagnosis	Number	Percentage
Choledocholithiasis	28	56
Choledochal Cyst	8	16
Adenocarcinoma of CBD	6	12
Adenocarcinoma of GB	2	4
CBD Stricture	4	8
Sclerosing Cholangitis	2	4
Total	50	100

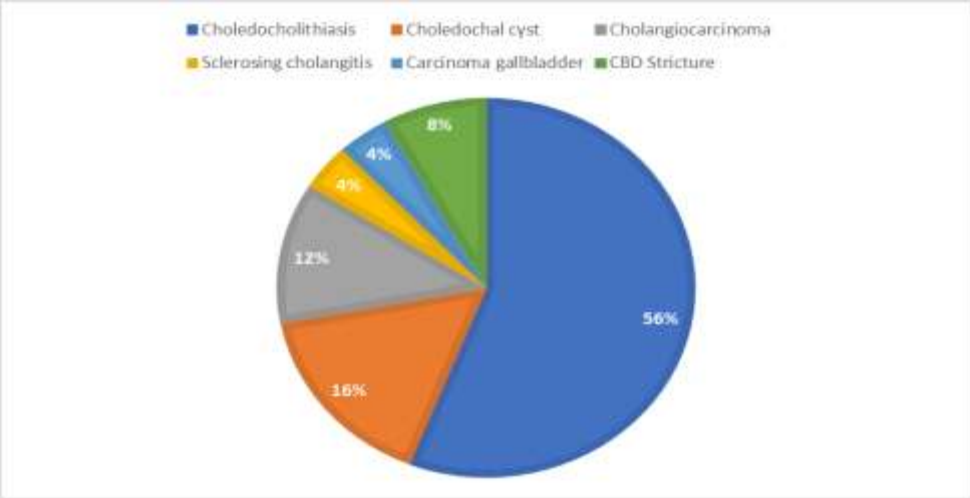

Figure 3: Pie chart showing number of patients showing various biliary diseases diagnosed on USG and MRCP and confirmed on ERCP/ Histopathology/ Surgery.

In our study of 50 patients, maximum patients were of choledocholithiasis followed by choledochal cyst.

Table 4: Distribution of benign and malignant biliary diseases diagnosed on USG and MRCP and confirmed on ERCP/ Histopathology/ Surgery.

Diagnosis	Number	Percentage
Benign	42	84
Malignant	8	16
Total	50	100

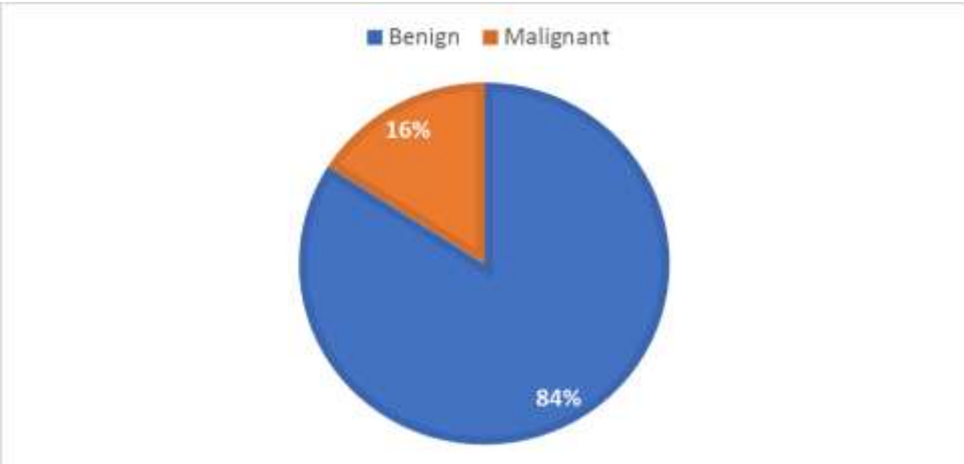

Figure 4: Pie chart showing distribution of benign and malignant pathologies diagnosed on USG and MRCP and confirmed on ERCP/ Histopathology/ Surgery.

In our study of 50 patients, Benign pathologies (84%) of biliary system were predominant than that of malignant pathologies (16%).

Table 5: Distribution of biliary pathologies diagnosed in patients with obstructive jaundice on USG.

