Role of MRCP in Hepatobiliary Diseases

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ABSTRACT

BACKGROUND

Sonography has limitations especially in the evaluation of the distal CBD which may be obscured by bowel gas and demonstration of biliary strictures. CT has a low sensitivity for detecting biliary stones which have high cholesterol content and they may be missed as their attenuation is same as bile. Biliary strictures are not directly visualized on CT. The length and extent of the stricture is difficult to determine on CT. ERCP has a morbidity rate of 7%, (post procedures pancreatitis, sepsis, bleeding and gastro-duodenal perforation). A mortality rate of 1% is reported and unsuccessful cannulations in 3-9%. In view of the limitations of ultrasound/CT scan, the invasiveness and complications of ERCP, MRCP was developed and is now assuming the position of the modality of choice in evaluation of the biliary tree after initial USG.

METHODS

During the period August 2010 - September 2012, a prospective study of 75 patients was carried out. MRI examinations were performed using 1.5 Tesla MR scanner (GE HDXT-8 channels) using torso-array surface coil.

RESULTS

Out of 75 examinations performed, malignant bile duct stricture was the most common pathology. Out of 21 patients, choledochal cyst was the most common, present in 13 patients. Iatrogenic bile duct injury is the most common cause of benign stricture in this study accounting for 9 out of 19 patients. Cholangiocarcinoma is the most common cause of malignant stricture.

CONCLUSIONS

Choledochal cyst is most common in the age group of 0-10 years. Choledochal cyst is more common in female than male. Type 1 Choledochal cyst is the most common type followed by type 4A. MRCP is of advantage when distal CBD calculi are obscured by gas on USG. Iatrogenic injury is the most common cause of the benign bile duct stricture. Hilar cholangiocarcinoma is the most common type of the cholangiocarcinoma. MRCP is less time consuming than ERCP. MRCP can visualise the status of the biliary apparatus proximal to the complete stricture, which is not feasible on ERCP. MRCP is useful when ERCP fails or it is incomplete.

KEYWORDS

MRCP, Cholangiocarcinoma, Bile Duct Stone, Choledochal Cysts

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BACKGROUND

Sonographic evaluation of the biliary tract is one of the most appropriate and efficacious use of the ultrasound examination. Sonography has limitations especially in the evaluation of the distal CBD which may be obscured by bowel gas and demonstration of biliary strictures.[1] CT has a low sensitivity of for detecting biliary stones which have high cholesterol content may be missed as their attenuation is same as bile. Biliary strictures are not directly visualized on CT. The length and extent of the stricture is difficult to determine on CT. Endoscopic Retrograde Cholangio Pancreatography is an imaging modality which provides high resolution images of the pancreatic duct and biliary tree.[2] A great advantage of ERCP is the ability to perform interventional procedures. The main drawback of ERCP is that it is invasive. ERCP has a morbidity rate of 7%, (post procedures pancreatitis, sepsis, bleeding and gastro-duodenal perforation). A mortality rate of 1% is reported and unsuccessful cannulations in 3-9%.

In view of the limitations of sonography/CT scan, the invasiveness and complications of ERCP, there is need for an imaging modality which is non-invasive and provides high resolution projection images of the biliary tree and pancreatic duct. For these reasons MRCP was developed and is now assuming the position of the modality of choice in evaluation of the biliary tree after initial USG.

Objectives

- To evaluate MRCP appearances of various hepatobiliary lesions.
- To identify the aetiology of benign and malignant strictures.
- To classify the iatrogenic bile duct stricture and hilar cholangiocarcinoma according to Bismuth classification.
- To classify choledochal cyst according to Todani classification.

METHODS

During the period from August 2010 to September 2012 a prospective study of 75 patients was carried out.

Examination Technique

Preparation

Items such as jewellery, watches, credit cards, hearing aids, pins, hairpins, metal zippers and similar metallic items and removable dental work were removed prior to the scan.

MRI Procedures

MRI examinations were performed by using closed type 1.5 Tesla MR scanner (GE HDXT-8 channels, superconducting magnet) using torso-Array surface coil, with the study subjects in the supine position.

The following sequences were taken in GE HDXT- 8 channel machine-

A localizer sequence was taken first. (3 axial, 3 sagittal and 3 coronal)

1) Axial T2 RTr
2) Axial 2D Fiesta.
3) Coronal 2D Fiesta.
4) 3 D MRCP RTr ASSET.

Performa

The following information was recorded for each patient in this study.

