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Evaluation of the role of MRCP and Ultrasound in Diagnosing Obstructive Jaundice

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Abstract
Background: *Obstructive jaundice, a common clinical problem which has been documented as one of the leading causes of increased mortality and morbidity. Proper clinical data like history, physical examination, and laboratory tests can differentiate between extrahepatic & intrahepatic obstruction in 90% of patients, imaging modalities are essential in diagnosing the cause and site of obstruction.*
The diagnostic accuracy of MRCP gives it strong potential to replace the more invasive procedures like diagnostic ERCP, which should be used only in cases where intervention is being contemplated.
Method: *In this present study we have prospectively examined 38 patients with obstructive jaundice using Ultrasound and MRCP.*
Results: *Of the thirty eight patients, one hundred and one patients had benign causes of obstructive jaundice while fifty two patients had malignant causes of obstructive jaundice. MRCP had an accuracy of 95.45% in detecting the cause of obstructive jaundice while USG had a accuracy of 81.63%. The performance of MRCP when compared to USG was statistically more significant ($p<0.05$).*
Conclusion: *Assessment of obstructive jaundice and its cause, site and area of involvement of the lesion, MRCP proves to be better imaging modality over other modalities like ultrasound. It also has added advantage of being non invasive procedure with no ionization radiation.*
Keywords: *Ultrasound, MRCP, Obstructive jaundice.*

Introduction

Obstructive jaundice, a common clinical problem which has been documented as one of the leading causes of increased mortality and morbidity. Proper clinical data like history, physical examination, and laboratory tests can differentiate between extrahepatic & intrahepatic obstruction in 90% of patients, imaging modalities are essential in diagnosing the cause and site of obstruction. The main aim of any imaging procedure in obstructive jaundice is to confirm the presence of obstruction, its location, extent, probable cause, and attempt to obtain a map of the biliary tree (normal anatomy or

any variants if present) that will help the surgeon or the interventionist to determine the best approach to each case individually.

The imaging modalities commonly used are Ultrasonography (USG),Computed Tomography (CT), Endoscopic Retrograde Cholangiopancreatography (ERCP) and Magnetic Resonance Cholangiopancreatography (MRCP). Percutaneous Transhepatic Cholangiography (PTC) is used for drainage procedures.

MRCP displays the entire biliary tract and pancreatic duct without any

The diagnostic accuracy of MRCP gives it strong potential to replace the more invasive procedures like diagnostic ERCP, which should be used only in cases where intervention is being contemplated.

Aims & Objectives

- To evaluate the diagnostic accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) in diagnosis of the level and cause ofobstruction in patients with obstructive Jaundice.
- To establish the accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) over ultrasound in assessing thecauses of obstructive Jaundice.

Material and Methods

All the patients were referred with the clinical suspicion of obstructive jaundice and elevated serum bilirubin levels. Ultrasonography followed by MRCP were done for all the patients. Two radiologists reviewed the images separately and evaluated the cause and site of obstruction in patients. The accuracy of both modalities was analysed statistically and correlation was done with the surgical findings or histopathological reports.

Study Design: Prospective observational longitudinal study.

Total Study Period: 24 months

Sample Size: In this present study we have prospectively examined 38 patients with obstructive jaundice using Ultrasound and MRCP. We have examined the efficiency of MRCP as a imaging modality of choice in comparison with Ultrasound.

Equipment's Used

Ultrasound was performed on GE {LOGIQ p-5 Ver R-4.0} and Siemens Acuson Juniper machine using a 3.5 MHz curvilinear transducer. MRCP was performed on Siemens 1.5 Tesla MRI Scanner. All images were obtained with breath holding and parameters were individualized.

Inclusion Criteria

- Symptoms of obstructive jaundice were to be seen in All patients with clinical symptoms suggestive of obstructive jaundice.
- All patients with Total Bilirubin more than 5mg/dl.

Exclusion Criteria

- MRI incompatibility (metal implants, dental filling, pacemakers etc.)
- Claustrophobia
- Critically ill patients on life support
- Patients not giving consent.

Observations and Results

Statistical Analysis was performed with help of Epi Info (TM) 7.2.2.2 EPI INFO is a trademark of the Centres for Disease Control and Prevention (CDC).