USG diagnosis	Number	Percentage
Choledocholithiasis	25	50
Choledochal Cyst	8	16
Dilated CBD	8	16
Gall bladder Mass	1	2
Gall bladder wall thickening	1	2
Dilated CBD + IHBR Dilatation	4	8
Normal	3	6
Total	50	100

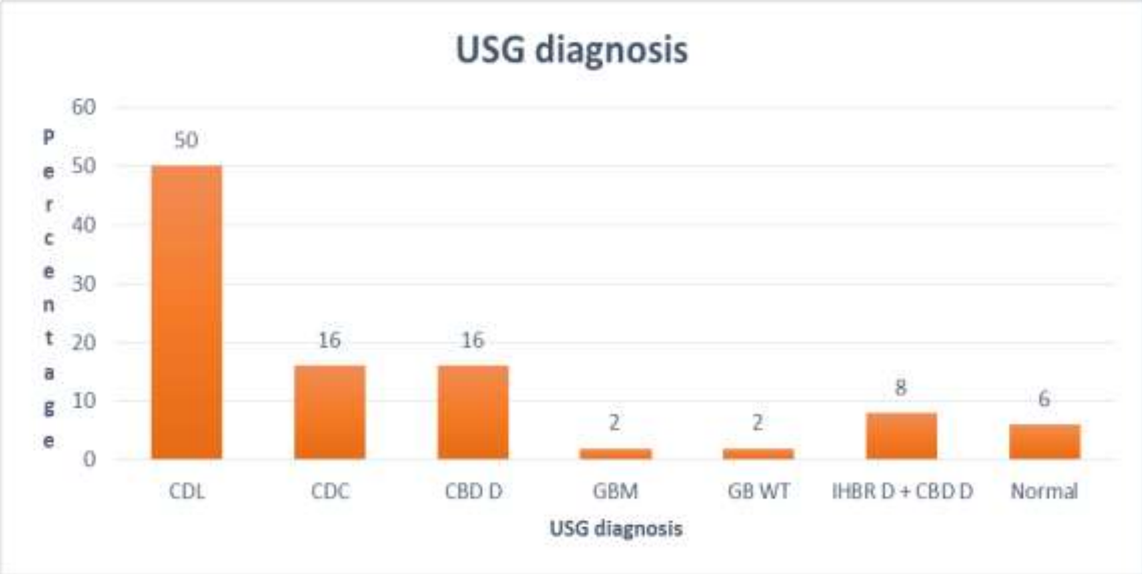

Figure 5: Graph showing Distribution of biliary pathologies diagnosed in patients with obstructive jaundice on USG.

In our study of 50 patients, Choledocholithiasis was the most common cause of obstructive jaundice found on USG followed by choledochal cyst.

Table 6: Distribution of biliary pathologies diagnosed in patients with obstructive jaundice on MRCP.

MRI diagnosis	Number	Percentage
Choledocholithiasis	28	56
Choledochal Cyst	8	16
Cholangiocarcinoma	6	12
Ca Gallbladder	2	4
CBD Stricture	4	8
Sclerosing Cholangitis	2	4
Total	50	100

