International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 7, July 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.7.2024.4

ORIGINAL RESEARCH

Diagnostic accuracy of Ultrasonography& Magnetic resonance cholangiopancreatography in obstructive jaundice patients – A comparative study

Dr. Chandini Reang[1], Dr. Bithika Jamatia[2], Dr. Jaybrata Ray[3]

[1]Assistant Professor, Department of Radio diagnosis, Tripura Medical College & DR BRAM Teaching Hospital, Tripura, India
[2]Consultant Physician, MD Medicine, IGM Hospital, Tripura, India
[3]Associate Professor, Department of Radio diagnosis, Agartala Government Medical College & G.B. Pant Hospital, Tripura, India

Corresponding Author
Dr. Chandini Reang
Assistant Professor, Department of Radio diagnosis, Tripura Medical College & DR BRAM Teaching Hospital, India

Received Date: 25 May, 2024 Acceptance Date: 28 June, 2024

ABSTRACT

Background and Objective: Obstructive jaundice is a common problem routinely seen in clinical practice. The diagnosis relies on proper history taking, clinical examination, laboratory investigations and different non invasive imaging modalities. Ultrasonography (USG) and magnetic resonance cholangiopancreatography (MRCP) are non-invasive modalities for evaluation of patients with obstructive jaundice. USG is widely available and cost effective modality compared to MRCP. But the value of USG is limited in obese patients and distal CBD evaluation due to poor window caused by bowel gas. With this knowledge, the aim of the study is to evaluate the diagnostic accuracy of USG and MRCP in detecting the level and cause of obstructive jaundice considering the gold standard being the final diagnosis made at surgery/Endoscopic retrograde cholangiopancreatography (ERCP)/biopsy. **Settings and Design:** Comparative study. **Material and Methods:** The study was included 60 consecutive patients who were referred to the department of Radio-diagnosis with the clinical suspicion of obstructive jaundice and elevated serum bilirubin levels. USG followed by MRCP were done in all the patients and findings were correlated with per operative, biopsy and ERCP report to calculate the diagnostic performance. **Results:** Of the 60 patients with obstructive jaundice, thirty six patients had benign while twenty four patients had malignant etiology. Most common benign causes observed was choledocholithiasis (77.77%) and malignant cause was carcinoma gall bladder (33.33%). For diagnosing the cause of obstructive jaundice, MRCP has a diagnostic accuracy of 97.2% and USG has a diagnostic accuracy of 86.4%. The sensitivity of MRCP is greater than USG in diagnosing the cause of obstructive jaundice. In diagnosing the level of obstruction, MRCP had an accuracy of 100%, while USG 81%. **Conclusion:** The results of this study demonstrate MRCP has a high diagnostic accuracy, high sensitivity and moderate specificity compared to ultrasound in diagnosis of the level and cause of obstruction in obstructive jaundice patients. But USG may be considered as an initial screening test and MRCP for definitive treatment planning.

Key words: Magnetic resonance cholangiopancreatography, Ultrasonography, Obstructive jaundice, Hepato-biliary diseases, pancreatic pathologies.

INTRODUCTION

Obstructive jaundice is one of the most frequent and grave form of hepato biliary disease. Its results from obstruction to the flow of bile into the duodenum. Obstructive jaundice itself is not a disease but a symptom of underlying conditions of the liver, the gallbladder or the pancreas and requires surgical intervention. So, it is important to distinguish between the possible causes of obstructive jaundice and mandatory to determine preoperatively the existence, the nature and site of obstruction because an ill chosen therapeutic approach can be dangerous. Ultrasound is used as an initial modality to confirm or exclude duct obstruction, which it does with at least 90% accuracy[1]. However, USG is operator dependent and has a limitation in patients with obesity and those with large amount of bowel gas.

On the other hand Magnetic resonance

DOI: 10.69605/ijlbpr_13.7.2024.4

Cholangiopancreatography (MRCP) techniques have greatly evolved, and have emerged as an accurate, non invasive means of visualization of the biliary tree and pancreatic duct without injection of contrast material[2]. 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[3]. 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.

Though it has a huge potential studies have shown few pit falls which may hamper its accuracy. It is not widely available, expensive, cannot be done in claustrophobic patients or with aneurysm clips or cardiac pacemakers, long cystic duct running parallel to the common bile duct may simulate a dilated common duct, whilst a contracted choledochal sphincter may mimic an impacted stone or stricture in the distal common bile duct, pulsatile vascular compression from adjacent vessels may mimic a stricture, filling defects in the bile may arise, not only from bile duct calculi but also from the presence of gas, debris, hemorrhage[4].

Hence, aim of the present study was to compare the diagnostic accuracy between Magnetic Resonance Cholangiopancreatography (MRCP) and Ultrasonography (USG) in detection and characterization in patients suspected with pancreatic and biliary system pathologies.

AIM& OBJECTIVES

1. To compare the diagnostic accuracy of Ultrasonography and Magnetic Resonance Cholangiopancreatography in evaluation of patients with clinical features of biliary obstructive disease.
2. To assess the sensitivity and specificity of Ultrasonography and Magnetic Resonance Cholangiopancreatography in diagnosis of obstructive jaundice.
3. T o identify the etiology, location and extension of disease.

MATERIALS AND METHODS

Patients with clinical and laboratory features suggestive of obstructive jaundice referred to the Radio-diagnosis Department of AGMC&GBP Hospital for ultrasonography were taken as a target population during the study period of 02years (2016 - 2018).60 patients were included in our study. USG followed by MRCP were done in all the patients.

Exclusion criteria

1. Patients having cardiac pacemakers and electromagnetic implants.
2. Patients with claustrophobia.
3. Patients not giving he consent for study.

