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Role of MRCP in the evaluation of Choledocholithiasis

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Abstract:
Aim *: To evaluate the role of Magnetic resonance cholangiopancreatography (MRCP) and ERCP in assessment of choledocholithiasis with peroperative findings and repeat imaging as reference.*
Materials And Methods : *Fifty patients with clinically suspected choledocholithiasis and sonological evidence of hepatobiliary obstruction with gallstone disease were included in this prospective study performed In The Department Of Radiodiagnosis And Gastroenterology, Stanley Medical College, Chennai.*
Results : *MRCP had a sensitivity, specificity, positive and negative predictive values of 0.895, 0.833,0.944, 0.714 respectively which is comparable to similar international studies.*
Conclusion : *MRCP has comparable sensitivity, specificity, positive and negative predictive values to ERCP and can be used as a safe first line imaging modality of choice in the evaluation of choledocholithiasis.*
Keywords*: MRCP, choledocholithiasis, HASTE, RARE*

I. Introduction

Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive imaging method for examining the biliary and pancreatic ducts. The technique uses heavily T2-weighted imaging, which produces high signal from bile and other static fluids by virtue of their long T2 time, while suppressing background signal. Fast scanning techniques, particularly half-Fourier fast spin-echo techniques, are continuing to improve image resolution and allow scans within short breath-holds, reducing the effects of respiratory movement. MRCP since its introduction by Wallner et al in 1991 has experienced remarkable growth in the diagnosis of biliary diseases. The MRCP method has reached a level of resolution and reliability where it has well largely replaced diagnostic endoscopic retrograde cholangiopancreatography (ERCP).

Use of MRCP shows a high sensitivity and specificity for detection of biliary dilatation, calculi, strictures and anatomical variants. Experience with MR imaging of the pancreatic duct is less extensively described in the literature, but pancreatic duct dilatation, calculi and anatomy can now be reliably detected. However, as experience with MRCP increases, some sources of errors and limitations are becoming apparent, with image artefacts such as bright signals arising from stationary fluid within duodenum, duodenal diverticulae , and gas, blood or sludge within ducts potentially mimicking stones or strictures. Tumor, parasites, mucin and pseudocalculus at the ampulla can also mimick choledocholithiasis (1,2)

Magnetic resonance cholangio pancreatography (MRCP) provides images similar to those obtained with invasive cholangiography (ERCP and PTC). In the evaluation of biliary tree and pancreatic duct, ultrasonography has limitations as the bowel gas and obesity can degrade the image. CT scan also has limitations because cholesterol stones may be missed as their attenuation resembles fluid. Biliary strictures are also not visualised directly on CT. ERCP and PTC are invasive imaging modalities and hence associated with complications related to procedure and contrast.

1.1 Evolution Of MRCP

Wallner B K et al introduced MRCP in 1991, using a breath hold, two dimensional T2 weighted gradient echo sequence using steady state free precession (SSFP).

Morimoto et al tried to improve the image quality by introducing 3D (SSFP). These sequences are extremely susceptible to motion and magnetic susceptibility artifacts.

Laubenberger in 1995 introduced modified Fast Spin Echo (FSE) sequences. These are RARE and HASTE sequences.

1.2 MRCP sequences:

RARE – Rapid Acquisition with Rapid Enhancement Sequence

This sequence is a single shot echoplanar sequence using a thick oblique coronal slice of 2-7 cm thickness. This sequence provides a single projectional image of the biliary tree and a breath hold of only 2 – 7 seconds. The disadvantage of this sequence is, as there is only a single projection image, no source images are available for post-processing.

HASTE – Half fourier acquisition single shot turbo spin echo sequence

In this sequence multiple thin slices usually 13, ranging from 2 – 7 mm in thickness are obtained in a 18 – 20 second breath hold without interslice gap. Individual slices contribute to the source images from which post-processing is performed forming the maximum intensity projection (MIP). The image quality of HASTE multi slice images appear superior to RARE.

The ideal cholangiographic sequences for MRCP are a combination of both HASTE and RARE sequences. This takes only 10 minutes imaging time.

II. Aim

To evaluate the role of MRCP alone with per operative findings in the evaluation of choledocholithiasis. To evaluate and compare MRCP and ERCP in the evaluation of choledocholithiasis. To compare the sensitivity and specificity of MRCP versus ERCP and determine which modality is better for evaluation of choledocholithiasis.