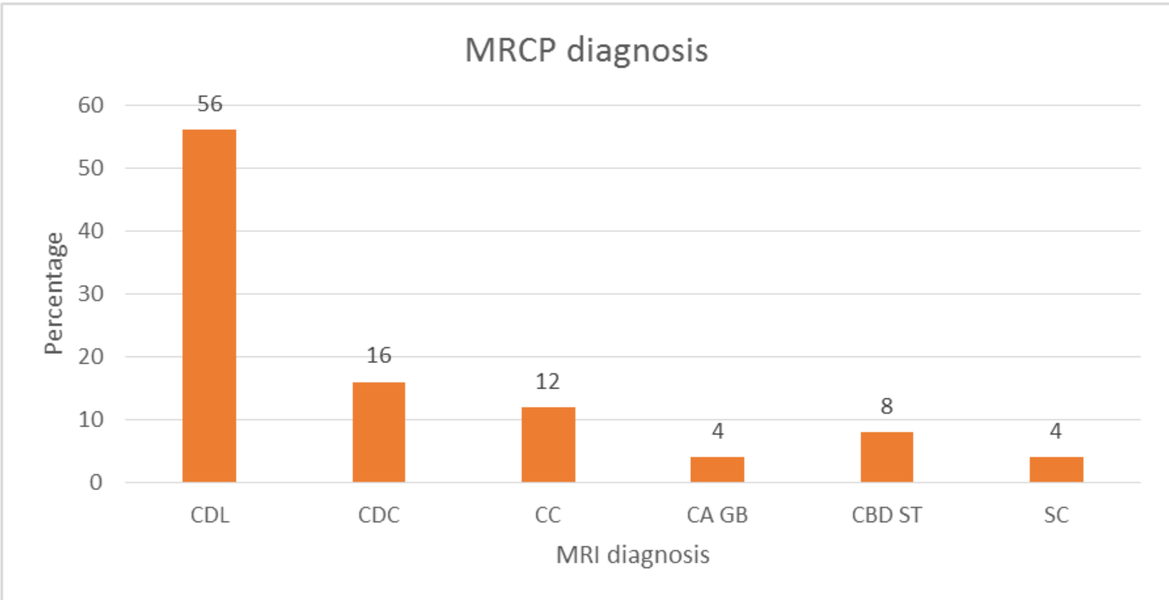

Figure 6: Graph showing Distribution of biliary pathologies diagnosed in patients with obstructive jaundice on MRCP.

In our study of 50 patients, Choledocholithiasis was the most common cause of obstructive jaundice found on MRCP followed by choledochal cyst.

Table 7: Sensitivity and specificity of USG and MRCP of benign lesions of biliary system.

Benign Pathologies	USG		MRCP	
	Sensitivity	Specificity	Sensitivity	Specificity
Choledocholithiasis	89.3 %	100 %	100 %	100 %
Choledochal cyst	75 %	100 %	100 %	100 %
Stricture	75 %	100 %	75 %	100 %
Sclerosing Cholangitis	50 %	100 %	75 %	100 %

Table 8: Sensitivity and specificity of USG and MRCP of malignant lesions of biliary system.

Malignant Pathologies	USG		MRCP	
	Sensitivity	Specificity	Sensitivity	Specificity
Cholangiocarcinoma	75 %	100 %	83 %	100 %
Carcinoma Gallbladder	50 %	100 %	100 %	100 %

DISCUSSION

Obstructive jaundice can be caused by the obstruction of bile duct with gall stones, strictures, malignancy etc. In our study, obstructive jaundice was more common in females and choledocholithiasis was the commonest cause. In our study, IHBR were visualized in 100% cases on MRCP as compared to sonography (98%). Dilatation of the IHBR found in all 50 cases by MRCP as compared to 49 cases on sonography and there was a declining trend observed in the ability of sonography to visualize the biliary tree as we moved distally. Visualization of the proximal ducts was possible in 91.6% cases and dropped to 63.3% for distal CBD. Decreasing the diagnostic performance of sonography was because of difficulty in visualizing the distal CBD and the pancreatic region mainly due to interference by bowel gasses. Similar observations were also made by Vicary *et al*. who opined that limitation in the sonographic evaluation of the distal biliary tree and pancreas was due to bowel gasses besides the operator's experience. MRCP was better in showing the distal biliary tree. The distal CBD was visualized in 42/50 patients (84%) as against 40/50 (80%) patients by sonography.[11]

Regan *et al*. in their prospective study on MRCP demonstrated biliary dilatation in 100% cases.[12] A recent meta-analysis of 67 published controlled trials by Romagnuolo *et al*. have shown both sensitivity of 95% and specificity of 95% for detecting the presence of a biliary obstruction.[13] According to our study most common site of obstruction was hilar and intra-hepatic (50%) was comparable to Kumar *et al*.[14] who found a variable range of accuracy ranging from 27% to 95% for detecting the level of obstruction by ultrasound. The extent of the lesion could be determined in 100% of patients by MRCP as compared to only 66% by sonography. When considering only mass lesions, an extent of biliary involvement could be completely assessed in 4 cases by sonography while it was detected in all 8 cases by MRCP.

MRCP showed good accuracy and an optimal capability of evaluating tumour extent as reported by Manfredi et al.[15], who analysed only hilar malignant stenosis of the biliary structures, reported an accuracy of 89% in the assessment of their extent. Our finding is also in concurrence with the study conducted by Soto *et al*. [16] who suggested that in case of mass lesions, when MRCP is combined with MRI, a complete staging information can be obtained about the tumour size, bile duct involvement, and vascular invasion. Hall-Craggs *et al*.[17] in a prospective study comparing MRCP with conventional cholangiography found that MRCP predominantly demonstrates dilated ducts proximal to the stricture and does not distend the stricture itself. It was found that the stricture itself was not visualized, and it was not possible to assess the length and extent of the stricture.