The armamentarium used had the specifications as under

- SIEMENS 3.0Tesla (SKYRA model) installed in AGMC &GBP hospital, with workstation and software.
- SIEMENS ACUSONX 300 ultrasonography machine with 3.5 Hz frequency
- MEDISON SONOACEX 8 ultrasonography machine with 3.5 Hz frequency,

The data entered in master chart and proportion, mean, standard deviation and other statistical tests are applied as per need and analyzed using appropriate statistical software. E.g. SPSS16 statistical package. Results are obtained, discussed and compared with the available literature and conclusions are drawn keeping in mind the limitation of study. Final diagnosis was made with per operative or histopathological correlation/ERCP findings.

ETHICAL APPROVAL

The study was conducted after getting approval from the ethical committee, AGMC & GBP Hospital, Agartala.

OBSERVATIONS & RESULTS

Our study was conducted to assess diagnostic accuracy of Ultrasonography& Magnetic resonance cholangiopancreatography in obstructive jaundice patients and consists of 60 patients. The youngest patient of our study was 9 years old and the oldest was 85 years. The mean age of patients with benign lesions was 37.4 years and that with malignant lesions was 46.5 years. All the lesions were detected by both USG and MRI with MRCP. USG characterized 36 patients had benign cause of obstructive jaundice, out of which, 3 cases (8.3%) turned out to be malignant.

Out of 36 cases characterized benign by MRI with MRCP imaging, only 1 case (2.7%) turned out malignant. Out of 24 cases characterized as malignant by MR with MRCP, 1 case (4.1%) turned out to be benign.

Table-1: Table showing Age distribution of study subjects

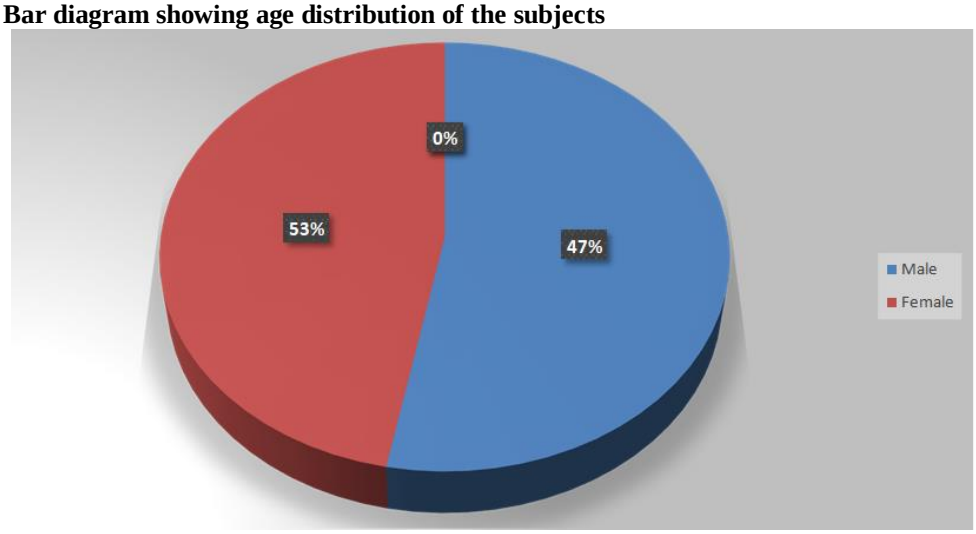
Age group	No. Of patients	Percentage (%)
1-10years	02	3.33
11-20years	00	00
21-30years	02	3.33
31-40years	10	16.66
41-50years	09	15.00
51-60years	11	18.33

DOI: 10.69605/ijlbpr_13.7.2024.4

61-70years	13	21.66
71-80years	12	20.00
>81years	01	1.66
Total	60	100

In the study it was observed that majority i.e.22% of the patients with obstructive jaundice were between 61-70 years of age. The youngest patient was 9 years old with choledochal cyst and the oldest was 85years with GB carcinoma.

Figure 1: Bar diagram showing age distribution of the subjects



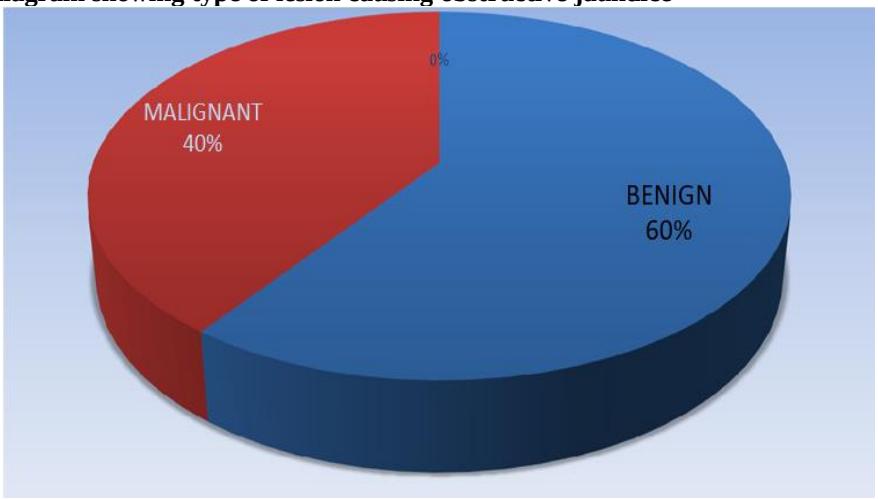
In our study it was observed that majority i.e. 53% of the patients with obstructive jaundice were females. It is evident that there is female preponderance in hepato-biliary disorders.

Table 2: Distribution of subjects according to presenting complaint

Presenting complaint	No. of patients	Percentage (%)
Jaundice	25	41.66
Vomiting	15	25.00
Abdominal pain	10	16.66
Abdominal lump	05	8.33
Itching	03	5.00
Loss of appetite	02	3.33
Total	60	100

In the study it was observed that most common presenting complaint is jaundice i.e.41.66% followed by vomiting (25%), abdominal pain, abdominal lump, itching and loss of appetite.

