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Original Research Article

Ultrasonography vs. CT Scan for Biliary Obstruction: A Hospital-based Retrospective Study

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Abstract:

Introduction: Obstructive jaundice, a frequent hepatobiliary disease, presents significant diagnostic and management challenges, particularly in cases of intrahepatic cholestasis.

Aims & Objectives: This study aimed to evaluate the diagnostic accuracy of abdominal ultrasound (USG) and CT scan in biliary tract obstruction, comparing them with operative findings.

Materials and Methods: The study included patients admitted to the surgery wards of Shri Jagannath Medical College and Hospital, Puri, Odisha, for evaluation and treatment of suspected obstructive biliary tract diseases.

Results: Tumors were the most common cause of obstruction, affecting 29 patients (58%), followed by choledocholithiasis (gallstones in the bile duct) in 14 patients (28%) and benign biliary strictures in 4 patients (8%). Ultrasound (USG) exhibited 100% sensitivity and 86.2% specificity in detecting benign lesions as the cause of obstruction, while CT scans achieved 100% sensitivity and 93.1% specificity in the same context. For malignant lesions, USG maintained 86.2% sensitivity and 100% specificity, while CT scans surpassed it with 93.1% sensitivity and 100% specificity. Overall, 10 cases were falsely diagnosed by USG while only 4 cases were falsely diagnosed by CT scan among all 50 cases. Compared to USG, CT scans offer improved sensitivity for detecting choledocholithiasis (gallstones in the bile duct), CBD strictures, and malignant pathologies. While the sensitivity, specificity, and accuracy of CT scan for choledochal cysts are comparable to USG.

Conclusion: Ultrasonography (USG) remains the most common initial imaging modality for diagnosing obstructive biliary diseases. However, its sensitivity can be limited for certain conditions, particularly benign strictures and distal common bile duct (CBD) diseases. In such cases, or when clinical and laboratory findings suggest biliary obstruction despite negative or inconclusive ultrasound results, a CT scan becomes a valuable diagnostic tool. Furthermore, CT scans offer superior accuracy for comprehensive malignancy staging.

Keywords: Ultrasonography, Computed Tomography, Billiary Obstruction, Choledocholelithiasis.

Introduction

Obstructive jaundice, a frequent hepatobiliary disease, presents significant diagnostic and management challenges, particularly in cases of intrahepatic cholestasis. While advancements in surgery for obstructive jaundice initially resulted in high morbidity and mortality, the past decade has seen remarkable progress in understanding its pathogenesis, diagnosis, staging, and effective management of obstructive biliary tract diseases [1, 2]. Accurate therapeutic decisions depend on a precise assessment of the cause, location, level, and extent of the obstruction [3].

Therefore, preoperatively determining the presence, nature, and site of obstruction with precision is crucial, as an inappropriate treatment approach can be detrimental. A combined approach using ultrasonography (USG), computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP), and percutaneous transhepatic cholangiography (PTC) typically provides the most detailed information for diagnosing biliary obstruction. Magnetic resonance cholangiopancreatography (MRCP) and cholangiography computed tomography (CCT) have recently been added to the diagnostic toolkit.

Ultrasound, while the first-line investigation for detecting surgical obstructive jaundice, has limitations in precisely determining the cause and extent of the obstruction. This often necessitates the use of additional imaging modalities like CECT and MRCP, which offer superior diagnostic accuracy [4].

This study aimed to evaluate the diagnostic accuracy of abdominal ultrasound (USG) and CT scans in biliary tract obstruction, comparing them with operative findings. We also compared the diagnostic accuracy of USG and CT scans.

Materials and Methods:

The study material consisted of patients with a history suggestive of obstructive biliary tract diseases who were admitted to the surgery wards of Shri Jagannath Medical College and Hospital, Puri, Odisha, between August 2021 and July 2023 for evaluation and treatment. Upon admission, a detailed clinical history was obtained from each patient. Subsequently, they underwent ultrasound after an overnight fast (6 to 8 hours), followed by a CT scan (plain and with intravenous contrast). Surgery was performed in appropriate cases.

