Original Article

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Biliary Tract Obstructive Diseases: A Comparative Evaluation by Ultrasonography and Magnetic Resonance Cholangiopancreatography (Magnetic Resonance Imaging)

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Abstract

Background: Biliary disorders are one of the common problems routinely seen in clinical practice. Hence, the study was carried out to compare two non-invasive, non-radiating modalities (ultrasonography [USG] and magnetic resonance cholangiopancreatography [MRCP]) for the evaluation of biliary duct system and to compare the diagnostic accuracy between USG and MRCP in the patients suspected of obstructive biliary tract pathology.

Materials and Methods: Patients suspected of biliary pathology were examined first by real time USG with convex (3-5 MHz) transducer, then MRCP with 1.5 Tesla magnetic resonance imaging.

Result: Of 50 patients majority of the case were found 51-60 year age groups. Among 60% were female, and 40% were male. Predominant symptoms in the study group were jaundice in 46 patients (92%). Overall malignant obstruction was more common then benign (68% vs. 32%). USG was found sensitive in 81.2% and specific in 100% cases while MRCP was sensitive in 93.7% and specific in 97% in benign lesion as a cause of obstruction while among malignant lesion as a cause of obstruction USG was found 94.1% sensitive and 68.7% specific and MRCP was 97% sensitive and 93.7% specific. On USG, intra-hepatic biliary radicals were found to be dilated in all except one patient i.e. 98% while it was 100% on MRCP. Overall 10 cases were falsely diagnosed by USG while only 2 cases were falsely diagnosed by MRCP among all 50 cases.

Conclusion: USG is considered the first choice option in the diagnostic imaging of obstructive biliary disease. However, owing to its low sensitivity in most of the benign stenosis and distal common bile duct disease, where the clinical and laboratory suspicion is strong and unsupported by ultrasound and/or in the presence of conditions affecting ultrasound performance, and for a thorough staging evaluation of malignancy, MRCP is highly accurate and superior diagnostic modality in establishing diagnosis of obstructive biliary pathologies.

Key words: Biliary obstruction, Magnetic resonance cholangiopancreatography, Ultrasound

INTRODUCTION

Biliary disorders are one of the common problems routinely seen in clinical practice. These include cholelithiasis, choledocholithiasis, malignancy, strictures, etc. Ultrasonography (USG) is actually a routine examination in daily practice, and it is the first line imaging modality of choice in many clinical presentations as well as asymptomatic patients, as a screening tool.[1] It is an accurate, safe, non-invasive, repeatable imaging modality, which is highly sensitive and specific for the detection of many biliary tract diseases.[2] Magnetic resonance cholangiopancreatography (MRCP)[3] is a new non-invasive and safe modality for imaging the biliary tree and investigating biliary obstruction. MRCP refers to selective

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fluid-sensitive magnetic resonance imaging (MRI) of the biliary ducts that show fluid in the biliary and pancreatic ducts. MRCP evaluate the biliary ductal system without the use of ionizing radiation that produces both high-quality cross-sectional images of ductal structures and projection images of biliary tree that are similar in appearance to those obtained by invasive radiographic methods, such as endoscopic retrograde cholangiopancreatography (ERCP).[4] MRCP has proved effective in demonstration bile duct dilatation, strictures, and choledocholithiasis.

Sometimes specific diagnosis by USG is not possible and in such condition alternative imaging may be useful to assess the extent and character of the disease process. When the site or cause of biliary obstruction is not apparent, as in cholangiocarcinoma or distal common duct obstruction, further evaluation with MRI with MRCP is indicated.

So, the study was carried out to compare two non-invasive, non-radiating modalities (USG and MRCP) for the evaluation of biliary duct system and to compare the diagnostic accuracy between USG and MRCP in the patients suspected of obstructive biliary tract pathology.

