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Original Article

Role of preoperative Magnetic resonance cholangio-pancreatography in avoiding complicated gall stone surgery

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Abstract:

Background: Gallstone disease is a common disease responsible for considerable morbidity in the society. Surgery is the definitive treatment and laparoscopic cholecystectomy has largely replaced conventional surgery. However, laparoscopic cholecystectomy carries a higher risk of injury to biliary tree than conventional surgery. Significant number of these injuries is caused by variations in the biliary tree anatomy. By precisely delineating the biliary tree anatomy, magnetic resonance imaging and magnetic resonance cholangiopancreatography can assist the surgeons in predicting difficult surgery.

Objective: The present study attempts to determine the role of magnetic resonance imaging and magnetic resonance cholangiopancreatography prior to laparoscopic cholecystectomy in gallstone disease.

Method: In the present study, 100 patients with gallstone disease, referred for magnetic resonance imaging and magnetic resonance cholangiopancreatography were evaluated

Result: The most common age group to be involved was 4th and 5th decade. Females were almost twice commonly affected than males. The sensitivity of MRI was 95 -100%, specificity 97 – 100% and accuracy 96 - 98% for detecting gallstones. Similar sensitivity and specificity was found for CBD calculi.3. The sensitivity and specificity for delineation of biliary tree anatomy was 100% each. Type A IHBR pattern was seen in 42 %, Type B in 22%, Type C in 26%, Type D in 6% and Type E in 2%. The cystic duct anatomy was delineated with 100% sensitivity and specificity. Anomalous cystic duct insertion patterns were seen in 11%. The incidence of CBD calculus was 7%. The mean diameter of CBD was 5.73±2.65 mm. The gall bladder volume had no statistically significant correlation with difficult surgery. The patterns of IHBR did not have any impact of difficult surgery. However, the pattern of cystic duct insertion had a statistically significant correlation with difficult surgery with anomalous insertions leading to difficult surgery with a p value of 0.025. It was significant on multivariate analysis too with a p value of 0.034. The CBD diameter also had a statistically significant correlation with difficult surgery with a p value of 0.011 on Univariate analysis and 0.021 on multivariate analysis. There were no bile duct injuries or forced conversion to open surgery. The mean operation time was 54.13±33.73 min.

Conclusion: MRI and MRCP can accurately detect gallstones and delineate biliary tree anatomy. They can also detect anomalous biliary tree and can predict difficult surgery thus helping the surgeon to be prepared for the eventualities during surgery.

Key words: MR Cholangiopancreatography, gall stone surgery, biliary tract

Introduction:

Gallstones constitute a significant health problem in developed societies, affecting 10% to 15% of the adult population. [1] Mostly it is asymptomatic but sometimes presents with serious symptoms. It can be diagnosed by investigations like Ultrasonography, Computerized Tomography (CT), Magnetic Resonance Cholangiopancreatography (MRCP) and Endoscopic Retrograde Cholangiopancreatography (ERCP). The definitive treatment for gallstone disease is surgery. Since the advent of laparoscopic cholecystectomy, preliminary evaluation of the biliary tree has assumed great importance. Pre-operative evaluation of the biliary tree helps to avoid intraoperative difficulties like damage to the biliary tree and "forced conversion" to open surgery. The need for a time consuming and potentially hazardous intraoperative cholangiogramis also eliminated if a confident prior assessment and appropriate pre-operative clearance of the CBD is carried out.

Presently, ERCP is considered to be the gold standard for the diagnosis of the ductal calculus[2], but carries potential risk of complications including pancreatitis, bleeding from sphincterotomy sites and duodenal perforation[3]. MRCP is the ideal imaging modality and when used with proper indications, based on clinical suspicion and predictive scoring, offers a safe and more acceptable alternative to diagnostic ERCP[4]. MRCP carries an additional advantage of diagnosing abnormalities of the biliary tree including duplication, choledochal cyst, pancreas divisum and cholangiocarcinoma.

The present study was carried out in order evaluate the anatomical variations, incidental stones in common bile duct and to assess whether routine MRCP before laparoscopic cholecystectomy can reduce the risk of per-operative biliary tree injury.

Material and Methods:

A prospective study was conducted between January to December 2014 at a tertiary teaching hospital. Out of total 126 sonologically diagnosed gallstone diseases that were posted for laparoscopic cholecystectomy during the study period, 26 patients were excluded from this study due to various factors such as metallic implants, pacemakers and claustrophobia during the MRI procedure.

A predesigned, pretested and pre-validated proforma was used to collect the basic demographic data and data pertaining to MRCP and per operative findings. Philips Acheiva A series1.5 tesla MRI was used and heavily T2 weighted axial, coronal and sagittal sequences were acquired. Navigator triggered heavily T2 weighted fast 3D SENSE sequence were acquired.

