Original Research Article

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Role of magnetic resonance cholangiopancreatography in conjunction with 3D assessment in patients of different billiary obstruction causes

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ABSTRACT

Background: Conventional 2d MRCP has pitfalls which may stimulate or mask various pathologic conditions of extrahepatic ducts or pancreatic duct, to overcome this a number of new modern techniques are being used.

Methods: Observational study carried out in Government Medical College Srinagar including a total of 50 patients. **Results:** Gallstone disease was the most common etiology responsible for biliary obstruction. Both Malignant and Benign strictures, IHBR dilatation and pancreatic duct dilatation were better appreciated by 3D MRCP than 2D MRCP.

Conclusions: In patients with biliary obstruction, MRCP aims at finding the pathology. It also helps in planning of surgical or interventional management and serves to guide these procedures with 3D MRCP definitely having advantages.

Keywords: 2D MRCP, 3DMRCP, Biliary obstruction, MIP, Choledocholithiasis

INTRODUCTION

Obstructive jaundice is defined as a condition occurring due to block in the pathway between the site of bile conjugation in hepatocytes and the entry of bile into the second part of duodenum through the ampulla.¹ Obstructive jaundice is more prevalent in 5th and 6th decade of life with male to female ratio of 1:1.5.²

The most common cause of biliary obstruction is gall stone disease.³ With biliary obstruction, the proximal biliary tree gets dilated and there is increase in intrabiliary pressure with the result cellular microvilli in biliary canaliculi become distorted and dysfunctional.^{4,5}

Imaging of biliary obstruction

Biliary obstruction can pose problems in diagnosis and management especially because of the wide etiology. So, it is mandatory to determine preoperatively the existence, the nature and site of obstruction because an ill-chosen therapeutic approach can be dangerous.⁶ As imaging techniques have improved, radiologists have increasingly studied images of the biliary tract by novel methods.

Sonography is most commonly employed as the primary imaging tool because of its high sensitivity for the presence of gallstones, it enables us to accurately evaluate the status of the intra and extra hepatic biliary ducts, and the sonographic examination can be performed relatively rapidly and at a very low cost, but occasionally imaging pitfalls or because of some unusual presentations the sonographic evaluation may be difficult.⁷

MRCP was introduced in 1991 by Wallner et al as a non-invasive method of imaging of biliary tree.8 MRCP uses heavily weighted T2 sequences, as a result the static and slow-moving fluid filled structures such as bile and

pancreatic duct are greatly intensified, resulting in intensified duct to the background contrast. MRCP combines the advantages of both projectional imaging and cross-sectional imaging and is an established diagnostic technique that has replaced direct cholangiopancreatography for diagnostic purposes. MRCP provides an efficient alternation when diagnostic ERCP or PTC is unsuccessful or inadequate. MRCP can visualize biliary tract above and below the level of the obstruction, which is essential for treatment planning and one that is neither provided by ERCP nor PTC. 10

Conventional 2D MRCP also has pitfalls which may stimulate or mask various pathologic conditions of extra hepatic ducts or pancreatic duct and may be caused by a variety of reasons and to overcome this, number of new modern techniques including fast imaging sequence, parallel imaging techniques, phased array coils, 3D turbo spin echo techniques are being used, which allow the acquisitions of higher quality diagnostic imaging. 3D imaging techniques provide better image quality compared to 2D sequences even though the combinations of different MRCP sequences have proven to be valuable in the assessment of biliary anatomy and pathology.¹¹ Three dimensional respiratory triggered T2 weighted fast spin echo techniques have been used in several applications for some time. As compared with 2D dimensional techniques, they offer higher signal to noise ratio, contrast to noise ratio, improved spatial resolution and thinner imaging sections without intersection gaps allowing more robust post processing manipulation, but are disadvantaged by the long acquisition times [generally 8 to 10 minutes]. 12 For post processing techniques of 3D MRCP, maximum intensity projection [MIP] and volume rendering VRT has been commonly used because of its handiness. 13 The potential advantages of 3D T2weighted MRCP techniques over 2D imaging include the capacity for use of thinner sections without inter slice gap and a higher SNR and for post processing manipulation of the images with techniques such as multiplanar reconstruction, maximum projection, and volume rendering. With these tools, unlimited projectional views in any arbitrary plane can be obtained to clarify anatomic relationships. 14

Aims and objectives of study

To evaluate the patients with clinical suspicion of biliary tract obstruction and USG documented biliary obstruction with 3D MRCP and compare it with conventional MRCP.