Inclusion Criteria:

- Patients with evidence of biliary tract obstruction with special emphasis on upper abdominal pain, itching, jaundice, upper abdominal mass and weight loss.

Exclusion Criteria:

- Patients unfit for surgery
- Patients unwilling for any investigation like USG & CT.
- Dropout cases
- Patients who are unwilling to undergo operation.

Before starting the study, patients were informed about its objectives, procedures, risks, and benefits. Informed consent was then obtained. Each patient participated in a single-institution, prospective trial approved by the institutional ethics committee.

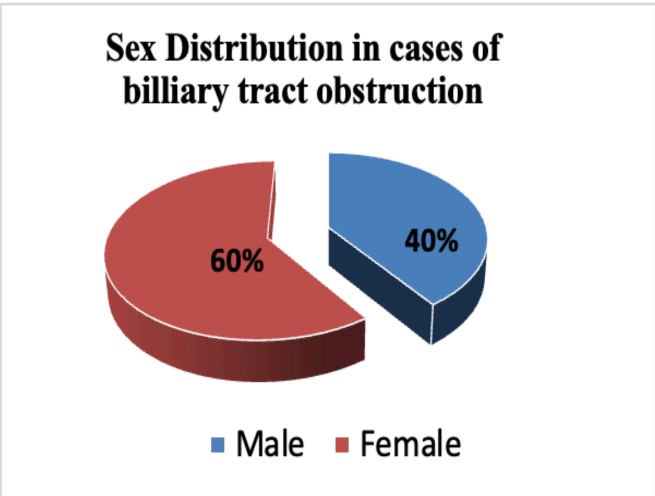
During the review of their medical history, particular attention was paid to symptoms such as upper abdominal pain, itching, jaundice, the presence of an upper abdominal mass, tenderness, and the condition of surrounding structures.

Patients then underwent routine investigations using appropriate hematological and biochemical parameters to confirm a clinical diagnosis of biliary tract obstruction. Subsequently, abdominal ultrasonography (USG: SHIMADZU450XL; Probe frequency: 2.5 to5MHz) and plain/contrast CT scans (Siemens Somatom Esprit) of the abdomen were performed to evaluate the biliary tract for any obstructive lesions.

The surgical approach was determined based on the diagnosed etiology and operative/histopathological confirmation of pathology.

Results

Fifty patients meeting the inclusion criteria participated in this study. A descriptive comparative analysis was performed to compare imaging findings between ultrasound and CT scan modalities. The mean age of the participants was 48.18 years. The majority of cases fell within the 51-60 year age range (out of a total range of 1-90 years). The incidence of biliary tract obstructive disease was higher in females (60%) than in males (40%), as shown in Graph 1.



Jaundice (92% of patients) and abdominal pain (80% of patients) were the most prevalent symptoms in the study group.

In this study group, tumors were the most common cause of obstruction, affecting 29 patients (58%), followed by choledocholithiasis (gallstones in the bile duct) in 14 patients (28%) and benign biliary strictures in 4 patients (8%) (Table 1).

Table 1: Distribution of cases according to final diagnosis and their comparative evaluation of USG and CT scan

Cause of obstruction	**USG**		**CT Scan**		**Final Diagnosis**	
	N	%	N	%	N	%
Cholangiocarcinoma	7	14	8	16	9	18
Benign biliary stricture	3	6	5	10	4	8
Choledochal cyst	3	6	3	6	3	6
GB Mass	10	20	10	20	10	20
Periampullary carcinoma	2	4	2	4	3	6
Choledocholithiasis	19	38	15	30	14	28
Carcinoma Head of pancreas	6	12	7	14	7	14

Ultrasound (USG) successfully visualized dilated intrahepatic biliary radicles (IHBR) in all patients except one (98%), while CT scans achieved 100% detection. The single case on USG with an obscured hepatobiliary system was attributed to interference from excessive bowel gases.