After obtaining the written consent, patients were made to fast overnight and were given dilute Gadolinium solution orally (0.5mmol/ml) 15 min before the study. MRCP images were obtained by using a body-phased array coil through the liver and pancreas. The mean time of the MRCP examination with evaluation was 15 minutes. Initially, screening SENSE T2 axial, coronal and sagittal images were acquired which provided basic images for identifying the pathology and helped in further planning of MRCP. MRCP was performed by using thick slab SENSE sequences (half Fourier acquisition single-shot turbo spin echo), with selective fat saturation. They were obtained two to three times each with slight alteration in the angle of acquisition. The parameters used were, TR/TE/FA (624/80/90), matrix 256 × 256, field of view of 280 mm, and acquisition time of 4.5 seconds.

Following this, coronal projections were also obtained with Navigator echo gated 3D SENSE fat-suppressed sequence by using the aforementioned parameters with additional fat suppression. The individual images were examined with maximum intensity projections and multiplanar reconstructions. These permitted better evaluation of exact anatomy of the biliary tree. Only high-T2 tissues such as static fluids (e.g., in the biliary tree) yielded high signal intensities as a long echo train was used. Because of the T2 decrease during data acquisition, the low-T2 tissues generated practically no signal; this along with fat saturation and oral gadolinium virtually suppressed the background signal.

Data interpretation:

Imaging data was evaluated for Anatomy of hepato-biliary system comprising confluence pattern of right and left hepatic ducts, insertion pattern of cystic duct, volume of gall bladder & caliber of the CBD

Per-operative surgical data was obtained for the same parameters and were compared. Determinants of difficult surgery were also assessed during the study.

The overall accuracy of the MRCP findings was tested against per operative findings by calculating the sensitivity, specificity, positive and negative predictive values. Univariate and multivariate analysis was used to predict the difficulty of the surgery.

Results:

In our study, the peak age group incidence of gall stone disease was between 36-55 years independent of gender with mean age of 46.94 ± SD 14.20. The maximum incidence was in 4th and 5th decades with males (35.3%) being affected a decade later than females (25.8%). Sensitivity of MRCP was 95 -100%, specificity 97 – 100% and accuracy 96 – 98%.

There was positive correlation of distended gall bladder below the level of ampulla and difficult surgery but it was not statistically significant. Intra hepatic biliary radicles (IHBR) Anatomy showed type A pattern in 42 %, type B in 22%, type C in 26%, type D in 6% and type E in 2%. The incidence of anomalous patterns, i.e., types D and E were similar in our study. The incidence of CBD calculus was 7%. The sensitivity and specificity for detection of CBD calculus by MRCP was found to be 100%. In our study mean diameter of proximal CBD was 5.73 mm with a SD of ±2.65 mm. It was also confirmed that the dilated CBD (> 7 mm) could predict difficult surgery (p=0.011). In our study we were able to demonstrate cystic duct and biliary tree anatomy in all the patients with 100% sensitivity and specificity. Low insertion of cystic duct was found in 5% and medial insertion into CHD in 19% patients. High insertion into the CHD was found in 3 patients and insertion into RHD was found in 2 patients. Abnormally long cystic duct was found in one patient. In our study, 8 out of 11 patients (72.73%) with anomalous cystic duct anatomy had difficult surgery. Our study also showed that the anomalous cystic duct anatomy predicts the difficult surgery (p = 0.025). This resulted in surgeon being well prepared for consequences thus reducing the bile duct injury or forced conversion to open surgery. The mean operation time was found to be 54.13±33.73 min. Our study had no conversion or mortality. Motion artifacts were the main limitation in the study. They were avoided with respiratory gating and prior counseling.

Discussion:

A higher prevalence of cholelithiasis among females, observed in the present study, has been corroborated by several authors[3-5]. Genetic and environmental factors contribute to gallbladder disease. Female gender, previous pregnancies, and family history of gallstone disease are highly correlated with cholelithiasis. Pregnancy and sex hormones are believed to place women at a higher risk, and the view has been supported by several classical epidemiologic studies[6, 7]. Estrogen increases biliary cholesterol secretion causing cholesterol super saturation of bile rendering it lithogenic. There was positive correlation of distended gall bladder below the level of ampulla and difficult surgery. This difference might have been due to

objective criteria used for defining distended gall bladder as gall bladder distension below the level of ampulla. It is also established that the distended gall bladder as evidenced by palpable gall bladder was associated with difficult surgery[8, 9].

