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Diagnostic utility of MRCP in obstructive jaundice and comparison with CT & ultrasonography

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Abstract
Introduction: With availability of multiple therapeutic options accessible to patients with obstructive jaundice, it is crucial to convey vital information through radiological investigations to decide further management plan. Apart from confirming presence of obstruction in biliary tract and identifying its cause whether benign or malignant, imaging can provide details about anatomical level of obstruction, extent of the pathology as well as its amenability to interventional procedures.
Aim and objective: To evaluate the diagnostic accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) compared with Ultrasound and Computed Tomography (CT) in patients with obstructive jaundice taking findings of ERCP/ PTC and histopathology as gold standard.
Materials and Methods: This prospective study included 36 patients who were referred to the department of radio-diagnosis with clinical features of obstructive jaundice.
Initial ultrasonography (USG) was followed by Computed tomography (CT) and Magnetic Resonance Cholangiopancreatography (MRCP), however in cases of benign pathologies where USG findings were unequivocal Computed tomography (CT) was not done to avoid unnecessary radiation exposure. The reporting was done by radiologists blinded to other imaging findings. The characteristic Endoscopic Retrograde Cholangiopancreatography (ERCP) features/ histopathological diagnosis (as applicable) were considered as final.
Results: For diagnosing the cause of obstructive jaundice, MRI with MRCP has a greater diagnostic accuracy of 94.4% than CT with accuracy is 91.6% and USG with diagnostic accuracy of 30.56%.
Conclusion: Ultrasound is a good screening modality to confirm biliary obstruction and to decide whether MRCP is required as next step or not. MRCP is a highly useful non-invasive imaging study in the pre-operative workup of cases with obstructive jaundice.

Keywords: MRCP, Obstructive jaundice, biliary tract

Introduction

Obstructive jaundice is a commonly encountered condition in surgical practice but it needs a methodological and systematic workup for evaluation to reach to a precise diagnosis [1]. After a battery of biochemical tests, radiological investigations are performed. These days the role of radiologist is not only confined to differentiate between obstructive or non-obstructive etiology but is to elaborate the exact anatomical site of obstruction, extent of the disease as well as the feasibility for interventional procedures. Only after accurate assessment of these factors, appropriate therapeutic option can be decided for further management [2, 3].
Ultrasound (USG) is usually the first imaging tool utilised in the work up owing to its easy availability and cost effectiveness [4]. Computed Tomography (CT) scan is considered more accurate than USG for determining the specific cause and level of obstruction [5]. Ultrasound is used as a screening tool to confirm or exclude biliary tract obstruction and has at least 80% accuracy [6]. The range of application of CT has been partially limited by MRCP as MRCP provides better soft tissue resolution images of the biliary tree without exposure to ionizing radiations [8].

Aims and Objective

This prospective study aimed to compare the diagnostic accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) with Ultrasound and Computed Tomography (CT) in evaluation of patients with obstructive jaundice taking ERCP, PTC and histopathology as gold standard.

Materials and Methods

Type of study
Prospective observational study.

Sample size
The study has been conducted on 36 patients.

Duration and place of study
The study was conducted after approval from the institutional ethic committee starting from January 2018 to December 2019 at JJMC Medical College, Davangere Karnataka

Inclusion criteria
All patients with clinically diagnosed obstructive jaundice were included in the study.

Exclusion criteria
1. Patients with contraindications to MRI e.g claustrophobic patient.
2. Patients with non-obstructive (prehepatic/hepatic) cause of jaundice.

Methodology
Written informed consent was taken from all the subjects. Initial USG evaluation was followed by Contrast enhanced Computed Tomography (CECT) and MRI/ MRCP, however in patients with Obstructive Jaundice with CBD calculi as diagnosed on USG, CT was performed if required.
Transabdominal ultrasonography was done using curvilinear probe on GE Logiq-e machine followed by CECT on a 40 Slice Philips Brilliance machine.
MRCP was done in all patients on Philips Achieva 1.5 Tesla MRI scanner. For MRCP, patients were asked to come with 8-12 hours fasting to promote gall bladder distension, reduce fluid secretions in stomach and duodenum and reduce peristalsis. Using heavily T2 weighted images (at longer echo time (TE) ranging from 600-1200 ms) we aim to suppress the background signal so that only bile in biliary tract can show bright signal. We also used blueberry juice or iron oxide prior to scan to suppress signal from fluid present in the stomach and duodenum. Few centers gives intravenous secretin to promote pancreatic secretions and distend pancreatic duct and its side branches in certain cases. However, it was not used in our study. Three most important sequences included axial T2 weighted scan from liver to ampullary region followed by T2 weighted 3D FSE sequence acquired in coronal oblique plane using respiratory triggering by tying bellows over abdomen. After this breath hold HASTE sequence was acquired in coronal plane. Maximum intensity projection (MIP) and thick slab images were also used for interpretation.
USG, CECT and MRCP scans were interpreted by radiologists blinded to other imaging findings. We used direct cholangiography (ERCP and PTC) and histopathological findings after biopsy or surgery as the gold standard.

