

The Radiological Study to Establish the Accuracy of MRCP over USG & CT in Diagnosing the Case of Obstructive Jaundice

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Abstract

Background: MRCP is a relatively new MR imaging technique that has revolutionized the imaging of biliary and pancreatic ducts. **Methods:** The study was conducted in the department of Radio Diagnosis, MGMC&RI, for a period of 2 years. Thirty three patients of obstructive jaundice were included in the study. Ultrasonography followed by MRCP and then CT were done in all the patients. Three experienced radiologists reviewed the images separately and evaluated the cause and site of obstruction in these patients. The accuracy of each modality was analyzed statistically and correlation was made with the surgical findings or histopathological reports. **Results:** MRCP had an accuracy of 97% in detecting the cause of obstructive jaundice while CT & USG had a accuracy of 82% & 67% respectively. In diagnosing the site of obstruction MRCP had a accuracy of 100% while CT had 88% and USG 55%. The performance of MRCP when compared to CT and USG was statistically more significant ($p < 0.05$). **Conclusion:** In the diagnosis of obstructive jaundice and to know the cause, site and extent of the lesion MRCP being a non invasive, non ionizing procedure seems to be a better choice over other radiological procedures like USG, CT or ERCP.

Keywords: MRCP, USG, CT, Obstructive Jaundice.

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Introduction

MRCP is a relatively new MR imaging technique that has revolutionized the imaging of biliary and pancreatic ducts and has emerged as an accurate, noninvasive means of visualization of the biliary tree and pancreatic duct without radiation & injection of contrast material.^[1,2]

Since its introduction by Wallner et al in 1991, MRCP has undergone a wide range of changes. It relies on heavily T2-Weighted image sequences that display stationary water as high signal. Multiplanar thin and thick section acquisitions are obtained using fast spin-echo techniques. Magnetic Resonance Cholangiopancreatography with its inherent high contrast resolution, rapidity, multiplanar capability and virtually artifact free display of anatomy and pathology, is proving to be imaging of choice in these patients.^[3-6]

MRCP shows the entire biliary tract and pancreatic duct without any intervention and use of oral or IV contrast. The quality of images obtained is comparable with those of direct cholangiography procedure like ERCP, which is considered as standard of reference in ductal pathologies. The diagnostic accuracy of MRCP suggests that, it has the potential to replace the more invasive procedures like diagnostic ERCP, which should be used only in cases where intervention is being contemplated.^[7-10]

It has proved effective in demonstrating bile duct dilatation, stricture and choledocholithiasis. In patients with malignant obstruction or stenosis of biliary-enteric anastomosis, this noninvasive imaging technique demonstrates the site and extent of the stenosis, the degree of proximal dilatation, the presence and size of biliary stones, and associated findings.^[11,12]

Other imaging modalities used in the diagnosis of biliary tree and pancreatic duct are Ultrasonography, Computed Tomography, IV cholangiography and Endoscopic Retrograde Cholangiopancreatography (ERCP) and Percutaneous Transhepatic Cholangiography (PTC). For patients with suspected ductal pathology there are advantages and disadvantages that are unique to the specific technology.^[13-17]

Though Ultrasonography and CT are non invasive, they have their drawbacks as well. USG is ineffective in accurately diagnosing the site of obstruction in most cases. CT has an increased risk of radiation and is also not sufficiently sensitive for detecting stones. IV cholangiography has its own limitations as in 30-40 % of the cases there is incomplete opacification of the biliary passage and increased contrast reaction. ERCP and PTC are complicated procedures and require technical expertise and contrast media. Also several complications from the procedure may arise.^[18,19]

Magnetic Resonance Cholangiopancreatography (MRCP) has few added advantage as follow:^[20]

- Non-invasive imaging modality
- No ionizing radiation needed
- No need of contrast media
- Multiplanar imaging capability
- No post procedure complications
- It can show biliary tract proximal as well as distal to the level of obstruction.

In the present study we have prospectively analyzed 33 patients with obstructive jaundice using MRCP, CT and USG. These patients were suffering from various disease of the biliary tree or the pancreas. We have evaluated the efficiency of MRCP as imaging modality of choice in comparison with USG and CT.

