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EVALUATION OF OBSTRUCTIVE JAUNDICE IN A TERTIARY CARE CENTER USING PLAIN AND CONTRAST-ENHANCED MULTIDETECTOR COMPUTED TOMOGRAPHY- 128 SLICE

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ABSTRACT

Background: Obstructive jaundice, a clinical syndrome characterized by blockage in bile flow, leads to elevated levels of bile and its derivatives in the bloodstream. The condition's prognosis is influenced by whether the etiology is benign or malignant. Imaging modalities play a pivotal role in determining the cause and location of obstruction, with multidetector computed tomography (MDCT) emerging as a crucial non-invasive diagnostic tool. **Aim:** This study aims to assess the efficacy of plain and contrast-enhanced MDCT in evaluating obstructive jaundice, specifically in identifying the cause and level of obstruction, and comparing the sensitivity and specificity of MDCT findings against surgical, histopathological, or ERCP outcomes. **Materials and Methods:** In this prospective cross-sectional study, 68 participants with clinically suspected obstructive jaundice or lab-confirmed deranged liver function tests were examined using a 128-slice MDCT scanner. Following renal function assessment, participants underwent plain and contrast-enhanced CT imaging. Images were analyzed for baseline HU values, presence of calcium-containing biliary calculi, and post-contrast changes in arterial, porto-venous, and delayed phases. Findings were correlated with surgical, histopathological, or ERCP results for validation. The study cohort had a mean age of 57.98 ± 12.90 years, with a slight female predominance (52.9%). MDCT revealed masses in 47.1% of patients, enhancement in 45.6%, and calcifications in 45.6%. Malignant causes of obstruction were diagnosed in 42.6% of cases, **Results:** Predominantly periampullary obstructions like choledocholithiasis and pancreatic head masses were the most frequent diagnoses. CT findings demonstrated 100% sensitivity, 97.5% specificity, 99.01% positive predictive value, 100% negative predictive value, and an overall accuracy of 99.29% in differentiating between malignant and benign lesions. **Conclusion:** Contrast-enhanced MDCT is a highly effective non-invasive modality for diagnosing obstructive jaundice, offering precise identification of the obstruction cause and location. It exhibits high diagnostic accuracy, significantly aiding in differentiating benign from malignant etiologies, thus supporting optimal patient management and treatment planning.

Keywords: Obstructive jaundice, Multidetector computed tomography, Contrast-enhanced CT, Diagnostic accuracy, Benign and malignant obstruction, imaging modality.

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INTRODUCTION

Obstructive jaundice is a clinical disease caused by bile flow obstruction, causing excess bile and its byproducts to be redirected into the bloodstream.(1) The morbidity and mortality depends upon the cause of obstruction and it can be benign or malignant.(2) Radiologists are responsible for determining the cause and location of biliary obstruction using various imaging techniques. Ultrasonography (USG) is often used for detecting biliary obstruction, but its sensitivity and specificity are limited.(3) Endoscopic retrograde cholangio-pancreatography (ERCP) is the best method, but it is limited to assessing the intrinsic biliary tree and cannot identify extrinsic disorders. ERCP has a 3-9% complication rate and a 0.2-0.5% death rate.(4) Magnetic resonance imaging (MRI) and computed tomography are cross-sectional imaging methods that can diagnose obstructive jaundice efficiently. MRCP is considered the most reliable non-invasive method for evaluating solid organs and producing high contrast, high resolution biliary tree pictures. However, its application is limited by contraindications, high costs, and susceptibility to artifacts.(5)

Computed tomography (CT) hepatobiliary imaging has significantly improved since its introduction in the late 1990s. Its non-invasive nature allows for quicker scanning, reducing breathing and movement artifacts. Contrast enhancement is used to delineate and differentiate underlying pathologies. MDCT uses Multiplanar Reconstruction (MPR) and Minimal Intensity Projection (MinIP) to produce volume datasets with sub-millimeter spatial resolution, improving diagnostic accuracy in five areas: staging complex biliary malignancies, encasing and engulfing the main artery and venous channel, identifying benign from malignant strictures, and exhibiting regional lymphadenopathy and hepatic metastases.(6) Ultrasound is typically used for obstructive jaundice, but its sensitivity and specificity are 55-95% and 71-96% respectively.(3) Endoscopic Retrograde Cholangio Pancreatography (ERCP) has a sensitivity of 90.6% and specificity of 57.9%, but is only used after cross-sectional imaging due to its limitations. MRI is a useful imaging tool for obstructive jaundice, but its usage is limited by contraindications and high costs.(7) Hence, contrast enhanced MDCT is one of the preferred modalities in the diagnosis and characterization of different pathologies due to its faster scan time and reduced motion artifacts.

Aim and objectives

Aim:

To find out the role of Plain and Contrast enhanced Multidetector Computed Tomography in the evaluation of obstructive jaundice.

Objectives:

- To identify the cause and level of obstruction in obstructive jaundice.
- To find the sensitivity and specificity of radiological findings with Surgical/HPE/ERCP findings.

MATERIAL AND METHODS

Study Design: A Prospective Cross-sectional study was conducted among patients with clinically suspected obstructive jaundice who visited the Department of Radio-diagnosis at Yenepoya Medical College Hospital, Mangalore.