Figure 2: Pie diagram showing type of lesion causing obstructive jaundice



It was observed that the most common cause for obstructive jaundice is benign causes i.e. in 60% compared to malignancy i.e. 40%.

DOI: 10.69605/ijlbpr_13.7.2024.4

Table 3: Table showing benign causes for obstructive jaundice among the study subjects

Benign causes	No. of patients	Percentage (%)
CBD calculi	20	55.55
CBD calculi with GB calculi	8	22.22
Benign stricture	4	11.11
Choledochal cyst	2	5.55
Cholangitis with RHD calculi	2	5.55
Mirizzi syndrome	1	2.77
Total	36	100

It was observed that the most common benign cause for obstructive jaundice was CBD calculi with GB calculi and benign stricture i.e. 88.88%. Least common cause for obstruction was cholangitis and Mirizzi syndrome.

Table 4: Table showing malignant causes for obstructive jaundice among the study subjects

Malignant causes	No. of patients	Percentage (%)
Ca Gall bladder	8	33.33
Periampullary Ca	6	25.00
Cholangiocarcinoma	5	20.80
Ca head of pancreas	3	12.50
Klatskins tumor	1	4.16
Malignant duodenal lesion	1	4.16
Total	24	100

In the study it was observed that the most common malignant cause for obstructive jaundice was Ca gall bladder i.e. 33.33%. Least common cause for obstruction was Klatskins tumor and malignant duodenal mass i.e. 4.16%.

Table 5: Table showing distribution of the cases on the basis of level of biliary obstruction by USG and MRCP

Level of obstruction	No. of level of obstruction with Percentage(%)			
	USG		MRCP	
Hepatic	14	23.33	14	23.33
Supra pancreatic	30	50.00	40	66.66
Intra pancreatic	3	5.00	6	10.00
Total	47	78.33	60	100

In the study it was observed that MRCP correctly identify the level of obstruction (100%) as compared to USG (78.33%).

Table 6: Table showing comparison of diagnosis in patients of the suspected biliary obstruction

SL.NO	Causes of obstruction	USG	MRCP	Final diagnosis(surgical/histopathological/ERCP)
1	Choledocholithiasis	15	19	20
2	CBD calculi with GB calculi	8	8	8
3	Benign stricture	2	4	4
4	Choledochal cyst	2	2	2
5	Cholangitis with RHD calculi	1	1	1
6	Mirizzi syndrome	1	1	1
7	Ca Gall bladder	6	8	8
8	Periampullary Ca	2	5	6
9	Cholangiocarcinoma	4	5	5
10	Ca head of pancreas	2	3	3
11	Klatskins tumor	1	1	1
12	Malignant duodenal lesion	0	1	1
	Total	42	58	60

In my study it was observed that based on surgical/histopathology/ERCP diagnosis, MRCP has more diagnostic ability as compare to USG in different causes of obstructive jaundice

Table No. 7: Showing performance of USG and MRCP for different causes of obstructive jaundice

SL.NO	Causes of obstruction	True positive		True negative		False positive		False negative	
		USG	MRCP	USG	MRCP	USG	MRCP	USG	MRCP
1	Stone	23	26	3	1	0	0	2	1
2	Malignant obstruction	16	21	3	1	2	0	3	2

DOI: 10.69605/ijlbpr_13.7.2024.4

3	Benign stricture	1	4	2	0	0	0	1	0
4	Choledochal cyst	1	1	1	0	0	0	0	0
5	Mirizzi syndrome	1	1	0	0	0	0	0	0
6	Cholangitis	1	1	0	0	0	0	0	0

SL.NO	Causes of obstruction	Sensitivity (%)		Specificity (%)		Positive predictive value (%)		Negative predictive value (%)		Accuracy (%)	
		USG	MRCP	USG	MRCP	USG	MRCP	USG	MRCP	USG	MRCP
1	Stone	92	96	100	100	100	100	60	100	92.85	96.42
2	Malignant obstruction	80	96	60	100	89	100	50	100	79.16	91.66
3	Benign stricture	50	100	100	100	100	100	67	100	75.00	100
4	Choledochal cyst	100	100	100	100	100	100	100	100	100	100
5	Mirizzi syndrome	100	100	100	100	100	100	100	100	100	100
6	Cholangitis	100	100	100	100	100	100	100	100	100	100

Figure 3: Bar diagram showing performance of USG for different causes of Obstructive jaundice