In the present study, the difference in the incidence of normal anatomical variants, i.e., types A, B and C might have been due to different population group and smaller sample group. In a study of anatomic variation of IHBR by Jin Woo Choi et al, the majority of the subjects (63%) showed the type A or typical anatomy of the IHDs (drainage of right posterior septal duct into RHD). 37% showed atypical anatomy (Types B, C, D, E and unclassified and complex anomalies) [10.In] our study the sensitivity and specificity was 100% each. These were probably due to inclusion of 3 dimensional HASTE fat suppressed coronal sequences which were reviewed in all planes with the help of source images before coming to conclusion.

Measuring proximal CBD diameter provide a more accurate estimate of true CBD diameter than measurements taken distally[11]. Dilated CBD was described to have an association with difficult surgery and conversion to open surgery by Liu et. al[12]. In our study mean diameter of proximal CBD was 5.73 mm with a SD of 2.65 mm. Our study confirmed that the dilated CBD (> 7 mm) could predict difficult surgery with a p value of 0.011.

On univariate and multivariate analysis, anomalous cystic duct insertion patterns and a CBD diameter > 7 mm were found statistically significantly associated with difficult surgery. Male sex, age > 65 years, GB volume, CBD calculi and IHBR anatomy were not statistically significantly associated with difficult surgery.

Conclusion:

MRI and MRCP are noninvasive, radiation free imaging modalities with multiplanar capabilities, excellent post processing and delineation of biliary anatomy. They can accurately detect gallstones and delineate biliary tree anatomy. They can detect anomalous biliary tree and can predict difficult surgery thus helping the surgeon to be prepared for the eventualities during surgery and to prevent biliary injury. Overall, there is reduction in patient morbidity.

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Table 1: Comparison of MRI and Per-op findings - Cystic duct insertion

Cystic duct insertion	MRI No.	Per-op	
A. Right lateral insertion	70	70	Sensitivity = 100.0% Specificity = 100.0%
B. Anterior spiral insertion	8	8	
C. Posterior spiral insertion	11	11	
D. Low lateral insertion	3	3	
E. High insertion	3	3	
F. Low medial insertion	2	2	
G. Others (long cystic duct, insertion into RHD)	3	3	

Table 2: Comparison of GB volume and cystic duct insertion in relation to difficult surgery

Variables		Easy surgery (N = 60		Difficult surgery (N = 40)		P value
		Number	%	Number	%	
MRI-GB volume	Contracted	10	16.7	3	7.5	0.084
	Normal volume (distended above ampulla)	41	68.3	26	65	0.728
	Distended below ampulla	9	15	11	27.5	0.126
Cystic duct insertion	Right lateral position	44	73.3	26	65	0.025
	Anterior spiral insertion	6	10	2	5	
	Posterior spiral insertion	7	11.7	4	10	
	Low lateral insertion	0	0	3	7.5	0.025
	High insertion	2	3.3	1	2.5	
	Low medial insertion	0	0	2	5	
	Others (long cystic duct, insertion into RHD)	0	0	2	5	
IHBR pattern	Normal biliary tree (right dorso-caudal branch draining into RHD)	26	43.3	16	40	0.762
	Trifurcation of biliary Duct	11	18.3	11	27.3	
	Right dorso-caudal branch draining into LHD	17	28.3	9	22.3	
	Aberrant RHD emptying into CHD	3	5	3	7.5	
	Aberrant RHD draining into cystic duct	1	1.7	1	2.5	
	Others	2	3.3	0	0	
CBD diameter (mm)	< 7	53	88.3	27	67.5	0.011
	> 7	7	11.7	13	32.5	

Table 3: Univariate and Multivariate analysis to predict the difficult surgery

Variables	**Outcome**		**Univariate**			**Multivariate**		
	Easy surgery (n=60)	Difficult surgery (n=40)	P Value	OR	95%CI	P Value	OR	95%CI
Age >65 year	12(20.0%)	2(5.0%)	0.034	0.21	0.04-0.99	0.044	0.14	0.02-0.95
Male	21(35.0%)	13(32.5%)	0.796	0.89	0.38-2.08	0.843	1.11	0.39-3.08
MRI GB volume – Distended below Ampulla	9(15.0%)	11(27.5%)	0.126	2.15	0.79-5.79	0.271	1.96	0.59-6.45
MRI-CBD stone	2(3.3%)	5(12.5%)	0.122	4.14	0.76-22.5	0.438	0.37	0.03-4.51
Cystic duct insertion pattern (D+E+F+G)	3(5.0%)	8(20.0%)	0.025	4.75	1.17-19.1	0.034	10.5	1.19-93.9
IHBR pattern (D + E + Others)	6(10.0%)	4(10.0%)	1.000	1.00	0.26-3.79	0.991	0.99	0.21-4.78
CBD >7.0 mm	7(11.7%)	13(32.5%)	0.011	3.64	1.30-10.2	0.021	7.41	1.36-40.5

