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Role of Ultrasonography in Diagnosis of Biliary Tract Diseases: A Single Centre Experience

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ABSTRACT

Background: The development of new diagnostic imaging techniques has not eliminated the challenge of diagnosing right upper quadrant pain in some patients. This challenge persists for both clinicians and radiologists. To study the role of ultrasonography in diagnosing biliary tract diseases.

Methods: This study included patients suspected of having biliary tract diseases who were admitted to the surgical wards of Shri Jagannath Medical College and Hospital, Puri, between August 2021 and July 2023.

Results: Among the 104 patients in this study, 36 (34.6%) were diagnosed with acute cholecystitis through surgery and pathological examination. Ultrasonography identified acute cholecystitis in 44 patients. Of these, there were 34 true-positive diagnoses, 10 false-positive diagnoses (8 interpreted as chronic cholecystitis and 2 others), and 2 false-negative diagnoses. Maximal focal tenderness was located over the gallbladder fossa in 34 of the 36 patients with surgically and pathologically confirmed acute cholecystitis.

Conclusion: Due to its advantages of being inexpensive, non-invasive, and time-saving (particularly for critically ill patients), along with its high sensitivity, specificity, and accuracy, ultrasound has become the primary modality for investigating and managing biliary tract diseases.

Key-words: Ultrasonography, Biliary disease, Acute cholecystitis, Biliary obstruction

INTRODUCTION

Right upper quadrant pain is a joint clinical presentation, but diagnosing its cause can be challenging. Even with the development of new diagnostic imaging techniques, patients with this type of pain continue to pose a challenge for clinicians and radiologists. The rise in ultrasound investigations has likely contributed to the observed increase in diagnosed biliary tract diseases, highlighting its importance in this context.

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As available imaging modalities expand and their applications become more diverse and sophisticated, clinical and imaging guidelines remain crucial despite advancements in other non-invasive modalities like MRI and magnetic resonance cholangiopancreatography (MRCP) [1].

While both intravenous cholangiography and technetium-99m iminodiacetic acid (HIDA) derivatives offer high accuracy in diagnosing acute cholecystitis, it is essential to note that most patients experiencing right upper quadrant (RUQ) pain do not have this condition. Surgical studies have revealed that only 13–34% of patients presenting with signs and symptoms of acute cholecystitis possess the condition [2].

Similar symptoms can be seen in several medical conditions affecting the liver, right kidney, colon,

pancreas, and ovary that mirror the clinical presentation of acute cholecystitis. [3]. Compared to radionuclide scanning and intravenous cholangiography, ultrasound offers several advantages: it's non-invasive, independent of liver function, time-saving, and avoids radiation exposure. Studies show it boasts over 90% accuracy in diagnosing gallbladder disease [4].

Given the widespread use of ultrasound, this study prospectively evaluated its role in diagnosing biliary tract diseases. The sensitivity, specificity, and accuracy of ultrasound findings are assessed by comparing them with operative and histopathological results.

MATERIALS AND METHODS

The patients suspected of having biliary tract disorders who were admitted between August 2021 and July 2023 to the surgical department of the Shri Jagannath Medical College and Hospital in Puri, Odisha, India, were included in this study. Each participant provided a thorough clinical history using a standardized form upon admission.

Inclusion criteria- The patients of all ages and sexes met any of the clinical criteria mentioned earlier; they were included in this study and subsequently subjected to ultrasonography.

Exclusion criteria- Non-cooperative patients were excluded from our study.

Clinical criteria

- ✓ Pain in the right upper abdomen: suspected gallstones and/or cholecystitis.
- ✓ Jaundice
- ✓ Palpable right upper abdominal mass.
- ✓ Recurrent symptoms of peptic ulcer.
- ✓ Pyrexia of unknown origin

Methodology- Sonographic examinations were performed by one or two experienced physicians using a real-time ultrasound machine equipped with a 3.5 MHz transducer. For thin or anteriorly located gallbladders, a 5 MHz transducer was used. Adjustments were made to the time gain compensation curve and transducer power to optimize visualization of the gallbladder's internal contents and wall compared to surrounding structures. An intercostal approach with the right lobe of the liver as a window provided the best visualization. The gallbladder was typically identified as inferior to the interlobar fissure between the right and left liver lobes. For the intrahepatic bile ducts, the anatomy was best delineated by transverse scans of the right lobe of the liver.

To minimize obscuration by overlying bowel gas, the distal CBD was prioritized during the examination. We achieved satisfactory visualization by positioning the patient first in an erect right posterior oblique or right lateral decubitus position and utilizing transverse scans instead of the parasagittal approach. This positioning minimized gas in the antrum and duodenum, while transverse scans optimized tracing the course of the intrapancreatic distal duct. A curvilinear transducer with compression applied over the pancreatic head further aided visualization by eliminating gastric and colonic gas interference. If gas obscuration persisted, 16 ounces of water were administered orally, followed by repositioning the patient in a right lateral decubitus position for 2-3 minutes and rescanning.