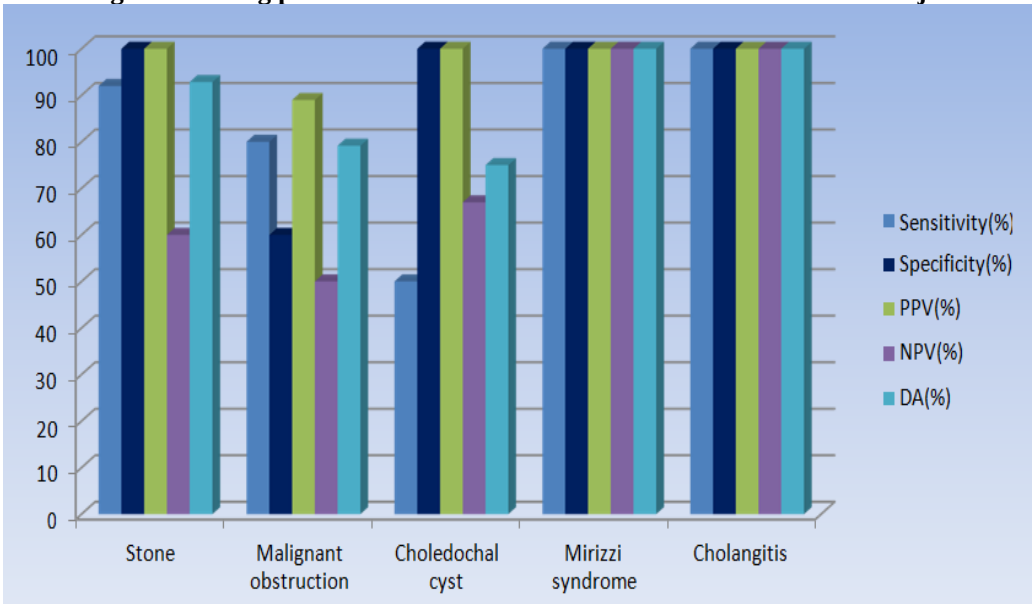
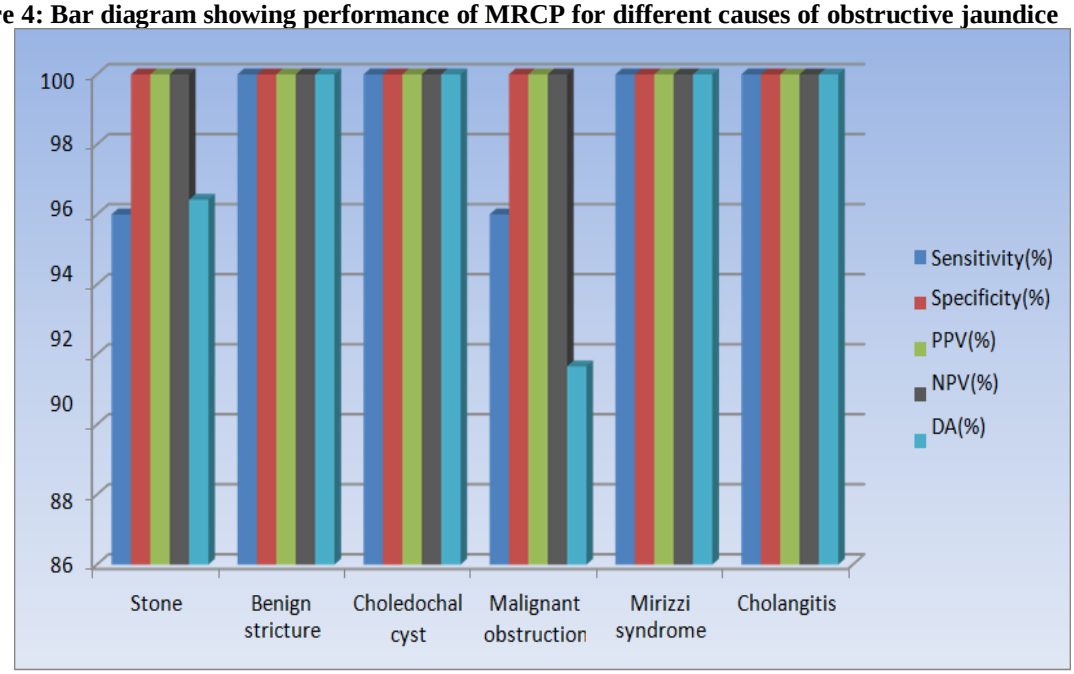


Figure 4: Bar diagram showing performance of MRCP for different causes of obstructive jaundice



