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Diagnostic Validity of Ultrasonography in Evaluation of Biliary Obstruction and its Comparison with Magnetic Resonance Cholangiopancreatography

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Abstract

Objective: *To assess the diagnostic validity of ultrasonography in evaluation of biliary obstruction and its comparison with magnetic resonance cholangiopancreatography.* ***Methods:*** *This cross sectional study was carried out in the Department of Radiology and Imaging, Combined Military Hospital, Dhaka, during the period of October 2021 to March 2022 (6 months). The sampling technique was purposive and sample size was 60. The patient attending the (outpatient department) OPD and admitted in indoor in Combined Military Hospital, Dhaka, who referred to the Radiology and Imaging department for ultrasonography and magnetic resonance cholangiopancreatography were included in the study. After selection of the patient, informed written consent were obtained from the patients or their legal guardians upon describing them the purpose, method, benefit and hazard of the study. Ethical measures were taken in throughout the study. Data collection was done by the researcher and a preformed questionnaire was used during data collection. Following completion of data collection, it was analyzed by SPSS 23.0.* ***Results:*** *Total 60 patients were studied with an age range from 9 years to 75 years. Mean age of the included patients was 47.8 years with a standard deviation of 12.4 years. Study showed a female dominance with a male-female ratio of about 1:1.2. Regarding the cause of obstruction 40.0% patients had choledocholithiasis (CBD stone), followed by 20% infiltrating GB mass, 16.66% cholangiocarcinoma, 10% periampullary carcinoma, 11.66% carcinoma head of the pancreas, 1.6% had choledochal cyst. The validity test of ultrasonographic evaluation for choledocholithiasis in obstructive jaundice had sensitivity 87.5%, specificity 100%, accuracy 95%, positive predictive values 100% and negative predictive values 92.3%.The validity test of ultrasonographic evaluation for cholangiocarcinoma in obstructive jaundice had sensitivity 80%, specificity 100%, accuracy 96.6%, positive predictive values 100% and negative predictive values 96.1%. The validity test of ultrasonographic evaluation for periampullary carcinoma in obstructive jaundice had sensitivity 83.3%, specificity 98.1%, accuracy 96.6%, positive predictive values 83.3% and negative predictive values 98.1%. The validity test of ultrasonographic evaluation for infiltrating GB mass in obstructive jaundice had sensitivity 100.0%, specificity 97.9%, accuracy 98.3%, positive predictive values 92.3% and negative predictive values 100.0%. The validity test of ultrasonographic evaluation for pancreatic head carcinoma in obstructive jaundice had sensitivity 85.7%, specificity 100%, accuracy 98.3%, positive predictive values 100% and negative predictive values 98.1%. The validity test of ultrasonographic evaluation for choledochal cyst in obstructive jaundice had sensitivity 100.0%, specificity 100.0%, accuracy 100.0%, positive predictive values 100.0% and negative predictive values 100.0%.* ***Conclusion:*** *Ultrasonography is an effective & good modality in the evaluation of biliary obstruction.*

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Introduction

Disorders of the biliary tract affect a significant portion of the worldwide population [1] and contribute significantly to high mortality and morbidity. As patients with obstructive jaundice

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have high morbidity and mortality, early diagnosis of the cause of obstruction is very important specially in malignant cases.

Jaundice due to biliary obstruction may be caused by a heterogeneous group of diseases that include both benign and malignant conditions.[2]

Benign causes include choledocholithiasis, inflammatory stricture, Mirizzi syndrome, extra hepatic localized form of primary sclerosing cholangitis and idiopathic benign focal stricture. Common malignant causes are cholangio-carcinoma, gallbladder carcinoma, pancreatic cancer and neoplasm arising around ampulla of vater.[5]