The aim of this study is to establish the accuracy of MRCP over Ultrasound & Computed Tomography in diagnosing the causes of Obstructive Jaundice.

Subjects and Methods

This study was conducted in the Department of Radio Diagnosis, MGMC&RI, Pondicherry. A total no of thirty three patients suffering from obstructive jaundice of all age groups and either sex were included in this study.

Inclusion criteria-

- Patient clinically diagnosed as suffering from obstructive jaundice.
- Total Bilirubin greater than 5mg/dl.
- Patient referred to the Department of Radio Diagnosis for further investigation.

Exclusion criteria

- Claustrophobia
- Renal insufficiency
- Pregnancy
- MR incompatibility

The study protocol was approved by the ethical committee

at Sri BalajiVidyapeeth University and all the patients gave informed consent to participate.

Patient preparation:

All the patients were instructed to fast over night prior to examination.

Renal functional status of all the patients was noted before undergoing contrast CT.

Clinical history of all the patients was elicited to rule out previous contrast reactions/allergies.

All the metallic belongings removed prior to the examination.

Procedure:

All the patients in the study underwent USG examination first followed by MRCP and finally CT. This order is followed so that there is no interference of image quality from the previous study.

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USG was performed using a GE Healthcare Voluson 730 pro equipment. Both curvilinear and linear probes were used in the study. Images of the biliary tree were recorded for later review.

Helical CT was performed on a GE Healthcare HiSpeedCTe Dual CT Scanner. Unenhanced CT with 7mm collimation of the upper abdomen was performed. Contrast (100 ml, 300mg I/ml) was then injected intravenously. The scans were taken from diaphragm to iliac crest on 5mm collimation, 2mm reconstruction interval, pitch of 1.5, and FOV of 30-40 cms. The images were reformatted up to smaller intervals.

MRCP was performed on Philips Healthcare Intera 1.5 Tesla MRI Scanner. All images were obtained with breath holding and parameters were individualized. Detailed parameters of each sequence are summarized below.

Sequence	TR(ms)	TE(ms)	No of Slices(mm)	Slice Thickness(mm)	Gap(mm)	Matrix	FOV(mm)
MRCP 3D HR	1204	650	110	1.0	0.8	512	266
Ssh MRCP RAD	8000	800	12	40	0.4	512	300
Ssh SPAIR COR	465	80	25	5	0.5	486	330
Ssh SPAIR TRA	425	80	40/35	5	0.5	420	330
Ssh SPAIR SAG	462	80	40	5	0.5	384	270
T2TSE HR TRA	2504	100	36	5	0.5	512	360
T1W 3D TSE	10	4.6	80	1.0	0.1	256	375

The following Parameters were studied for MRCP-

1. Level of obstruction(four Anatomical Segments)
 - Hepatic
 - Suprapancreatic
 - Pancreatic
 - Ampullary
2. Presence of bile duct calculi
 - Non visualized
 - Definitely visualized.
3. Status of CBD
 - Smooth tapering

- Abrupt end
 - Rounded
 - Irregular
4. Degree of dilatation of intra hepatic biliary radicles.
 5. Gall bladder pathology including size, wall, stones.
 6. Dilatation of pancreatic duct.
 7. Pancreatic atrophy, calcifications, and pseudocysts.
 8. Invasion of viscera, fascial planes.
 9. Presence of metastasis.

Then classification of imaging findings as benign or malignant cause of obstructive jaundice is based on following scale of confidence.

Definitely benign:

Biliary duct dilatation with a visible stone in the duct with no associated mass or stricture.

Probably benign:

Cystic dilatation of bile duct. Pancreatico-biliary duct dilatation considered benign (i.e. Sign of chronic pancreatitis).

Inconclusive:

Not confidently diagnosed as benign or malignant.

Probably malignant:

Iso-Hypo enhancing mass(for CT only) with indirect signs of tumor such as duct dilatation with ductal cut-off adjacent to the mass or atrophic distal parenchyma or pancreato biliary dilatation considered malignant without sign of a mass or lesion in pancreatic head without duct dilatation.