- Name
- Age
- Sex
- Registration no. (IPD/OPD)
- Complaints
- Relevant past history
  - I. History of similar complaints.
  - II. History of any previous surgery.
  - III. History of known disorder/malignancy.
- MRCP Evaluation
  - I. Evaluation of IHBR, RHD, LHD, CHD and CBD for size, presence of calculus, mass, stricture within it.
  - II. Location of calculus, mass, stricture within RHD, LHD, CHD and CBD.
  - III. Status of Gall Bladder.
  - IV. Status of MPD.
  - V. Presence of other significant findings.
  - VI. MRCP diagnosis.
- Evaluation of ERCP/CT/USG/ postoperative / Histopathological finding.

RESULTS

Hepatobiliary Diseases	No. of Patients	%
Choledochal cyst	21	28.00%
Choledocholithiasis	13	17.33%
Benign bile duct stricture	19	25.33%
Malignant bile duct stricture	25	33.33%
Cystic duct leak	1	1.33%
Liver abscess rupturing in to common bile duct	1	1.33%
Total	80	

Table 1. Spectrum of Hepatobiliary Diseases

Types of Choledochal Cyst	No. of Patients	%
Type I	13	61.90%
Type II	0	0.00%
Type III	1	4.76%
Type Iva	5	23.80%
Type IVb	0	0.00%
Type V	2	9.52%
Total	21	

Table 2. Types of Choledochal Cyst

Aetiology	No. of Patients	%
Iatrogenic bile duct injury	9	47.36%
Chronic pancreatitis	3	15.78%
Mirizzi's syndrome	1	5.26%
AIDS cholangiopathy	1	5.26%
Primary sclerosing cholangitis	1	5.26%
Compression by hydatid cyst	1	5.26%
Secondary to Choledochal cyst	1	5.26%
Indeterminate cause	2	10.52%
Total	19	

Table 3. Aetiology in Patients with Benign Stricture

Bismuth Classification of Iatrogenic Bile Duct Stricture	No. of Patients	%
Type I	2	22.22%
Type II	1	11.11%
Type III	2	22.22%
Type IV	3	33.33%
Type V	1	11.11%
Total	9	

Table 4. Bismuth Classification[3] of Iatrogenic Bile Duct Stricture

Aetiology	No. of Patients	%
Cholangiocarcinoma	17	68.00%
Gall bladder mass infiltrating bile duct	2	8.00%
Pancreatic mass infiltrating CBD	2	8.00%
Liver mass infiltrating CHD	1	4.00%
Periampullary mass	3	12.00%
Total	25	

Table 5. Aetiology in Patients with Malignant Stricture

Image 1. Patient 11: Type 1 Choledochal Cyst

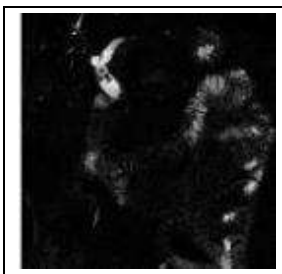

Image 2. Patient 11: Multiple CBD Calculi

Image 3. Patient 27: Iatrogenic Bismuth Type 4 Stricture Following Cholecystectomy

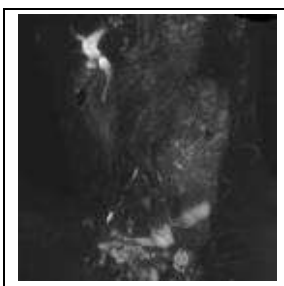

Image 4. Patient 21: Iatrogenic Bismuth Type 1 Stricture Following Cholecystectomy

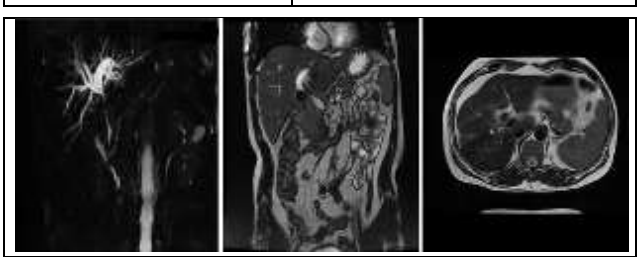

Image 5. Patient 54: Mirizzi's Syndrome MRCP Image Shows Stricture in CHD and Proximal CBD. Coronal Fiesta and Axial T2W Image Shows Stone Within Cystic Duct