The major signs and symptoms of biliary obstruction result directly from the failure of bile to reach its proper destination.[1] Prominent features of obstructive jaundice are jaundice, itching and malabsorption. Conjunctival icterus is generally a more sensitive sign of hyperbilirubinemia than generalized jaundice. The lack of bilirubin in the intestinal tract is responsible for the pale stools typically associated with biliary obstruction. The cause of itching (pruritus) associated with biliary obstruction is not clear. Some believe it may be related to the accumulation of bile acids in the skin. Others suggest it may be related to the release of endogenous opioids. In deeply jaundiced patients, there may be hemorrhage and an increased risk of sepsis. Pain can be related to duct stones, tumor or gallbladder disease. Fever and rigors may indicate cholangitis due to duct stone or traumatic stricture. All the constituents of the bile show an increased level. The serum conjugated bilirubin level is raised. The serum alkaline phosphatase level in raised, usually more than three times the upper limit of normal. The serum aspartate transaminase is only moderately elevated [6]. The gall bladder & bile duct system can be demonstrated by a variety of imaging techniques.[7] The role of imaging in patients with suspected bile duct obstruction is confirmation of the presence of biliary obstruction, determination of level and cause of obstruction and the extent or stage of the disease process.[8] Many imaging modalities are available today for the evaluation of patients with suspected biliary obstruction including ultrasonography, computed tomography(CT), percutaneous transhepatic cholangio-pancreatography (PTC), endoscopic retrograde cholangiopancreatography (ERCP) and magnetic resonance cholangiopancreatography (MRCP).[9] Ultrasonography has high degree of accuracy for the detection of obstruction in the biliary tree. It is widely available noninvasive and radiation free imaging modality.[10]

The sensitivity of CT in differentiating hepatocellular from obstructive jaundice and determining the level and cause of obstruction parallels that of ultrasound. CT is reserved for those patients in whom there is doubt as to the cause of obstruction and in staging of biliary tumors, particularly cholangio-carcinoma.[12]

Magnetic resonance cholangiopancreatography (MRCP) is becoming established as a non-invasive alternative for evaluating the biliary tree. MRCP is a relatively new technique, which has gained popularity because of its excellent diagnostic capabilities in the evaluation of biliary obstruction.[9] MRCP provides many obvious advantages, regardless the simplicity and the safety of the technique. It is non-invasive informative study, not requiring ionizing radiation or administration of contrast agent.[6] In biliary obstruction, advantages of MRCP are mainly related to routine visualization of ducts without using ionizing radiation and produce high quality projection and cross sectional images which are similar to ERCP.[13]

Sonographic evaluation of the biliary tract is one of the most appropriate and efficacious uses of the ultrasound examination. Ultrasound is widely advocated as noninvasive imaging study in evaluating suspected biliary obstruction. This is noninvasive and cost effective. Real time evaluation of intrahepatic and extrahepatic bile duct dilatation can be done. It has high sensitivity and accuracy for detecting cause and level of biliary obstruction. In comparison to CT scan, it has lack of ionizing radiation. Ultrasound can be done in patient with gastrointestinal, hepatic and renal dysfunction. Ultrasound is widely available in all corners of our country.

As there is paucity of literatures and limited number of studies in this regard in our country, this study is designed to evaluate the diagnostic performance of USG in evaluation of biliary

obstruction and its comparison with MRCP. As for this purpose, by hypothesis testing, patients will be benefited by early diagnosis and management of obstructive jaundice.

Materials and methods

This cross sectional study was carried out on patients with clinically suspected biliary obstruction, who were referred to department of Radiology and Imaging, Combined Military Hospital, Dhaka from outpatient department of Combined Military Hospital, Dhaka or indoor of Department of Gastroenterology and indoor of department of surgery, Combined Military Hospital, Dhaka from October 2021 to March 2022(Six months).

Depending on the inclusion and exclusion criteria, 60 patients were taken for the study. Non random purposive sampling was taken. All the patients and their attendants were informed appropriately about the procedure and gave informed written consent for participating in this study. Formal ethical clearance was taken from the Ethical review committee (ERC) of Combined Military Hospital, Dhaka. Demographic information such as age, sex and detailed history were collected. All the patients were evaluated by ultrasonography and MRCP and findings subsequently compared.

Patients suspected of biliary pathology was examined first by real time ultrasonography (Philips Affinity 70G) with a curvilinear transducer at transducer frequency of 2.5 MHZ using neutral matching gel over the examination parts. Subjects were examined initially in supine position with transverse, oblique and sagittal scan were made over the upper abdomen to identify the gall bladder, biliary system and pancreas. Scanning was done during patients were in deep inspiration. Patients were also scanned in right lateral and in sitting position in some cases for proper visualization of common bile duct. The liver, gall bladder, pancreas, intrahepatic and extrahepatic bile ducts were evaluated to look for the abnormality of intra and extra- hepatic biliary channels, the common bile duct (CBD) and possible cause of obstruction.