METHODS

This is an observational study carried out in the Department of Radiodiagnosis and Imaging and Department of Gastroenterology, Government Medical College Srinagar from June 2019 to January 2021 over a period of 18 months after obtaining ethical clearance from Institutional Ethical Committee. Study group consisted of 50 cases (patients) of biliary obstruction.

Inclusion criteria

The study includes cases of biliary obstruction referred to the department of radio diagnosis and imaging from the department of medical and surgical gastroenterology for imaging investigations.

Exclusion criteria

This study will exclude, patients with MRI incompatible cardiac pacemakers, stents, coils, cochlear implants and other devices, patients with claustrophobia and other contraindications to MRI.

Instrument and technique used

MRCP Magnetic Resonance Cholangiopancreatography (MRCP) was carried out on a superconductive 3 .0Tesla scanner (Magneton, Skyra, Siemens) using phased array body coils. Patients were instructed to fast for 4 hours prior to the study in order to reduce fluid secretions within the stomach and duodenum to reduce bowel peristalsis and promote gallbladder distension.

Protocol followed was:

Localizer to localize the pancreaticobiliary duct. This was accomplished by acquiring a scout MRCP obtained in a slice thickness of 3-4 mm. MRCP images were acquired using half- Fourier single shot turbo-spin-echo (HASTE) sequence.

Single-shot fast spin-echo sequence (SSFS) for T2-weighted MRCP technique.

Coronal oblique respiratory-triggered 3D fast spin-echo sequence; slice thickness, 2 mm; TR, 1500; echo train length, 716; field of view, 320; signals acquired, 2; average examination time, 6 min.

Axial respiratory triggered 3D fast spin-echo sequence; slice thickness, 2 mm; TR, 1500; TE, 700; Field of view, 300; FOV phase, 100; signals acquired, 2; average scan time, 3 min. The axial sequence was added to minimize the risk of missing small periampullary lesions.

Statistical methods

The recorded data was compiled and entered in a spreadsheet (Microsoft excel) and then exported to data editor of Statistical package for social sciences (SPSS) version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS (version 20.0) and Microsoft excel were used to carry out the statistical analysis of data. Continuous variables were expressed as Mean±SD and categorical variables were summarized as percentages. Graphically, the data was presented by bar and pie diagrams. Diagnostic accuracy (sensitivity, specificity, positive predicted value and negative predicted value) of conventional 2D MRCP and 3D

MRCP with MIP and VRT was obtained for detection of various causes of biliary obstruction, taking ERCP, surgical findings and histopathology as gold standard.

RESULTS

Table 1 showing age distribution of cases. The mean age in our study was 47.5 years (range 7-76 years) with standard deviation of 16.57 years. The maximum number of patients were in the age group of 51 to 60 years (32%).

Table 1: Age distribution of study patients.

Age (years)	Number (n)	Percentage
≤30	6	12
31-40	9	18
41-50	10	20
51-60	16	32
> 60	9	18
Total	50	100

Mean±SD (Range)=47.5±16.57 (7-76)

Table 2: Gender distribution of study patients.

Gender	Number (n)	Percentage
Male	21	42
Female	29	58
Total	50	100

Table 3: Diagnostic accuracy of conventional 3D MRCP with MIP and VRT in detecting biliary tree stricture.

Parameter	Sensit ivity	Specific ity	PPV	NPV
EHBD benign stricture	100	97.3	92.3	100
EHBD malignant stricture	100	97.3	92.8	100
IHBR stricture	100	100	100	100

Table 4: Diagnostic accuracy of 3D MRCP with MIP and VRT in detecting choledocholithiasis and Cholelithiasis.

Parameter	Sensiti vity	Specif icity	PPV	NPV
Filling defect in IHBD	91.3	100	100	93.1
Filling defect in GB	100	100	100	100

Table 2 showing the distribution of patients with respect to gender. In our study out of the total 50 patients, 21 (42%) patients were males and 29(58%) were females.

Table 3 shows the diagnostic accuracy of 3D MRCP with MIP and VRT in detecting biliary stricture and cut off. For benign stricture the sensitivity, specificity, PPV and NPV was 100%, 97.3%, 92.3% and 100%, respectively. For malignant stricture the sensitivity, specificity, PPV and NPV was 100%, 97.3%, 92.8% and 100%, respectively. For IHBR stricture the sensitivity, specificity, PPV and NPV was 100% each.