Z-test (Standard Normal Deviate) was used to test the significant difference between two proportions. t-test was used to compare the means. $p<0.05$ was considered to be statistically significant.

Table-1: Distribution of age of the patients

Age Group (in years)	Number	%
<40	1	2.6%
40 - 49	7	18.4%
50 - 59	10	26.3%
60 - 69	10	26.3%
70 - 79	9	23.7%
≥80	1	2.6%
Total	38	100.0%
Mean ± s.d.	59.52±11.22	
Median	60	
Range	39 - 86	

Table-2: Distribution of gender of the patients

Gender	Number	%
Male	24	63.2%
Female	14	36.8%
Total	38	100.0%
Male:Female	1.7:1.0	

The ratio of male and female (Male:Female) was 1.7:1.0. Test of proportion showed that proportion of males (63.2%) was significantly higher than that of females (36.8%) (Z=3.73;p<0.001).

Table-3: Distribution of type of obstructive jaundice of the patients

Type of obstructive jaundice	Number	%
Benign	23	60.5%
Malignant	15	39.5%
Total	38	100.0%

60.5% of the cases were benign which was significantly higher than that of the malignant cases (39.5%) (Z=2.96; p<0.001).

Table-4: Diagnostic distribution of the patients

Diagnosis	Number	%
Cholangiocarcinoma	9	23.7%
Common bile duct calculi	8	21.1%
Gall bladder calculi with Common bile duct calculi	5	13.2%
Pancreatic carcinoma	5	13.2%
Gall bladder calculi	4	10.5%
Cystic duct calculi	2	5.3%
Papillary stenosis	2	5.3%
Biliary cystadenoma	1	2.6%
Gall bladder carcinoma	1	2.6%
Hepatic calculi	1	2.6%
Total	38	100.0%

Prevalence of Common bile duct calculi (34.3%) followed by Cholangiocarcinoma (23.7%) were significantly higher than that of other diagnoses (Z (=2.74; p<0.001).

Table-5: Distribution of USG Findings of the patients

Obstructive jaundice as per USG Findings	Number	%
Present	30	78.9%
Absent	8	21.1%
Total	38	100.0%

As per the USG findings 78.9% of the patients had obstructive jaundice which was significantly higher than that of no obstructive jaundice cases (21.1%) (Z=8.17;p<0.0001).

Table-6: Distribution of MRCP Findings of the patients

Obstructive jaundice as per MRCP Findings	Number	%
Present	34	89.5%
Absent	4	10.5%
Total	38	100.0%

As per the MRCP findings 89.5% of the patients had obstructive jaundice which was significantly higher than that of no obstructive jaundice cases (10.5%) (Z=11.17;p<0.0001).

Table-7: Distribution of level of obstruction of the patients

Level of obstruction	Number	%
Suprapancreatic	15	39.4%
Periampullary	14	36.8%
Suprapancreatic + Periampullary	6	15.8%
Periampullary + Pancreatic	2	5.3%
Hepatic	1	2.6%
Total	38	100.0%

Most of the level of obstruction was only at suprapancreatic level (39.4%) followed by only at periampullary region (36.8%) which were significantly higher than that of other level of obstruction (Z=3.37; p<0.001).

Table-8: Distribution of FNAC/HPE/ERCP findings of the patients

Findings of FNAC/HPE/ERCP	Number	%
Benign	21	55.3%
Malignant	17	44.7%
Total	38	100.0%

55.3% of the cases were benign which was higher than that of the malignant cases (44.7%) which was not significant (Z=1.49;p>0.05).

Table-9: Comparison of USG and MRCP findings of the patients

USG Finding	MRCP Findings		TOTAL
	Correctly diagnosed	Not correctly diagnosed	
Correctly diagnosed Row % Col %	30 100.0 88.2	0 0.0 0.0	30 100.0 78.9
Not correctly diagnosed Row % Col %	4 50.0 11.8	4 50.0 100.0	8 100.0 21.1
TOTAL Row % Col %	34 89.5 100.0	4 10.5 100.0	38 100.0 100.0

Since one of the cell frequencies was zero (χ^2) test could not be applied. However, Fisher Exact test showed that both USG and MRCP findings showed significantly higher proportion of obstructive jaundice cases (p<0.0001). In 34(89.5%) [In 30(78.9%) cases both showed obstructive and in 4(10.5%) cases both showed non-obstructive] findings of USG and MRCP were matched with each other.