Ultrasound (USG) detected dilation of the common hepatic duct and proximal common bile duct (CBD) in 92% of cases, compared to 100% for CT scans. For the distal CBD, USG identified dilation in 80% of cases, while CT scans achieved 84% detection (Table 2).

Table 2: Distribution of cases on the basis of dilatation of biliary tree.

Biliary tree dilatation	**USG**		**CT Scan**	
	N	**%**	**N**	**%**
IHBR	49	98	50	100
Common Hepatic Duct (CHD)	46	92	50	100
Proximal CBD	46	92	50	100
Distal CBD	40	80	42	84

Out of 21 total benign cases, ultrasound (USG) detected 25, while CT scans detected 23. Conversely, for the 29 malignant cases, USG detected 25 and CT scans detected 27. Choledocholithiasis (gallstones in the bile duct) was the most prevalent benign cause (14 cases), followed by benign biliary strictures (4 cases) and choledochal cysts (3 cases) (Table 1).

Ultrasound missed one case of benign biliary stricture and five cases of distal CBD stones, while CT scans falsely identified one case each of benign biliary stricture and CBD stone. Infiltrating gallbladder mass (10 cases) emerged as the most common malignant cause of obstructive jaundice in our study, followed by cholangiocarcinoma (9/50 cases) and pancreatic carcinoma (7/50 cases). Notably, ultrasound missed one case of pancreatic head mass and one case of periampullary carcinoma.

This study found two cases of distal common bile duct (CBD) masses that were undetectable by ultrasound. This resulted in a diagnostic accuracy of 90% for ultrasound compared to 98% for a CT scan. Additionally, the CT scan missed one case of periampullary carcinoma and failed to detect another case of cholangiocarcinoma.

This study identified two false-positive cases of distal CBD mass diagnosed by ultrasound due to limitations in visualizing the area through overlying bowel gas. The evaluation of the distal CBD was impeded by these gases, leading to misidentification of the cause of obstruction. In contrast, the CT scan only had one false-positive case, misinterpreting a distal CBD stricture as a mass.

Ultrasound (USG) exhibited 100% sensitivity and 86.2% specificity in detecting benign lesions as the cause of obstruction, while CT scans achieved 100% sensitivity and 93.1% specificity in the same context. For malignant lesions, USG maintained 86.2% sensitivity and 100% specificity, while CT scans surpassed it with 93.1% sensitivity and 100% specificity. Overall, 10 cases were falsely diagnosed by USG, while only 4 cases were falsely diagnosed by CT scan among all 50 cases.

For cholangiocarcinoma, ultrasound (USG) detected 76 out of 9 cases with 2 false negatives, while CT scans identified 8 out of 9 cases with 1 false negative. For biliary stricture, USG diagnosed 3 out of 4 cases with 1 false negative, while a CT scan diagnosed 5 out of the confirmed 4 cases with 1 false positive. Both USG and CT scans accurately detected all choledochal cysts and gallbladder masses. In periampullary carcinoma, both modalities detected 2 out of 3 cases with 1 false negative each. For choledocholithiasis, USG detected 19 cases out of 14 confirmed cases, resulting in 5 false positives, while CT scans detected 15 cases with 1 false positive. Finally, for carcinoma of the pancreatic head, USG detected 6 out of 7 cases, while CT scans accurately diagnosed all 7 cases.

IHBR was visualized in 100% of cases on a CT scan as compared to sonography (98%). Dilatation of the

IHBR was found in all 50 cases by CT scan as compared to 49 cases on sonography. On the CT scan, CHD and proximal CBD dilatation were detected in all 50 cases, whereas USG could only detect 40 cases out of 50, and 42 cases were detected on the CT scan.