Table 5: Diagnostic accuracy of 3D MRCP with MIP and VRT in detecting CBD dilatation and IHBR dilatation.

Parameter	Sensit ivity	Specif icity	PPV	NPV
Dilatation of CBD	100	94.1	97.1	100
Dilatation of IHBR	100	89.5	93.9	100

Table 6: Diagnostic accuracy of 3D MRCP with MIP and VRT for detection of hepatolithiasis.

Parameter	Sensiti vity	Specif icity	PPV	NPV
Hepatolithiasis	100	100	100	100

Table 7: Diagnostic accuracy of 3D MRCP with MIP and VRT for dilated MPD.

Parameter	Sensiti vity	Specifi city	PPV	NPV
Dilated MPD	100	100	100	100

Table 8: Diagnostic accuracy of 3D MRCP with MIP and VRT for pancreatic divisum.

Parameter	Sensitivi ty	Specifi city	PPV	NPV
Divisum	100	100	100	100

Table 4 shows that the sensitivity, specificity, PPV and NPV of 3D MRCP with MIP and VRT in detecting choledocholithiasis is 91.3%, 100%, 100 and 93.1%, respectively. For Cholelithiasis it is 100% each.

Table 5 Shows that the sensitivity, specificity, PPV and NPP of conventional MRCP for CBD is 100%, 94.1%, 97.1%, 100%, respectively and for IHBR dilatation it is 100%, 89.5%, 93.9% and 100%, respectively.

Table 7 shows that the Sensitivity, Specificity, PPV and NPV of 3D MRCP with MIP and VRT and it is 100% for each.

Table 8 shows the sensitivity, specificity, PPV, NPV of 3D MRCP with MIP and VRT and it is 100% for each.

Table 9 shows 100% sensitivity, 100% specificity, 100% PPV and 100% NPV of conventional 2D MRCP for pancreatic Divisum.

Table 9: Frequency and percentage of patients with different image quality of IHBR Visualization on 2D MRCP and 3D MRCP.

IHBR visualization	Number (n)	Percentage
3D better than 2D	35	70
2D better than 3D	3	6
No significant difference	12	24
Total	50	100

DISCUSSION

Biliary obstruction because of the wide etiology possesses a significant challenge in diagnosis. Imaging plays a key role in diagnosis, helps in accurate evaluation and management of the patient with biliary obstruction.

Even though MRCP offers many advantages currently it still has a few drawbacks like, low spatial resolution, imaging in the physiologic non-distended state, which decreases the sensitivity to subtle ductal abnormalities, image artifacts of various types and lack of therapeutic option.

To overcome some of these drawbacks, a number of new modern techniques are being used, which allow the acquisitions of higher quality diagnostic imaging with lower incidence of technical pitfalls. 3D MRCP is one of the breakthrough improvements in the MRCP techniques.

In our study we studied 50 patients out of which 21 were men and 29 were women. The average age of patients was 47.5 years with a range of 7 to 76 years. Most cases were seen in the age group of 51 to 60 years of age. In our study females were affected more commonly with a female to male ratio of approximately 1.4: 1.

Mean age in our study was 47.5 years which is similar to the study done by Shukla et al where it was 48.5 years.² Similarly, Agal et al who studied 62 patients and Meena Set al who studied 75 patients of both benign and malignant etiology of biliary obstruction, there is more or less equal age incidence in present study.¹⁵

In our study, females were predominantly affected which is similar to study done by Hasan et al where 62% of patients were females. ¹⁶ Out of a total 29 patients, 18 were male and 11 were females with a female to male ratio of 1.63:1.

In our study of 50 patients, we evaluated various causes of biliary obstruction. The most common findings were gallstone disease (40%), malignancy (26%) and benign stricture (26%).