MRCP is done by Philips Ingenia 3 Tesla MRI machine. It uses heavily T2weighted sequences that depict the static fluid bile in the pancreaticobiliary tree. The image is made heavily T2-weighted by using longer echo times (TE). At thislong TE, only fluid or tissues with high T2 relaxation time retain signal. Background tissue with shorter T2 cannot retain sufficient signal, it is suppressed. Image is acquired as two dimensional (2D) FSE and three dimensional MIP breathing averaged or breath hold sequences.

Different sonographic features were considered for the diagnosis of different causes of biliary obstruction e.g. Choledocholithiasis, Cholangiocarcinoma, Periapullary carcinoma, Carcinoma head of the pancreas, Choledochal cysts etc.

In each case the data was collected and recorded in a pre-designed structured data collection sheet. All statistical analyses were performed by using computer based software program statistical package for social science (SPSS). All the relevant collected data were compiled on a master chart first. Then organized by scientific calculator and standard statistical formulae. Percentages were calculated to find out the proportion of the findings. The sensitivity, specificity, accuracy, positive and negative predictive values of USG in diagnosis of causes of biliary obstruction were calculated out. The results were presented in tables, figures and diagrams.

Results and Observations

Table-I

Age distribution of the study subjects

Age group (years)	Frequency	Percentage (%)	Range of age (min, max)
< 20	2	3.3	
20-29	2	3.3	
30-39	16	26.7	47.8±12.4
40-49	20	33.3	9-75
50-59	9	15	
60-69	6	10	
> 69	5	8.4	
Total	60	100	

A total of 60 cases were included in the study. The mean age was 47.8 years with standard deviation (SD) ±12.4 years and their age ranged from 9 to 75 years. Maximum number was found in the age group of 40-49 years.

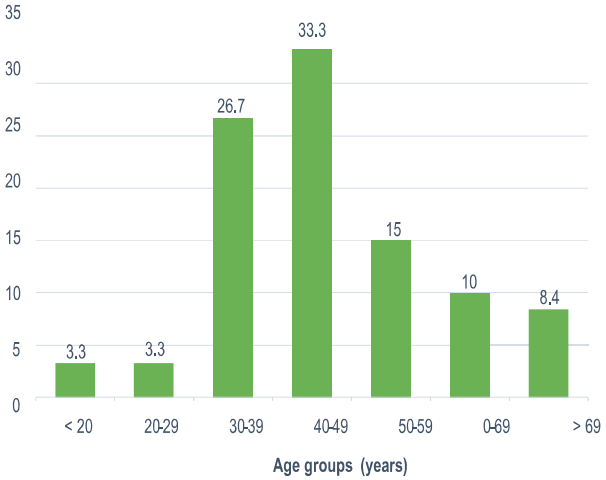

Figure-1: *Bar diagram showing age distribution of the study subjects.*

Table-II

Gender distribution of the study subjects

Sex	Frequency	Percentage (%)
Male	27	45
Female	33	55
Total	60	100

This study was carried out in 60 subjects. They were divided in to male and female groups. Out of which 45% were male and rest 55% were female patients.

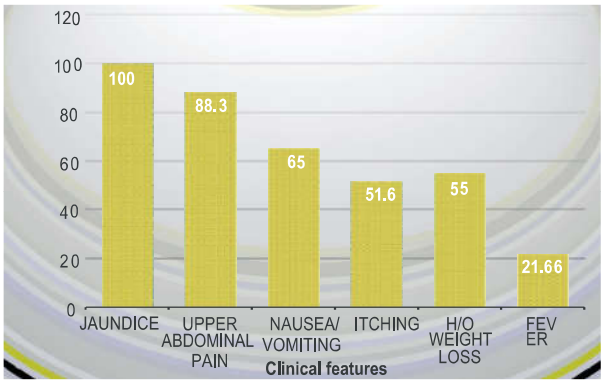

Figure-2: Bar diagram showing distribution of patients according to clinical features

Table-III

Distribution of the patients according to clinical features

Clinical features	Number of patients*	Percentage * (%)
Jaundice	60	100
Upper abdominal pain	53	88.3
Nausea/ vomiting	39	65
Itching	31	51.6
weight loss	33	55
Fever	13	21.66

* Multiple response

All the patients (100%) had jaundice, 88.3% had upper abdominal pain, 65% had nausea/ vomiting, 51.6% had itching, 55% had H/O weight loss, and 21.66% had fever.

