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Accuracy of 1.5 Tesla MRI and Ultrasonography in Diagnosis of Biliary Diseases

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I. Introduction

Disorders of the biliary tree affect a significant portion of the population with a wide spectrum disorder ranging from gall stones to deadly malignancies such as cholangiocarcinoma.(**1)**

Cholelithiasis and choledocholithiasis are common in middle aged females. If untreated, they may lead to complications such as cholangitis, sepsis, hepatic failure, biliary cirrhosis, malignancies (long standing cases).Anatomic variations of the biliary tree occur in more than 50% individuals.(**2)** Anomalous biliary anatomy is frequently encountered by surgeons during cholecystectomy. Importance of its recognition lies in avoiding serious biliary injuries.**(3)**

Evaluation of suspected biliary tract diseases is a common radiological problem and is diagnosed by a variety of imaging modalities including Ultrasonography (USG), Computed tomography (CT), Magnetic resonance cholangiopancreatography (MRCP). ERCP is used by intervention and diagnostic procedures.**(4)**

In a suspected case of biliary obstruction with clinical and laboratory findings suggestive of obstructive Jaundice, the main aim of radiologist is to confirm the presence of obstruction and to identify its location, extent and probable cause. In suspected biliary obstruction, Ultrasonography is being used as the initial screening procedure due to its many advantages such as ready availability, cost effectiveness and no requirement of contrast material and lack of ionizing radiation. Though it is very useful to visualize the common hepatic duct and proximal common bile duct, but its major limitation in the visualization of distal common bile duct and pancreas, due to obscuration by overlying gas in 30 -50 % of cases and obesity can degrade the image quality.**(5)**

MRCP is a non-invasive technique for work-up of patients with suspected biliary obstruction, which has gained popularity because of its excellent diagnostic capabilities ln the evaluation of biliary obstruction the important advantages of MRCP are complete mapping of the ductal system, noninvasiveness, no requirement of contrast material and lack of exposure to ionizing radiation and its ability to produce highly accurate cholangiographic images, similar in appearance to those obtained by invasive procedures like Endoscopic Retrograde Cholagiopancreatography(ERCP), yet combining the patient safety and comfort associated with ultrasound.**(6)**

MRCP delivers important anatomic details of the biliary tree; it is superior to CT in diagnosing the hepatocholedochallithiasis; MRCP tends to replace endoscopic retrograde cholangiopancreatography (ERCP)-the diagnostic "gold standard" reducing the number of unnecessary evolve diagnostic procedures.**(7)**

Objectives

i. To study the demographic profile of patients with Biliary Pathologies.
ii. To Detect, localize and characterize the Biliary Pathologies by MRI and USG.
iii. To compare the results of MRI and USG in Diagnostic accuracy, Sensitivity, Specificity in respect to biliary pathologies.

II. Materials and Methods

Study population: OPD and indoor patients attending USG unit at Dept. of Radiodiagnosis, Medical College Kolkata and EKO MRI at Medical College, Kolkata.

Sample size: A total of 90 patients of all age and sex groups referred to the Dept of Radiodiagnosis, Medical College, Kolkata were taken after informed consent for USG followed by MRI.

Study Design: Institution based prospective, comparative study.

Period of Study: January 2017 to December 2017.

Inclusion criteria: Patients of all age groups belonging to either sex with suspected biliary pathologies by clinical examination and biochemical tests were included in the study. Patients with elevated Serum Bilirubin > 2.5gm/dl were considered as having biliary obstruction.

Exclusion criteria:

- Patients who have received surgical treatment for obstructive jaundice or any other intervention directed at diagnosis, which may alter the gross morphology.
- Unstable patients, claustrophobic patients or having any MR incompatible devices.
- Patient not giving consent for examination.

Study tools :

- Datasheet of patient
- Biochemical Reports of patient
- Ultrasonography: Ultrasonography machine- Philips iU22 Ultrasound system using C5-2 Abdominal Transducers and L9-3 Linear Transducer (when required).
- MRI: MRI was done using GE VOYAGER 1.5T MRI including MRCP images
- Operative notes, if any.
- Histopathology Reports

III. Results and Analysis

The study consists of 54 females and 36 males. The youngest patient was 10 years and the oldest was 76 years. The distribution of Demographic characteristics of study sample is tabulated below.

Table 1: Gender Distribution

	Gender	Frequency	Percent
	Female	54	60.0
	Male	36	40.0
	Total	90	100.0

From the above Table-1, Males comprised 40% and females 60% of the total cases. Same subjects were included in both MRCP and USG. There is a female predominance in our study.