Results and Observations
Of the 36 patients included in our study, 19 were male and 17 were female. They belonged to age group ranging from 3 months-85 years. Benign cause was found in 16 cases (44%) and malignant cause was reported in 20 cases (56%).

As shown in Table 1, most frequent benign causes of obstructive jaundice were calculi in CBD or gall bladder and CBD. Benign strictures also contributed to 25% of benign causes. Cholangitis causing beaded appearance of biliary tract and anatomical variants were also encountered in our study.

Table 1: Benign causes of obstructive jaundice

Benign Causes	No of cases	Percent
CBD calculi	4	25
CBD with GB calculi	4	25
Benign stricture	4	25
Anatomic variant	3	19
Cholangitis	1	6
Total	16	100

Among the malignant causes of obstructive jaundice, malignancy arising within 1 cm of ampulla of vater i.e periampullary carcinomas were most commonly encountered etiology. Cholangiocarcinoma and gall bladder carcinomas were second most common cause reported in our study.
Klatskin tumour was reported in 10% cases of malignant lesions and detailed assessment for its resectability was done using CT and MRI/MRCP.
Ca head of pancreas as well as compression of biliary tract by enlarged malignant nodal masses was also found in our study.

Table 2: Malignant causes of obstructive jaundice

Malignant Causes	No of cases	Percent
Periampullary Carcinoma	8	40
Cholangiocarcinoma	4	20
Carcinoma GB	4	20
Klatskins tumor	2	10
Carcinoma head of Pancreas	1	5
Metastatic compression	1	5
Total	20	100

Our study revealed that common cause of obstructive jaundice is malignant in older age groups whereas in younger and middle age, benign causes were found to be relatively more common (Table 3).

Table 3: Table showing distribution of Benign and Malignant Lesions with respect to age of patients

Age Group	Benign Cases		Malignant Cases		Total cases
0-12	1	50	1	50	2
13-30	5	83.3	1	16.7	6
31-60	8	47	9	53	17
>60	2	18.1	9	81.9	11
Total	16		20		36

X^2=6.8, df = 3, p=0.078

Correlation of the findings in ultrasound, CT and MRI/MRCP was done taking histopathology or cholangiography as gold standard to evaluate the diagnostic accuracy of each of these modalities (Table 4, 5, 6).
Thereafter final comparison was done among all these 3 imaging modalities in terms of sensitivity, specificity, positive and negative predictive values and diagnostic accuracy (Table 7). Our study revealed that the diagnostic accuracy of MRI/MRCP is better than that of CT and USG which are 94.44, 91.67 and 30.56% respectively.

Table 4: Table showing diagnosis by Helical CT scan and Histopathological diagnosis

		Histopathological diagnosis			Significance
		Benign	Malignant		
Helical CT	Benign	14 (TP)	1 (FP)	15	$X^2 = 24.89$, df =1,
	Malignant	2 (FN)	19 (TN)	21	$p < 0.000000607$
		16	20	36	

Table 5: Table showing diagnosis by MRI/MRCP and Histopathological diagnosis

		Histopathological diagnosis			Significance
		Benign	Malignant		
MRI with MRCP	Benign	15 (TP)	1 (FP)	16	$X^2 = 28.36$, df = 1
	Malignant	1 (FN)	19 (TN)	20	$p < 0.000000101$
		16	20	36	

Table 6: Table showing diagnosis by ultrasonography and Histopathological diagnosis

		Histopathological diagnosis			Significance
		Benign	Malignant		
USG	Benign	13	8	21	$X^2 = 7.106$
	Inconclusive	3	8	11	df = 2
	Malignant	0	4	4	$p < 0.028$
		16	20	36	

Table 7: Table showing Comparison of diagnostic values of ultrasound, Helical CT and MRI/MRCP

