March 2004

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Article *in* Journal of the Pakistan Medical Association · April 2004

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The Role of Magnetic Resonance Cholangiopancreatography (MRCP) in Obstructive Jaundice

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Abstract

Objective: To evaluate the diagnostic value of MRCP in studying the sites and cause of obstructive jaundice in comparison with other imaging modalities at the Department of Radiology, Aga Khan University Hospital, from January 1999 to May 2001.

Methods: Forty nine consecutive patients included 19 men and 30 women, suspected of obstructive jaundice. Patients underwent ultrasound (n=49), CT (n=11), ERCP (n=25) and biliary surgery (n=17). Final diagnosis was established by surgical exploration, endoscopic sphincterectomy, cytology and clinical follow up.

Results: Of the 49 patients 17 had choledocholithiasis. Twenty five patients had malignant strictures, out of which 11 had non-specific malignant strictures, 7 had pancreatic carcinoma, 3 had Klatskin tumors, 3 had periampullary carcinoma and 1 had gallbladder carcinoma. Six patients had benign strictures and 1 patient had choledochal cyst. Overall, MRCP was sensitive (88%) and specific (96.8%) in detecting choledocholithiasis. MRCP sensitivity and specificity in detecting benign main bile duct stricture was equal to 83.3% and 97.6% respectively, and 92% and 100% for malignant stricture.

Conclusion: Our prospective study confirms that MRCP, a noninvasive and well tolerated imaging technique is of value in the diagnosis of obstructive jaundice (JPMA 54:128;2004).

Introduction

Magnetic resonance cholangiopancreatography (MRCP) is a new application of MR imagining that is a simple, accurate and non-invasive method to visualize the biliary system in patients suspected of obstructive jaundice. Currently, the non-invasive diagnosis of bile duct obstruction relies mainly on ultrasound and computerized tomographic findings. However the accuracy of these techniques is limited because of low sensitivity for the diagnosis of stones in the common bile duct (CBD), or detection of strictures, which are the common causes of obstructive jaundice, when compared with that of endoscopic retrograde cholangiopancreatography (ERCP), which is regarded as the procedure of choice for diseases of the biliary system. ERCP is invasive and has significant failure rate, mortality and morbidity.[1]

MRCP is an application of MR imaging that can provide both high quality cross -sectional images of ductal structures and projectional (coronal) images of the biliary tree and pancreatic duct. Unlike ERCP, MRCP is noninvasive and the images are obtained without administration of oral or intravenous contrast agents.

A first approach towards projection cholangiography in biliary tract dilatation by magnetic resonance was published by Wallaner et al. in 1991.[2] It was then followed by Morimoto et al.[3] and Hall-Craggs et al.[4] using the three dimensional (3D) CE-FAST technique. The CE-FAST technique is a fast T2-weighted method of acquiring maximum intensity projection (MIP) post processing to obtain cholangiograms. In a recent publication Takehara et al.[5] showed 3D reconstruction images of the pancreatic ducts acquired with a modified fast spin-echo (FSE) technique requiring an acquisition time of 20-40 seconds.

Since the introduction of rapid acquisition by relaxation enhancement (RARE) technique by Henning et al.[6,7] a large variety of applications have been described using modification of RARE such as turbo spin-echo (TSE or FSE) imaging. The clinical applications of MRCP include:[8]

- Obstructive jaundice
- Incomplete or failed ERCP
- Post-surgical alteration of the biliary tract
- Intrahepatic bile duct pathology, e.g., sclerosing cholangitis and AIDS cholangiopathy
- Chronic Pancreatitis
- Congenital anomalies of the biliary tract and pancreatic duct
- Gallbladder pathology

Patients and Methods

This study included patients suspected of obstructive jaundice, who were referred to Radiology Department, Aga Khan University Hospital, Karachi for MRCP between January 1999 to May. 2001. Fifty five consecutive patients suspected of obstructive jaundice on the basis of clinical

signs, laboratory workup and ultrasound scan were prospectively included during a 29 month period. The radiologist was not blinded to the results of other imaging modalities while interpreting MRCP.

Criteria for main bile duct dilatation were: a diameter greater or equal to 7mm, or greater or equal to 9mm in patients older than 75 years or with past history of cholecystectomy. Criteria for choledocholithiasis greater than 3mm diameter were: visualization of stones on ultrasound and/or CT or ERCP or on intraoperative cholangiography with extraction. Criteria for small stones (choledocholithiasis less than or equal to 3mm) included: multiple small gall bladder stones on ultrasound and evacuation of fine stones seen on ERCP after sphincterectomy or during intraoperative choledochoscopy. Criteria for benign strictures were: Ultrasound, CT, ERCP, and/or intraoperative evidence of benign obstruction and concordant clinical evaluation during 6 months of follow up.