Chart 1: Gender Distribution

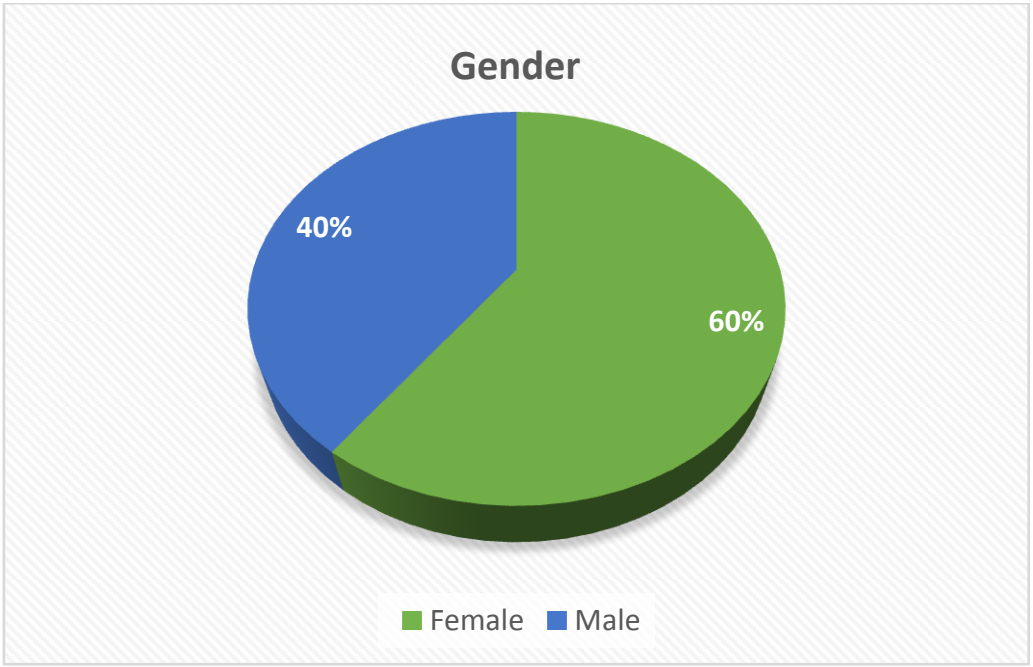


Table 2: Age Distribution

	Female		Male		Total	
Age Group (Years)	N	Percent	N	Percent	N	Percent
10-19	1	1.11%	1	1.11%	2	2.22%
20-29	3	3.33%	2	2.22%	5	5.56%
30-39	15	16.67%	7	7.78%	22	24.44%
40-49	18	20.00%	9	10.00%	27	30.00%
50-59	11	12.22%	6	6.67%	17	18.89%
60-69	4	4.44%	9	10.00%	13	14.44%
70-80	2	2.22%	2	2.22%	4	4.44%
Grand Total	54	60.00%	36	40.00%	90	100.00%

Table 2 shows age distribution between our patients. 27 (30%) were in the age group of 40-49 years, irrespective of their sex. Second largest group of patients were in the 30-39 years age group with 22 (24.4%) of patients.

Table 3: Clinical Presentation (Major Complaints)

Complaints	Number	Percentage
Pain	59	65.55
Jaundice	69	76.66
Weight Loss	22	24.4
Fever	8	16.66

Table 4 shows that, 69 (76.6%) had complaints of jaundice, 59 (65.5%) complained of pain, 22 (24.4%) had weight loss and a small number of patients, 8(16.6%) had fever.

Table 4: MRCP in cause of Biliary Pathologies

	Female		**Male**		**Total**	
Pathology	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Acute Pancreatitis	2	2.22%	4	4.44%	6	6.67%
Benign Stricture	3	3.33%	2	2.22%	5	5.56%
CBD Calculus	11	12.22%	6	6.67%	17	18.89%
Choledochal Cyst	1	1.11%	2	2.22%	3	3.33%
CBD and GB Calculus	7	7.78%	1	1.11%	8	8.89%
Cholangitis	1	1.11%	2	2.22%	3	3.33%
Cholangiocarcinoma	5	5.56%	5	5.56%	10	11.11%
Gall Bladder Carcinoma	6	6.67%	2	2.22%	8	8.89%
Gallbladder Calculus	11	12.22%	4	4.44%	15	16.67%
CA Head of Pancreas	2	2.22%	2	2.22%	4	4.44%
Normal	3	3.33%	4	4.44%	7	7.78%
Periampullary CA	2	2.22%	2	2.22%	4	4.44%

Grand Total	**54**	**60.00%**	**36**	**40.00%**	**90**	**100.00%**

From the above table according to MRCP, irrespective of sex 18 (18.89%) were having CBD Calculus, 15 (16.67%) patients were having Gall Bladder Calculus, 7 (7.78%) cases were having both CBD and GB Calculus, and 8 (8.89%) cases were reported as Gall Bladder carcinoma, and 10 (11.11%) cases as Cholangiocarcinoma. There were 4 (4.44%) cases of periampullary CA diagnosed on MRCP, 3 (3.33%) cases of Choledochal cyst and 1 case of benign stricture.