	MRI with MRCP	Helical CT	USG
Sensitivity	93.75%	87.5%	18.75%
Specificity	95%	95%	40%
Positive Predictive Value	93.75%	93.33%	20%
Negative Predictive Value	95%	90.48%	38.1%
Diagnostic Accuracy	94.44%	91.67%	30.56%

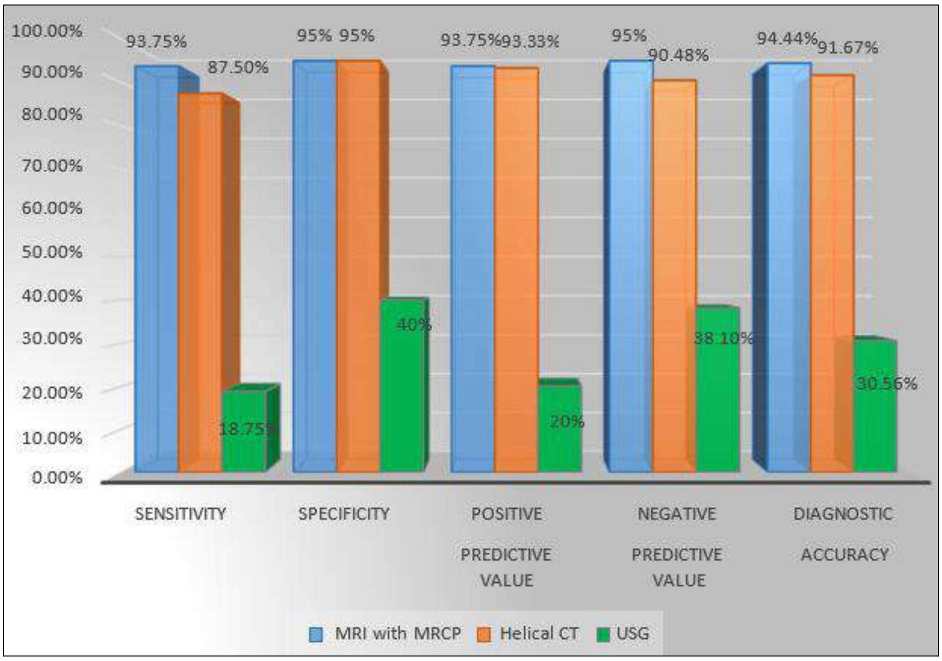

Fig1: Histogram showing comparison of sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MRI/MRCP, CT and USG

Discussion

USG is regarded as the first imaging tool for patient presented with obstructive jaundice as radiograph usually does not helps much because biliary calculi are radiolucent in 80-85% cases. However, since USG is operator dependent and it is difficult to visualise distal CBD and periampullary region clearly in obese patients, the sensitivity of USG is variable from 20-80% in previous studies.

Todua *et al*. revealed in their study that for choledocholithiasis, CT and ultrasound have comparable accuracy with a sensitivity range of 23% to 85% and specificity of 97% [12]. In our study, diagnostic accuracy, sensitivity and specificity of MRCP were found to be better than those of USG and CT for benign causes of obstructive jaundice which is similar to results shown in earlier studies (Calvo *et al*., [10], Huassein *et al*., [13], Boraschi *et al*., [9] Varghese *et al*., [14]).

We found that MRI/MRCP revealed 100% accuracy in diagnosing cases with malignant causes of obstructive jaundice. The overall sensitivity was 66.67%, specificity was 100% and accuracy was 96% for cases with cholangiocarcinoma on ultrasound. The finding of our study matches with findings by Hann *et al*. [17]

Among benign causes, choledocholithiasis was found to be most common cause. CBD is $\leq$6 mm in caliber and shows physiological prominence by 1 mm per decade after sixth decade of age. Post cholecystectomy, CBD shows reservoir status and can measure upto 10 mm in diameter. In our study, MRCP helped in better depiction of calculi in distal CBD which were noted as signal voids and were difficult to be seen on ultrasound. On CT also, these calculi can be missed as most of them are not radiodense.

Strictures were also better delineated on MRCP as compared to ultrasound and CT. Benign strictures were characterized by gradual smooth tapering of CBD with upstream dilatation. Benign strictures were found to be shorter in length (usually <9 mm) in contrast to malignant strictures (>18 mm long with abrupt change in caliber). Regular borders, wall thickness <1.5 mm and usually no enhancement or periductal soft tissue or significant lymph nodes were other imaging features that helped in diagnosing benign strictures on MRCP which were confirmed by direct cholangiography. Anatomy of stricture was optimally visualized on MRCP for categorizing them according to Bismuth classification.