DOI: 10.69605/ijlbpr_13.7.2024.4

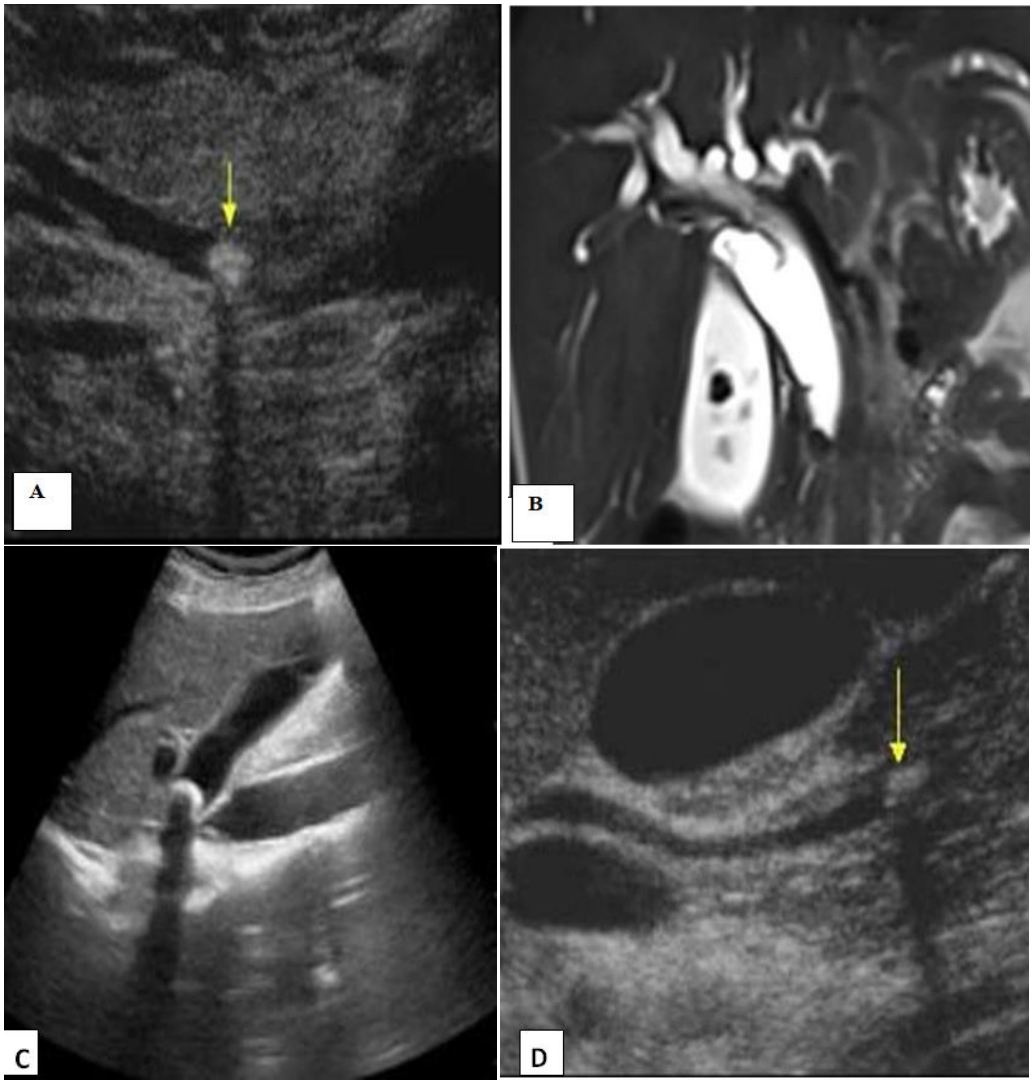


IMAGE 1: Cholelithiasis and CBDcalculi.USG image–(A, D)A small calculus in mid part of CBD and distal part of CBD.(C) A rounded calculus in gallbladder lumen. MRCP image-(B)Multiple calculi in gallbladder lumen with a small calculus in distal part of CBD with dilated CBD and IHBR on T2HASTEcoronal STE coronal

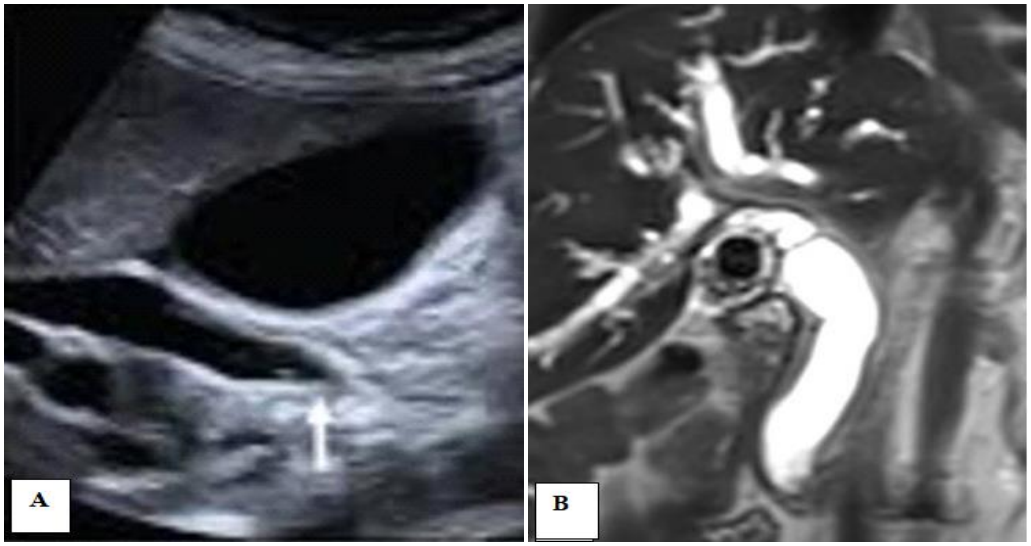


IMAGE 2: Benign stricture of CBD. USG image – (A) Smooth narrowing of distal part of CBD. MRCP image –(B) Smooth narrowing of distal part of CBD with dilated CBD and IHBR on T2HASTE coronal with a calculus in gall bladder neck.

DOI: 10.69605/ijlbpr_13.7.2024.4

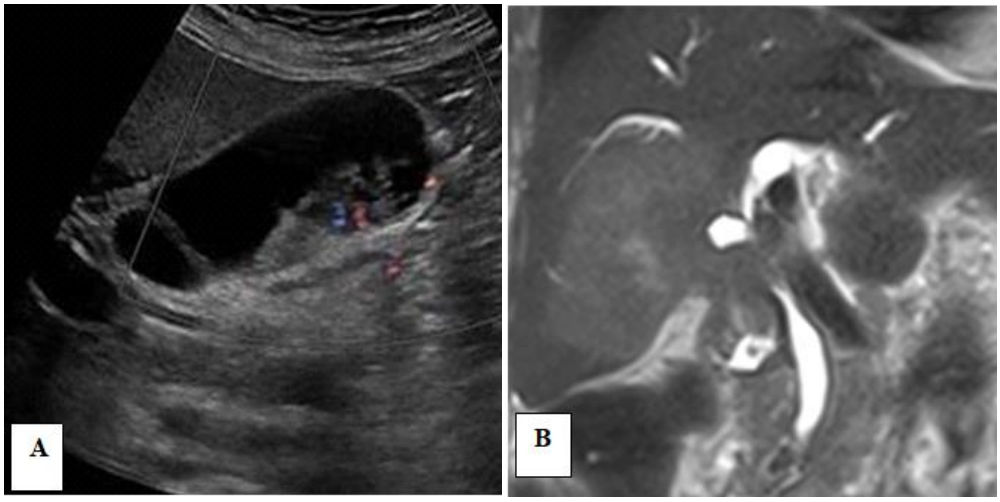


IMAGE 3: Carcinoma gall bladder. USG image- (A) Ill-defined soft tissue mass lesion in gall bladder with intralesional flow. MRCP image-(B) Ill-defined mild heterogeneous lesion in gall bladder fossa with confluence and CHD invasion T2 HASTE coronal

IMAGE 4: Cholangiocarcinoma. USG image – (A) An ill-defined soft tissue mass lesion in common hepatic duct with dilatation of IHBR. MRCP image – (B)Ill-defined mass lesion in common hepatic duct with upstream dilatation of biliary radicals seen on T2HASTE coronal