Chart 2: MRCP in causes of Biliary Pathologies

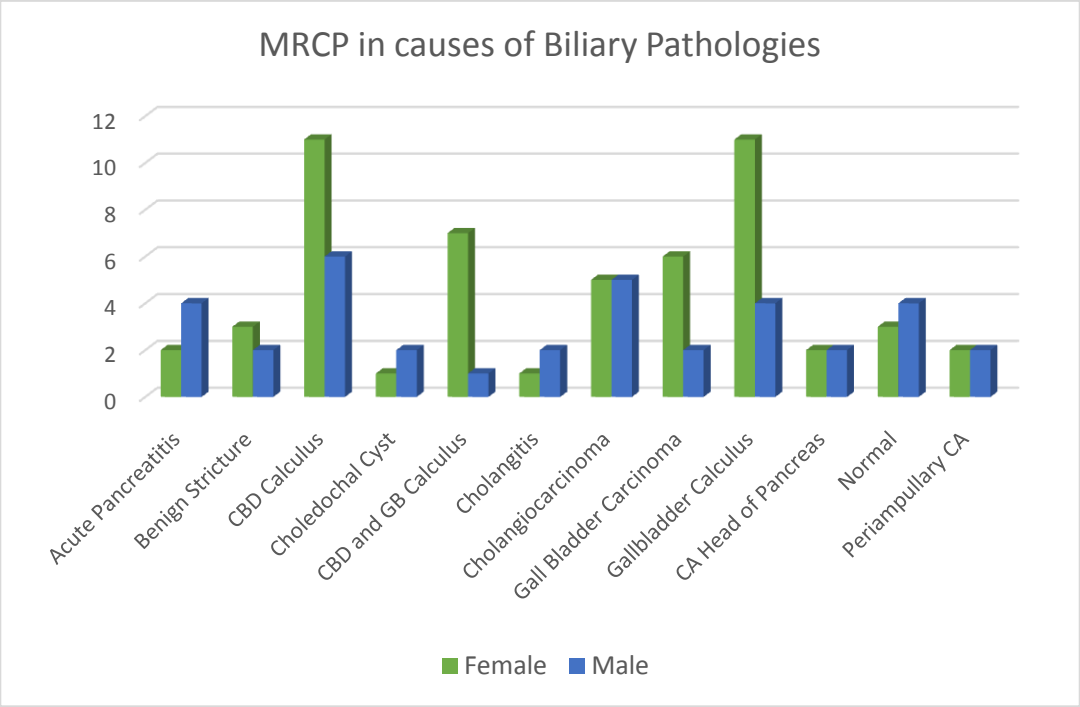


Table 5: USG of biliary pathologies

	F		**M**		**Total**	
Pathologies	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Acute Pancreatitis	2	2.22%	4	4.44%	6	6.67%
Benign Stricture	1	1.11%		0.00%	1	1.11%
CBD Calculus	7	7.78%	4	4.44%	11	12.22%
Choledochal Cyst	1	1.11%	2	2.22%	3	3.33%
CBD and GB Calculus	4	4.44%		0.00%	4	4.44%
Cholangitis	1	1.11%	2	2.22%	3	3.33%
Cholangiocarcinoma	4	4.44%	4	4.44%	8	8.89%
Gall Bladder Carcinoma	4	4.44%	2	2.22%	6	6.67%
Gallbladder Calculus	16	17.78%	6	6.67%	22	24.44%
CA Head of Pancreas	2	2.22%	2	2.22%	4	4.44%
Normal	6	6.67%	6	6.67%	12	13.33%
Indeterminate	6	6.67%	4	4.44%	10	11.11%
Grand Total	**54**	**60.00%**	**36**	**40.00%**	**90**	**100.00%**

From the above table according to USG, irrespective of sex 22 (24.44%) were having Gall Bladder Calculus, 11 (12.22%) patients were having CBD Calculus, 4 (4.44%) cases were having both CBD and GB Calculus, 6 (6.67%) cases were reported as Gall Bladder carcinoma, and 8 (8.89%) cases as Cholangiocarcinoma. There were 10 cases (11.11%) where a definite diagnosis could not be given by USG.