III. Materials And Methods

The study was conducted in the Department of Radiology & Imaging and Department of Gastroenterology, Stanley Medical College, Chennai between January 2015 and April 2016 over a period of 16 months. It was a Prospective study. The study was submitted to the scientific and ethical committee for approval and conducted after approval.

This study included Patients of all age groups with clinically suspected choledocholithiasis and sonological evidence of hepatobiliary obstruction with gallstone disease. This study excluded patients with Obstructive jaundice secondary to proven malignancy, Patients with at least 1 absolute contraindication to either technique, certain patients with degenerative or ankylotic conditions or those with senile dementia, because of the impossibility of patient cooperation in MRCP. Patients with severe clinical conditions were not included as they needed urgent therapeutic requirements.

Criteria For MRCP Postive Status was Rounded or multifaceted signal voids seen in atleast two sequences. Criteria For ERCP Positive Status was well defined static filling defect within the common bile duct. From January 2015 and April 2016, 50 patients were referred to our institution for MRCP / ERCP. In all of these patients referred for choledocholithiasis, a reliable reference standard was available. The reference standard was established by per operative findings and repeat imaging after 3 months if treatment was conservative.

Prerequisities for the study included, fat free diet on the previous day and nil per oral since the previous night. Ryle's tube fluid aspiration was done just before the procedure.

MRCP was performed by 1.5Tesla 8 channel MRI SIEMENS AG, Medical Solutions, Magnetom Symphomy Syngo, Erlangen, Germany. ERCP was performed with FUJINON ED 450X75, Fujinon Corporation, Saitama, Japan

Sequences used include Localizers in all three planes, T1 axial, T2 coronal, T2 cor – thick slab- RARE (TR-4090, TE-1080, FA-150^{o}, FOV-300 x 300, Thickness -80mm with fat suppression done in 4sec), T2 – HASTE – cor – thin slab (TR-2150, TE-90, FA-150^{o}, FOV-300 x 300, Thickness -4 mm with fat suppression done in 4sec), MIP reconstruction, VOL mode and SSD

3.1 Image Analysis :

MRCP and ERCP acquired in this enrolled population were interpreted as follows: MRCP and ERCP images were interpreted independently by one radiologist and one gastroenterologist, respectively, who were blinded to any additional clinical and other imaging findings.

3.2 Standard Of Reference :

All patients who needed surgical correction underwent the same (as therapeutic approach to treatment). Per operative findings / repeat imaging after 3 months remained the gold standard of reference.

IV. Analysis

Using the standard of reference, sensitivity, specificity, positive predictive value, negative predictive value were calculated .In addition, comparison between groups was performed using the unpaired t test and

McNemar`s test. Correlations were sought using the Pearson correlation. A p-value of <0.05 was considered significant.

V. Results

Demographic Data:

A total of 50 patients with choledocholithiasis who underwent MRCP / ERCP at Stanley Medical College between January 2015 and April 2016, who fit the inclusion criteria were enrolled in this study. Continuous data were represented by mean and standard deviation and categorical data were represented by frequencies and percentages and were analyzed with help of Pearson's Chi-square, McNemar`s test. A value of $p<0.05$ was considered to be statistically significant. Data's were analyzed with SPSS 14.0 version.

Table.1: Age distribution

Age in yrs.	No. of patients	Percentage
10-20	1	2
20-30	5	10
30-40	9	18
40-50	12	24
50-60	12	24
60-70	6	12
70-80	5	10
Total	50	100

Table 1 demonstrates age wise distribution of the sample size. Highest prevalence observed between 40-50 and 50-60 yrs with 24 cases in each group.

Table.2: Sex distribution

Sex		Frequency	Percent
	Female	19	38.0
	Male	31	62.0
	Total	50	100.0

Table 2 demonstrates sex wise distribution of the sample size. Male predominance with 31 cases out of 50 cases accounting for 62% of sample size.

Table 3. MRCP vs ERCP

		ERCP		
		PRESENT	ABSENT	TOTAL
MRCP	PRESENT	34	2	36
	ABSENT	4	10	14
	TOTAL	38	12	50

Table 3 demonstrates cross tabulation and correlation between MRCP and ERCP.