Out of 50 cases, 25 cases of obstruction at the hilar and intrahepatic levels are detected by USG and CT scans, respectively. 12 cases each were detected by USG and CT scans for obstruction at the supra-pancreatic level, and 13 cases each of obstruction at the infra-pancreatic level were detected by USG and CT scans.

Sensitivity of USG is 100% in detecting cases of choledochal cyst, GB mass, and choledocholithiasis, whereas sensitivity is 77% for cholangiocarcinoma, 75% for benign biliary structure, 66% for periampullary carcinoma, and 85.7% in the cavern of the pancreas

Specificity of USG is 100% in cases of cholangiocarcinoma, benign biliary structure, choledochal cyst, GB mass, periampullary carcinoma, and carcinoma head of pancreas, whereas specificity in cases of choledocholithiasis is 86%. Positive predictive value is 100% in all the cases, except in cases of choledocholithiasis, where PPV is 73% (Table 3).

Table 3: Diagnostic performance of USG

Cause of obstruction	Diagnostic performance of USG		
	Sensitivity	Specificity	PPV
Cholangiocarcinoma	77	100	100
Bening Biliary Stricture	75	100	100
Choledochal Cyst	100	100	100
GB Mass	100	100	100
Periampullary Ca	66	100	100
Choledocholithiasis	100	86	73
Ca. Head of pancreas	85.7	100	100

The sensitivity of CT scans is 100% for detecting choledochal cysts, gallbladder masses, choledocholithiasis, carcinoma of the pancreatic head, and benign biliary strictures. However, the sensitivity drops to 66% for periampullary carcinoma. The specificity of CT scans remains 100% for choledochal cysts, gallbladder masses, periampullary carcinoma, and carcinoma of the pancreatic head. It is 97.2% for choledocholithiasis, 97.6% for cholangiocarcinoma, and 97.8% for benign biliary strictures.

Positive predictive value is 100% in cases of choledochal cyst, GB mass, periampullary Ca. head of pancreas and PPV in cholangiocarcinoma is 88.8%, benign biliary stricture cases showed PPV of 80%, and in cases of choledocholithiasis PPV is 93.3%. (Graph-5)

Discussion:

Obstructive jaundice, often caused by gallstones, strictures, or malignancies affecting the bile duct, is more common in females. Choledocholithiasis is the most frequent benign cause. [4, 5] The current study confirms this trend, with females constituting the majority of patients experiencing biliary tract obstruction.

For visualizing intrahepatic biliary radicles (IHBR), CT scans excelled over ultrasound in our study. While CT scans visualized IHBR in all 50 cases (100%), sonography achieved 98%. Similar disparities emerged in detecting dilated IHBR, with CT scans identifying it in all 50 cases compared to 49 identified by sonography. A notable trend emerged: sonography's ability to visualize the biliary tree declined as moved distally. Visualization of proximal ducts reached 91.6%, but plunged to 63.3% for the distal CBD. This decreasing performance likely results from difficulties visualizing the distal CBD and pancreatic region due to bowel gas interference.

Similar observations were made by Fernandez et al. [6] who attributed limitations in sonographic evaluation of the distal biliary tree and pancreas to the presence of malignant masses at the level of the hilum. Both ultrasound and CT scans exhibited high sensitivity and specificity, close to 100%, in detecting biliary obstruction presence. Studies by Mitchell et al. [7] highlighted this disparity in detecting choledocholithiasis. Their findings showed 18% sensitivity and 19% accuracy for ultrasound, compared to 87% and 84% sensitivity and accuracy for CT scans, respectively.

The present study aligns with Kumar et al. regarding the most common obstruction site. Both studies identified the hilar and intrahepatic region as the most frequent location, accounting for 50% of cases. However, Kumar et al.[8] reported a wider range of accuracy for ultrasound in determining the obstruction level, varying from 27% to 95%. In terms of lesion extent determination, CT scans again surpassed ultrasound. CT scans successfully determined the extent in all patients (100%), while sonography achieved this in only 66%. Naffisa et al. [9] reported 100% accuracy in tumor extent assessment, and our findings concur with theirs. Similarly, Pasanen et al. [10] prospective study comparing ultrasound (USG), CT scan, and ERCP found that for benign extrahepatic obstructions, ERCP was most accurate. However, for malignant cases, CT was comparable to ERCP. In diagnosing intrahepatic disease, both US and CT offered effective diagnosis.