Criteria for malignant strictures were: imaging findings on Ultrasound or CT (presence of mass, abrupt narrowing and proximal dilatation of biliary system), and/or ERCP (irregular stricture with mucosal irregularity and destruction and dilatation of proximal biliary system) and/or intraoperative evidence of malignant obstruction, concordant past medical history and/or clinical evolution during six months of follow-up and cytology and histological confirmation when available.

MRCP Technique

MRCP were acquired in 1.5 tesla MR scanner using commercially available software. A 2D multi-slice T2 weighted breath hold sequence with a quadrature (QD) spine coil in the axial plane was used to facilitate anatomical pinpointing. The patient was in prone position. Imaging parameters for axial FE in phase were: average echo time 5 millisecond, repetition time 137 millisecond, field of view 9x27.5mm, a 128x256 matrix, 5 0.5-mm thick slabs and approximately 2 minute duration with breath hold of 20 seconds. MR cholangiograms were acquired by a 2D FASE breath hold sequence using a QD spine coil. Imaging parameters for coronal axial T2-FASE were: average echo time of 250 millisecond, repetition time of 4000 millisecond, field of view of 30mm, a 384x384 matrix, 50mm thick slabs with fat-suppression for coronal sequences. Coronal slabs in the hilar plane were post processed using a maximum intensity pixel projection (MIP) algorithm (Table 2). Projectional images of biliary tree were obtained at different angles so as to eliminate overlapping.

Statistical Analysis

All the variants were analyzed as categorical variants and Chi square test was used as a test of significance.

Results

Six of the initial 55 patients were excluded because of uncertainty of final diagnosis .The remaining 49 patients included 19 men and 30 women, with a mean age of 56 years (range: 1-110 years). Patients underwent ultrasound (n=49), CT (n=11), ERCP (n=25) and biliary surgery (n=17). MRCP was performed before ERCP in 21 patients with a median lapse of 48 hours and range of 0-15 days. MRCP was performed after ERCP in 3 patients, at day 7 in one (choledocholithiasis), at day 3 in one (benign stricture) and at day 2 in one (benign stricture). Final diagnosis was established by surgical exploration, endoscopic sphincterectomy, cytology and clinical follow up.

Of the 49 patients, 14 (28%) had a past history of cholecystectomy. Of the 17 cases of choledocholithiasis, eight (47%) had a past history of cholecystectomy.

Of the 49 patients 17 had choledocholithiasis. Malignant strictures were detected in 25, of which 11 had non-specific malignant strictures, 7 pancreatic carcinoma, 3 Klatskin tumors, 3 periampullary carcinoma and 1gallbladder carcinoma. There were 6 benign strictures and one choledochal cyst.

Of the 49 MRCP studies, all visualized intrahepatic and extrahepatic ductal system. Forty seven studies were of excellent quality and 2 of average quality, because of patient agitation (independent of the MRCP exam). Coronal sequences were the most optimal for detection of choledocholithiasis, including small stones. In this sequence, only intraluminal aspect of strictures could be detected. Axial sequences allowed for a better detection of intrahepatic bile duct dilatation, extraluminal aspects of biliary strictures, as well as tumors of the pancreas.

MRCP correctly diagnosed 15 of the 17 cases of choledocholithiasis. The two cases misdiagnosed by MRCP was stones less than or equal to 3mm diagnosed by ERCP. Of the 32 cases without choledocholithiasis, MRCP made the false diagnosis of choledocholithiasis in only one case for which final diagnosis was common bile duct adenocarcinoma confirmed at surgery. Overall, MRCP was sensitive (88%) and specific (96.8%) in detecting choledocholithiasis. p value is <0.000 and Chi square test is 31.0

Of the 6 cases of benign strictures, MRCP correctly diagnosed 5. The case misdiagnosed by MRCP was stricture of sphincter of Oddi seen on ERCP.One case of hilar carcinoma was misinterpreted as benign stricture of common hepatic duct. No case of choledocholithiasis was misinterpreted as benign stricture.