Chart 3: USG in biliary pathologies

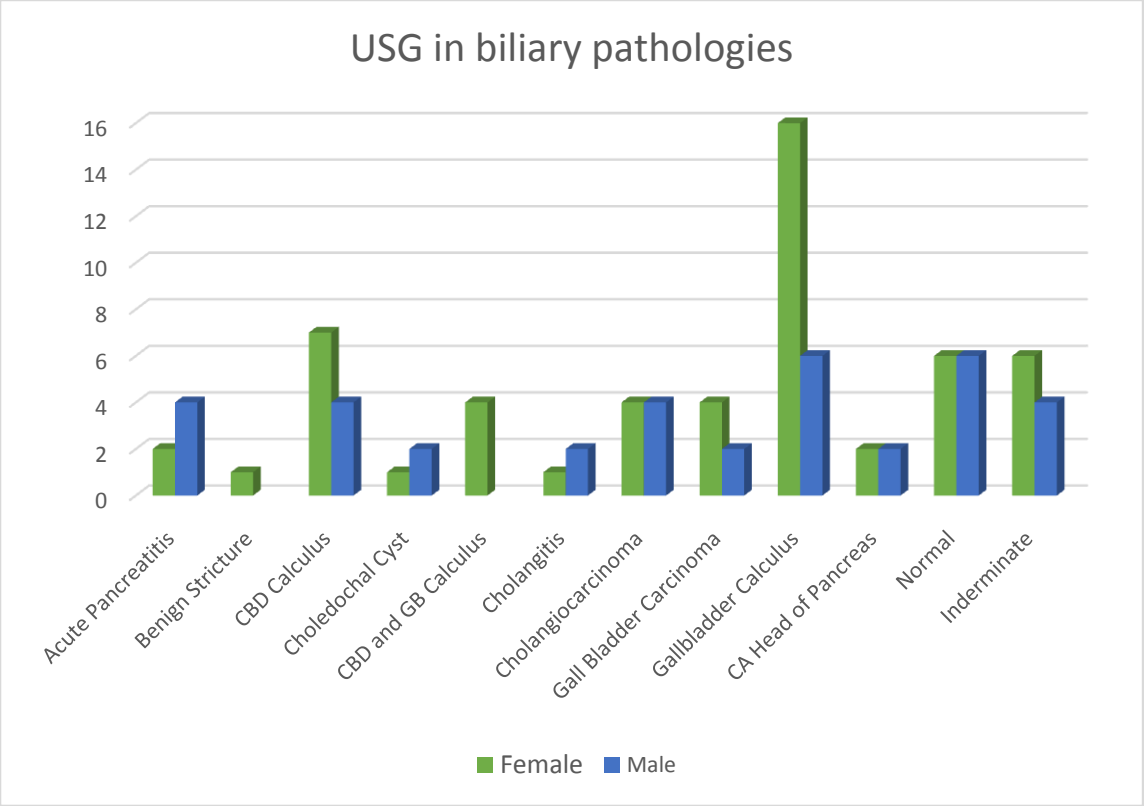


Table 6: Clinico-pathological diagnosis of biliary pathologies: On the basis of final diagnosis obtained by surgery/pathology, total cases are as follows.

Pathology	Female		Male		Total	
	N	Percent	N	Percent	N	Percent
Acute Pancreatitis	2	2.22%	4	4.44%	6	6.67%
Benign Stricture	4	4.44%	2	2.22%	6	6.67%
CBD Calculus	11	12.22%	6	6.67%	17	18.89%
Choledochal Cyst	1	1.11%	2	2.22%	3	3.33%
CBD and GB Calculus	7	7.78%	1	1.11%	8	8.89%
Cholangitis	1	1.11%	2	2.22%	3	3.33%
Cholangiocarcinoma	5	5.56%	5	5.56%	10	11.11%
Gall Bladder Carcinoma	6	6.67%	2	2.22%	8	8.89%
Gallbladder Calculus	11	12.22%	4	4.44%	15	16.67%
CA Head of Pancreas	2	2.22%	2	2.22%	4	4.44%
Normal	2	2.22%	4	4.44%	6	6.67%
Periampullary CA	2	2.22%	2	2.22%	4	4.44%
Grand Total	**54**	**60.00%**	**36**	**40.00%**	**90**	**100.00%**

Chart 4: Clinico-pathological diagnosis of biliary pathologies

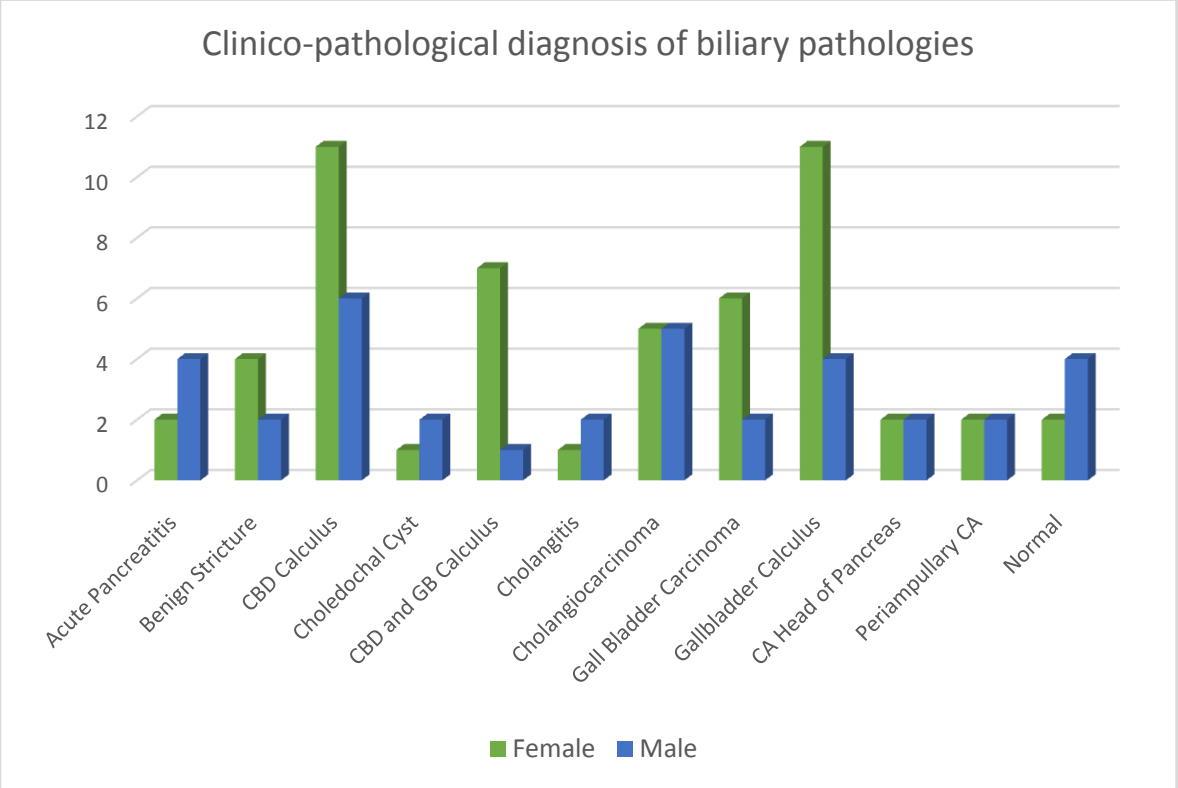


Table 8: Clinicopathological causes of Obstruction

Type of Causes	Number	Percentage
Biliary Calculus	25	27.7%
Stricture	6	6.6%
Malignancy	26	25.8%
Cysts	3	3.33 %
Total	60	66.6%