While the proximal CBD could also be visualized in this position, the parasagittal plane typically offered better visualization after repositioning the patient to a supine left posterior oblique position. Upon conclusion, the patients were placed into one of three categories. Acute cholecystitis was diagnosed based on the presence of calculi and directly centered tenderness over the gallbladder. Chronic cholecystitis, on the other hand, was diagnosed in patients with calculi who exhibited a more diffuse pain pattern and maximal tenderness elsewhere. Finally, the 'other diagnoses' category was reserved for patients with a normal-appearing gallbladder lacking focal tenderness.

Statistical Analysis- Descriptive statistics, such as means, percentages, and frequencies, were used to analyse the data. Evaluations were conducted on the USG's sensitivity specificity and diagnostic accuracy. The measured diagnostic variables were then compared using a chi-square test. A statistically significant p-value was defined as one that was less than 0.05.

Ethical Clearance- The institutional ethics committee approved the study protocol.

RESULTS

Acute cholecystitis and chronic cholecystitis- Among the 104 patients in this study, 36 (34.6%) were diagnosed with acute cholecystitis through surgery and pathological examination. Ultrasonography identified acute cholecystitis in 44 patients. Of these, 34 were true-positive diagnoses, 10 were false-positive diagnoses (8 were interpreted as chronic cholecystitis, and 2 were others). Similarly, 34 out of 104 patients (32.7%) had a diagnosis of chronic cholecystitis. In twenty-four cases, the diagnosis of chronic cholecystitis was made accurately by ultrasonography. Ten incorrect negative diagnoses and two false positive diagnoses in two individuals with acute cholecystitis made up the twelve occurrences of mistakes (Table 1).

Table 1: Ultrasonography diagnosis compared with final diagnosis.

Final Diagnosis	Ultrasonography				
	Acute cholecystitis	Chronic cholecystitis	Other	Total cases	Percentage
Acute cholecystitis	34	2	0	36	34.60
Chronic cholecystitis	8	24	2	34	32.70
Other	2	0	32	34	32.70
Total	44	26	34	104	100

Calculi were diagnosed in 30 patients with acute cholecystitis. Stones could not be visualized in the remaining 6 patients. Despite the lack of visible calculi, these 6 patients were diagnosed with acute cholecystitis based on exquisite focal tenderness, sludge, wall thickening, and gallbladder distention. Among patients undergoing cholecystectomy, only two had pus present, while two others had single stones impacted in the cystic duct, leading to false-negative diagnoses. Calculi were correctly identified in 32 patients with chronic cholecystitis. Ultrasound misdiagnosed two patients without stones, placing them in the "other diagnoses" category. Sludge was present in 22 patients with acute cholecystitis, 4 with chronic cholecystitis, and 2 in the "other diagnoses" group. In the study's 36 acute cholecystitis patients, 26 (72%) had a thickened gallbladder wall. This finding was also present in 10 (29.4%) of the 36 chronic cholecystitis patients and 4 in the "other diagnoses" category. Additionally, 34 of the 36 patients with acute cholecystitis exhibited maximal focal tenderness over the gallbladder fossa (Table 2).

Table 2: Percentage of various clinical variables in different patients.

Variables	Diagnosis		
	Acute cholecystitis (N=36)	Chronic cholecystitis (N=34)	Other (N=34)
	No(%)	No(%)	No(%)
Focal tenderness	34(94.4)	8(23.5)	-
Stone	32(88.8)	32(94.1)	-
Sludge	22(61.1)	4(11.7)	2(5.8)
Wall thickness(>3mm)	26(72.2)	10(29.4)	4(11.7)

The presence of focal tenderness, stones, sludge, and wall thickening (>3 mm) was compared between acute and chronic cholecystitis cases. The present study revealed a significant difference (p<0.001) in wall thickening, focal tenderness, and sludge between acute and chronic cholecystitis. However, there was no significant difference (p>0.1) in the presence of stones between the two forms of cholecystitis. (Table 3).

Table 3: Clinical presentation of acute cholecystitis vs. chronic cholecystitis.