Image 6. Patient 58: Benign Distal CBD Stricture Due to Chronic Pancreatitis

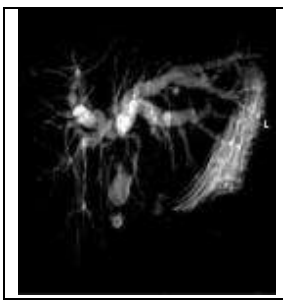

Image 7. Patient 35: Hilar Cholangiocarcinoma Bismuth Type 2

Image 8. Patient 59: Distal CBD Cholangiocarcinoma

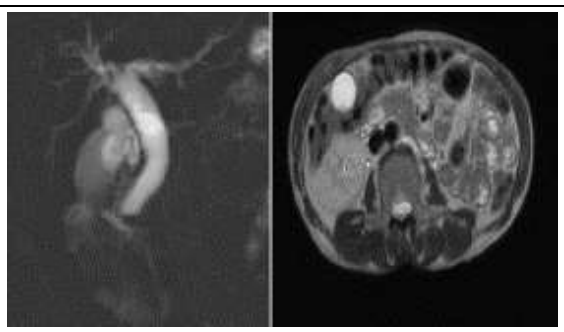

Image 9. Patient 39: Distal CBD Cholangiocarcinoma. Axial T2W Image Shows Polypoidal Filling Defect in Distal CBD Which is Not Seen on MRCP Image

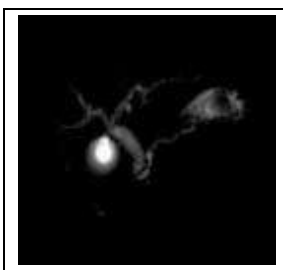

Image 10. Patient 48: Periampullary Carcinoma with Presence of "Double Duct sign"

Image 11. Patient 50: Periampullary Carcinoma with Presence of "Double Duct sign"

The present study included 75 MRCP patients having lesions affecting hepatobiliary system. 4 patients had

choledocholithiasis secondary to choledochal cyst. 1 had benign stricture associated with choledochal cyst.

DISCUSSION

Distribution of Hepatobiliary Apparatus Lesions

Malignant stricture of the bile duct was the most common pathology in this study comprising 25 patients followed by Choledochal cyst comprising 21 patients. Adamek H et al[4] studied 60 patients of the biliary pathology. Out of the total 60 patients malignant stricture of the bile duct was the most common pathology comprising 27 patients followed by benign stricture of the bile duct comprising 15 cases.

Choledochal Cyst

This study included total 21 patients of Choledochal cyst, 13 patients with Todani[5] type 1 Choledochal cyst, 5 patients with type 4A Choledochal cyst, 1 patient with type 3 and 2 patients with type 5 Choledochal cyst (Caroli's disease). In Irie H et al[6] study 11 of total 16 cases of Choledochal cyst were of type 1 and remaining 5 were of type 4 Choledochal cysts. So type 1 Choledochal cyst is the most common type. Out of 21 patients 15 were female and 6 were male. In Irie H et al[6] study out of 16 patients 13 were female and 3 were male, so Choledochal cyst is more common in female. 15 of the 21 patients were less than 10 years of age and 6 were more than 10 years of age. Thus, Choledochal cyst is most common in the first decade of life. Associated complications were present in 6 patients, which include common bile duct calculi in 4 patients, gall bladder calculi in 1 patient and common bile duct stricture in 1 patient. In Irie H et al[6] study common bile duct calculi were present in 8 patients out of total 16 patients.

Choledocholithiasis

There were total 13 patients of choledocholithiasis in this study. 8 of 13 patients were male and 5 were female. Out of the 13 patients choledocholithiasis was secondary to Choledochal cyst in 4 patients. Associated Cholelithiasis was present in 4 patients. History of Cholecystectomy was present in 2 patients. One patient had associated carcinoma of gall bladder. 2 patients had findings of cholecystitis on T2W images. 4 patients had single calculus within bile duct, rest all patients had multiple calculi. Size of the calculi ranges from the 4 mm to 19 mm in this study. Smallest sized calculus detected in this study was 4 mm in distal CBD which was not visualised on USG. In the study done by Regan et al[7] of the 23 patients of choledocholithiasis, 15 had common bile duct stones. Stones ranged from 3 mm to 35 mm (mean, 11mm). Most were situated at the distal common duct. In two patients a stone was impacted at the ampulla. MR Cholangiography revealed stones ranging from 4 to 30 mm. In 12 patients the common bile duct was dilated, as shown on MR Cholangiography. 2 patients with distal CBD calculi on MRCP had no calculi visible on USG examination due to obscuration of distal CBD by gas. Thus, MRCP is better for visualisation of the calculi located in the distal CBD. Small calculi were best displayed on axial T2W images because they were perpendicular to the axis of the bile duct. Small calculi were obscured on MIP images because of volume averaging with surrounding hyper intense bile in two patients in this study.[8] Patient no. 45 in this study had distal CBD stricture and had undergone ERCP. Patient had multiple hypo intensities in the CBD and CHD on MRCP examination which can be confused with CBD calculi; however the diagnosis of the pneumobilia was made on the basis of the nondependent position of the hypo intensities. Intraluminal blood clot may be differentiated from choledocholithiasis by other MR sequences. Flow artefact due to pulsatile vessels may also mimic choledocholithiasis. Pamos S et al[9] mentioned in his study that the presence of pneumobilia, bile haematobilia or intraductal protein plugs involve a potential diagnosis problem, since they have a short T2 results in a signal void within the bile ducts. However, axial MR sections often allow the differentiation of air bubbles, which float in the bile and lay nondependent and thus allow allows differentiation from calculi which are seen as dependent hypo intensities.