Definitely malignant:

Mass in the pancreatic head with consistent duct dilatation. Isolated CBD dilatation with an abrupt narrowing located cranial to the level of mass lesion.

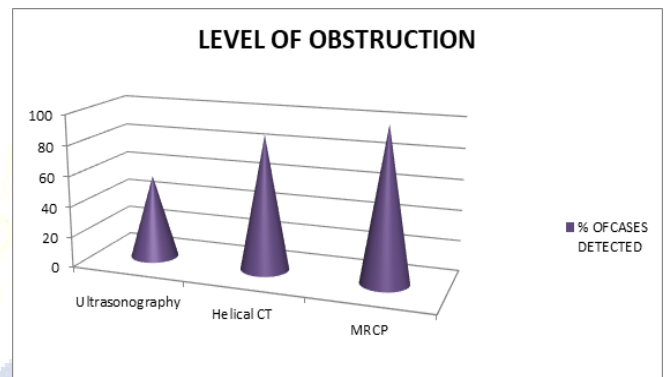
MRCP, CT and USG scans were analyzed separately in a blinded fashion without knowledge of the results of other examinations, or of clinical findings. Final diagnosis was established with per operative or histopathological correlation. Among these twenty six patients underwent surgery, five patients underwent cytology and remaining with other modalities of investigation. Probably benign lesions were considered as benign and similarly probably malignant lesions were considered as malignant.

This study was conducted to establish the superiority of MRCP when compared to CT & USG in the evaluation of obstructive jaundice. A total of thirty three patients were included in the study.

Of the thirty three patients, seventeen patients had benign lesions while sixteen patients had malignant lesions. While MRCP and CT had diagnosed sixteen of the seventeen lesions, USG could diagnose all the benign lesions. However USG had diagnosed several of the malignant lesions as benign.

Table 1: Site of Obstruction in the studied population.

Modality	No of Cases Detected Correctly	Percentage %
Ultrasonography	18	55
Helical CT	29	88
MRCP	33	100
Total	33	100

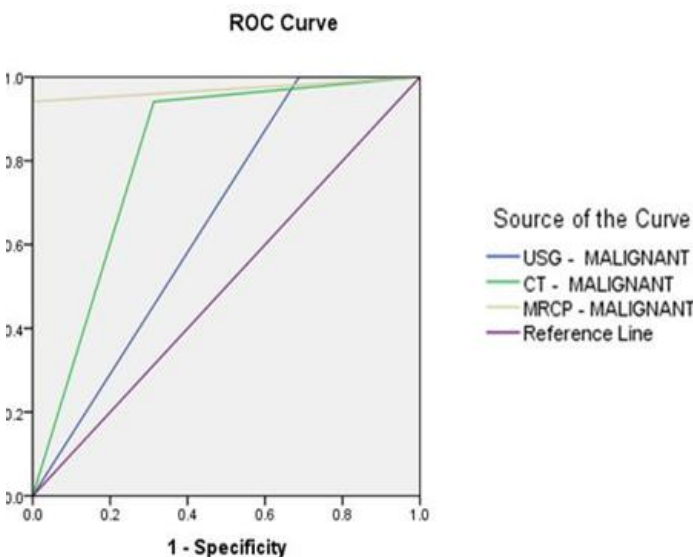


MRCP has 100% accuracy in detecting the site of obstruction followed by CT and USG [Table 1].

Results

Table 2: Comparison of diagnostic values of USG, Helical CT and MRCP in benign causes of Obstructive Jaundice.

Modality	Sensitivity (%)	Specificity(%)	Positive Predictive Value (%)	Negative Predictive Value(%)	Accuracy (%)
USG	100	69	61	100	67
CT	94	69	76	92	82
MRCP	94	100	100	94	97



From the above [Table 2] it is inferred that MRCP has the highest accuracy for detecting benign lesions followed by CT and USG. The sensitivity of MRCP and CT is the same for both modalities while it is 100% for USG.