Morphology of various types (I- VI) of choledochal cysts was better visualized on MRCP with respect to USG and CT which is in agreement to the previous studies.

Some patients were unable to hold their breath for the interval required. This compromised the quality of the 3D MRCP sequence in few of our cases. Based on our study, we recommend ultrasound as the initial screening modality to demonstrate the cause and level of biliary tract obstruction. For further characterization, MRI/MRCP is modality of choice for benign as well as malignant causes of obstructive jaundice.

As per the recent American College of Radiology (ACR) appropriateness criteria, MRI/MRCP is considered as an appropriate imaging tool after initial screening with ultrasound in patients with obstructive jaundice associated with pain (variant 1) or when mechanical obstruction is suspected (variant 2) to look for any mass lesion using contrast enhanced MRI/MRCP as well as in cases where mechanical obstruction is less likely (variant3) to look for any infiltrative liver disease etc.

Conclusion

Diagnostic accuracy of MRI/MRCP was found superior to ultrasonography and CT scan in analysing various causes of obstructive jaundice. Most common benign causes were calculi or benign stricture. The accuracy of MRI/MRCP was significantly better for cases with benign etiology since biliary tract calculi are usually not radiodense and can be missed on CT. Similarly distal CBD calculi are difficult to visualize on ultrasonography. Among the malignant causes, periampullary carcinoma was most common etiology. MRI/MRCP and contrast enhanced CT showed high diagnostic accuracy in such cases. Hence, MRI/MRCP serve as a reliable and accurate imaging tool in patients with obstructive jaundice.

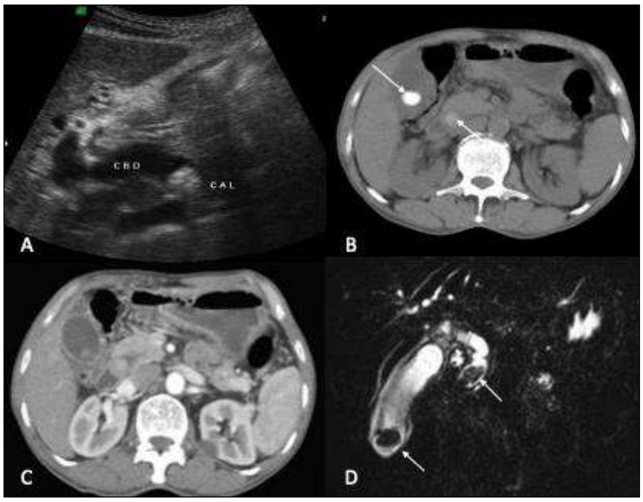

Fig 2: Image (A) shows calculus in distal CBD with dilated CBD proximal to it on ultrasound. Images (B and C) are non-contrast and contrast enhanced CT images depicting hyperdense calculi in gall bladder and CBD (arrows). Image (D) reveals round signal voids in dependent position in GB fundus and CBD (arrows) suggestive of calculi

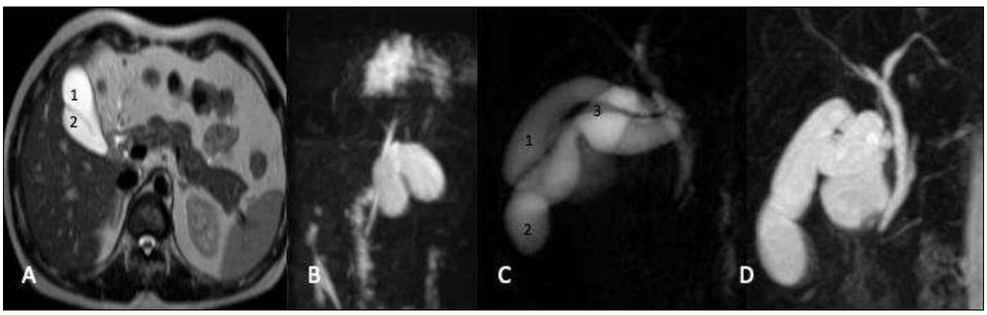

Fig 3: Images (A and B) shows duplication of gall bladder (lumen labelled as 1 & 2). (C and D) shows triplication of gall bladder (lumen labelled as 1, 2, 3)