MATERIALS AND METHODS

This prospective study was conducted on 50 patients, who were referred to the Radiology Department of NSCB Medical College Hospital, Jabalpur from September 2012 to October 2013. All patients of any age, sex, and profession who had undergone USG and MRCP with strong clinical suspicion of biliary obstruction and altered liver function test were taken as study subjects. All patients with medical jaundice and cirrhosis of the liver were excluded. Permission from the Ethical Institute Committee was obtained prior to the study and informed consent of study subjects was taken before undergoing screening for USG, and subsequent MRCP was done.

It was recommended that a patient undergo a period of fasting (at least 6-8 h) prior to upper abdominal imaging of the biliary tree.[5]

Patients suspected of biliary pathology were examined first by real time ultrasonographic (GE-LOGIQ 3 Expert and Siemens-Sonoline 50 MCMD 01AA) with convex, high frequency (3-5 MHz) transducer. We used transverse, sagittal or slightly oblique right sub-costal scan with the patients placed on the left side in a 45° inclined position The liver, gall bladder, pancreas, intra-hepatic and extra-hepatic bile ducts were evaluated to look for the abnormality of intra and extra-hepatic biliary channels, the common bile duct (CBD), level and possible cause of obstruction. In most cases THI was applied, mainly for better visualization of the CBD subsequently followed by MRCP with MRI (GE-HDx Signa 1.5 Tesla [T]).

For all MRCP with MRI patients: 1.5 T GE Signa HDx MRI machine was used for the study. All patients were imaged with a body phased-array receives coil. Slice thickness was 1 cm with a 37" field of view and 256 × 192 matrix were taken from right dome of diaphragm to lower edge of liver following are sequence used after the localizer: T2SSFSE-axial/coronal, axial T2FRFSE, 2D FIESTA axial/coronal, coronal 3D FSE (respirated trigged), Additional; T1-axial/coronal and 3D reconstruction was performed by MIP post-processing. Mean performances time was 20-25 min. Patients with a metallic implant, cardiac pacemaker and claustrophobia were excluded from the study. Findings of USG and MRCP were compared. Radiological diagnosis was confirmed by post-operative findings/biopsy/histopathology.

RESULTS

A total of 50 patients satisfying the inclusion criteria were included in the study. A descriptive comparative analysis of imaging findings in each modality was compared, and results were derived. Majority of cases were found in 51-60 years age group (28%) and age group range was 1-90 years and incidence of biliary tract obstructive disease was more in female (60% cases) as compared to male (40%). Predominant symptoms in the study group were jaundice in 46 patients (92%) and pain abdomen in 40 patients (80%).

In our study group tumors comprised the largest group of cases 34 (68%) followed by choledocholithiasis 9 (18%) cases and benign biliary stricture 4 (8%) cases (Table 1).

On USG, intra-hepatic biliary radicles (IHBR) were found to be dilated in all except one patient i.e. 98% while it was 100% on MRCP (Table 2). Excessive bowel gasses hindered evaluation of the hepatobiliary system in one patient.

Common hepatic duct and proximal CBD was dilated on USG in 92% cases and in MRCP 100% cases. On USG and MRCP distal CBD was found to be dilated in 50% and 84% cases respectively (Table 3).

In our study, most common level of obstruction detected by both modalities was Hilar and intra-hepatic CBD. The level of obstruction was diagnosed accurately both by MRCP and USG.

Of a total of 16 benign cases, 13 cases were detected by USG and 16 cases were detected by MRCP while, among total 34 malignant cases, USG detected 37 cases and MRCP detected 34.

The most common benign cause of obstructive jaundice was choledocholithiasis (9) followed by benign biliary stricture in 4 cases, and choledochal cysts were 3 cases.

USG missed 1 case of benign biliary strictures, and 2 cases of distal CBD stone, while MRCP missed 1 case of distal CBD stone and falsely detected 1 case of benign biliary stricture.

