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Original Research Article

Ultrasound Diagnostic Accuracy in Evaluation of Obstructive Jaundice in Adults Taking MRCP as Gold Standard

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Abstract: *MRCP is highly sensitive in diagnosing obstructive jaundice, strictures, and malignancies, particularly in suspected cases. Although its higher accuracy in identifying the cause of obstruction makes it a sheer requirement in accurate diagnosis and treatment planning, ultrasound can be a screening modality.* ***Objective:*** *To determine the diagnostic accuracy of biliary tract ultrasound in diagnosing obstructive jaundice and its cause, keeping magnetic resonance cholangiopancreatography (MRCP) as the gold standard. Study Design: Cross-sectional study. Place and Duration of Study: Department of Radiology, POF Hospital, Wah Cantt, from 20th February 2024 to 19th August 2024.* ***Methodology:*** *A total of 300 patients aged 16 to 65 years, presenting with obstructive jaundice at the Radiology Department of POF Hospital Wah Cantt, were enrolled after informed consent. Baseline data, including age, gender, weight, and illness duration, were recorded. Patients underwent biliary tract ultrasound by a consultant radiologist for a provisional diagnosis, and the researcher noted the findings. MRCP was then performed and interpreted by a consultant radiologist to confirm the diagnosis, with results documented by the researcher. Data were collected using a predesigned proforma, ensuring patient confidentiality. Statistical analysis was conducted using SPSS version 22.* ***Results:*** *The mean age of the patients was 52.10±10.87 years, the mean BMI was 27.28±3.53 kg/m², and the mean disease duration was 7.01±5.86 weeks. The accuracy of biliary tract ultrasound in diagnosing obstructive jaundice was compared to MRCP as the gold standard. Specificity was 77.78%, showing that it can rule out non-obstructive cases. The positive predictive value (PPV) was 92.52%, showing that there were high chances that the people classified as positive did indeed have the disease, and the negative predictive value (NPV) was 65.12%, showing that a high proportion of negative ultrasounds still had the disease afflicting them. Ultrasonography of the biliary tract was very accurate and sensitive for all the etiologies of obstructive jaundice compared to MRCP.* ***Conclusion:*** *Ultrasound is moderately specific, sensitive, and accurate in diagnosing obstructive jaundice and its causes.*

Keywords: Obstructive jaundice, Biliary tract ultrasound, MRCP

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Introduction

Obstructive jaundice is the yellow discoloration of skin and sclera caused by obstruction either in or external to the liver. It leads to deranged bile flow (1). Obstructive jaundice accounts for 17.1% of cases of jaundice (2). A case study proved the main etiologies of obstructive jaundice to be choledocholithiasis (95.83%), gallbladder carcinoma (62.5%), cholangiocarcinoma (12.5%), pancreatic head carcinoma (12.5%), periampullary carcinoma (12.5%), benign bile duct stricture (3.07%) and Mirizzi syndrome (1.53%) (3). ERCP and MRCP are great diagnostic tools for diagnosing obstructive jaundice; various case studies have proven better detection capabilities (4,5). However, their availability is restricted in developing countries by their resource constraints. Thus, in most clinical practices, radiologists use ultrasound, the more readily available modality, to establish the etiology of obstructive jaundice before instituting treatment. However, there is now some evidence with increasing use to indicate a substantial variation in diagnostic accuracy for ultrasound in establishing the etiology of biliary obstruction.

The sensitivities, specificities, and accuracies in one study about the use of biliary ultrasound to differentiate the causes of obstructive jaundice as either benign or malignant, as opposed to MRCP, were found to be 97%, 86%, 67%, 100%, and 97.4% and 87.5%, respectively.[6] In the same study, the commonest cause of obstructive jaundice was choledocholithiasis at 35.1% and benign common bile duct (CBD) stricture at 25.2%. Biliary tract ultrasound, when compared with MRCP as a gold standard, showed 84.57% sensitivity, 79.10% specificity, 91.36% PPV, and 66.25% NPV.[7]

In another study with different results, it was stated that the ultrasound sensitivity, specificity, and accuracy for the cause of obstructive jaundice were very high at 33.3%, 84%, and 48.9%, respectively, compared to MRCP. In the same paper, the following was found: in benign lesions, ultrasound compared with MRCP as a gold standard presented with a sensitivity of 20.88%, a specificity of 79.31%, a PPV of 76%, and an NPV of 24.21%. On the other hand, the values for malignant lesions, which are much higher than those, included all parameters like sensitivity, specificity, PPV, and NPV and equated to 72.41%, 98.90%, 95.46%, and 91.84%, respectively. All the above findings suggest that using an ultrasound presents different performances in diagnostics for differentiating between malignant and benign causes of obstructive jaundice (6).