The above table shows 60 cases (66.6%) were having biliary obstruction. Biliary calculi was the most common cause of obstruction, 25 cases. (27.7%).Malignancy was the second most common case of obstruction constituting 25.8% of the total cases.

Chart 5: Clinicopathological cause of Obstruction

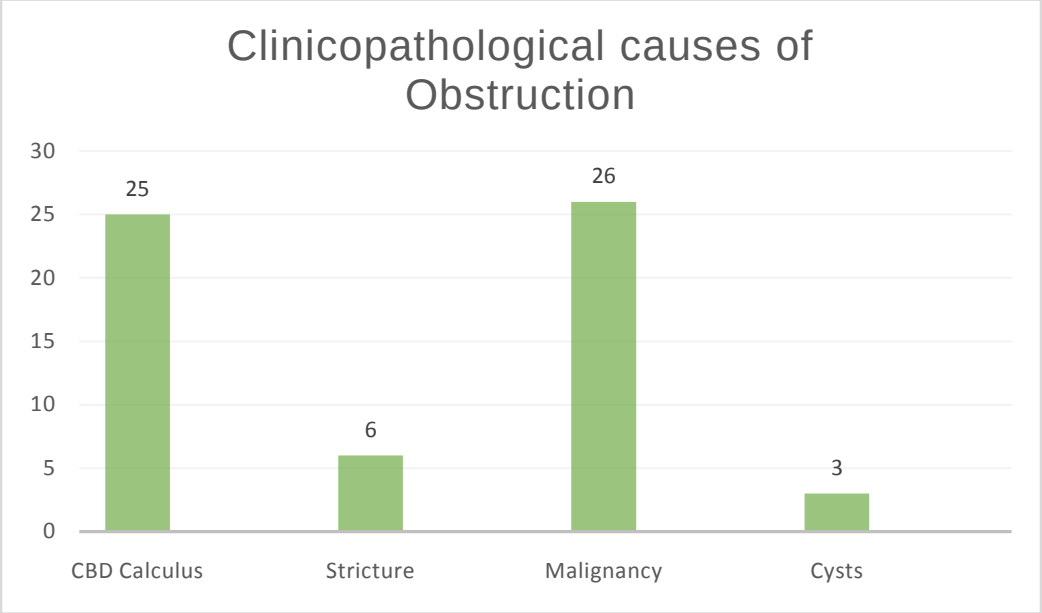


Table 9: MRCP vs USG of Pancreatico Biliary Pathologies

Final Diagnosis of Biliary Pathologies	N	Diagnosed on MRCP	Diagnosed on USG
Acute Pancreatitis	6	6	6
Benign Stricture	6	5	1
CBD Calculus	17	17	10
Choledochal Cyst	3	3	3
CBD and GB Calculus	8	8	4
Cholangitis	3	3	3
Cholangiocarcinoma	10	10	8
Gall Bladder Carcinoma	8	8	6
Gallbladder Calculus	15	15	15
CA Head of Pancreas	4	4	4
Periampullary CA	4	4	0

The above Table -13 compares the two modalities (MRCP & USG) with Clinicopathological findings. MRCP clearly identifies the pathologies better than Ultrasound in most cases.