Table 4: Statistical measure

Measures	Statistic	95% confidence interval
Sensitivity	0.895	0.758 to 0.958
Specificity	0.833	0.552 to 0.953
Positive predictive rate	0.944	0.870 to 0.982
Negative predictive rate	0.714	0.522 to 0.812
Chi-square value	23.980*	
Kappa	0.689**	

MRCP was found to have a sensitivity of 0.895 and specificity of 0.833 which is comparable to similar international studies. 34 cases were detected to have choledocholithiasis by MRCP and ERCP with identical findings. 10 cases were detected not to have choleldocholithiasis by MRCP and ERCP even though clinical suspicion of choledocholithiasis was present, which could probably be atributed to passed out calculi / other etiology of obstructive jaundice (stricture / periampullary obstruction). 2 cases were detected to have choledocholithiasis by MRCP and negative by ERCP which could be attributed to detection of proximal calculi detected by MRCP and not detected by ERCP. ERCP may not be helpful in the detection of proximal calculi with coexistent distal calculi causing complete obstruction. 4 cases which were negative by MRCP were diagnosed to have choledocholithiasis by ERCP which could be attributed to detection of small calculi <4mm which were not detected by MRCP but detected by ERCP. ERCP may be helpful in the detection of small calculi which may be missed by MRCP. Overall the positive and negative predictive value of MRCP as compared to ERCP was 0.944 and 0.714 respectively. Chi- square value was highly significant for the comparison (23.980). Kappa score was 0.689 which suggested fair to good agreement.

Table 5. MRCP VS Standard

		PER op / 3 months follow up		
		PRESENT	ABSENT	TOTAL
MRCP	PRESENT	35	1	36
	ABSENT	6	8	14
	TOTAL	41	9	50

Table 5 demonstrates cross tabulation and correlation between MRCP and standard of reference (Per operative findings).

Table 6: MRCP VS Standard statistical measures

Measures	Statistic	95% confidence interval
Sensitivity	0.854	0.793 to 0.874
Specificity	0.889	0.611 to 0.980
Positive predictive rate	0.972	0.903 to 0.995
Negative predictive rate	0.571	0.393 to 0.630
Chi-square value	20.184**	
Kappa	0.610**	0.332 to 0.701

MRCP was found to have a sensitivity of 0.854 and specificity of 0.889 which is comparable to similar international studies. 35 cases were detected to have choledocholithiasis by MRCP and confirmed by per operative findings. 8 cases were detected not to have choledocholithiasis by MRCP and per operative findings / follow up even though clinical suspicion of choledocholithiasis was present, which could probably be atributed to passed out calculi / other etiology of obstructive jaundice (stricture / periampullary obstruction). 1 case was detected to have choledocholithiasis by MRCP and negative by peroperative findings which could be attributed to detection of calculi which was passed out prior to surgery. 6 cases which were negative by MRCP were diagnosed to have choledocholithiasis by peroperative findings which could be attributed to detection of small calculi <4mm which were not detected by MRCP. Overall the positive and negative predictive value of MRCP as compared to ERCP was 0.972 and 0.571 respectively. Chi- square value was highly significant for the comparison (20.184). Kappa score was 0.610 which suggested fair to good agreement.

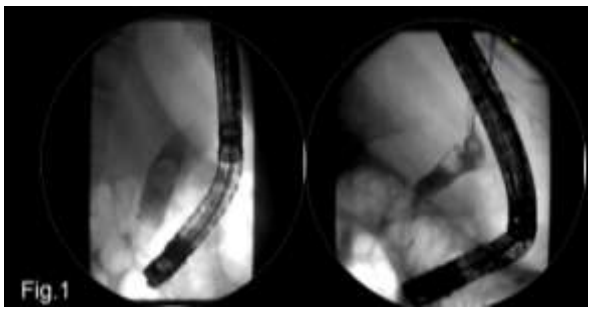

Fig.1. ERCP images demonstrating well defined intraluminal filling defects in the extrahepatic segment of common bile duct.

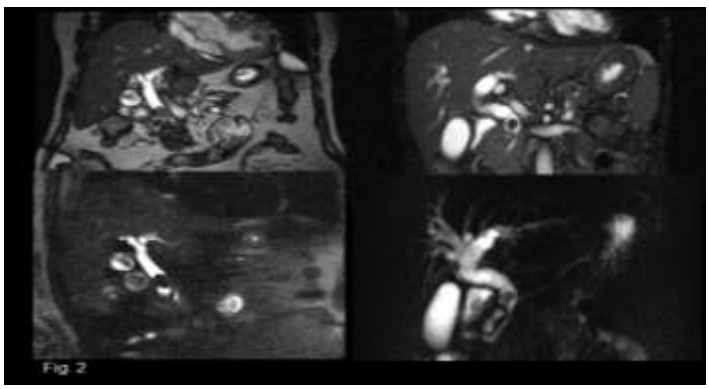

Fig. 2. MRCP (TRUFI Coronal, Coronal thin slab and thick slab)images demonstrating welldefined intraluminal filling defects suggestive of Choledocholithiasis in the extrahepatic segment of common bile duct.