In resource-challenged settings like ours, MRCP is not readily available in most health facilities. The radiologists will therefore often utilize ultrasound, which is more available than the imaging tool, to diagnose the cause of obstructive jaundice before commencing treatment. However, ultrasound as a stand-alone test for diagnosis shows varying diagnostic accuracy; there are some reports of high sensitivity (6, 7). while others indicate that the sensitivity is substantially lower.[8] Therefore, this warrants further study. Hence, the purpose of this study was to evaluate the diagnostic accuracy of biliary tract ultrasonography for the presence and cause of obstructive jaundice using MRCP as the reference standard. These data will contribute to answering the question of how reliable ultrasound is in the clinical setting. They may increase radiologists' confidence in using ultrasound as a useful method for diagnosis, at least in locations where MRCP is not available.

Thus, the study's objective was to determine the accuracy of biliary tract

ultrasound in diagnosing obstructive jaundice and its cause, using magnetic resonance cholangiopancreatography (MRCP) as the gold standard.

Methodology

From 20th February 2024 to 19th August 2024, a total of 300 patients, both males and females between 16 and 65 years presenting with obstructive jaundice, reporting to the Radiology Department of POF Hospital Wah Cantt, were enrolled in the study after taking informed consent. Those who had a history of bone, kidney, or liver diseases, those with contraindications for MRCP in the presence of metallic implants or claustrophobia, patients presenting with AST/ALT above normal levels, and pregnant women were excluded from the study. The baseline information includes age, gender, weight in kilograms, and illness duration in weeks. Following that, all the patients had an initial ultrasound of the biliary tract performed by a consultant radiologist with a provisional diagnosis of obstructive jaundice and its aetiology. The researcher noted the findings of the ultrasound examination. Later, all the participants underwent MRCP, which was also interpreted by a consultant radiologist in order to establish the diagnosis of obstructive jaundice and its aetiology. The researcher also recorded the MRCP findings. The data was all collected on a pre-designed proforma for the study. During the research, the anonymity and confidentiality of the patients were kept strictly. Statistical analysis was done on SPSS version 22. All the quantitative variables, such as age, weight, and disease duration, were presented as mean±standard deviation (SD). In contrast, the categorical variables were gender, obstructive jaundice, and its cause on biliary tract ultrasound and MRCP, presented in frequency and percentages. The 2x2 table for this analysis established ultrasound's sensitivity, specificity, NPV, PPV, and diagnostic accuracy in detecting obstructive jaundice. The potential effect modifiers were also controlled in the stratification according to age, gender, BMI, and disease duration.

Results

The demographic description of the study population indicates that the largest segment of the study sample, 246 (82.0%), aged between 41–65 years, and 54 (18.0%) aged between 16–40 years. The average age was 52.10±10.87 years. BMI showed that 237 (79.0%) of the patients had a BMI less than 30 kg/m², and 63 (21.0%) had a BMI of 30 kg/m² or higher, with a mean BMI of 27.28±3.53 kg/m². About disease duration, 284 patients (94.7%) had a disease duration of 21 weeks or less, and 16 (5.3%) had a disease duration of more than 22 weeks, with a mean disease duration of 7.01±5.86 weeks. About gender distribution, 179 (59.7%) of the sample were female respondents, and 121 (40.3%) were male respondents. Population-based evidence is important in reporting on data about patient characteristics, which influence disease progression and treatment (Table 1). The performance of biliary tract ultrasound in diagnosing obstructive jaundice was evaluated against MRCP as the gold standard. Out of 300 patients, ultrasound correctly identified 198 true positive (TP) cases, and 16 were falsely identified as positive (FP). It also missed 30 cases (FN), and 56 were correctly identified as negative (TN). The sensitivity of the ultrasound was 86.84%, demonstrating its high degree of ability to identify true cases of obstructive jaundice. Specificity was 77.78%, demonstrating its ability to exclude non-obstructive cases. The positive predictive value (PPV) was 92.52%, indicating a high likelihood that the individuals identified as positive had the disease, and the negative predictive value (NPV) was 65.12%, indicating that a significant percentage of negative ultrasounds remained affected by the disease (Table 2). The utility of biliary tract ultrasound in diagnosing the multiple etiologies of obstructive jaundice was assessed against MRCP as the gold standard. In choledocholithiasis, ultrasound had a sensitivity of 94.1% and specificity of 83.8% with a positive predictive value (PPV) of 95.7% and negative predictive value (NPV) of 78.7%, with an overall diagnostic rate of 92.0%. In identifying benign strictures, it exhibited a 91.2% sensitivity and an 88.1% specificity, and the PPV and NPV values were found to be 95.1% and 79.5%, respectively, to give a result of accuracy that was 90.3%. Mirizzi syndrome was identified with sensitivity being 96.0% and specificity 84.8%, and in conjunction with these findings, PPV and NPV were recorded at 92.7% and 91.3%, respectively, which produced an accuracy result of 92.3%. For malignant strictures, ultrasound had a sensitivity of 92.8% and specificity of 82.5%, with a PPV of 95.2% and an NPV of 75.3%, resulting in an accuracy of 90.6%. Gallbladder carcinoma was diagnosed with the highest sensitivity (97.5%) and specificity (86.6%), with a PPV of 96.6%, an NPV of 89.6%, and an accuracy of 95.3%. In diagnosing carcinoma of the head of the pancreas, sensitivity was 92.2% and specificity was 75.0%, with PPV being 94.1%, NPV being 68.8%, and accuracy being 89.0%. These results show that biliary tract ultrasound is a highly sensitive and effective method of diagnosis, especially for carcinoma of the gallbladder and Mirizzi syndrome. Nevertheless, false positives and negatives highlight the value of confirmatory imaging in low specificity and NPV cases (Table 3). The accuracy of biliary tract ultrasound in detecting obstructive jaundice was evaluated by controlling for different effect modifiers using MRCP as a reference. Analysis stratified by age showed that sensitivity of ultrasound in patients 16–40 years was higher than in those between 41–65 years (92.1% vs. 85.7%), even though specificity in the older patients was greater (80.3% vs. 68.7%), yielding overall accuracies of 85.1% and 84.5%, respectively. Gender stratification revealed sensitivity to be greater in men (91.8%) than in women (83.8%), but specificity was higher among women (86.4% vs. 68.5%), and diagnostic accuracies were 85.1% and 84.3%, respectively. Where the BMI was analyzed, those below 30 kg/m² yielded 86.3% sensitivity and 78.6% specificity, but those at and above 30 kg/m² had higher sensitivity (88.4%) and lower specificity (72.7%), with accuracies of 84.3% and 85.7%, respectively. The duration of the disease also affected performance, with sensitivity being 87.1% in the condition lasting 21 weeks or less and 81.8% in the longer duration. Specificity was better in the latter (80.0% vs. 76.6%), and total accuracy was 84.8% for shorter disease and 81.2% for longer duration. These results demonstrate that biliary tract ultrasound has significant diagnostic potential. At the same time, variation in specificity and NPV across subgroups implies the necessity of further imaging for more specific diagnosis in individual patient populations (Table 4).