Chart 6: MRCP vs USG in Biliary Pathologies

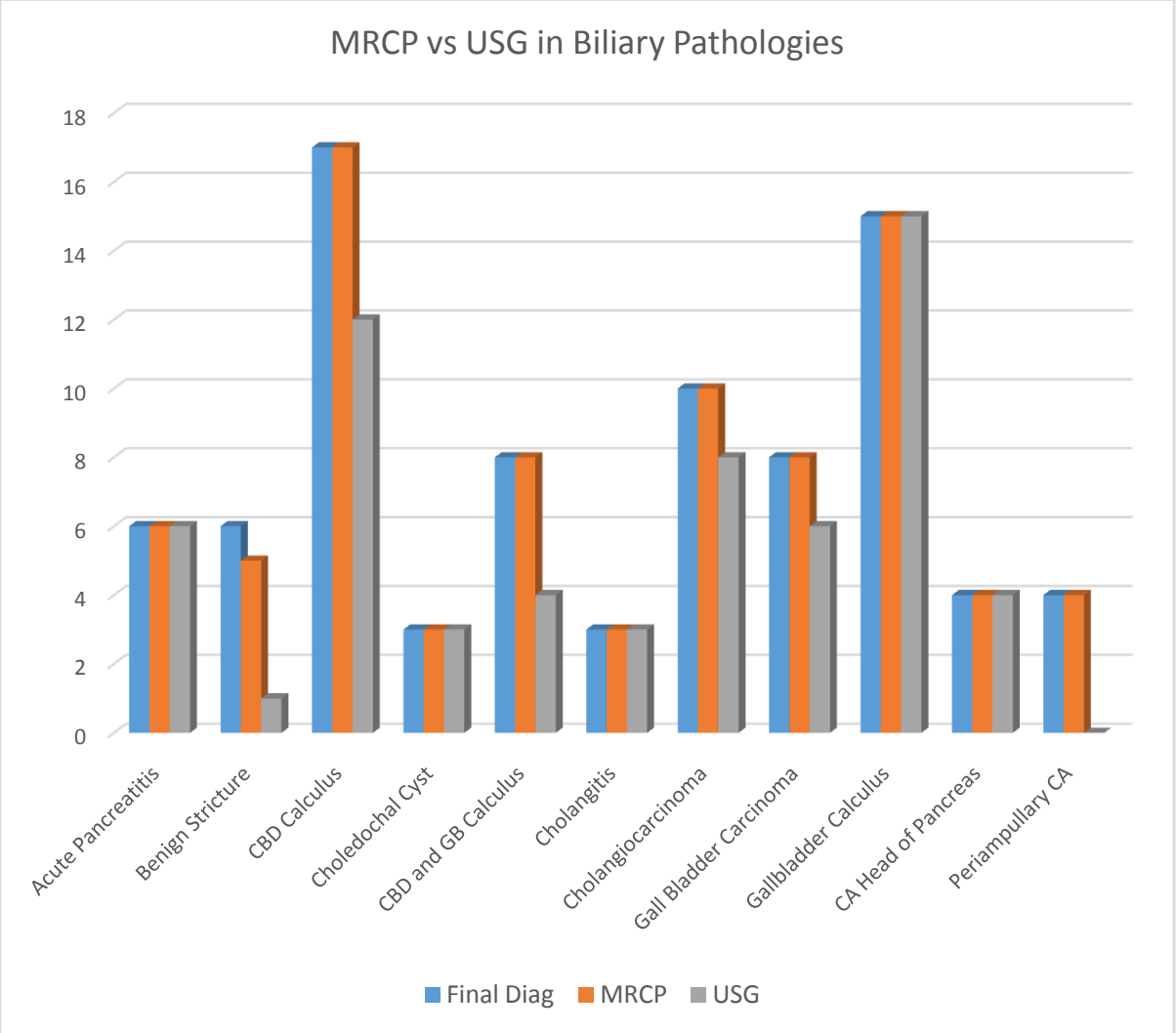
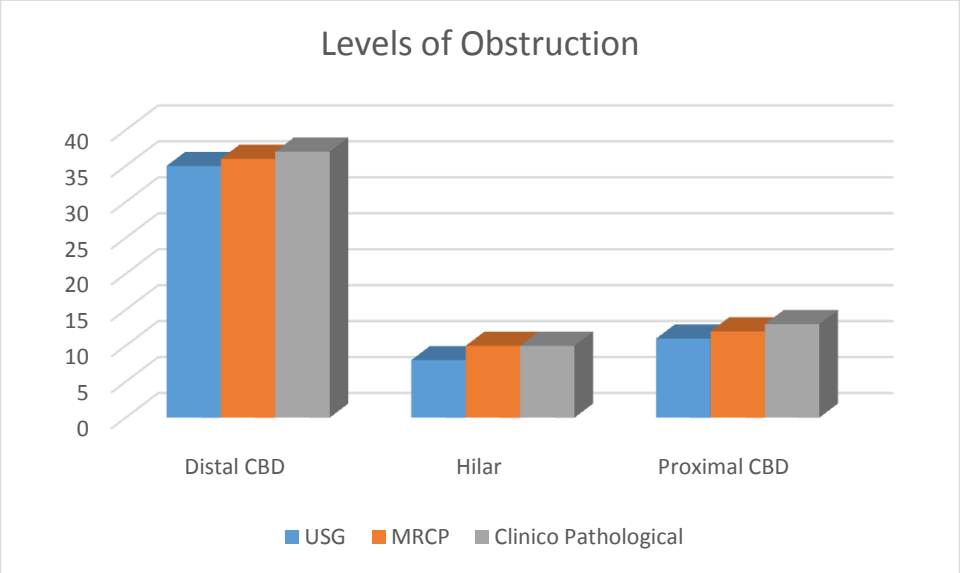


Table 10: Level of Obstruction

Level of Obstruction	USG	Percent	MRCP	Percent	Clinico Pathological	Percent
Distal CBD	35	58.3	36	60	37	61.6
Hilar	8	13.3	10	16.6	10	16.6
Proximal CBD	11	18.3	12	20	13	22.2
Total	54	89.9	58	96.6	60	100

Chart 7: Levels of Obstruction



From the above table and graph, 60 cases had significant obstruction. USG was able to correctly diagnose the level of obstruction in 89.9% case. MRCP on the other hand identified 96.6% of the cases. Most of the obstructions were at distal CBD.