Gallstone disease was the commonest etiology responsible for biliary obstruction in 40% of the patients. These results were comparable to the study done by Prabakar et al.¹⁷ In their study of 30 patients of biliary obstruction, 18 patients (60%) had gall stone disease. Similar results were also observed in study done by Ethan et al.¹⁸

In our study, CBD stones were present in 23 patients [14 patients had choledocholithiasis, 6 patients had cholelithiasis with choledocholithiasis and 3 patients had OCH with associated CBD stones]. It was observed that 2D conventional MRCP and 3DMRCP with MIP and VRT had similar sensitivity, specificity, PPV and NPV of 91.3%, 100%, 100% and 93.1%, respectively in detecting bile duct stones. Two patients with small [less than 3 mm] CBD stones were missed on both 2D MRCP and 3D MRCP. These results are in concordance with study done by Hemant et al in which MRCP has a sensitivity of 90% and specificity of 90%–100% for the detection of stones.⁹ Similar results were seen in a study done by Hasan et al which showed similar diagnostic accuracy of 2D and 3D MRCP for choledocholithiasis. 16 Similarly, Zidi et al stated that small stones with diameter lower than 5 mm is a limiting factor in MRCP for diagnosis of choledocholithiasis.19

In our study of 50 patients, 15 patients had associated cholelithiasis. Both 2D MRCP and 3D MRCP very accurately detected all the patients of cholelithiasis with equal sensitivity, specificity, PPV and NPV of 100% each. These results were similar with the study done by Calvo et al in which sensitivity of MRCP in detecting cholelithiasis was 97.7%. ²⁰

Benign strictures were seen in 13 patients in our study [with different etiology iatrogenic,] post inflammatory, chronic pancreatitis, ampullary dysfunction, PSC and OCH. The sensitivity, specificity, PPV and NPV of 2D MRCP for benign stricture were 92.3%, 97.3%, 92.3% and 97.3%, respectively. On 3D MRCP with MIP and VRT the sensitivity, specificity, PPV and NPV for benign stricture were 100%, 97.3%, 92.3% and 100%, respectively. Both 2D MRCP and 3D MRCP failed to differentiate stricture associated with chronic pancreatitis from a malignant stricture, however one benign stricture that was missed by 2D MRCP in an OCH patient was well demonstrated by 3DMRCP on MIP images. These results were similar to the study done by Choi et al which showed that 3D MRCP performs better than 2D MRCP for benign strictures with sensitivity and specificity of 2D MRCP being 73.3% and 90.4%, respectively and for 3D MRCP the sensitivity and specificity was 86.7and 93.6%, respectively.²¹ Similar results were demonstrated by the study done by Hasan et al.16 According to the study conducted by Griffin et al22the sensitivity of MRCP for benign strictures was 91% -100%.

In our study of 50 patients, 3 patients were malignant, cholangiocarcinoma in 5 patients, periampullary

carcinoma in 4 patients, gall bladder carcinoma 2 patients and Pancreatic carcinoma 2 patients. Both 2DMRCP and 3D MRCP with MIP and VRT showed similar diagnostic accuracy in characterizing the lesions with sensitivity, specificity, PPV and NPV of 100%, 97.3%, 92.8% and 100%, respectively. The results were comparable to study by Hasan et al and Pamos et al here the sensitivity and specificity for malignant biliary stricture was 100% and 83.3%, respectively. In addition, the 3D reconstructed images were helpful in identifying the extent of common bile duct infiltration as well as the intra-hepatic duct infiltration, and were considered as an excellent preoperative drawer of the biliary system anatomy.

In our study, 2 patients had IHBR strictures. Only 1 was picked by conventional 2D MRCP with sensitivity and specificity of 50% and 100%, respectively. 3D MRCP with MIP and VRT clearly demonstrated strictures in both patients with sensitivity and specificity of 100% and 100%, respectively. Our results were in agreement with study done by Hasan et al who concluded that 3D MRCP with MIP and VRT MRCP has high sensitivity and very high specificity for the diagnosis of intra-hepatic strictures. ¹⁶

In our study CBD was dilated in 34 patients and was detected on 2D MRCP and 3D MRCP. Thus, both 2D MRCP and 3D MRCP has 100% sensitivity and specificity in detecting CBD dilatation.

The results were comparable to study done by Romagnolo et al in which MRCP had a 95% sensitivity and 97% specificity for the detection of biliary dilatation, comparable to ERCP and EUS and surpassing CT and transabdominal US.²⁴

In our study IHBR dilation was seen in 33 patients. IHBR were considered dilated if duct diameter was wider than 40% of the diameter of the accompanying Portal venous branches or more than 2 mm. The sensitivity, specificity, PPV and NPV of 2D MRCP for IHBR dilatation was 96.8%, 89.5%, 93.8% and 94.4%, respectively. On 3D MRCP with MIP and VRT, the sensitivity, specificity, PPV and NPV was 100%, 89.5%, 93.9% and 100%, respectively. This is comparable to the study done by Kaur Aet al.25who reported 100% sensitivity and 97.3% specificity of IHBR dilatation on MRCP.