In our study, choledocholithiasis was the commonest benign cause (56%) of obstruction followed by choledochal cyst (16%). Cholangiocarcinoma comprised maximum number of malignant cases (75%) in our study with hilar and proximal CBD and distal CBD cholangiocarcinoma forming a majority of these masses. The second most common malignant lesion was Infiltrative G.B mass (25 %). In our study, ultrasound was found to have sensitivity 70%, specificity 100% for benign and 63% for malignant lesion for detecting the cause of obstruction while MRCP correctly detected cause of obstruction in all 100% cases with sensitivity: 93.7%, specificity: 97%. Upadhyaya *et al*.[6] in a prospective study of comparative assessment of imaging modalities in biliary diseases found that MRCP had the accuracy of 87.5% for assessing the cause. Vaishali *et al*.[18] found the overall diagnostic accuracy of 89.65% for detection of the cause of obstruction. Aube *et al*.[19] found sensitivity of 90.5% and specificity of 87.5% of MRCP in etiological diagnosis. In our study, MRCP showed more promising results than ultrasound in assessing the nature of disease i.e. benign or malignant. Our results are comparable to Ghimire *et al*.[20] who found sensitivity: 67%, specificity: 91%, PPV: 71%, and negative predictive value (NPV): 73%, for ultrasound in the detection of benign lesions.

In our study, ultrasound was found to have sensitivity: 89.3%, specificity: 100 for choledocholithiasis while MRCP correctly detected 28/28 cases of choledocholithiasis with sensitivity: 100%, specificity: 100. Ferrari et al.[21] in their study showed the diagnostic accuracy of 80.15%, with a sensitivity of 71.08% and a specificity of 95.83% that were in concordance with our study. Ferrari et al.[21] have found that MRCP has a diagnostic accuracy of 93.89%, sensitivity of 93.97% and specificity of 93.75% in the diagnosis of choledocholithiasis. Two false negative cases on USG were due to hindering of distal CBD evaluation by bowel gas shadow and obese body habitus. Pasanen et al.[22] found that the sensitivity of ultrasound for choledocholithiasis varies widely from 20% to 80% with a high specificity of approximately 98%. Mendler et al.[23] have also found decreasing sensitivity of MRCP in detecting stones according to the stone size: 67-100% for stones >10 mm size, 89-94% for stones measuring 6-10 mm, and 33-71% for bile duct stones <6 mm in size).

In our study for stricture ultrasound detected 3 out of 4 cases with sensitivity: 75% and specificity: 100% while MRCP detected 3 out of 4 cases of biliary strictures with sensitivity of 75% and specificity of 100%.

In contrast to our study, Pandit et al.[24] in their study found accuracy of ultrasound in detection of benign stricture was 31% but results are comparable to a study done by Lomas et al.[25] who compared MRCP and ERCP in 78 patients with obstruction and reported a sensitivity and specificity of 86.4% and 82.4% respectively for benign stenosis. The high specificity was attributable to the capability of USG to detect true negatives in benign stenosis, thus showing the cause of the obstruction by calculi or malignant stenosis. The low sensitivity figures are to be related to intrinsic limitations of the methodology, which, though showing the indirect signs of stenosis, did not allow optimal visualization of the distal CBD and the ampullary region, which is where benign stenosis is often localized. Both USG and MRCP detected all the three cases of the choledochal cyst and gave information of involvement confidently similar findings were discussed by Kim et al.[26] in their study.

Illustrative Cases

Figure 7: A case of choledocholithiasis showing intraluminal filling defects (calculus) in proximal CBD with dilatation of CBD on RCP Coronal Haste T2(a), T2 3D(b) and MIP(c) images.