Benign Stricture

This study includes total 19 patients of benign stricture. Iatrogenic injury[10] was the most common cause of the bile duct stricture in patients of benign biliary stricture consisting of 9 patients followed by distal CBD stricture associated with the chronic pancreatitis in 3 patients. Smooth, symmetrical and long segment tapered narrowing is the pattern seen most commonly in the patients of the benign stricture.[11] Common hepatic duct was the most common site of involvement present in 9 patients followed by distal common bile duct involvement present in 8 cases. Confluence of the right and left hepatic duct was involved in 3 cases. 2 cases of cholangiocarcinoma were false positively diagnosed as having benign stricture on MRCP. One of these two patients had short segment stricture without shouldering and irregularity in CHD; however on biopsy report it turned out to be cholangiocarcinoma. In another patient who had long segment tapered narrowing in distal CBD diagnosis of benign stricture was made on MRCP. However, on biopsy it turned out to be cholangiocarcinoma. Thus, false positive diagnosis of benign stricture was made on MRCP in these two patients. Park M, et al[12] studied 50 patients (27 with cholangiocarcinoma and 23 with benign cause of stricture). Final diagnosis in his study was based on surgical or biopsy findings. Sensitivity, specificity, and accuracy of the MRCP for differentiation of malignant from benign causes of biliary stricture were 81% (22 of 27), 70% (16 of 23), and 76% (38 of 50), respectively, for MRCP. In his study an irregular and asymmetric stricture margin was more common in cholangiocarcinoma, and a smooth and symmetric stricture margin was more common in benign. Irregular margins and asymmetric narrowing; however, were not specific to malignant strictures but were seen also in benign strictures in his study (in 26% and 35% of cases, respectively). In addition, in his study gradual tapering was seen in strictures due to cholangiocarcinoma,

as well as in benign strictures and abrupt narrowing was seen in benign strictures, as well as in strictures due to cholangiocarcinoma.

Malignant Stricture

There were total 25 patients of malignant stricture in this study. Of the total 25 patients of malignant stricture, most common cause of malignant stricture was cholangiocarcinoma which accounted for total 17 patients. 3 patients of the malignant stricture were due to peri ampullary mass, 2 were due to pancreatic mass infiltrating common bile duct, 2 were due gall bladder mass infiltrating common bile duct and one was due to liver mass infiltrating common hepatic duct. Among 17 cases of the cholangiocarcinoma hilar cholangiocarcinoma was the most common type (8 patients).[13] Only one patient had cholangiocarcinoma involving upper and mid common bile duct. 6 patients had cholangiocarcinoma involving distal part of common bile duct. Abrupt narrowing was the most common pattern seen 23 patients of malignant bile duct stricture on MRCP. Other patterns seen were irregularity and asymmetric narrowing of the bile duct seen in 5 patients. Intraluminal mass was visualised in 2 patients. Kim MJ et al[14] noted 'double-duct sign' in 13 patients among total 21 patients of pancreatic head mass. All the 3 patient of Periampullary carcinoma had 'double duct' sign. All three patients had abrupt cut off the distal CBD. Dilatation of side branches of MPD was not seen in any of the 3 patients. Kim MJ et al[14] noted 'double-duct sign' in 15 patients among total 29 patients of Periampullary carcinoma while only the bile duct was dilated in the remaining 14 patients, with dilatation of the pancreatic side branches was rarely seen.