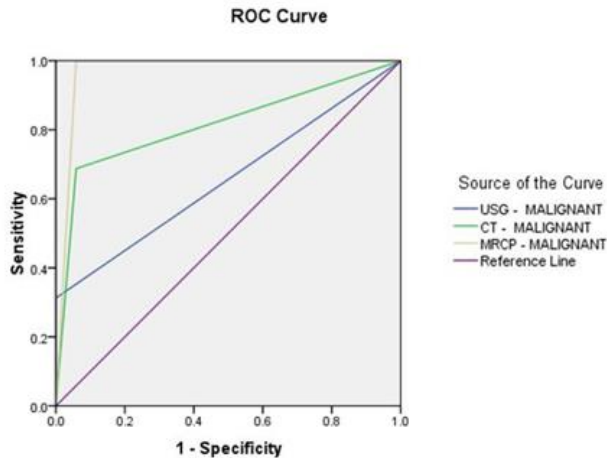
In spite of the high sensitivity for USG, the specificity for the same is very low at 69% when compared to that of CT's 69% and MRCP's 100%. Thus USG is a very good screening tool for benign lesions for obstructive jaundice while CT and MRCP are the specific investigations.

From the above ROC curve we infer that MRCP has the largest area proving that MRCP is the most sensitive and specific investigation. The p value is also <0.05 making MRCP statistically better investigation than CT and USG in detecting benign lesions.

Table 3: Comparison of diagnostic values of USG, Helical CT and MRCP in malignant causes of Obstructive Jaundice.

Modality	Sensitivity(%)	Specificity(%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Accuracy(%)
USG	69	100	100	61	67
CT	69	94	92	76	82
MRCP	100	94	94	100	97

The above [Table 3] suggests that MRCP is again the most accurate investigation with an accuracy upto 97%. The sensitivity and specificity of MRCP is high making it more accurate while USG and CT have high sensitivity their specificities are low.



The ROC curve suggests that MRCP has the largest area among the three investigations, proving it to be the most efficient investigation in the detection of malignant lesions. The p value again is >0.05 making it significant. Thus MRCP is statistically more significant CT and USG in the diagnosis of obstructive jaundice.

Discussion

USG was done prior to MRCP and CT for all patients. While USG all lesions with cholelithiasis (accuracy 100%), it had difficulty in diagnosing distal CBD calculi in about two patients which was easily picked up by MRCP.^[21,22] Our study is in concordance with Hiroyuki Irie²² et al; in their study they found an accuracy of 100% in detecting CBD calculi on MRCP in cases with equivocal sonographic and CT results.

Of the eight patients diagnosed with CBD and GB calculi both MRCP and CT had accurately diagnosed all the eight cases. MRCP showed calculus region as an area of signal void and CT showed it as hyperdense lesion. Our study is in concordance with Soto et al,^[12] In their study they found, sensitivity of 94% and specificity of 100% for detecting biliary calculi in MRCP⁵⁷. Regan et al¹⁴: In their study they found the sensitivity of diagnosing CBD calculus was 87% and our study showed that CT is more superior to their study.

Van Hoe et al,^[20] in prospective study of 15 patients with bile duct obstruction with various radiologic modalities,

were compared for their capability to demonstrate the level and cause of obstruction, and found that USG appears to be the single most useful modality in evaluation of bile duct obstruction, compared to CT & Direct cholangiography.

Robert N. et al,^[2] in her study of 35 patients with obstructive jaundice using ISG concluded that USG had a sensitivity of 85% in finding the site of obstruction. USG being a simple, safe and non invasive tool, it can be used in the first line of investigation in patients with obstructive jaundice.

Threasa H.^[7] have analyzed the role of USG in the detection, characterization and staging of cholangiocarcinoma and have concluded that in well trained hands, with high resolution equipments it is possible to detect and characterize this rare tumor using USG as sensitively as with other radiological modalities.