The most common malignant cause of obstructive jaundice was cholangiocarcinoma (14) in which hilar cholangiocarcinoma was common, followed by infiltrating GB carcinoma in 10/50 cases, and pancreatic carcinoma in 7/50 cases. In our study, USG missed 1 case of pancreatic head mass and 1 case of periampullary carcinoma.

Table 1: Distribution of cases according to final diagnosis and their comparative evaluation of USG and MRCP

Sl. no.	Cause of obstruction	Final diagnosis (histopath/ surgical) (%)	USG (%)	MRCP (%)
1.	Choledocholithiais	9 (18)	7 (77.7)	8 (88.8)
2.	Benign billiary stricture	4 (8)	3 (75)	5 (125)
3.	Choledochal cyst	3 (6)	3 (100)	3 (100)
4.	Infiltrating GB mass	10 (20)	10 (100)	10 (100)
5.	Periampullary carcinoma	3 (6)	2 (66.6)	2 (66.6)
6.	Cholangiocarcinoma	14 (28)	19 (135.7)	15 (107.1)
7.	Pancreatic head of carcinoma	7 (14)	6 (85.7)	7 (100)
	Total	50	50	50

GB: Gall bladder, USG: Ultrasonography, MRCP: Magnetic resonance cholangiopancreaticography

Table 2: Distribution of cases on the basis of level of dilatation and obstruction of biliary tree

S. no.	Biliary tree dilatation	USG	MRCP	Level of biliary obstruction	USG	MRCP
1	IHBR	49	50	Hilar and intra-hepatic	25	25
2	Common hepatic duct	46	50	Supra-pancreatic	12	12
3	Proximal CBD	46	50	Intra-pancreatic	13	13
4	Distal CBD	25	42	-	-	-

IHBR: Intra-hepatic biliary radicals, USG: Ultrasonography, MRCP: Magnetic resonance cholangiopancreaticography, CBD: Common bile duct

5 cases of distal CBD mass were falsely detected on ultrasound, with a diagnostic accuracy of USG (90%) as compared to 98% in MRCP. MRCP missed 1 cases of periampullary carcinoma and falsely detected 1 case of cholangiocarcinoma.

In our study on USG 2 case of distal CBD stone were falsely reported as distal CBD mass because evaluation of distal CBD was not possible due to overlying bowel gases, while MRCP falsely reported 1 case of distal CBD stone as distal CBD mass.

USG was found sensitive in 81.2% and specific in 100% cases while MRCP was sensitive in 93.7% and specific in 97% in benign lesion as a cause of obstruction while among malignant lesion as a cause of obstruction USG was found 94.1% sensitive and 68.7% specific and MRCP was 97% sensitive and 93.7% specific.

Overall 10 cases were falsely diagnosed by USG while only 2 cases were falsely diagnosed by MRCP among all 50 cases.

DISCUSSION

Obstructive jaundice can be caused by the obstruction of the bile duct with gall stones, strictures, malignancy, etc. Obstructive jaundice is common amongst females and choledocholithiasis are the commonest benign cause.[6] In our study, IHBR were visualized in 100% cases on MRCP as compared to sonography (98%). Dilatation of the IHBR found in all 50 cases by MRCP as compared to 49 cases on sonography and there was a declining trend observed in the ability of sonography to visualize the biliary tree as we moved distally (Table 2). Visualization of the proximal ducts was possible in 91.6% cases and dropped to 63.3% for distal CBD. Decreasing the diagnostic performance of sonography was because of difficulty in visualizing

Table 3: Diagnostic performance of USG for different causes of obstructive jaundice