Table 11: USG and MRCP with Clinicopathological correlation

Modality	**USG**		**MRCP**	
Diagnosis	N	Percent	N	Percent
Correct	64	71.11%	89	98.89%
Incorrect	26	28.8%	1	1.11%

IV. Statistical Analysis

Data was analysed using SPSSv23 for Windows. Descriptive (frequencies, percentages, mean and standard deviation) and inferential statistics were used to analyze data. The inferential statistics used were Chi Square. Continuous variables were presented as mean± (SD). Continuous variables were analyzed through t-test. Sensitivity, specificity, PPV, NPV and accuracy was also calculated in comparing diagnosis. For all statistical tests $p<0.05$ was considered statistically significant.

Table 12: MRCP Statistics

MRCP			Disease Present		Total
			No	Yes	
	Test Negative	Count	6	1	7
		%	100.0%	1.2%	7.8%
	Test Positive	Count	0	83	83
		%	0.0%	98.8%	92.2%
Total		Count	6	84	90
		%	100.0%	100.0%	100.0%

Sensitivity: 98.8%
Specificity: 100%
Positive Predictive Value: 100%
Negative Predictive Value: 85.71%
Accuracy: 98.88%
P<0.01

Table 13: USG Statistics

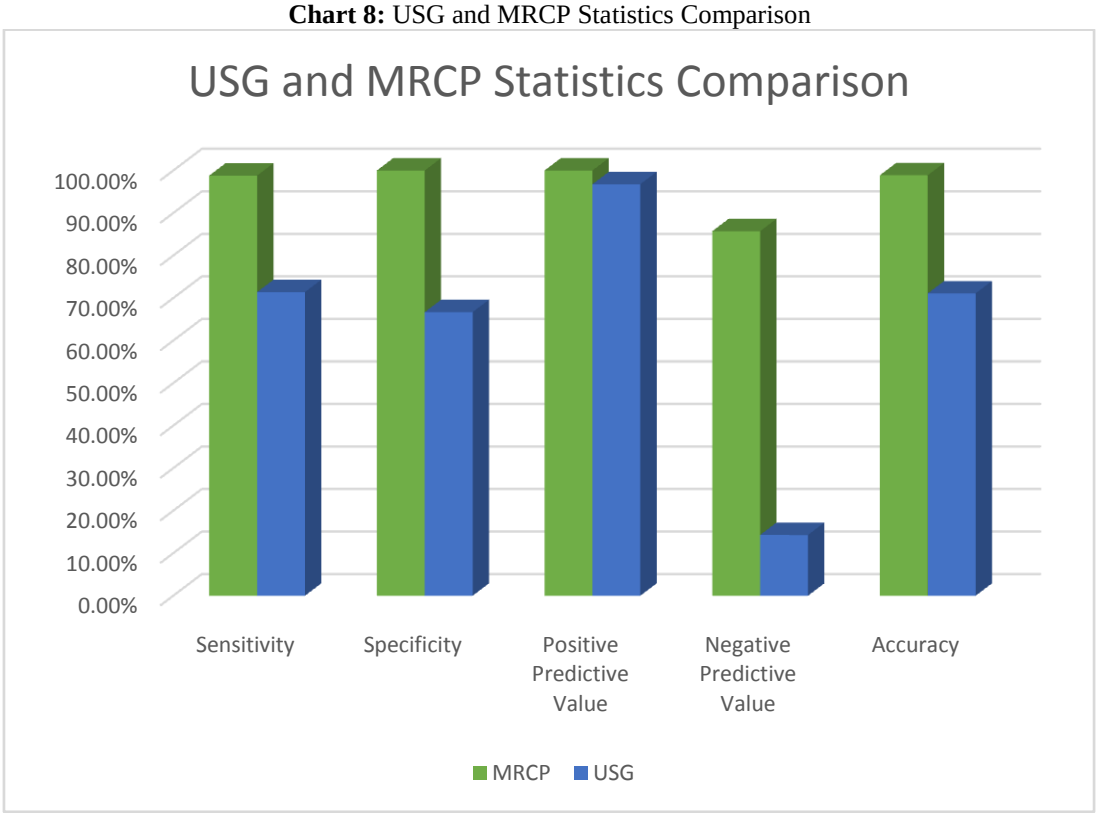
USG			Disease Present		
			N	Y	Total
	Test Negative	Count	4	24	28
		%	66.7%	28.6%	31.1%
	Test Positive	Count	2	60	62
		%	33.3%	71.4%	68.9%
Total		Count	6	84	90
		%	100.0%	100.0%	100.0%

Sensitivity: 71.4%
Specificity: 66.7%
Positive Predictive Value: 96.77%
Negative Predictive Value: 14.28%
Accuracy: 71.1%
P<0.01

Table 14: USG and MRCP Comparison

MODALITY	MRCP	USG
Sensitivity	98.8%	71.40%
Specificity	100%	66.70%
Positive Predictive Value	100%	96.77%
Negative Predictive Value	85.71%	14.28%
Accuracy	98.88%	71.10%

Chart 8: USG and MRCP Statistics Comparison



V. Discussion

90 patients of various age groups belonging to both sexes were included in our study. A sizeable percentage (30.00%) of the patients belong to the age group 40-49 years. 24.44% belongs to 30-39 years and 18.89% belongs to 50-59 years. Mean age of the whole group was 46.11± 13.58.