Table-IV

Distribution of the patients according to biochemical parameters

Biochemical parameters	Normal range	High		Mean ± SD	Range (min, max)
		Number of patient	Percentage(%)		
Serum bilirubin	0-2.0mg/dl	60	100	11.1± 8.3	1.8, 26
Alkaline phosphatase	44-147U/L	60	100	912 ±393.8	168, 1923

The mean Serum bilirubin of the study subjects was 11.1± 8.3 mg/dl (mean ± SD), which ranged from mg/dl. Alkaline phosphatase was 44-147 U/L, which ranged from 168-1923. It was observed that serum bilirubin and alkaline phosphatase were higher in 100% cases respectively.

Table-V

Detection of biliary tree dilatation by USG & MRCP

USG diagnosis	Dilated	60	100
	Not dilated	0	0
MRCP diagnosis	Dilated	60	100
	Not dilated	0	0

A total 60 cases were under went both USG and MRCP. At both procedures it was observed that biliary tree dilatation was present in 60 (100%) cases.

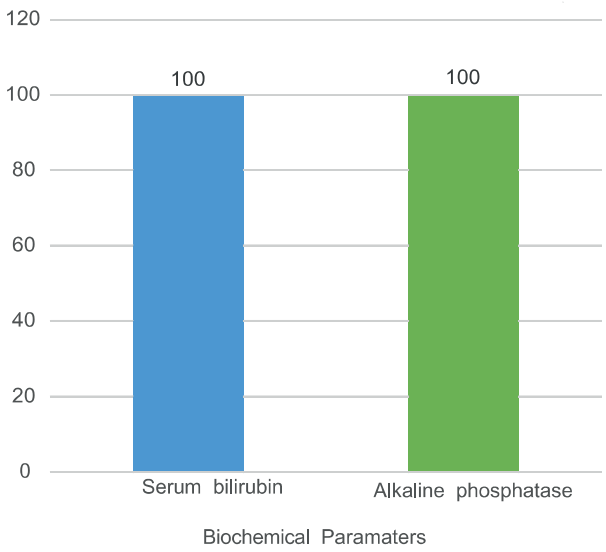

Figure-3: *Bar diagram showing distribution of patients according to biochemical parameters*

Table-VI

Detection of intrahepatic bile duct dilatation by USG and MRCP

Intrahepatic bile duct at USG	Intrahepatic bile duct at MRCP		Total
	Dilated	Not dilated	
Dilated	56	0	56
Not dilated	1	3	4
Total	57	3	60

A total 60 cases were under went both USG and MRCP and dilated intrahepatic bile duct was found in 56 and 57 cases by those procedures respectively.

Table VII

Sensitivity, specificity, accuracy, positive and negative predictive values of USG in the diagnosis of intrahepatic bile duct dilatation

Validity test	Percentage (%)
Sensitivity	98.2
Specificity	100
Accuracy	98.3
Positive predictive value	100
Negative predictive value	75