Thus MRCP correctly diagnosed the cause of obstructive jaundice in 89.5% cases whereas USG could diagnose it in 78.9% cases. Fisher exact test showed us that the performance of MRCP when compared to USG was statistically more significant (p<0.05).

Table-11: Association between findings of USG & MRCP and HP findings to diagnose obstructive jaundice

USG and MRCP Finding	HP findings		TOTAL
	Benign	Malignant	
Obstructive Row % Col %	21 91.3 100.0	2 8.7 11.8	23 100.0 60.5
Non-obstructive Row % Col %	0 0.0 0.0	15 100.0 88.2	15 100.0 39.5
TOTAL Row % Col %	21 55.3 100.0	17 44.7 100.0	38 100.0 100.0

Out of the 21 benign cases as per HP findings 21 (100.0%) were found to be obstructive by USG & MRCP.

Out of the 17 malignant cases as per HP findings 2 (11.8%) were found to be obstructive by USG & MRCP.

Table-12: Comparison of findings of USG and MRCP with HP findings to diagnose obstructive jaundice

Comparison	Number	%
TP	15	39.5%
TN	21	55.3%
FN	2	5.3%
FP	0	0.0%
Total	38	100.0%

TP= correctly diagnosed malignant cases.
TN= correctly diagnosed benign cases.
FN=incorrectly diagnosed as benign
FP= incorrectly diagnosed as malignant.

Diagnostic Accuracy = (TP+TN) / TOTAL CASES X 100 = 94.74%

Sensitivity = TP/ (TP+FN) x 100 = 88.24%

Specificity = TN/ (TN+FP) x 100 = 100.0%

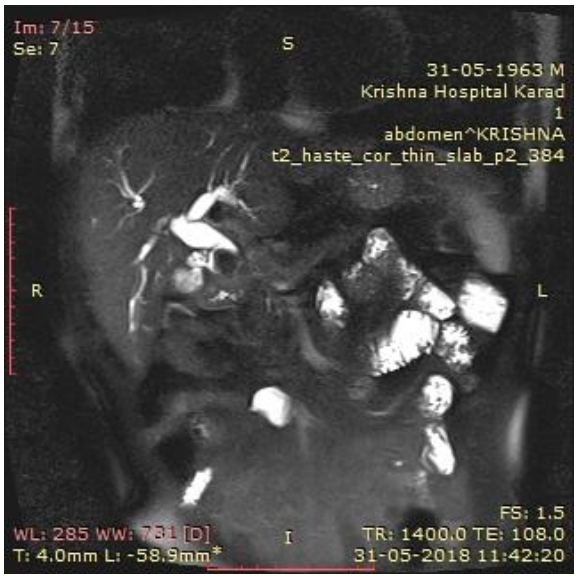
Positive Predictive Value = TP/(TP+FP) x 100 =100.0%

Negative Predictive Value = TN/(TN+FN) x 100 = 91.3%

Illustration-1

USG showing dilated common bile duct, however the cause of distal obstruction could not be found.

Illustration-2



T2 haste coronal thin slab section shows abrupt cut-off in suprapancreatic CBD. A well-defined hypointense calculus is seen at CBD.

Illustration-3

T2 haste axial FS section shows well defined round hyperintense lesion in liver with multiple round septae within. It was misdiagnosed as hepatic hydatid, but turned out as biliary cystadenoma.

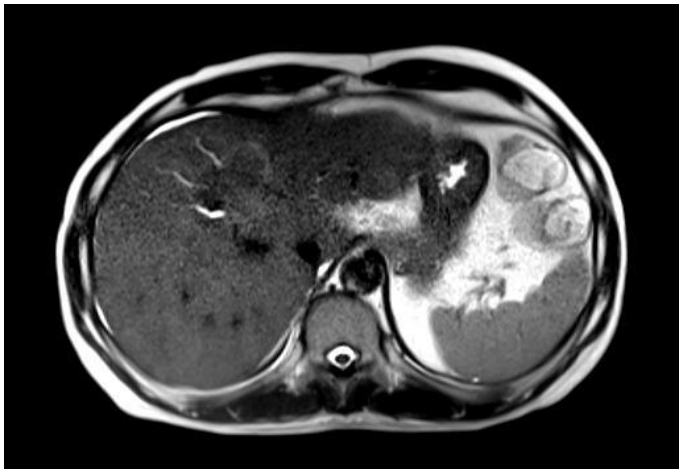
Illustration-4

T2 haste coronal thin slab section showing dilated IHBR and CBD, however no mechanical obstruction was found on imaging. On ERCP it was then confirmed as papillary stenosis.