Thus, our results show that both 2D MRCP and 3D MRCP efficiently demonstrate IHBR dilation with almost equal accuracy but 3D MRCP was better in delineating the complex anatomy of bile ducts, which is useful in the planning of treatment.

In our study intra ductal calculi were present in 3 patients of OCH. Both 2D MRCP and 3D MRCP not only detected the stones in all patients but demonstrated their location within the ducts effectively with sensitivity and specificity of 100% each. These results are in concordance with study done by Kubo et al in which

patients with recurrent pyogenic cholangitis underwent MRCP and ERCP followed by surgery.^{9,26}

In our study dilated MPD was seen in 8 patients. The sensitivity, specificity, PPV and NPV of 2D MRCP in diagnosing pancreatic duct dilatation was 75%, 100%, 100% and 97.9%, respectively. On 3D MRCP with MIP and VRT the sensitivity, specificity, PPV and NPV for pancreatic duct dilatation was 100% each. Not only 3D MRCP detected all the patients with MPD dilatation, but the associated findings including wall irregularity, side branch dilatation and focal duct narrowing were much better appreciated on 3D MRCP.

These results are in concordance with study done by Gulati et al which concluded that pancreatic duct dilation, anomalies and sequalae of chronic pancreatitis are more confidently visualized on 3D MRCP than 2D MRCP.²⁷ Similar results were reported by Soto et al.28who concluded that the sensitivity of MRCP for MPD dilatation was 87%-100%.

In our study, pancreatic divisum was present in 4 patients. All the patients were detected both on 2D MRCP and 3D MRCP with 100% sensitivity and 100% specificity. Tirkes et al in their study reported sensitivity and specificity of 73%-100% and 97%-100%, respectively for pancreatic divisum on MRCP.²⁹

Limitations

MRCP is a proven high sensitivity and specificity modality in the evaluation of various conditions of the pancreaticobiliary ductal system. However, its sensitivity is limited with some different technical, anatomical and local pitfalls, which can lead to over or underestimation of the actual pathology. In our study various technical, anatomical and physiological pitfalls were encountered in MR Imaging. However, their frequency varied depending on the MR technique used. On 2D MRCP, out of 50 patients, technical pitfalls were present in 11 patients (22%). On 3D MRCP with respiratory gating these were seen in only 4 patients (8%). Our results were similar to the study done by Agha M et al.30 in which they studied 200 patients with (T2 TSE Cor BH) thick slab (group A) and (3D-MRCP HR) thin slab sequences (group B), in correlation with routine MRI, CT scan and ERCP. Pitfalls were seen in 25% of patients in group A and 6% in group B.

CONCLUSION

From the present study we concluded, in patients with biliary obstruction, MRCP aims at finding the pathology. It also helps in planning of surgical or interventional management and serves to guide these procedures. For malignant stricture, both conventional 2D MRCP and 3D MRCP with MIP and VRT have equal diagnostic accuracy in detecting and categorizing malignant strictures. However, 3D MRCP with MIP and VRT

performed better for small benign strictures and intrahepatic strictures. For CBD stones and gallbladder stones, both 2D MRCP and 3D MRCP showed similar sensitivity and specificity and were highly accurate in detecting the location and size of stones. 3D MRCP with MIP and VRT out performed conventional 2D MRCP in detecting pancreatic dilatation and IHBR dilatation. 3D MRCP with MIP not only detected MPD dilatation but it was very sensitive in detecting early changes of chronic pancreatitis. Image quality of 3D MRCP was better than 2D MRCP with less frequency of technical pitfalls on 3D MRCP as compared to 2D MRCP. Conventional 2D MRCP imaging gives us a Comprehensive view of biliary and pancreatic system anatomy and pathology, however sometimes it is not enough to make a decision. By using 3D reconstructions, multiplanar and reformatted images (MIP, VRT) of the biliary tract, it provides quick and clear visualization of the complex relationships between the anatomy and pathologic changes. Furthermore, it increases our confidence in the diagnosis and contribution to understand the disease process. In fact, in most cases 3D imaging does not add quantitative information but the main advantage is that cross sectional imaging is depicted in pattern which is easier to interpret.

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