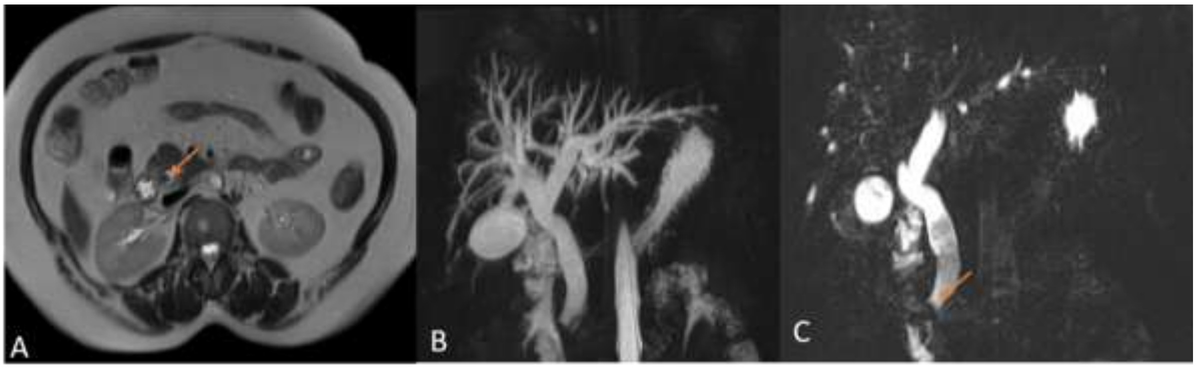

Figure 8: A case of choledocholithiasis showing intraluminal filling defects (calculus) in distal CBD with dilatation of CBD on MRCP Coronal T2 HASTE(a), T2 3D(b) and MIP(c) images.

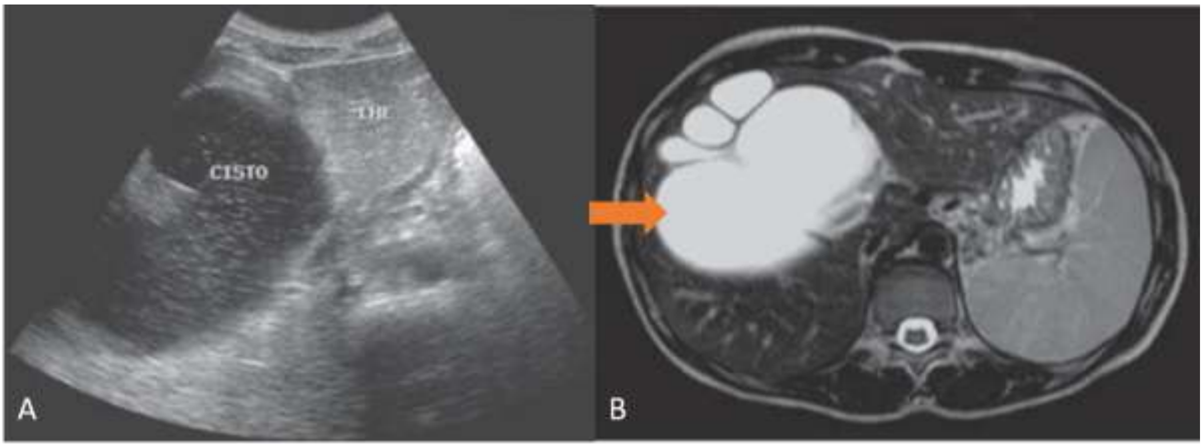

Figure 9: A case of 7-year-old female diagnosed of choledochal cyst Type IA, On ultrasound (a) showing a well-defined cystic lesion containing thin septa and hyperechoic echoes adjacent to the right hepatic lobe, in the gallbladder fossa and on MRCP T2 HASTE image (b) demonstrating cystic lesion with regular contours.