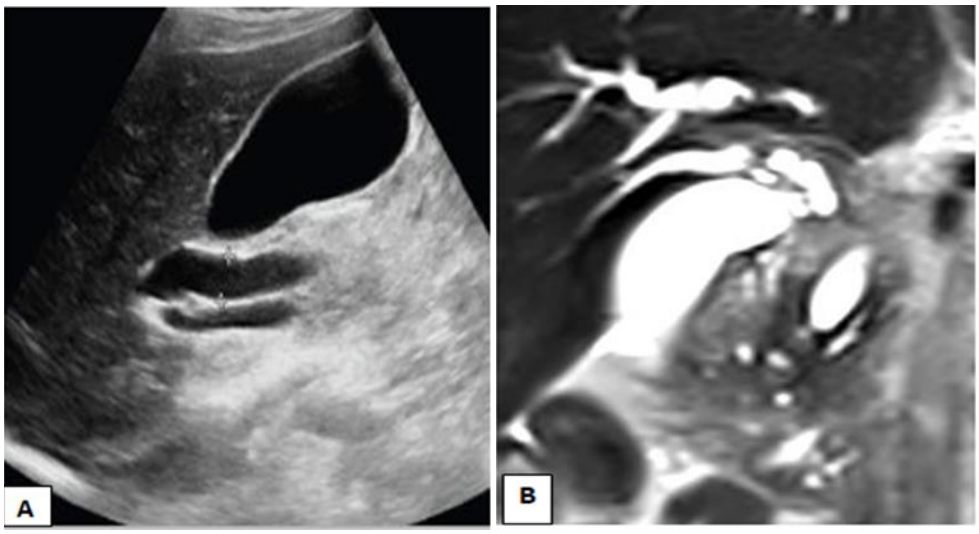


IMAGE 5: Periampullarycarcinoma.USG image – (A) Dilatation of CBD is noted with non-visualization of distal part of CBD. MRCP image – A periampullary mass with dilatation of biliary radicals compressing the distal part of CBD on T2 HASTE coronal (B)

DOI: 10.69605/ijlbpr_13.7.2024.4

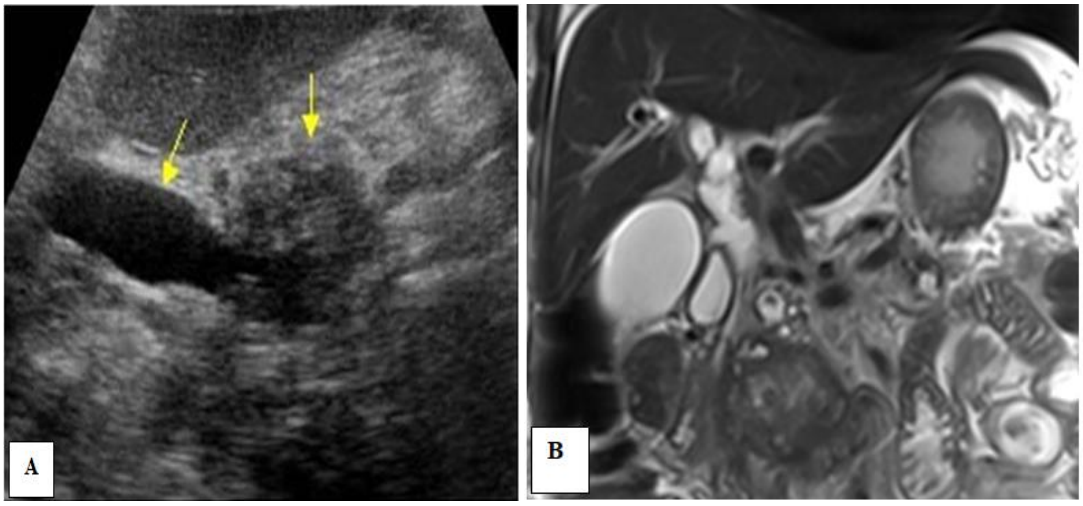


IMAGE 6: Ca head of pancreas.USG image-(A) Irregular margined soft tissue mass lesion is seen in head of the pancreas with invasion of distal part of CBD results in dilatation of CBD. MRCP image-(B) Ill-defined heterogeneous lesion in head of pancreas invading duodenum on coronal T2 HASTE.

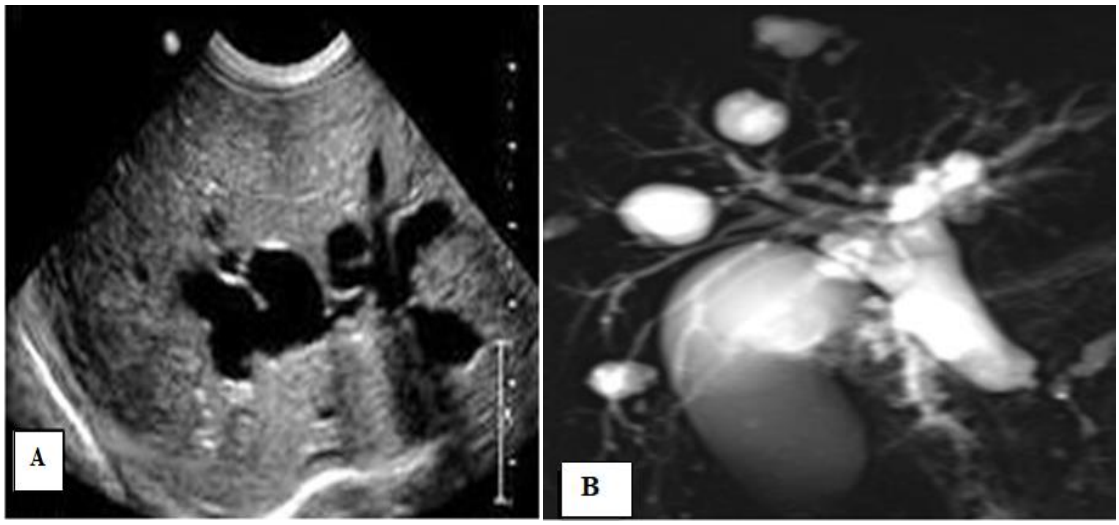


IMAGE 7: Choledochal cyst. USG image –(A) Segmental, saccular, or beaded appearance of the intrahepatic bile ducts(Type V). MRC image- (B) T2 Haste thick slab coronal shows multiple, segmental cystic spaces in biliary tree.