Type of variable	Acute Cholecystitis	Chronic Cholecystitis	p-value
Focal tenderness	34	8	p<0.001
Stone	32	32	p>0.1
Sludge	22	4	p<0.001
Wall thickness (>3mm)	26	10	p<0.001

Focal soreness was a substantial help in differentiating between acute and chronic cholecystitis (p<0.001). It's interesting to note that while the maximum discomfort in ten chronic cholecystitis patients was positioned elsewhere in the abdomen, they all showed mild focal tenderness concentrated over the gallbladder fossa. Pain radiated caudally to the gallbladder in four of these patients. These four patients had common bile duct stones discovered during surgery; as a result, they suffered from severe pancreatitis. The focal epigastric discomfort experienced by the other two individuals had no known explanation. In all 32 individuals with chronic cholecystitis, calculi were found and accurately diagnosed. Nevertheless, ultrasonography misidentified two individuals without stones, classifying them as having "other diagnoses." Of the 34 patients with chronic cholecystitis, 4 had sludge (12%), and 10 of the 26 patients (39%), had thickened walls. A normal gallbladder wall in 61% of patients and the lack of sludge in 88% of patients, respectively, statistically distinguished between acute and chronic cholecystitis (p<0.001 for both variables).

Other Diagnosis- Out of the 104 patients, 34 (32.7%) were placed in the 'other diagnoses' group. Ultrasonography correctly categorized 32 of these patients. However, there were two false-positive diagnoses (later found to have chronic cholecystitis) and two false-negative diagnoses (patients with ultrasound-diagnosed acute cholecystitis who did not have it). Beyond accurately visualizing normal gallbladders, ultrasound successfully identified the source of symptoms in an additional 12 patients within the 'other diagnoses' category, including amoebic abscesses (4), hepatomas (2), metastatic liver disease with paraaortic adenopathy (2), pancreatitis (2), and duodenal ulcer disease (2). Other investigations confirmed the absence of acute gallbladder pathology in the remaining 22 patients.

The absence of gallbladder calculi was the statistically most significant feature for determining placement in the "other diagnosis" category. This finding was highly significant Compared to the acute and chronic cholecystitis groups (p<0.0001). Similarly, the absence of tenderness over the gallbladder significantly differentiated patients with "other diagnoses" from those with acute cholecystitis (p<0.0001). However, due to the low prevalence of features like focal tenderness, sludge, and thickened walls in the chronic and "other diagnosis" groups, these did not help distinguish between the two categories.

Cases with a common bile duct diameter exceeding 10 mm were reviewed due to their potential association with the need for surgical exploration. However, the exact cause of obstruction was determined surgically in only 28 of these cases. Among these confirmed cases, stones were the most common cause of obstruction, identified in 19 (67.9%). Strictures were found in 5 cases (17.9%), and other causes were identified in the remaining 4 cases (14.3%). The cause remained undetermined in 2 cases (7.1%) (Table 4).

Table 4: Diagnostic accuracy of ultrasonography in diagnosis of billiary obstruction.

Cause of obstruction	Findings		Sensitivity
	U.S.G	Pre-operative	%
Stone	15	19	82.6
Stricture	1	5	55.5
Others	4	4	100
Total	20	28	77.7

The "other" category included diagnoses such as choledochal cysts (2 cases), carcinoma of the pancreatic head (1 case), and roundworm infestation (1 case). For surgically confirmed cases, ultrasonography successfully detected stones in 15 out of 19 patients (78.9%), strictures in 1 out of 5 patients (20%), and all 4 cases (100%) with other causes. This resulted in an overall sensitivity of 77%.

To assess the level of obstruction within the extrahepatic biliary tract, the tract was divided into three sections: porta hepatis, peripancreatic, and intrapancreatic. Ultrasonography correctly identified the location of the obstruction in all cases (1 out of 1) for porta hepatis, 85.7% (6 out of 7) for peripancreatic, and 70% (14 out of 20) for intrapancreatic cases (Table 5).

Table 5: Levels of Hepatobiliary Obstruction

Level	Actual No. of cases	U.S.G proved	%
Portahepatitis	1	1	100
Supra	7	6	85.7
Intra pancreatic	20	14	70
Total	28	21	75

Table 6: Overall accuracy of USG in diagnosis of Biliary Tract Diseases

Diagnosis	Sensitivity	%	Specificity	%
Acute cholecystitis	34/36	94	58/68	85
Chronic cholecystitis	24/34	71	68/70	97
Others	32/34	94	68/70	97

DISCUSSION

In this prospective study, all patients underwent clinical evaluation for suspected gallbladder pathology. Right upper quadrant pain, jaundice, a palpable right upper abdominal mass, recurrent symptoms of peptic ulcers, and pyrexia of unknown origin were among the clinical criteria taken into consideration. Nevertheless, only 34.6% of patients developed acute cholecystitis, according to the final diagnosis. In a similar vein, an analysis of surgical literature indicates that only 13%–14% of cases under study have acute cholecystitis [5]. Since most of these individuals won't have acute cholecystitis, it follows that many other organ systems need to be taken into account while evaluating these patients. It's important to consider differential diagnoses such liver neoplasms and pancreatitis. Ultrasonography can be used to confirm the diagnosis of acute cholecystitis, according to the previous study [6].