69 (76.6%) had complaints of jaundice, 59 (65.5%) complained of pain, 22 (24.4%) had weight loss and a small number of patients, 8(16.6%) had fever. There was no significant difference between male and female. (Table 4)

There was a clear female predominance in Gall stones and related biliary pathologies in our study. This correlated with data in most standard literature including a study by Toben Jorgensen(**8)**. In his study differences according to sex were significant in all age groups. Among subjects will gallstone disease, the disease was unknown to the proband in the majority of males and in the 30 year old female, but only in half of the woman aged 40,50 and 60 years.

In our study pathologies are common in females than males

In pancreatic malignancies there is a clear male predominance. In most studies there was a slight male predominance.**(9)**

Comparison of USG with MRCP

MRCP determined, irrespective of sex 18 (18.89%) were having CBD Calculus, 15 (16.67%) patients were having Gall Bladder Calculus, 7 (7.78%) cases were having both CBD and GB Calculus, and 8 (8.89%) cases were reported as Gall Bladder carcinoma, and 10 (11.11%) cases as Cholangiocarcinoma. There were 4 (4.44%) cases of periampullary CA diagnosed on MRCP, 3 (3.33%) cases of Choledochal cyst and 1 case of benign stricture.

MRCP missed one case of Stricture (1.11%) and detected the rest of the cases. USG was able to detect only one case of stricture and missed 5 cases (5.56%) MRCP could detect all cases of malignancies in our study. USG missed 8 cases of malignancies in our study, Transabdominal USG fared poorly in the diagnosis of periampullary carcinoma, none of the cases of could be correctly diagnosed on USG. Endoscopic Ultrasound should be of use in those cases. MRCP identified those cases of Periampullary carcinoma which USG could not identify. Masses of the head of pancreas however, could be identified both by USG and MRCP in our study.

USG correctly diagnosed 6 cases of gall bladder carcinoma and missed only 2 cases due to poor acoustic visibility in the patient. Similarly it missed 2 cases of cholangiocarcinoma. MRCP was able to correctly identify in all of the above cases.

Both USG and MRI were comparable to each other in the diagnosis of gallstones. Both the modalities picked up all cases of gall bladder stones. All cases of choledocholithiasis was identified in MRCP but USG missed 7 such cases. In cases of cholelithasis with choledocholithiasis, USG failed to visualize 4 cases of stones in the CBD. MRCP could identify all cases of cholelithasis with choledocholithiasis.

USG and MRCP were also comparable to each other in the diagnosis of 3 choledochal cyst cases (3.33%) as well as 6 cases of Acute Pancreatitis (6.67%). In the 3 cases of cholangitis, USG and MRCP were able to correctly identify the cases.

MRCP with clinicopathological correlation proved to be correct in 89 (98.89%) of cases. It missed one case. USG with clinicopathological correlation proved to be correct in 65 (71.11%) of cases. It missed/misdiagnosed 26 cases (28.8%). In our study MRCP was able to diagnose more cases than USG, and MRCP was clearly better than USG in evaluating biliary pathologies and level of obstruction.

In our study MRCP is more Accurate(98.88%) than USG (71.1%) in the diagnosis of biliary disease. Our study correlated with the similar study done by Bhatta C et al in India in 2005**(10)** where they found MRI was more accurate (97%) in diagnosing biliary disease and USG was less accurate.

In evaluating the cause and level of lesions in cases of significant biliary obstruction USG identified 54 out of 60 such cases (89.9%). MRCP clearly identified the level of obstruction in 58 out of 60 cases (96.6%). MRCP was better than USG in evaluating the level of obstruction

In our study the sensitivity of MRCP (98.8%) is more than USG (71.40%). Specificity of MRCP (100%) is also much higher than USG (66.70%).

USG has a high Positive Predictive Value of 96.77% but a poor Negative Predictive Value of 14.28% meaning a negative USG study does not mean the absence of pathology and if the patient has other clinical indications of disease he/she should be evaluated with a higher modality like MRCP/ERCP. In fact a negative USG study in patients with persistent biliary pathology is less likely to be negative and a further evaluation like MRCP should be done. MRCP has a much higher Negative Predictive Value of 85.71% meaning a negative result in MRCP is more likely to indicate the absence of that pathology. From our study we can say that MRCP is superior to USG in finding the level of obstruction, mapping out the extent of obstruction and evaluating the cause of obstruction. This is useful in planning further management of the disease. Thus MRCP may replace

ERCP for diagnostic purposes. USG may then be reserved for initial evaluation of patients with biliary obstruction.

VI. Conclusion

Ultrasonography is a cheap, widely available, and easier to use imaging modality and hence it should be used a primary investigative modality for suspected biliary pathologies. Overall, it has a fairly good sensitivity and very good Positive Predictive value for diagnosis of biliary diseases. However, it has a low sensitivity in strictures, distal CBD and periampullary pathologies. MRCP is a highly accurate modality and superior diagnostic modality for diagnosis of biliary pathologies. It can demonstrate biliary pathologies and related anatomies very well which can also be used for surgical planning and management. MRI (MRCP) should be used as mainstay for evaluation of biliary pathologies.

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