Cause of obstruction	Diagnostic performance of USG (%)				Diagnostic performance of MRCP (%)			
Cause of obstruction	Sensitivity	Specificity	PPV	Accuracy	Sensitivity	Specificity	PPV	Accuracy
CBD stone	77.7	100	100	96	88.8	100	100	98
Benign stricture	75	100	100	98	100	97.8	80	98
Choledochal cyst	100	100	100	100	100	100	100	100
Proximal CBD mass	100	100	100	100	100	100	100	100
Distal CBD mass	100	88.6	54.5	90	100	97.7	85.7	98
Infiltrating GB mass	100	100	100	100	100	100	100	100
Pancreatic head mass	85.7	100	100	98	100	100	100	100
Periampullary Ca	66.6	100	100	98	66.6	100	100	98
Benign lesion	81.2	100	100	94	93.7	97	93.7	96
Malignant mass	94.1	68.7	86.4	86	97	93.7	97	96

USG: Ultrasonography, MRCP: Magnetic resonance cholangiopancreaticography, CBD: Common bile duct, GB: Gall bladder the distal CBD and the pancreatic region mainly due to interference by bowel gasses. Similar observations were also made by Vicary *et al.*[7] who opined that limitation in the sonographic evaluation of the distal biliary tree and pancreas was due to bowel gasses besides the operator's experience. MRCP was better in showing the distal biliary tree. The distal CBD was visualized in 42/50 patients (84%) as against 40/50 (80%) patients by sonography. In eight cases, non-visualization of the distal CBD on MRCP was caused by complete cut-off at the level of hilum due to malignant masses. Both ultrasound and MRCP seem to have sensitivity and specificity of nearly 100% for detecting the presence of a biliary obstruction. Regan *et al.*[8] in their prospective study on MRCP demonstrated biliary dilatation in 100% cases. A recent meta-analysis of 67 published controlled trials by Romagnuolo *et al.*[9] have shown both sensitivity of 95% and specificity of 95% for detecting the presence of a biliary obstruction. According to our study most common site of obstruction was hilar and intra-hepatic (50%) was comparable to Kumar *et al.*[10] who found a variable range of accuracy ranging from 27% to 95% for detecting the level of obstruction by ultrasound. The extent of the lesion could be determined in 100% of patients by MRCP as compared to only 66% by sonography. When considering only mass lesions, an extent of biliary involvement could be completely assessed in 10 cases by sonography while it was detected in all 34 cases by MRCP.

MRCP showed good accuracy and an optimal capability of evaluating tumor extent as reported by Manfredi, who analyzed only hilar malignant stenosis of the biliary structures, reported an accuracy of 89% in the assessment of their extent.[11] Our finding is also in concurrence with the study conducted by Soto *et al.*[12] who suggested that in case of mass lesions, when MRCP is combined with MRI, a complete staging information can be obtained about the tumor size, bile duct involvement, and vascular invasion. Hall-Craggs *et al.*[13] in a prospective study comparing MRCP with conventional cholangiography found that MRCP predominantly demonstrates dilated ducts proximal to the stricture and does not distend the stricture itself. It was found that the stricture itself was not visualized, and it was not possible to assess the length and extent of the stricture.

Cholangiocarcinoma comprised maximum number of cases, (n = 14 [28%]) in our study (Table 1) with hilar and proximal CBD (n = 8) and distal CBD cholangiocarcinoma (n = 6) forming a majority of these masses. The second most common cause of obstruction was Infiltrative G.B mass 10/50 (20%) cases. In our study, choledocholithiasis comprised third common cause (n = 9 [18%]) of obstruction. In our study, ultrasound was found to have sensitivity 81.2%, specificity 100%, and diagnostic accuracy of 94% for benign and 86% for malignant lesion for detecting the cause of obstruction while MRCP correctly detected cause of obstruction in all 100% cases with sensitivity: 93.7%, specificity: 97%, positive predictive value (PPV): 93.7% and the diagnostic accuracy of 96%. Upadhyaya *et al.*[14] in a prospective study of comparative assessment of imaging modalities in biliary diseases found that MRCP had the accuracy of 87.5% for assessing the cause. Vaishali *et al.*[15] found the overall diagnostic accuracy of 89.65% for detection of the cause of obstruction. Aube *et al.*[16] found sensitivity of 90.5% and specificity of 87.5% of MRCP in etiological diagnosis. In our study, MRCP showed more promising results than ultrasound in assessing the nature of disease i.e. benign or malignant. Our results are comparable to Ghimire *et al.*[17] who found sensitivity: 67%, specificity: 91%, PPV: 71%, and negative predictive value (NPV): 73%, for ultrasound in the detection of benign lesions.