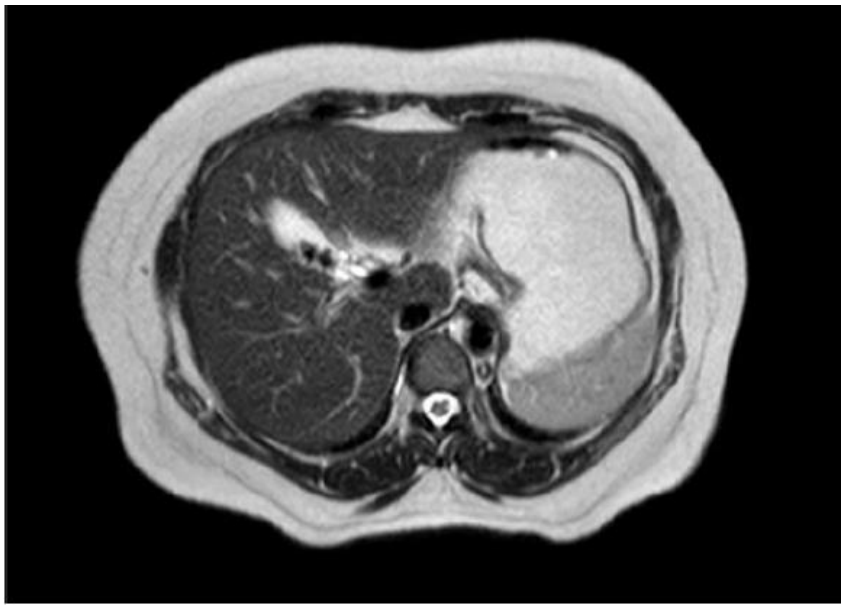

Fig – 1: A 60 year old male with dyspepsia; Axial heavy weighted T2 sequence showing signal voids within the gall bladder suggesting cholelithiasis.

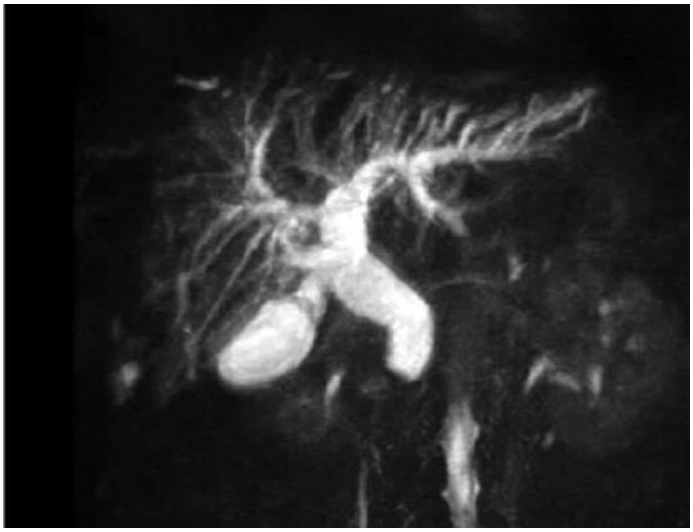

Fig – 2: A 38 year old male with obstructive jaundice oblique coronal 3D MIP sequence showing abrupt cutoff of the CBD at its distal end with dilated proximal CBD, central and peripheral IHBR suggesting Obstructive Choledocholithiasis

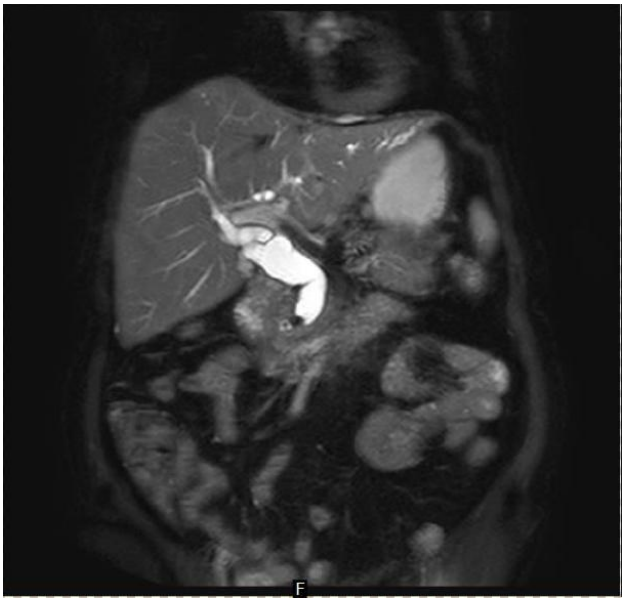

Fig – 3: A 55year old female with obstructive jaundice and vomiting; coronal heavy weighted T2 sequence showing a signal void in the distal end of CBD causing proximal CBD and IHRB dilation.

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