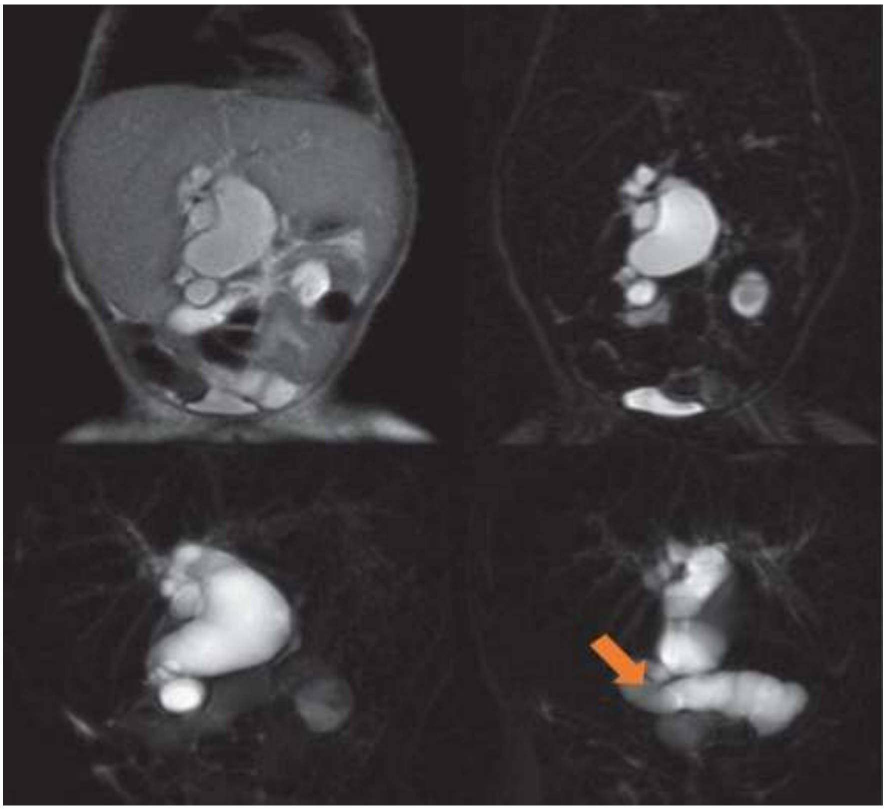

Figure 10: A case of a 3-year-old female child diagnosed with Type IC choledochal cyst showing marked tortuous fusiform dilatation of extrahepatic bile duct (*arrow*).

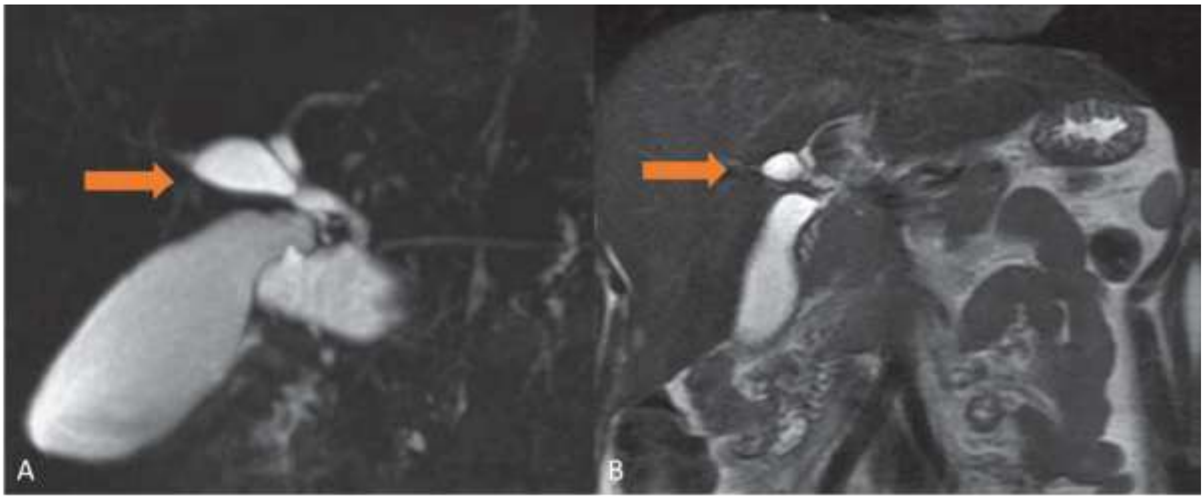

Figure 11: A case of 12-year-old male child diagnosed of choledochal cyst Type II showing diverticulum (arrow) arising from the lateral wall of common hepatic duct on MRCP MIP(a) and T2 HASTE(b) images.