There were total 3 patients of the distal CBD cholangiocarcinoma. Intraluminal mass was demonstrated in 1 of 3 cases of distal CBD cholangiocarcinoma. Whereas remaining 2 were of the periductal infiltrating type of cholangiocarcinoma. CBD was dilated in all three patients. MPD was normal in all three patients. Kim MJ et al[14] noted in his study of the 27 patients with distal bile duct cancer, 24 (89%) had ductal wall thickening with luminal obliteration (obstructive type). In three cases (11%) an intraductal polypoidal mass was present without complete obliteration of the lumen. CBD dilatation was found in 26 patients (96%). The pancreatic duct was dilated in three patients, in whom tumour extension to the pancreatic parenchyma or the ampulla was proved pathologically.

Advantages of the MRCP over ERCP in This Study

Two patients of hepatico-jejunostomy with operative site stricture were in this study. MRCP examination in these patients shows stricture at the site of anastomoses. In these two patients ERCP was not possible due to unfavourable anatomy. Extraductal pathologies like renal cysts (4 patients), hydronephrosis (2 patients) and liver cysts (1 patient) were visualised on MRCP images. T2W and T1W images also identified additional liver pathologies like haemangioma (1 patient), metastases in patient of cholangiocarcinoma (1 patient), hydatid cyst (1 patient), liver atrophy (2 patients) and liver abscess (2 patients). In addition other extraductal pathologies like ascites (4 patients), pleural effusion (3 patients), hepatomegaly (3 patients), splenomegaly (5 patients), pancreatic mass (2 patients), pseudo cyst of pancreas (2 patients), distended stomach and duodenum (2 patients). All these extraductal pathologies were not possible to be seen in ERCP. In 2 patients of hilar cholangiocarcinoma MRCP shows ductal dilatation proximal to stricture which was not possible on ERCP in these two patients due to tight stricture. MRCP examined bile duct in physiological state without the problem of the overestimation of the size of the bile ducts. MRCP does not involve ionising radiation, contrast media, and is totally non-invasive. One of the patients in this study who had undergone ERCP had post ERCP pancreatitis. MRCP as it is totally non-invasive, it is not associated with this complication.

Advantages of MRCP over USG in This Study

2 patients in this study had calculi in distal common bile duct which was not visualised on USG due to obscuration by gas. One patient of type 1 Choledochal cyst had also undergone USG. USG examination failed to identify communication of the cyst with bile duct due to the large size of the cyst. However, the communication was readily visualised on MRCP. In one patient of Gall bladder malignancy, although USG identified Gall bladder mass and dilated IHBR it failed to show infiltration of adjacent liver parenchyma, hilar confluence and common hepatic duct. In patients of iatrogenic bile duct injury USG was not able to identify exact site of the stricture as compared MRCP.

CONCLUSIONS

Choledochal cyst is most common in the age group of 0-10 years. Choledochal cyst is more common in female than male. Type 1 Choledochal cyst is the most common type followed by type 4A. Malignant stricture is the commonest disease, followed by Choledochal cyst and benign stricture of bile duct. T2WI is useful in the diagnosis of the presence of concurrent extra luminal pathology in field of view. Small biliary calculi are better seen on axial T2W images compared to MRCP images because they are perpendicular to the axis of the bile duct. Small calculi may be obscured on MIP images because of volume averaging with surrounding hyper intense bile. Pneumobilia can be differentiated from calculus by its non-dependent position. MRCP is of advantage when distal CBD calculi are obscured by gas on USG. Iatrogenic injury is the most common cause of the benign bile duct stricture. Cholecystectomy is the most common cause of iatrogenic bile duct stricture. Bismuth staging by MRCP can provide important clue to the surgeon on type of the intervention needed. Hilar cholangiocarcinoma is the most common type of the cholangiocarcinoma. Periductal infiltrating variety is the most common pathological variety of the cholangiocarcinoma. At MRCP, typical malignant common bile duct strictures manifest as irregular, asymmetric strictures with a shouldered margin whereas

benign strictures tend to have smooth and symmetric borders with tapered margins. However, MRCP is not 100% accurate in differentiating stricture in to benign and malignant based on above findings. MRCP is less time consuming than ERCP. MRCP can visualise the status of the biliary apparatus proximal to the complete stricture, which is not feasible on ERCP. MRCP visualises bile ducts in the normal physiological state of dilatation. MRCP is useful when ERCP fails or it is incomplete. MRCP cannot be used in patients with MR incompatible pacemakers. MRCP is a non-invasive tool for diagnosis and preoperative planning for diseases affecting biliary tree.

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