DISCUSSION

Jaundice is not a disease per se, but rather a visible sign of an underlying disease process. Diagnosing patients with suspected biliary or pancreatic pathologies in their early stage is most important in patient care and management. Knowledge of the advantages and disadvantages of each technique are needed to determine the appropriate work up of patients with these pathologies.

Ultrasonography, a non invasive, non ionizing, easy available and cost effective imaging modality. USG made possible to clarify the mist for the clinicians and be more specific in their diagnosis regarding the nature, extent, size and probable pathology leading to cholestasis. So USG is the initial technique which guides to choose patients for MRCP examination in obstructive jaundice patients. This modality of diagnosis though widely used, but it has diagnostic limitations in case of obese patients, gaseous abdomen and visualization of distal CBD.

With the introduction of MR Cholangiopancreatography in addition with conventional MRI, diagnosing hepato-biliary and pancreatic ductal pathologies invasive procedure like ERCP can be avoided solely for the purpose of diagnosis.

In our study we have studied 60 patients suffering from various causes of obstructive jaundice.

Maximum numbers of patients (47.3%) were adults in the age group of 51-60 years. This correlates with the study of Verma et al.[5] in most commonly affected age group was 50-60 years (mean age affected 50.4 years). In similar study by Al-Obaidi et al.[6] most of the patients were in 60-69 years age group.

Our study showed female predominance with 53% female patients which correlates with the study by Singh et al.[1]where majority of patients were females 27(54%) and 23 (46%) were males with male to

DOI: 10.69605/ijlbpr_13.7.2024.4

female ratio being 1:1.7. But in similar study by Goud set al.[7] maximum were male population (68%).

All of our cases presented with mostly were jaundice(42%) and vomiting (25%) respectively. Most common sign encountered in our study was icterus. The study is similar with Verma et al.[5] and Ankur Attriet al.[8]. They also encountered jaundice (82%) is a most common presented complaint followed by vomiting in their study (72%).

In our study the most common cause for obstructive jaundice is benign lesions i.e. 36(60%) cases out of 60 patients compared to malignant lesions which are accounting 24 (40%) cases. The study is similar to Singh A et al.[1] However, in a study done by Siddique et al.[9] majority of patients had malignant obstructive jaundice, i.e., 56.66% (34/60) while the benign lesions were seen in 43.33% (26/60).

In our study, twenty out of 60 patients proved to have a CBD stones. USG diagnosed 15 patients out of 20 cases with CBD stones, while MRI-MRCP correctly diagnosed the presence of CBD stones in all cases but there is one false negative case of small CBD stone that is seen in surgical finding. USG showed difficulty in picking up distal CBD calculus in 5 patients, diagnosed clearly with MR with 96% accuracy. This shows that MR with MRCP is superior to USG in detecting CBD calculi and other distal CBD pathologies. Our study is in concordance with Guibad et al.[10] In their study they found an accuracy of 100% in detecting CBD calculus on MRCP in cases with equivocal sonographic results.

In imaging of benign lesions(n=36) MR with MRCP diagnosed CBD with GB calculi in all 8 patients with such a final diagnosis showing 100% accuracy in detecting CBD and GB calculi. Our study is in concordance with Soto et al.[11]; In their study they found sensitivity of 94% and specificity of 100% for detecting biliary calculi in MRCP.

In our study, 2 out of 4 patients with benign CBD strictures, proved by ERCP & surgery to have post cholecystectomy strictures. USG did not detect the strictures in two cases while MRI-MRCP detected all cases correctly. Study conducted by Al Obaidi et al.[6] showed higher sensitivity (100%), specificity (98.5%), accuracy (98.7%) of MRI/MRCP for cases with benign stricture as compared to sensitivity of USG (44.4%) which is consistent with present study.

Two cases out of 60 proved to have choledochal cysts. USG and MRI-MRCP correctly diagnose the two cases. Our study is comparable to Bhatt et al.[12] In their study they found 100% accuracy for MRCP in diagnosing anatomical variants.

In our study, MRI-MRCP was correct in defining the level of obstruction in all cases. While USG was correct in 47 cases out of 60 patients (constituting 78 % of cases). Pavone et al.[13] in 2000 reported that the accuracy of MRCP in diagnosing the presence of obstruction ranges between 91- 100%, whereas the level of obstruction could be correctly evaluated in 85-100% of cases that approximates our results.

In our study, 24 cases diagnosed as malignant causes of obstructive jaundice. In our study, USG detects 17 out of 24 cases of tumors. On the other hand, MRI-MRCP suggests the correct diagnosis in 23 out of 24 cases with tumors. Our MRI results are similar to the results of studies done by Yousif S et al.[14] & Pavone et al.[13]

In imaging of malignant lesions (n=24), GB Carcinoma diagnosed all 8 cases by MR with MRCP while USG correctly diagnosed 6 cases. Conventional MRI added a lot once again in arriving final diagnosis. Liver metastasis is shown clearly by both the modalities. Our study is in concordance with Bhatt et al.[12] in their study they found an accuracy of 100% for MRCP alone in diagnosing GB Carcinoma.

In our study, 6 cases of periampullary growth were diagnosed with histopathological correlation. Among these 5 patients were diagnosed to have periampullary growth in MR with MRCP and 2 cases by USG. One patient was diagnosed to have stricture disease among the periampullary growth patients, due to technical fault and due to patient non-cooperation in both the modalities. Our study is in concordance with Anderrson et al.[15] In their study they found 90%accuracy for MR in diagnosing periampullary growth.