Illustration-5

On USG ill defined hypoechoic lesion was seen in liver with adjacent dilated IHBR.

Illustration-6



T2 axial section shows ill defined hypointense lesion in liver with adjacent dilated IHBR. On HPE it was confirmed to be cholangiocarcinoma.

Illustration-7

On USG section, gall bladder shows thickened wall which appears deficient at places and was seen invading the liver.

Illustration-8

T2 haste coronal thin slab section shows irregular, thickened GB wall deficient at places invading liver. On HPE it was proven to GB carcinoma

Results

Of the thirty-eight patients, twenty-one patients had benign causes of obstructive jaundice while seventeen patients had malignant causes of obstructive jaundice. MRCP had an accuracy of 89.5 % in detecting the cause of obstructive jaundice while USG had an accuracy of 78.9%. The performance of MRCP when compared to USG was statistically more significant ($p<0.05$).

Discussion

In our present study thirty eight patients presenting with obstructive jaundice clinically were studied. Most of these patients presented with symptoms of jaundice and abdominal pain. Jaundice was the most common presentation followed by passage of white stools and complains of pruritis.

All these patients had total bilirubin of more than 5mg/dl.

Among these patients, 76.3% patients had dilated common bile duct which was significantly higher than that of not dilated cases, 23.7 %.

68.4% of the IHBR statuses were dilated which was significantly higher than that of not dilated cases (31.6%).

The range of age of patients in our study was from 39 – 86 years, with mean age of presentation being 59.52 ± 11.22. Most patients were in age group of 50-69 which was significantly higher than other age groups.

Among all these patients, 63.2 % were male and rest female, with Male:Female ratio being 1.7: 1.0.

Among the patients participating in our study, after imaging, 60.5 % were found to have benign cause which was significantly higher than malignant causes (39.5%).

USG was done before MRCP for all patients. While in USG, features and causes of obstructive jaundice were found thirty patients, it was unable to find the causes in eight patients. Whereas MRCP was successful in finding the causes of obstructive jaundice for thirty four cases.

Our present study is in accordance with the study of Soto et al, 2000 where they found, sensitivity of 94% and specificity of 100% for detection of biliary calculi in MRCP[1].

Most common level of obstruction was at supra-pancreatic level in 15 cases (39.4%), followed by periampullary region, in 14 cases (36.8%), which were significantly higher than other level of obstruction.

USG however, had a poor sensitivity in diagnosing the malignant lesions. 1(5.8%) case, which had choledocolithiasis with gall bladder sludge was stated as benign but later was confirmed to have

cholangiocarcinoma in suprapancreatic CBD as well.

There were 5(29.5%) cases USG could not find the cause of obstructive jaundice and it turned out to malignant pathologies. In 11(64.7%) cases ultrasound was successful in diagnosing the malignant pathology.

Out of the 17 malignant cases as per HP findings 14 (82.4%) were found to be malignant by MRI. Among rest of the cases, in 2(11.8%) cases of cholangiocarcinoma causing obstruction at periampullary region could not be diagnosed and in 1(5.8%) case the cause of obstruction was given as benign by MRI.

Out of the 21 benign cases as per HP findings 18 (85.7%) were found to be benign by USG. Whereas in 3(14.3%) cases USG couldnot detect the pathology and it turned out to be benign pathology, among which one was the case of CBD calculus in periampullary region and two cases were diagnosed to have papillary stenosis.

On MRCP out of these 21 cases, 19(90.5%) cases were correctly diagnosed as having benign pathologies. Only in 2(9.5%) cases of papillary stenosis no mechanical obstruction were seen in biliary tree.