Table 1: Demographic profile

Age (Year)	Number	Percentage
16-40	54	18.0
41-65	246	82.0
Total	300	100.0
Mean±SD	52.10±10.87	
BMI (Kg/m^2)		
< 30	237	79.0
≥ 30	63	21.0
Total	300	100.0
Mean±SD	27.28±3.53	
Duration of disease (weeks)		

≤ 21	284	94.7
> 22	16	5.3
Total	300	100.0
Mean±SD	7.01±5.86	
Gender		
Male	121	40.3
Female	179	59.7
Total	300	100.0

Table 2: Diagnostic accuracy of biliary tract ultrasound in the diagnosis of obstructive jaundice by taking MRCP as the gold standard

Biliary tract ultrasound	**MRCP (Gold Standard)**		**Total**
	Positive	Negative	
Positive	198 (TP)	16 (FP)	214
Negative	30 (FN)	56 (TN)	86
Total	228	72	300
Sensitivity	86.84%		
Specificity	77.78%		
PPV	92.52%		
NPV	65.12%		
Diag. Accuracy	84.67%		

Table 3: Diagnostic accuracy of biliary tract ultrasound in the diagnosis of causes of obstructive jaundice by taking MRCP as the gold standard

Choledocholithiasis				
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
94.1%	83.8%	95.7%	78.7%	92.0%
Benign stricture				
Sensitivity	Specificity	PPV	NPV	Accuracy
91.2%	88.1%	95.1%	79.5	90.3%
Mirizzi syndrome				
Sensitivity	Specificity	PPV	NPV	Accuracy
96.0%	84.8%	92.7%	91.3%	92.3%
Malignant stricture				
Sensitivity	Specificity	PPV	NPV	Accuracy
92.8%	82.5%	95.2%	75.3%	90.6%
Gallbladder carcinoma				
Sensitivity	Specificity	PPV	NPV	Accuracy
97.5%	86.6%	96.6%	89.6%	95.3%
CA pancreatic head				
Sensitivity	Specificity	PPV	NPV	Accuracy
92.2%	75.0%	94.1%	68.8%	89.0%

Table 4: Stratification for effect modifiers about diagnostic accuracy of biliary tract ultrasound in diagnosing obstructive jaundice by taking MRCP as the gold standard.