Final diagnoses of malignant strictures were made by cytology and histopathological confirmation in 15

patients (4 non-specific malignant strictures, 7 pancreatic carcinoma, 3 periampullary carcinoma and 1 gallbladder carcinoma), and on imaging features on ultrasound, CT and ERCP and on follow up in 10 patients (7 non-specific malignant strictures, 3 Klatskin tumor).

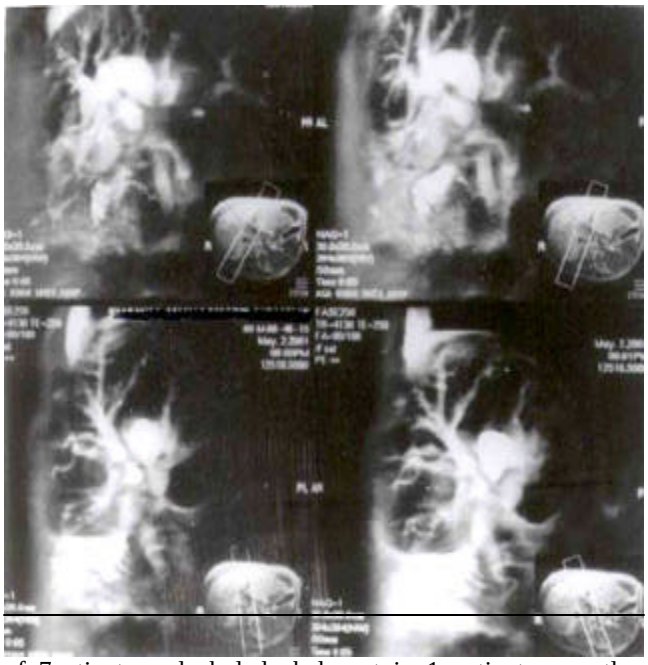
Of the 11 cases of non-specific malignant strictures, MRCP correctly diagnosed nine. The two cases misdiagnosed by MRCP included: one of hilar carcinoma confirmed by surgery and misinterpreted by MRCP as a benign stricture of common hepatic duct, and one case of common bile duct adenocarcinoma confirmed at surgery, interpreted by MRCP as calculus. Seven cases of pancreatic carcinoma, 3 cases of Klatskin tumor and periampullary carcinoma each and 1 case of gall bladder, all were correctly diagnosed by MRCP. Overall MRCP sensitivity and specificity in detecting benign main bile duct stricture was equal to 83.3% and 97.6% respectively, and 92% and 100% for malignant strictures.

Table 1. Diagnostic accuracy in etiology of obstruction.

Diagnosis	MRCP	ERCP	U/S
Common duct stone	15/17	13/13	10/17
Strictures			
Benign strictures	5/6	3/3	0/6
Non-specific malignant	9/11	6/6	0/11
Pancreatic carcinoma	7/7	0/0	6/7
Periampullary carcinoma	3/3	1/1	0/3
Klatskin tumor	3/3	2/2	3/3
Gall bladder carcinoma	1/1	0/0	0/1
Choledochal cyst	1/1	0/0	1/1
Total	44/49	25/25	20/49

Diagnostic accuracy in etiology of obstruction by each method is indicated in Table 1. MR cholangiography was able to distinguish malignancies from impacted common duct stones in all patients except in one patient in which MRCP misdiagnosed common bile duct adenocarcinoma, diagnosed at surgery and misinterpreted as common bile duct calculus.

On the other hand, ERCP not only correctly diagnoses all impacted common duct stones, but in 6 patients stones were removed during the procedure and in 3 patients biliary stent was placed at the time of ERCP. In 4 patients, ERCP failed due to inability to cannulate the common bile duct. Ultrasound detected common bile duct stones in 10 of 17 patients. Ultrasound detected klatskin tumor in 3 out of 3 patients, pancreatic carcinoma in 6 out