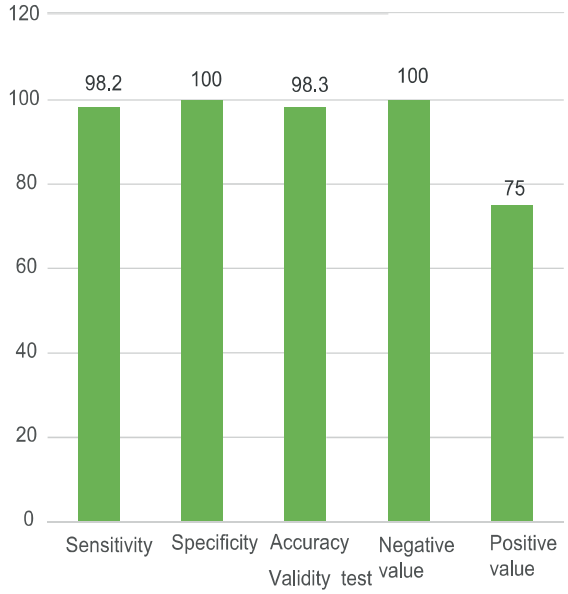

Figure-4: *Bar diagram showing sensitivity, specificity, accuracy, positive and negative predictive values of USG in evaluation of intrahepatic biliary tree dilatation.*

Table VIII

Detection of extrahepatic bile duct dilatation by USG and MRCP

Extrahepatic bile duct at USG	Extrahepatic bile at MRCP		Total
	Dilated	Not dilated	
Dilated	55	0	55
Not dilated	2	3	5
Total	57	3	60

A total 60 cases were under went both USG and MRCP. Dilated extra-hepatic bile duct was found in 55 and 57 cases at USG and MRCP examination respectively.

Table IX

Sensitivity, specificity, accuracy, positive and negative predictive values of USG in the diagnosis of extrahepatic bile duct dilatation

Validity test	Percentage (%)
Sensitivity	96.5
Specificity	100
Accuracy	96.6
Positive predictive value	100
Negative predictive value	60

Table X

Number of patients diagnosed by USG and MRCP

Diagnosis	USG	MRCP
Choledocholithiasis	21	24
Infiltrating GB mass	13	12
Cholangiocarcinoma	8	10
Carcinoma head of the pancreas	6	7
Periampullary	5	6
Choledochal cyst	1	1

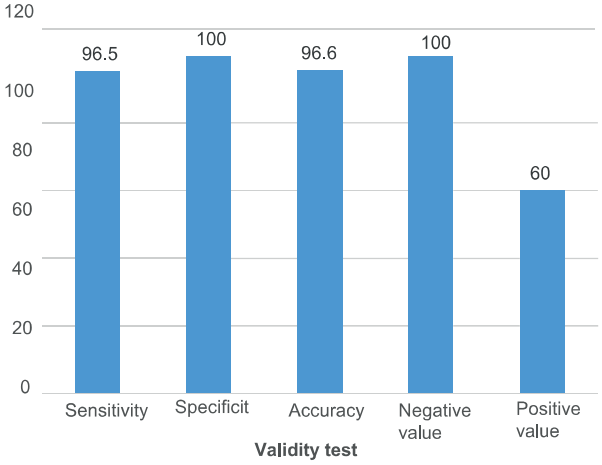

Figure-5: *Bar diagram showing sensitivity, specificity, accuracy, positive and negative predictive values of USG in evaluation of extrahepatic bile duct evaluation (n=60).*

Table IX

Validity test of USG in evaluation of biliary obstruction

Cause of obstruction	USG				
	Sensitivity	Specificity	Accuracy	PPV	NPV
Choledocholithiasis	87.5	100	95	100	92.3
Infiltrating GB mass	100	97.9	98.3	92.3	100
Cholangiocarcinoma	80	100	96.6	100	96.1
Carcinoma head of the pancreas	85.7	100	98.3	100	98.1
Periampullary carcinoma	83.3	98.1	96.6	83.3	98.1
Choledochal cyst	100	100	100	100	100

PPV= Positive predictive values; NPV= Negative predictive values.

Discussion

This cross sectional study was carried out with an aim to evaluate sonographic and MRCP findings of biliary obstruction and comparing them. This study was also carriedout to find out the sensitivity, specificity, accuracy, positive predictive value and negative predictive value of USG in the diagnosis of causes of biliary obstruction. A total of 60 patients with obstructive jaundice who underwent USG and MRCP in the Department of Radiology & Imaging were included in this study. Study period was two years, from July 2017 to June 2019.

In this present study, it was observed that 33.3% patients were belonged to age 40-49 years. The mean age was found 47.8±12.4 years with ranged from 9-75 years. A study [9] have shown in their study that the mean age of presentation of biliary obstruction was 48.14±12.55 years and ranged from 15-72 years. Most of the patients were in the 5th decade of life which closely agrees with the present study. Similarly, a study[4] also found obstructive disease to be common in the 5th to 6th decade.