Romagnuolo *et al.*[9] has found MRCP to be less reliable (88%) for the differentiation between benign and malignant obstruction. In our study, the most common benign cause of biliary obstruction was choledocholithiasis comprising 9/50 cases (Table 1).

In our study, ultrasound was found to have sensitivity: 77.7%, specificity: 100%, PPV: 100% and diagnostic accuracy of 96% for choledocholithiasis while MRCP correctly detected 8/9 cases of choledocholithiasis with sensitivity: 88.8%, specificity: 100%, PPV: 100% and the diagnostic accuracy of 98%. Ferrari *et al.* in their study showed the diagnostic accuracy of 80.15%, with a sensitivity of 71.08% and a specificity of 95.83% that were in concordance with our study. Ferrari *et al.*[18] have found that MRCP has a diagnostic accuracy of 93.89%, sensitivity of 93.97% and specificity of 93.75% in the diagnosis of choledocholithiasis. Two false negative cases on USG were due to hindering of distal CBD evaluation by bowel gas shadow and obese body habitus. Pasanen *et al.*[19] found that the sensitivity of ultrasound for choledocholithiasis varies widely from 20% to 80% with a high specificity of approximately 98%.

Other authors like Mendler *et al.*[20] have also found decreasing sensitivity of MRCP in detecting stones according to the stone size: 67-100% for stones >10 mm size, 89-94% for stones measuring 6-10 mm, and 33-71% for bile duct stones <6 mm in size).

In our study for stricture ultrasound detected 3 out of 4 cases of post-operative stricture with diagnostic accuracy: 98% sensitivity: 75% and specificity: 100% while MRCP detected 5/4 cases of biliary strictures with sensitivity, specificity and diagnostic accuracy of 100%, 97.8%, and 98%, respectively. In contrast to our study, Pandit *et al.*[21]

in their study found accuracy of ultrasound in detection of benign stricture was 31% but results are comparable to a study done by Lomas *et al.*[22] who compared MRCP and ERCP in 78 patients with obstruction and reported a sensitivity and specificity of 86.4% and 82.4% respectively for benign stenosis. The high specificity was attributable to the capability of USG to detect true negatives in benign stenosis, thus showing the cause of the obstruction by calculi or malignant stenosis. The low sensitivity figures are to be related to intrinsic limitations of the methodology, which, though showing the indirect signs of stenosis, did not allow optimal visualization of the distal CBD and the ampullary region, which is where benign stenosis are often localized. Both USG and MRCP detected all the three cases of the choledocal cyst and gave information of involvement confidently similar findings were discussed by Kim *et al.*[23] in their study.

CONCLUSION

USG is considered the first choice option in the diagnostic imaging of obstructive biliary disease. However, owing to its low sensitivity in most of the benign stenosis and distal CBD disease, where the clinical and laboratory suspicion is strong and unsupported by ultrasound and/or in the presence of conditions affecting ultrasound performance, and for a thorough staging evaluation of malignancy, MRCP is highly accurate and superior diagnostic modality in establishing diagnosis of obstructive biliary pathologies. MRCP is more sensitive and more likely to detect choledocholithiasis, CBD strictures and malignant pathologies as compared to USG. Sensitivity, specificity and accuracy of MRCP for choledochal cyst are same as in USG. However, the potential applications of MRCP in the detection of obstructive biliary pathologies are limited by the expanse and availability of technology due to its high cost and lack of expertise available in operating the machine.

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