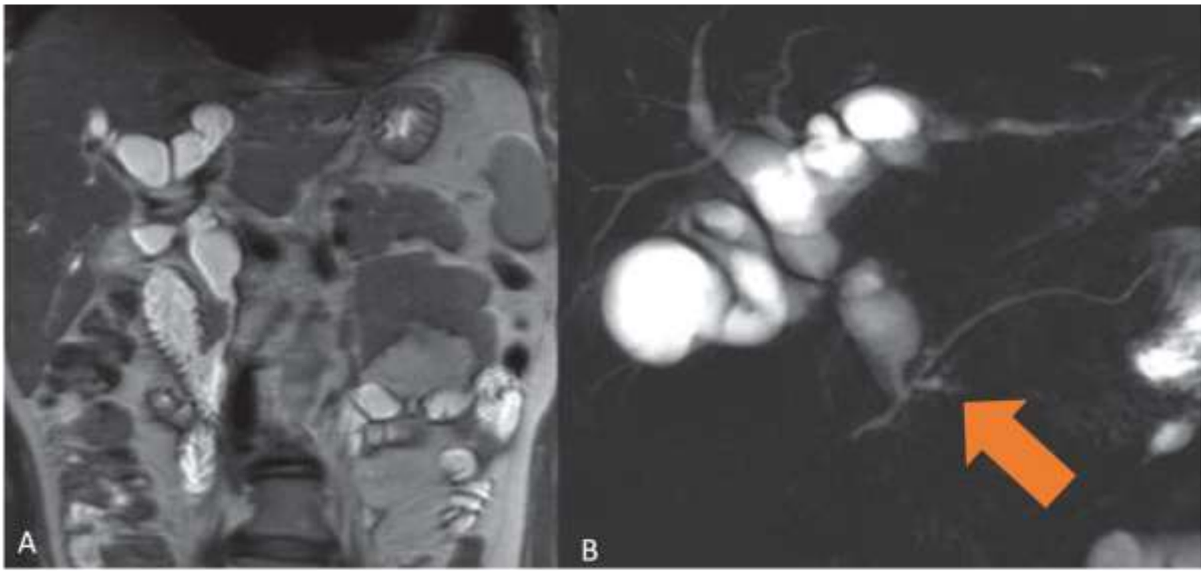

Figure 12: A case of 6-year-old female diagnosed of Type IV choledochal cyst showing normal peripheral tapering of intrahepatic bile ducts on MRCP Coronal FSE T2W(a) and thick-section single-shot fast spin-echo heavily T2W images(b).

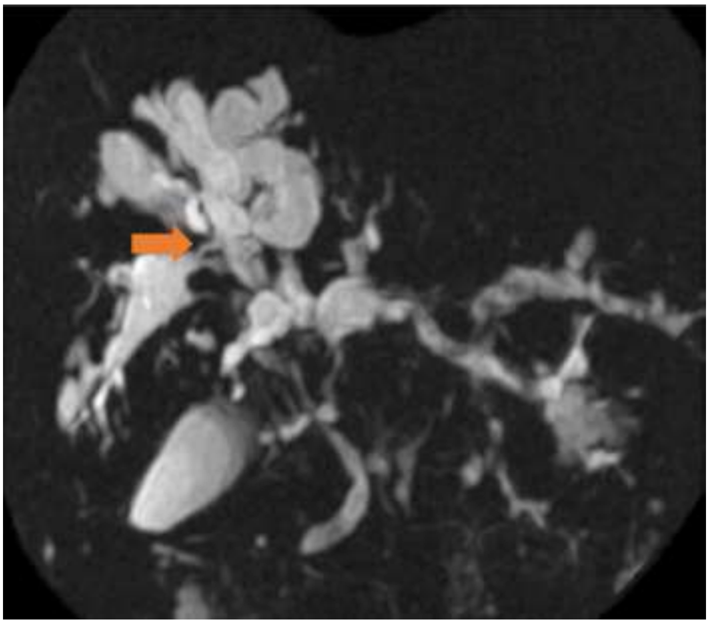

Figure 13: A case of 3-year-old female with vomiting and yellowish discoloration of skin diagnosed as Caroli disease on MRCP T2 MIP image showing multifocal irregular dilatation of intrahepatic duct without common bile duct dilatation.

CONCLUSION

Since the introduction of MRCP two-decades ago, the technology and methodology has evolved in areas of both acquisition and post processing techniques which permits the study of anatomy of biliary system and accurate detection of pathologies of the biliary system. It remains the investigation of choice for the non-invasive diagnosis of many pancreatico-biliary disorders.

USG is considered the first-choice option in the diagnostic imaging of obstructive biliary disease. However, owing to its low sensitivity in most of the benign stenosis and distal CBD disease, where the clinical and laboratory suspicion is strong and unsupported by ultrasound and/or in the presence of conditions affecting ultrasound performance, and for a thorough staging evaluation of malignancy, MRCP is highly accurate and superior diagnostic modality in establishing diagnosis of obstructive biliary pathologies.

MRCP is more sensitive and more likely to detect choledocholithiasis, CBD strictures and malignant pathologies as compared to USG. Sensitivity, specificity and accuracy of MRCP for choledochal cyst are same as in USG. However, the potential applications of MRCP in the detection of obstructive biliary pathologies are limited by the expense and availability of technology due to its high cost and lack of expertise available in operating the machine.

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