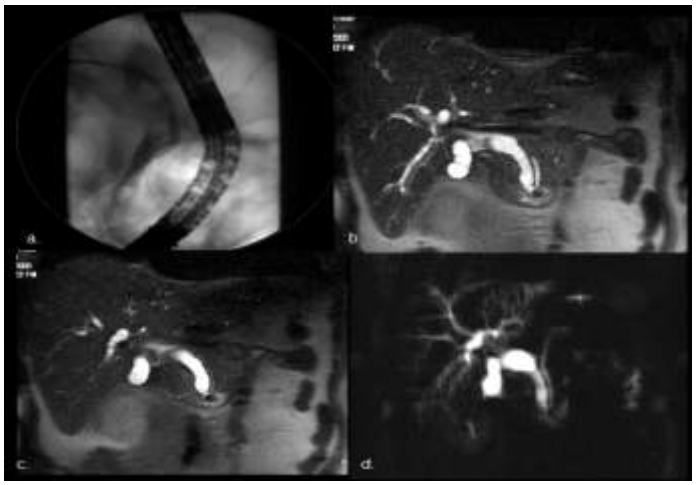

Fig 3. a. ERCP and MRCP (b & c Coronal thin slab, and d, thick slab) images demonstrating evidence of choledocholithiasis.

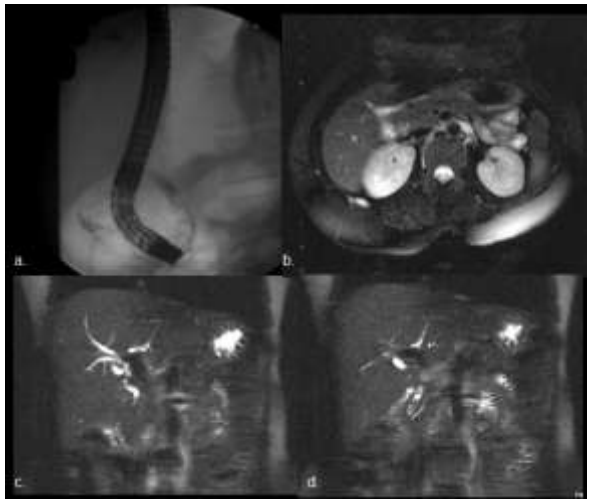

Fig 4. a. ERCP and MRCP, (b, axial T2 weighted, c & d - coronal thin slab) images demonstrating evidence of choledocholithiasis

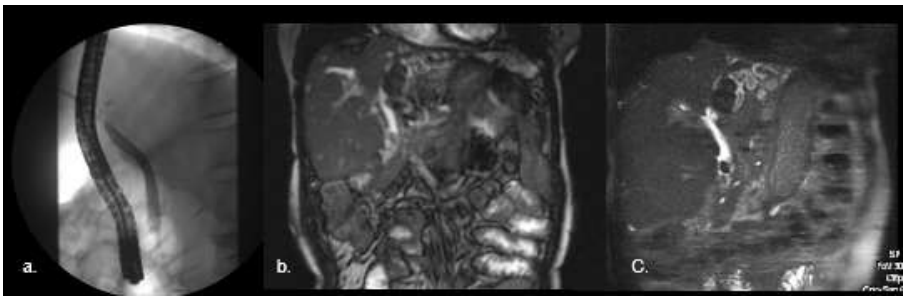

Fig 5. a. ERCP and MRI (b. coronal trufi, c. thick slab) demonstrating evidence of Choledocholithiasis

VI. Discussion

Magnetic Resonance Cholangiopancreatography represents a relatively new development in MR technology that allows for rapid evaluation of the biliary tract, pancreatic duct and gallbladder without contrast material administration, instrumentation or radiation. Special imaging sequences that are heavily-T2-weighted are utilized to depict the biliary tract, pancreatic duct and gallbladder as high signal intensity or bright structures owing to the fluid within them. Studies performed at various institutions have shown that the accuracy of MRCP is comparable to that known as ERCP (endoscopic retrograde cholangiopancreatography), the traditional but invasive means of imaging the pancreaticobiliary system in the evaluation of choledocholithiasis, malignant obstruction, anatomic variants and chronic pancreatitis. In most instances, MRCP can be completed in 10 minutes and is easily performed as an outpatient examination.