Choledocholithiasis (gallstones in the bile duct) emerged as the most common cause of obstruction in our study, affecting 14 patients (28%) as shown in Table 1. The second most prevalent cause was infiltrative gallbladder mass, diagnosed in 10 out of 50 patients (20%). Cholangiocarcinoma ranked third on the list, with 9 patients (18%) presenting with this obstructive cause.

In this study, ultrasound exhibited 100% sensitivity and 86.2% specificity for detecting benign lesions as the cause of obstruction, while CT scans achieved 100% sensitivity and 93.1% specificity in the same context. For malignant lesions, ultrasound maintained 86.2% sensitivity and 100% specificity, while CT scans surpassed it with 93.1% sensitivity and 100% specificity. Additionally, CT scans offered a higher positive predictive value (PPV) of 93.7% and diagnostic accuracy of 96% compared to ultrasound in diagnosing benign diseases (80.77%). Likewise, CT scans demonstrated superior sensitivity (91.67%) than ultrasound (79.17%) in diagnosing malignant diseases. Our findings align with Ghimire et al. [11] study, which reported 67% sensitivity, 91% specificity, 71% positive predictive value (PPV), and 73% negative predictive value (NPV) for ultrasound in detecting benign lesions.

This study found that ultrasound has a sensitivity of 100%, specificity of 86%, positive predictive value (PPV) of 73%, and diagnostic accuracy of 96% for diagnosing choledocholithiasis (gallstones in the bile duct). In comparison, CT scans achieved higher sensitivity (100%), specificity (97.2%), PPV (93.3%), and diagnostic accuracy (98%). These findings align with Ferrari et al. [12] study, which reported a diagnostic accuracy of 80.15%, sensitivity of 71.08%, and specificity of 95.83%.In my study, five false-positive cases with ultrasound were attributed to limitations in visualizing the distal CBD due to bowel gas shadows and obesity. This aligns with Pasanen et al. [10] findings, which showed a wide range of ultrasound sensitivity (20%-80%) for choledocholithiasis despite high specificity (around 98%). In our study, stones were diagnosed in 19 cases, resulting in a sensitivity of 24.6%.

We identified strictures in 3 out of 4 postoperative cases with high diagnostic accuracy (98%). Sensitivity was 75% and specificity was 100%. In comparison, CT scans detected strictures in 5 out of 4 cases with even higher accuracy (100%), sensitivity (97.8%), and specificity (98%). These findings contrast with Pandit et al.[13] study, which reported an ultrasound accuracy of only 31% for detecting benign strictures. The high specificity of ultrasound in our study likely stemmed from its ability to identify true negatives (absence of stricture) and differentiate the cause of obstruction (e.g., calculi, malignant stenosis) with good accuracy. However, the lower sensitivity can be attributed to the inherent limitations of ultrasound technology.[14,15] While it can sometimes reveal indirect signs of stricture, it may not offer optimal visualization of the distal common bile duct and ampullary region, where benign strictures often occur. Both ultrasound and CT scans accurately identified all three choledochal cysts in our study and provided reliable information about their involvement, aligning with similar findings reported by Kim et al. [2]

Conclusion

Ultrasonography (USG) remains the most common initial imaging modality for diagnosing obstructive biliary diseases. However, its sensitivity can be limited for certain conditions, particularly benign strictures and distal common bile duct (CBD) diseases. In such cases, or when clinical and laboratory findings suggest biliary obstruction despite negative or inconclusive ultrasound results, a CT scan becomes a valuable diagnostic tool. Furthermore, CT scans offer superior accuracy for comprehensive malignancy staging.

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