Age (Year)		
	16-40	41-65
Sensitivity	92.1%	85.7%
Specificity	68.7%	80.3%
PPV	87.5%	93.6%
NPV	78.5%	62.5%
Accuracy	85.1%	84.5%
Gender		
	Male	Female
Sensitivity	91.8%	83.8%
Specificity	68.5%	86.4%
PPV	87.7%	95.9%
NPV	77.4%	58.1%
Accuracy	85.1%	84.3%
BMI (kg/m^2)		

	< 30	≥ 30
Sensitivity	86.3%	88.4%
Specificity	78.6%	72.7%
PPV	92.1%	93.8%
NPV	66.6%	57.1%
Accuracy	84.3%	85.7%
Duration of disease (weeks)		
	≤ 21	> 22
Sensitivity	87.1%	81.8%
Specificity	76.6%	80.0%
PPV	92.6%	90.0%
NPV	65.0%	66.6%
Accuracy	84.8%	81.2%

Discussion

Ultrasound is the most universally accepted first-line imaging test for assessing obstructive jaundice because it is noninvasive, inexpensive, and readily available (9, 10). It is most effective in showing biliary dilatation and assessing the site of obstruction. Studies have shown that ultrasound has a more than 80 percent sensitivity rate in diagnosing biliary diseases (10). However, its reliability is subject to variations based on the skill of the operator and patient-specific factors such as obesity.

Other imaging methods, such as CT and MRCP (Magnetic Resonance Cholangiopancreatography), provide complementary benefits. CT is especially valuable in detecting extrahepatic mass lesions and evaluating distant spread in malignancy-suspected cases. MRCP, in contrast, allows good visualization of the biliary tree and is very specific in defining the level of obstruction (9).

Although ultrasound is the first-line imaging modality, combining it with other imaging modalities can improve diagnostic accuracy and offer a complete assessment of the biliary tract. For example, combining ultrasound results with CT or MRCP can assist in characterizing lesions and planning the right interventions (10).

In the current study, biliary tract ultrasound demonstrated a high sensitivity of 86.84% and a positive predictive value (PPV) of 92.52%, making it an effective initial screening tool for diagnosing obstructive jaundice. However, its specificity (77.78%) and negative predictive value (NPV) (65.12%) indicate limitations in excluding non-obstructive cases and a relatively high rate of false negatives.

Hanif et al (7). in a study, presented findings similar to these, and the sensitivity of biliary tract ultrasound compared to MRCP as a gold standard was 84.57%, specificity was 79.10%, positive predictive value (PPV) was 91.36%, and negative predictive value (NPV) was 66.25%.[7] Although the findings were different in another study, the sensitivity of ultrasound was reported as 33.3%, specificity was 84%, and overall accuracy was 48.9% when used to diagnose the cause of obstructive jaundice compared to MRCP (8).

In one comparison, MRCP was found to be more diagnostically accurate relative to ultrasound, with 100% sensitivity and 100% specificity in defining the site of obstruction and 95.83% sensitivity and 100% specificity for the diagnosis of malignant disorders (11).

In our study, ultrasound of the biliary tract was highly sensitive and accurate in diagnosing all causes of obstructive jaundice compared to MRCP. It had the best diagnostic performance for gallbladder carcinoma (97.5% sensitivity, 86.6% specificity, 95.3% accuracy) and Mirizzi syndrome (96.0% sensitivity, 84.8% specificity, 92.3% accuracy). For choledocholithiasis, benign and malignant strictures, and pancreatic head carcinoma, sensitivity was between 91.2% and 94.1%, and overall accuracy was between 89.0% and 92.0%. Even though it is effective, false positives and negatives highlight the necessity of confirmatory imaging in instances with low specificity and NPV.

This study's results agree with earlier studies assessing the diagnostic accuracy of ultrasound in obstructive jaundice. For example, Hanif et al. indicated that the sensitivity of ultrasound was 84.57%, specificity was 79.10%, and diagnostic accuracy was 83.06% for obstructive jaundice detection, with the use of MRCP as the gold standard (7)

Likewise, according to a study by Phadnis et al., MRCP was 97% accurate in diagnosing the etiology of obstructive jaundice, whereas ultrasound was lower (12).

Chhettri and Rana have reported diagnostic accuracy of MRCP in benign and malignant pathology as 93.98% and 97.6%, respectively, in our study (13). These results support that although ultrasound is a cost-effective and readily available modality, MRCP should be used preferentially when the ultrasound results are not conclusive or when malignancy is suspected to provide a correct diagnosis and proper treatment planning.

Conclusion

In conclusion, biliary tract ultrasound was highly sensitive (86.84%) and positively predictive (92.52%) for obstructive jaundice and therefore a useful first-line screening test. Even though its specificity (77.78%) and negative predictive value (65.12%) suggest a very high likelihood of false negatives, these figures warrant MRCP confirmation in obstructive jaundice suspected cases. Though still a superb and easy diagnostic option, the downsides to ultrasound are such that vigilant clinical correlation with and supplementation with additional imaging when indicated are in order.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-POF-55-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Study Design, manuscript review, and critical input.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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