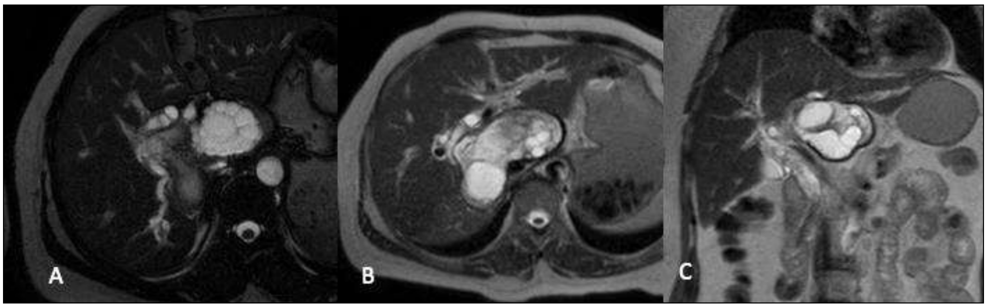

Fig 4: Images (A)fat saturated and images (B), (C) nonfat saturated axial and coronal T2 weighted images showing multiloculated lesion involving caudate lobe of liver with compression and upstream dilatation of biliary tract, suggestive of hydatid cyst of liver

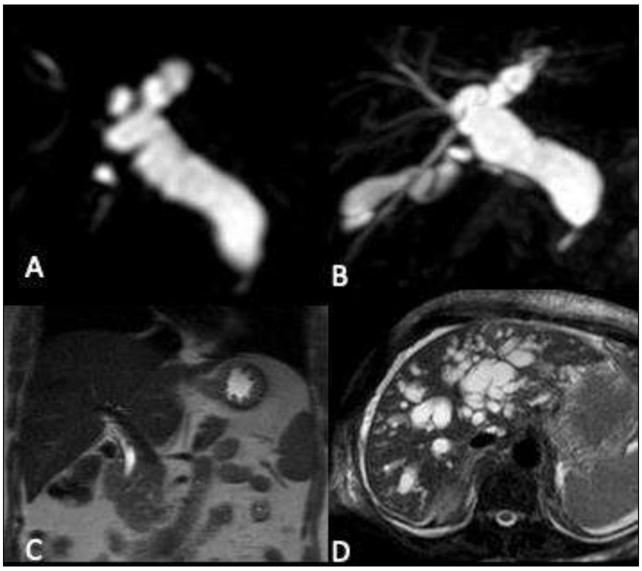

Fig 5: MRCP images demonstrating various types of choledochal cysts (A and B) dilatation of extrahepatic as well as intrahepatic biliary ductal system (Type IVa), (C) shows fusiform dilatation of entire extrahepatic bile duct (Type Ia) and image (D) shows Caroli disease (dilatation of intrahepatic ducts only).

Fig 6: Images (A and B) shows contrast enhanced CT with enlarged periportal and retroperitoneal lymph nodal masses compressing the biliary tract in an old immunocompromised patient. Images (C and D) are T2 weighted fat saturated MRI images showing the similar conglomerated large lymph nodal masses compressing the biliary tree

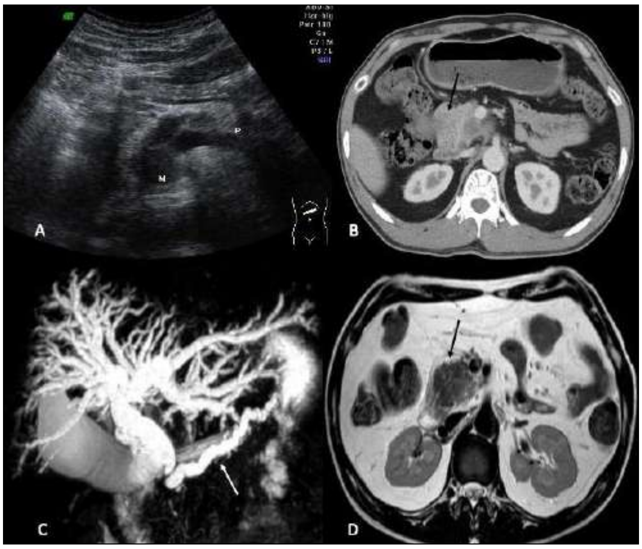

Fig 7: Image A shows USG depicting pancreatic head mass labelled as "M". Image (B) shows heterogeneously enhancing mass in pancreatic head region (arrow). Image (C) Maximum intensity projection (MIP) MRCP image reveals dilated pancreatic duct (white arrow) with dilated biliary ductal system with visualization of double duct sign. Image (D) axial T2 weighted MRI non contrast image showing hypointense mass in pancreatic head (black arrow).

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