Thus the diagnostic accuracy of both the imaging modalities combined was found to be 94.74%, sensitivity of 88.24%, specificity of 100%. Imaging modlaities had positive predictive value of 100% and negative predictive value of 91.3%.

In 13 cases of common bile duct calculus/ calculi, ultrasound detected calculi in 11 cases where as MRCP was able to detect all 13 cases precisely, thus sensitivity of ultrasound was 84.6 % and that of MRCP 100 %.

This is comparable to the study conducted by Hunt et al. which stated that sensitivity of approximate 77% on ultrasound[2].

Liu et al, Lomas et al in their research found that the sensitivity of MRCP to be in between 86% to 100% in different studies, which is in concordance to our study where sensitivity of MRCP was 100 %[3,4].

In 10 cases of gall bladder calculus/ calculi, ultrasound and MRCP were both able to detect all the cases accurately.

However, Shea et al reported sensitivity of approximate 88% and specificity of 80% on ultrasound in cases of gall bladder calculi[5].

Calvo MM et al found the sensitivity of MRCP to be in between 86% to 100% in different studies, which is in concordance with our study[6].

There were 2 cases of papillary stenosis (sphincter of oddi dysfunction). There were no positive findings in both these cases on MR or USG, and a possibility was raised after both imaging modalities were done.[7]

In our study, we had 1 case of biliary cystadenoma. It was misdiagnosed on USG and MR as hepatic hydatid disease. On histopathological studies it was then proved to biliary cystadenoma.

There are no literature available stating the sensitivity of either modality in correctly diagnosing the cystadenoma. However, according to study by Ahmad et al , 2017[8] the preoperative diagnosis of this entity is very low. Also, Inan et al.[9] and Oruc et al.[10] tried to differentiate all hepatic cysts from hepatic hydatid on the basis of ADC values but couldnot achieve any significant results.

In 9 cases of cholangiocarcinoma, ultrasound detected the pathology correctly in 5 cases where as MRCP was able to give definitive diagnosis in 7 cases precisely, thus sensitivity of ultrasound was 55.5 % and that of MRCP 77.8 %.

Out of 4 cases which were not diagnosed by USG, 2 cases had growth in periampullary region, 1 case in suprapancreatic CBD and the last one involved both suprapancreatic as well as periampullary region.

Out of 2 cases which were not diagnosed on MRCP as well were the ones involving periampullary region. In both these cases the image acquisition during MRCP showed due to poor acquisition and both patients were elderly and had ascites.

The rate of sonographic detection of mass in cases of cholangiocarcinoma varies from 21%-87% in studies conducted by Robledo et al, Hann et al etc [11,12].

Accuracy in predicting the pathology and extent of involvement of the biliary duct by cholangiocarcinoma varies from 88%-96% by MRCP[13].

In 5 cases of pancreatic carcinoma, both ultrasound and MRCP were able to diagnose the causative pathology in all cases.

Majority of the carcinoma arise from pancreatic head region (60% to 70%)[14]. The sonographic detection rate varies between 72%-98% in different studies like by Martinez-Noguera A et al in 2007[15].

MRCP was able to detect pancreatic carcinoma with a sensitivity ofapproximate 86%-97% in studies conducted by Faria et al, Tamm et al[16,17].

In our study we had only 1 case of GB carcinoma, which was correctly diagnosed by both USG and MRCP.

Dynamic MRI has been considered of use in the staging of gallbladder cancer. MRI combined with MRCP is highly sensitive in diagnosis of obstructive jaundice and hepatic invasion as well as spread of hepatic and lymph nodal metastasis.

It might be more difficult to appreciate any invasion to the duodenum or to look for omental metastasis by MRI[18]. Reported sensitivity values for direct hepatic invasion and lymph node invasion on MRI can be as high as 100% and 92% respectively [19].

Conclusion

Assessment of obstructive jaundice and its cause, site and area of involvement of the lesion, MRCP proves to be better imaging modality over other modalities like ultrasound. It also has added advantage of being non-invasive procedure with no ionization radiation.

However, few drawbacks associated with MRCP are its availability and cost.

In the following study, small sample size and the disease spectrum in the patients we got during the stipulated time for the study were the limitation of the study.

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