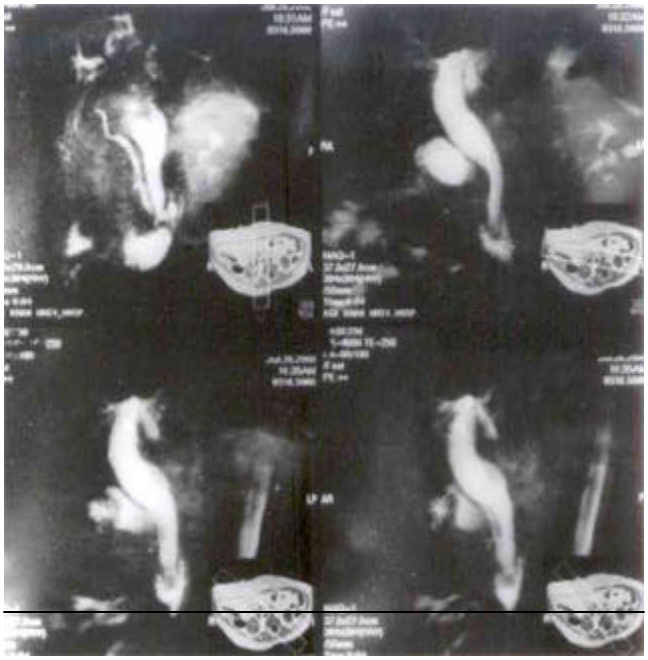


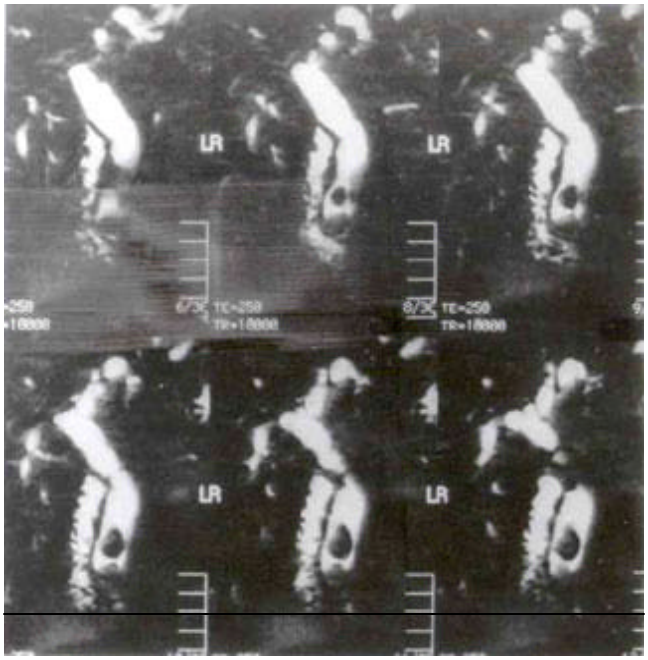
of 7patients and choledochal cyst in 1 patient correctly. Ultrasound was unable to detect benign and nonspecific malignant strictures in 17 patients however, in these patients ultrasound detected intrahepatic dilatation in 10 out of 17patients. Carcinoma of pancreas in 1 patient and periampullary carcinomas in 3 patients were not detected by ultrasound.

Table 2. Diagnostic accuracy in site of obstruction.

Diagnosis	MRCP	ERCP
Common duct stones	15/17	13/13
Strictures		
Benign	5/6	3/3
Non-specific malignant strictures	11/11	6/6
Pancreatic carcinoma	7/7	0/0
Periampullary carcinoma	3/3	1/1
Klatskin tumor	3/3	2/2
Gallbladder carcinoma	1/1	0/0
Total	46/49	25/25

Diagnostic accuracy in site of obstruction by each method is indicated in Table 2. MR imaging of the bile duct in the coronal plane demonstrated the specific site of obstruction and dilated intra and extrahepatic bile ducts, just proximal to the obstruction in 46 out of 49 patients. Three cases in which MRCP was unable to correctly diagnose the site of obstruction included; 2 cases of calculus less than





3mm which were missed at MRCP and diagnosed at ERCP and one case of stricture at sphincter at Oddi which was diagnosed at ERCP and misinterpreted as benign stricture of main bile duct on MRCP. ERCP also yielded high quality cholangiograms and correlated with those obtained by MR imaging.

Discussion

Initial workup of suspected obstructive jaundice begins with ultrasound and CT. For choledocholithiasis, ultrasound sensitivity varies from 20-80%.[9,10] with a high specificity of approximately 98%.[10] Performance of CT is similar, with a sensitivity of 23% to 85% and specificity of 97%.[11] Assessment of main bile duct diameter by ultrasound remains uncertain because normal diameter values range from 6-10mm according to patient's age and investigator criteria, and the intrapancreatic segment is correctly detected in only 40-50% of cases. In CT, the diameter is considered normal when less than 10mm. The hilar segment is correctly detected in only 40% of cases and intrapancreatic segment in only 60-75% of cases. Ultrasound and CT are limited in the diagnosis of biliary strictures. Three-dimensional CT cholangiography yields better results, but with risks of complications due to intravenous injection of iodipimide meglumine.[12-15]