In 5 patients with extra hepatic cholangiocarcinoma MR with MRCP diagnosed all five cases with a100% accuracy, while USG clearly showed growth in 4 cases and with suspicion in remaining 1 case, thus approaching 100% accuracy for MR with MRCP compared to accuracy in USG. Our study is in accordance with Andersson et al.[15] found that among MR with MRCP strictures with malignant characteristics at MRCP were the only independent predictor of malignancy.

One case has been diagnosed to have malignant mass lesion in duodenum by MRCP approaching 100% accuracy while USG failed to diagnose. In our study 3 patients were diagnosed to have Klatskins tumor, and the accuracy of two modalities remain 100% . Our study is in concordance with Bhatt et al.[12] in their study they found accuracy of 100% for MRCP alone in diagnosing Klatskins tumor.

In our study 5 cases were diagnosed as a ca head of pancreas. Among these all cases were correctly diagnosed by MRCP with accuracy of 100% while USG correctly diagnosed only 2 cases.

In present study, it is proved that MRCP is better than USG in diagnosing malignant cause of obstructive jaundice with the diagnostic accuracy of 79% and 92% respectively.

Overall our study depicts, for diagnosing the cause of obstructive jaundice, MRCP has a diagnostic accuracy of 97.2% while USG has a diagnostic accuracy of 86.4%. In the study conducted by Singh et al.[1] overall diagnostic accuracy of MRCP has 98% and USG has a diagnostic accuracy of 88%.

DOI: 10.69605/ijlbpr_13.7.2024.4

LIMITATIONS

- The study is a hospital based study involving only one tertiary hospital. The demographic profiles of obstructive jaundice found in our study may not be representative of actual distribution of the disease in the community.
- Sample size is small.
- USG and MRCP interpretation was done by same radiologist who was on duty, so blinding could not be done in these cases. On the other hand, inter observer variations was also there because of different days interpretation by different radiologist.
- The assessment and management of the patients were done by different physician/surgeons on duty, so inter observer variations was there.
- MRCP cannot provide therapeutic option to the patient/Claustrophobia.
- Some patients were unable to hold their breath for the interval required which compromised the quality of the 3DMRCP sequence.

CONCLUSION

Obstructive jaundice is associated with significant morbidity and mortality. Correct choices among therapeutic options usually rest upon a precise assessment of etiology, location, level and extent of disease. In these regards, USG is considered as a screening modality in patients suspected of obstructive jaundice due to its non-invasiveness, lacks of radiation exposure & wide availability. It can be used for follow up imaging after treatment also.

MRCP is an accurate, non invasive modality and should be the radiological investigation of choice in obstructive jaundice patient and has the potential to become the new Gold standard investigation for diagnosis owing to its excellent diagnostic performance.

REFERENCE

1. Singh A, Mann HS, Thukral CL, Singh NR. Diagnostic Accuracy of MRCP as Compared to Ultrasound/CT in Patients with Obstructive Jaundice. Journal of Clinical and Diagnostic Research. 2014;8:103-107.
2. M.A. Barish and J.A. Soto. MR Cholangiopancreatography: Techniques and clinicalapplications.AJR 1997;169:1295-1303.
3. Jorge A, Soto et al. MRCP: Findings on 3D fast spin-echo imaging.AJR1995;165:1397-1401.
4. L. Van Hoe, D. Vanbeckevoort, K. Mermuys, W. Van Steenbergen. MR Cholangio-pancreatography, Atlas with Cross-Sectional Imaging Correlation, Second Edition ,October2005
5. Verma S, Sahai S, Gupta P, Munshi A, Verma S, Goyal P. Obstructive jaundice-aetiological spectrum, clinical, biochemical and radiological evaluation at a tertiary care teaching hospital.Int JTropMed 2010;7:2.
6. Al-Obaidi s Mohammed Ridha Alwan, Al-Hilli Atheer Adnan Fadhel.The role of ultrasound and magnetic resonance imaging in the diagnosis of obstructive jaundice. Iraqi postgrad Med J2007; 6:7-17.
7. Goud S, Devi BV, Kale PK, Lakshmi AY, Reddy VV. To study diagnostic efficacy of ultrasound and magnetic resonance imaging in the diagnosis of obstructive jaundice. JNTRUniv Health Sci 2020; 9:217-21.
8. Ankur Attri, Ritu Dhawan Galhotraetal. Medical Journal of Dr. D.Y. PatilUniversity.July-August2016; 9 (4): 444-450.
9. Siddique K, Ali Q, Mirza S, Jamil A, Ehsan A, Latif S, et al. Evaluation of the aetiological spectrum of obstructive jaundice. J Ayub Med Coll Abbottabad2008;20:62-6.
10. Guidbaud L, Bret PM, Reinhold C, Atri M, Barkum AN. Diagnosis of choledocholithiasis: value of MR Cholangiography. AJR 1994 ; 163: 847-850.
11. Jorge A, Soto et al. MRCP: Findings on 3D fast spin-echoimaging.AJR1996;165(6):1397-1401.
12. Bhatt C, Shah PS, Prajapati HJ, Modi J. Comparision Of Diagnostic Accuracy Between USG and MRCP In Biliary And Pancreatic Pathology. Ind J Radiol Imag.2005;15(2):178-81.
13. Pavone P, Laghi A, Catano C, et al. MRI of the biliary & pancreatic duct .In: Baert AL, Adam G, Debatin JF, eds. Syllabus, MRI from basic knowledge to advanced strategies.Springer,ECR2000:132-147.
14. Yousif S, the role of MRI and MRCP in patients suspected of pancreaticobiliarydisorders. A thesis submitted to the department of radiology. Medical college. University of Baghdad. 2001.
15. Andersson M, Kostic S, , Lundell L, Asztely M, etal. MRI combined with MR cholangiopancreatography versus helical CT in the evaluation of patients with suspected periampullary tumors: a prospective comparative study. Acta Radiologica2005;46:16-27.