Most authors use ultrasound findings of gallstones and focal gallbladder tenderness for diagnosis. A study by Hwang *et al.* [7] reported a positive predictive value of 92% for diagnosing acute cholecystitis when a positive sonographic Murphy's sign was present in conjunction with cholestasis. However, it's important to note that acute cholecystitis only occurs in around 20% of gallstone patients [8]. This means many patients experience pain in the right upper quadrant due to other causes despite having gallstones. Therefore, sonographic

examinations for acute cholecystitis should also aim to determine if a stone is impacted in the cystic duct, as 90-95% of cases have obstructions caused by gallstones in either the gallbladder neck or the cystic duct.

False-negative results in ultrasonography for gallstones can occur due to several factors: stones may be too small to cast a visible shadow (typically under 1 mm in diameter), they may be soft and lack strong echoes, or they may be impacted in the gallbladder neck or cystic duct, making them less visible. While emergency radionuclide scans with technetium-99m (99Tc)-labeled iminodiacetic acid derivatives offer reported accuracy of 98-100% in diagnosing cystic duct obstruction, they are not suitable for routine use in most institutions. This is due to two main reasons: First, most individuals with symptoms do not have acute cholecystitis; second, nuclear imaging is less sensitive than ultrasonography at identifying diseases other than biliary tract disorders. When diagnosing acute cholecystitis, ultrasonography had a 94 percent sensitivity and an 85% specificity. In cases of chronic cholecystitis, the sensitivity and specificity were 71% and 97%, respectively. It was 94% and 97%, respectively, for the others. Because ultrasound has a high sensitivity and specificity for identifying gallbladder anomalies, it ought to be the first screening method [9]. This is important since, in the end, the diagnosis for two out of three individuals will be either non-biliary or chronic cholecystitis.

Even in cases where the gallbladder appears normal and non-tender on ultrasound, it can still be helpful. In such cases, ultrasound may localize the source of pathology in 12 out of 34 patients or guide further workup. Importantly, suppose pain persists despite a normal ultrasound but remains localized to the gallbladder fossa. In that case, a radionuclide scan is recommended to rule out a stone impacted in the cystic duct or acalculous cholecystitis. Diagnosing acalculous cholecystitis with ultrasound is more challenging due to two main reasons. Firstly, these patients are often quite ill, which means they can have other potential causes for gallbladder wall thickening. Secondly, they may be unable to communicate whether they experience tenderness in the gallbladder area.

Distinguishing acute calculus cholecystitis from acute acalculous cholecystitis via ultrasound remains challenging due to its reliance on subjective patient responses. Fortunately, the patients in this study were well-oriented, allowing precise localization of tenderness (focused or diffuse) in the majority. A gallstone impacted in the gallbladder neck or cystic duct may often go undetected by ultrasound. However, the high sensitivity of ultrasound in detecting dilated bile ducts makes it the preferred imaging technique for evaluating jaundice-related issues [10,11].

Precisely locating and identifying the cause of biliary obstruction is crucial for determining the course of further investigations and potential interventions. This information can guide decisions regarding surgery, endoscopy, percutaneous transhepatic cholangiography (PTC), or other relevant procedures [12]. Published reports on ultrasound's ability to pinpoint the level and cause of obstruction vary widely. Studies have found ultrasound has a high sensitivity, moderate specificity, and high diagnostic accuracy in diagnosing biliary obstruction [13,14]. Our study found an intermediate success rate of 93% for identifying the cause of obstruction and 75% for the level, falling within the broader range reported in the literature. According to other research, the range for detecting levels and determining the obstruction's origin by USG is 27-95% and 18-85%, respectively [15]. The general specificity of our analysis is similar to Kaur *et al*. [16] (100%), Al-Dhuhli *et al*. [17], Swaraj *et al*. [18] (83.3%), and Kurian *et al*. [19] (97.14%).

CONCLUSIONS

Ultrasound, because it is inexpensive, non-invasive, time-saving (especially for critically ill patients), and offers high sensitivity, specificity, and accuracy, has become the primary modality for investigating and managing biliary tract diseases. Additionally, its lack of ionizing radiation and contrast requirements makes it suitable for cases where other procedures are contraindicated. This has significantly impacted the profile of biliary tract surgery. Despite its advantages, it's crucial not to disregard ultrasound's limitations and subjective interpretation. In suspected cases, consider employing additional investigative methods like percutaneous transhepatic cholangiography, endoscopic retrograde cholangiopancreatography, magnetic resonance cholangiopancreatography, computed tomography, or radionuclide scanning for confirmation. By adhering to the clinical context and constantly examining the area of pain, ultrasound continues to be a strong and useful

diagnostic tool for determining the cause of acute right upper quadrant discomfort.

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