Cesar S et al,^[6] have analyzed 14 patients with obstructive jaundice using 3D USG. The level of obstruction was correctly depicted in all patients, and a dilated common bile duct, common hepatic duct, gallbladder, and main intrahepatic ducts were well visualized on minimum transparent mode images. The findings on minimum transparent mode images were well correlated with those on cholangiography; however, the perspective of the whole biliary tree on minimum transparent mode images was inferior to that on cholangiography in all cases.

Though USG is a very effective modality in the screening of obstructive jaundice its specificity seems to be low in many studies. CT as a modality of choice for obstructive jaundice was investigated by several researchers. In a study conducted by Cesar et al,^[6] in evaluating the site of obstruction with CT the results were accurate and comparable to that of direct cholangiography.

Another study was conducted to analyze biliary obstruction proximal to the pancreatic segment with CT. They concluded that CT is the most valuable as a non-invasive means of narrating surgical or radiologic drainage procedure in patients with biliary obstruction.^[10]

As CT was becoming popular MR Cholangiography was introduced by Matthew A.^[11] Authors used the rapid sequence gradient echo acquisition with three-dimensional post processing technique to evaluate the biliary system in five healthy volunteers and 13 patients of obstructive jaundice. The results were compared with other imaging modalities (US, CT scan and conventional radiographs obtained during PTC or ERCP). Authors concluded that MRCP has the capability for non invasive imaging of the biliary tree in patients with obstructive jaundice but improvement in technique is needed to overcome limited spatial resolution and low signal to noise ratio.

3D MR cholangiography using contrast enhanced Fourier acquired steady state technique (CE-FAST) was evaluated in 12 patients with malignancy related obstructive jaundice

and the results were correlated with percutaneous transhepatic biliary drainage performed 0-21 days later. Authors found dilatation and obstruction of the bile ducts were clearly demonstrated in all patients on MRCP and there was 100% correlation with PTBD gram. Authors concluded that though spatial resolution of 3D MR cholangiography is slightly inferior to the direct cholangiography the information obtained is similar to PTC and the non invasive MR Cholangiography procedure is less traumatic for the patient.^[12]

The initial results with MR cholangiopancreatography studies were achieved with gradient echo sequences by using a steady-state free precession techniques.^[18] Subsequently, MR Cholangiopancreatography studies were performed with fast or turbo spin echo pulse sequence (FSE). These sequences were not only slow and required longer scan time for adequate spatial resolution but were also prone to motion induced artifacts and signal loss. The latest imaging techniques for MRCP are Rapid Acquisition with relaxation Enhancement (RARE) and Half-Fourier Acquisition Single-Shot Turbo-Spin-Echo (HASTE).^[19] Using RARE and HASTE sequences, image acquisition is possible within a few seconds, allowing MRCP to be performed comfortably during a single breath hold thus markedly reducing the motion artifacts and improving the quality of images.

After the introduction of MRCP several studies were performed to compare the efficacy of MRCP with various other radiological modalities. The results and the conclusions of these studies are enumerated below.

Considering few limitations of Helical CT and USG and invasiveness and complications of ERCP, MRCP alone can become the imaging modality of choice in imaging patients with obstructive jaundice, and it becomes still more superior on adding conventional MRI sections to it because, it is Non-Invasive imaging modality.

No-Ionising radiation needed.

No need of contrast media.

Multiplanar imaging capability.

Non-operator dependant.

No post procedure complications.

Can be performed in critically ill patients.

It can show biliary tract proximal as well as distal to obstruction.

Like all investigations MRCP also has a few limitations. It cannot be used for patients with metallic implants or pacemakers or patients having claustrophobia. It cannot provide therapeutic options like ERCP.

The study also has a few limitations. The accuracy of the study would have improved had the sample size been larger. Also ERCP correlation, if available would have given a complete analysis of all the diagnostic modalities of obstructive jaundice.

Conclusion

In the diagnosis of obstructive jaundice and to know the cause, site and extent of the lesion MRCP being a non invasive, non ionizing procedure seems to be a better choice

over other radiological procedures like USG , CT or ERCP. The only drawback of MRCP is the cost involved and the availability. The limitation of the study is the small sample size and that ERCP correlation for these patients was not done.

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