In the current study, it was observed that 45% patients were male and 55% patients were female. A study[22] observed 70 patients. Among them 57% patients werefemale and 43% patients were male.

Regarding the present complaints, it was observed that most presenting complaints of the patients in the present study were jaundice in 100%, upper abdominal pain in 88.3%, nausea/vomiting 65%, itching 51.6%, H/O weight loss 55%, fever 21.66%.

Similarly, A study[22] observed in their study that the patients presented with overlapping symptoms of upper abdominal pain, jaundice, clay colored stool, high colored urine, fever, nausea, vomiting and weakness. Similar observation regarding the presenting complaints was also made.[20]

In this study causes of obstruction was choledocholithiasis 40%, followed by 20% infiltrating GB mass, 16.66% cholangiocarcinoma, 10% periampullary carcinoma, 11.66% carcinoma head of the pancreas, 1.6% had choledochal cyst.

A study[18] observed 71 patients, out of which 77.0% patients had stone by ERCP, which is higher with the current study. A study[20] found about the cause of obstruction, 28.0% patients had cholangiocarcinoma, 20.0% patients had Infiltrating GB mass, 18.0% had choledocholithiasis (CBD stone) followed by 6.0% had periampullary carcinoma, 8.0% benign biliary stricture, 6.0% Choledochal cyst, and 7.0% patients had pancreatic head carcinoma.

In this present study, it was observed that the validity test of USG evaluation for choledocholithiasis in obstructive jaundice has sensitivity 87.5%, specificity 100%, accuracy 95%, positive predictive value 100% and negative predictive value 92.3%.USG missed some cases of choledocholithiasis, as there was inadequate visualization of the entire CBD due to bowel gas and obesity. In a study[26] showed ultrasound was found to have specificity of 100% and diagnostic accuracy of 89% respectively, in diagnosing choledocholithiasis.

In this present study, it was observed that the validity test of USG evaluation for infiltrating GB mass in obstructive jaundice has sensitivity 100%, specificity 97.9%, accuracy 98.33%, positive predictive value 92.3% and negative predictive value 100%. This value is near to the finding of a study[14] where sensitivity of USG was 94%.

In this current study, it was observed that the validity test of USG in the evaluation of periampullary carcinoma as a cause of obstructive jaundice showed sensitivity 83.3%, specificity 98.1%, accuracy 96.6%, positive predictive value 83.3% and negative predictive value 98.1%. A study [20] found that USG was sensitive in 81.2% and specific in 100% cases. In this current study, one patient was diagnosed as a case of choledochal cyst. USG showed that sensitivity, specificity, accuracy, positive predictive value and negative predictive value all were 100% for evaluation of that case, which is closely resemble the study [20], where the authors found sensitivity 100.0%, specificity 100.0%, accuracy 100.0% and positive predictive values 100.0%.

The results of both USG and MRCP examination in the present study for evaluation of biliary obstruction are almost similar. Therefore, the inference can be drawn that ultrasonography is a good modality in the evaluation of biliary obstruction. It is a simple, non-invasive, rapid, widely available, diagnostic method, has high sensitivity and specificity, no radiation hazards and should be advocated for the diagnosis of biliary obstruction.

Limitations of the study

The study population was selected from one selected hospital in Dhaka city, so that the results of the study may not be reflect the exact picture of the country. The present study was conducted at a very short period of time. Another limitation was high BMI because affect the resolution of the ultrasound image. In some cases, distal portion of common bile duct and periampullary region were poorly visualized on ultrasonography due to bowel gas shadows. Small sample size & purposive sampling were also a limitation of the present study. Therefore, in future further study may be under taken with large sample size.

Recommendations

Ultrasonography is a sensitive and effective modality for the evaluation of patients with biliary obstruction, which suggests that it can be used as a reliable diagnostic tool. Further study is necessary with a large sample size and non-purposive sample technique. Multicenter study should be conducted specially in specialized centers.

Conflicts of interest

There were no financial or other conflicts of interest.

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