Insufficiency of ultrasound and CT often leads to repeated exams, ERCP or endoscopic ultrasonography (EUS). ERCP is the reference standard in diagnosis of biliary tract disease, allowing for definite or temporary treatment in many cases. Besides the radiological features of cholangiograms, direct or indirect per endoscopic signs of distal choledocholithiasis or main bile duct tumors can be observed during ERCP. ERCP presents two draw backs: selective main bile duct cannulation (80-90%)[16] operator dependence, and lowered rates in certain conditions as distal strictures, sphincter of Oddi stricture, tumor of papilla and duodenal diverticula. Risks of diagnostic ERCP include pancreatitis (0.7-7.4%) as well as cardiovascular, pulmonary and renal complications estimated at 4.2%.[17] For these reasons, preferential indications for ERCP remain therapeutic. EUS performed in the workup of suspected biliary obstruction for extrahepatic diseases[18] is able to confirm diagnosis of choledocholithiasis with sensitivity and specificity rate equal to those of ERCP[19] and is superior to ERCP for small stones less than or equal to 3mm[20] EUS is of value in the diagnosis and staging of distal main bile duct tumors, cephalic tumors of pancreas and chronic pancreatitis.[21,22] Drawbacks of EU include: Need for neurolep-analgesia or general anesthesia, operator dependence, limited hilar exploration, poor differentiation between small benign and malignant tumors of the ampulla, limited exploration in cases of duodenal strictures and past history of gastric or bilioenteric bypass surgery and perendoscopic therapy.[21]

Since initial reports 24 MRCP techniques have greatly evolved, providing high resolution images of biliary tree in short duration, while remaining noninvasive without contrast medium.[24] Technical considerations concerning the merits and drawbacks of breath-hold techniques, three dimensional imaging, fast spin-echo (FSE), and half-Fourier acquisition single-shot turbo spin-echo (HASTE) sequences still remain debated and require further study.[8]

Our protocol included complementary axial sequences with a QD spine coil, allowing for analysis for peribiliary and extrabiliary aspects, particularly helpful in the diagnosis of strictures. To date, clinical trials concerning the diagnostic accuracy show promising results, but are limited in number, comprise varying technique, and for most part include a small number of pathological cases; therefore, results remain preliminary. Reports show that MRCP can diagnose bile duct obstruction in 91-100% of cases and level of obstruction in 85-100% cases.[2,25] In the diagnosis of choledocholithiasis, sensitivity varies from 81-100% and specificity varies from 85 to 98%.[25-27] Diagnosis of stricture appears less sensitive but remains specific.[27,28]

Our results for detection of choledocholithiasis confirm high sensitivity and specificity, especially for stones >3mm in diameter (100% and 100% respectively). Poor detection of small stones have also been reported by Guibaud et al.[25] who considered that MRCP was not sensitive for stones < 4mm: in their series of 32 confirmed cases of choledocholithiasis, 6 false negative were observed on MRCP for which stone diameter ranged from 2mm to 7mm with a mean of 5mm. Chan et al.[26] reported depiction of stones as small as 3mm. In our series, 6 of the 17 stones were considered less than or equal to 3mm, 2 false-negative on MRCP being small stones, confirmed on ERCP. Reasons for poor detection of smaller stones by MRCP include technically limited resolution (3mm) and motion artifact. Motion artifact was prevalent in the distal portion of main bile duct (where smaller stones often migrate), thereby decreasing resolution. Our diagnosis of choledocholithiasis was made on native sequences as strongly suggested by several investigators[26,27,29] thereby increasing specificity.

MRCP sensitivity in detecting benign stricture was 83.3% and specificity was 97.6% showing that MRCP can differentiate benign strictures from malignant strictures and choledocholithiasis. The only case misdiagnosed by MRCP was stricture of sphincter of Oddi confirmed on ERCP. The two cases misdiagnosed by MRCP were hilar carcinoma confirmed by surgery and interpreted by MRCP as a benign stricture of common hepatic duct. and one case of common bile duct adenocarcinoma confirmed at surgery, interpreted by MRCP as calculus.

In conclusion, MRCP appears to be sensitive and specific for choledocholithiasis and biliary strictures which are the most common causes of obstructive jaundice. MRCP is easily performed in a short duration and is a noninvasive diagnostic modality. In view of our results, we would recommend that MRCP be indicated in patients suspected of obstructive jaundice, especially in patients at risk for sedation or invasive ERCP techniques and in situations where main bile duct cannulation by ERCP is expected to be difficult.

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