Since its introduction in 1991, the role of MRCP in evaluating pancreaticobiliary disease has continued to evolve. MRCP is assuming a larger role as a rapid, accurate and non-invasive alternative to diagnostic ERCP. During the past several years, radiologists and nonradiologists alike have shown a keen interest in MRCP and its clinical applications. Technical refinements such as fast MR sequences that allow for imaging of the entire biliary tract and pancreatic duct in a single breathhold have resulted in marked improvement in the quality and diagnostic yield of MRCPs. As the quality of MRCPs has improved, the clinical applications of this technique have expanded such that MRCP is now replacing diagnostic ERCP in many instances.

Current techniques allow for depiction of obstructed or dilated bile and pancreatic ducts in essentially all patients. Normal caliber extrahepatic bile ducts and central intrahepatic ducts are routinely depicted in as many as 100% of patients. Although the normal caliber pancreatic duct may be more difficult to visualize than the bile duct, the normal pancreatic duct can be visualized in 80-95% of cases. Dilated ducts proximal to an obstruction are well visualized, usually better than with ERCP where there can be difficulty in opacifying ducts proximal to a high-grade obstruction.

MRCP avoids the complications of ERCP such as pancreatitis (3-5%), sepsis, perforation and hemorrhage. The main disadvantage of MRCP is that it is purely diagnostic and does not provide access for therapeutic intervention. MR cholangiography performed before laparoscopic cholecystectomy,can significantly reduce purely diagnostic endoscopic retrograde cholangiography.(3)

Zidi SH et al showed that MRCP diagnostic accuracy for bile duct lithiasis was: sensitivity, 57.1%; specificity, 100%; positive predictive value, 100%; negative predictive value, 50% and stones smaller than 6 mm are still often missed by MRC when standard equipment is used (4).

In our study the sensitivity was shown to be significantly higher and specificity marginally lower. The positive and negative predictive values were more or less comparable thus making this study comparable to international standards.

Hochwalk S N et al studied Magnetic resonance cholangiopancreatography and concluded that it accurately predicts the presence or absence of choledocholithiasis They found that overall, MRCP had a sensitivity of 95%, a specificity of 89%, and an accuracy of 92% (5). In our study MRCP was found to have a sensitivity of 0.895 and specificity of 0.833 which is comparable to the above similar international study.

Griffin N et al studied magnetic resonance cholangiopancreatography versus endoscopic retrograde cholangiopancreatography in the diagnosis of choledocholithiasis. They concluded that MRCP has high sensitivity and high specificity for stones greater than 5 mm in diameter and should be performed in preference to ERCP as the first-line investigation in patients with gallstones and abnormal liver function tests in the elective setting(6). In our study similar findings were concluded.

Leytens J W demonstrated the specificity and sensitivity of magnetic resonance cholangiopancreatography for suspected choledolithiasis and concluded that the sensitivity of MRCP for choledocholithiasis was 100% and the specificity 95%. (7).

In our study MRCP was found to have a sensitivity of 0.854 and specificity of 0.889 which is comparable to similar international studies.

D Hurter demonstrated the sensitivity and specificity of magnetic resonance cholangiopancreatography to be 87 % and 80% respectively for bile duct calculi and concluded that MRCP has high diagnostic accuracy for bile duct calculi. (8) Results of our study were comparable to this study.

VII. Conclusion

In the evaluation of choledocholithiasis comparing MRCP and ERCP it was found that MRCP was found to have a sensitivity of 0.895 and specificity of 0.833 which is comparable to similar international studies. Overall the positive and negative predictive value of MRCP as compared to ERCP was 0.944 and 0.714 respectively. Chi- square value was highly significant for the comparison (23.980). Kappa score was 0.689 which suggested fair to good agreement.

Although ERCP has been the gold standard previously it has certain limitations. The primary pitfalls being complications related to invasiveness, radiation, contrast induced nephropathy and post procedural inflammation of pancreas thus limiting its use in morbid patients. MRCP on the other hand evaluates the biliary system as a noninvasive, non radiation imaging modality with no procedural related complications thus scoring over ERCP.

Overall in our study it was proved that MRCP has comparable sensitivity, specificity, positive and negative predictive values to ERCP and can be used as a safe first line imaging modality of choice in the evaluation of choledocholithiasis and ERCP can be useful for therapeutic intervention in this setting.

MRCP is not useful in evaluation and detection of calculi < 4mm. Compared to ERCP, MRCP has added advantage of no radiation and less post procedural complications / better patient compliance. MRCP can be used as a screening tool in evaluation of patients for elective cholecystectomy prior to surgery for the evaluation of the biliary system.

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