Sample Size calculation

Mathew RP *et al.*,3 carried out a study to evaluate the obstructive jaundice in a tertiary care center, sensitivity and specificity were 88% and 97.8% respectively.

$$\mathbf{N = Z^2_{1-\alpha/2} * Sn * (1 - Sn) / p * d^2}$$

d2 - prevalence

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Where,
z21- α/2 = 1.64
Pse = 88%
Psp = 97.8%
d = 15%
Prevalence = 24%
In order to estimate the accuracy of obstructive jaundice with 90% level of confidence and 15% margin of error. The minimal sample size is 68.

Sampling method:

As per convenient sampling patients those who fulfilling the inclusion criteria with consent were taken into the study.

Inclusion Criteria

- All participants (above 18 years of age) with either clinically suspected obstructive jaundice or lab proven clinical jaundice (Deranged liver function tests) or both.

Exclusion Criteria

- All cases where the cause of jaundice was due to a non-obstructive etiology.
- Those participants who have obstructive jaundice but are unable to undergo computed tomography scanning due to conditions such as contrast hypersensitivity or abnormal renal function testing.

Methodology

Data was collected from 68 participants (above 18 years), with clinically suspected obstructive jaundice or lab diagnosed (deranged liver function tests) or both. Then, renal function test was done and only after ensuring that it is within the normal range, the participant was evaluated by 128 slice multidetector CT scanner (GE REVOLUTION EVO128) and plain and contrast enhanced images were obtained. Before undergoing the scan, the patients were explained about the research, scan procedure and were given an informed consent form and information sheet. The informed consent form was explained by the principal investigator in the CT waiting area and if the participant agrees to be a part of the research the signature was taken prior to the scan by the principal investigator. The informed consent process took approximately 30 minutes. The participant's personal identifiers such as name and address were not collected so as to protect the privacy of the participant.

To find any biliary calculi containing calcium and to establish the baseline HU value, plain CT of the abdomen was done. To create post-contrast images, 90 mL of non-iodinated contrast agent (350 mg% w/v) was injected at a pace of 3 mL/second using a Mallinckrodt pressure injector. 18–22 seconds, 60–65 seconds, and 10-15 minutes were the times at which images of the arterial, portovenous, and delayed phases were acquired. A 3D reconstruction employing thin planar slicing (1 mm) and MPR was performed in the coronal and sagittal planes to better properly depict the intraluminal and wall lesions of the biliary system. The data that was collected, compiled, analysed and studied as a part of the research study. Also, all the findings were reported to the treating doctor of the participant.

Statistical analysis

All the data were entered in excel sheet and analysed using SPSS v21.0 operating on windows 10. The data were summarised as mean, standard deviation, frequency and percentage. The summarised data were represented using tables, figures, bar diagram and pie chart. The mean difference between continuous data was analysed using unpaired t-test and categorical data using the chi-square test. The diagnostic characteristics were analysed using

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ROC curve analysis and diagnostic accuracy, sensitivity, specificity, positive and negative predictive value. For all statistical purpose, a p<0.05 was considered statistically significant.
Ethical consideration: Ethical standards such as patient respect, beneficence, and justice were strictly upheld. The "Institutional Ethics Committee" (IEC) authorized this study. Before administering the questionnaire, all study participants supplied informed written permission and were given an explanation of the risks and benefits in their language. All interventions were supervised by a skilled and experienced guide. Participants' confidentiality was maintained throughout the study.

RESULTS

Table 1: Basic characteristics of the study participants

Basic characteristics	**Frequency**	**Percentage**
Mean age ± SD in years	57.98 ± 12.90	
Gender		
Male	32	47.1 %
Female	36	52.9 %
Total	**68**	**100.0 %**

Table 1 shows the mean age of the study participant was 57.98 ± 12.90, among them 47.1% were male and 52.9% were female with marginal preponderance of female.

Table 2: CT calcification findings distribution among participants

Basic characteristics	**Frequency**	**Percentage**
CT mass	32	47.1 %
CT Enhancement	31	45.6 %
CT calcification	31	45.6 %
CT diagnosis		
Benign	39	57.4 %
Malignant	29	42.6 %
Type of obstruction		
Extra luminal	29	42.6 %
Head of pancreas	1	1.5 %
Intraluminal	38	55.9 %
Level of obstruction		
Cysticduct	2	2.9
EHBT	15	22.1
EHBT;cysticduct	1	1.5
IEHBT	1	1.5
IHBT	6	8.8
Neckof GB	3	4.4
Neckof GB,Cysticduct	1	1.5
PeriAmpullary	38	55.8
PeriAmp,EHBT	1	1.5
Total	**68**	**100.0 %**

CT Mass was observed in 32 patients (47.1%), CT Enhancement and CT Calcification were noted in 31 patients each (45.6%). Benign conditions were more common, affecting 39 patients (57.4%). Malignant cases were present in 29 patients (42.6%). Intraluminal obstructions were the most frequent, seen in 38 patients (55.9%), extra-luminal obstructions occurred in 29 patients (42.6%) and obstruction involving the head of the pancreas was rare, with only 1 case (1.5%). In Level of Obstruction the peri-ampullary region was the most commonly affected site, with 38 cases (55.8%). Obstruction of the Extrahepatic Biliary Tree (EHBT) was noted in 15 cases (22.1%). Other less common sites included the Cystic Duct (2.9%), Neck of the Gallbladder (4.4%), and Intrahepatic Biliary Tree (IHBT) (8.8%).

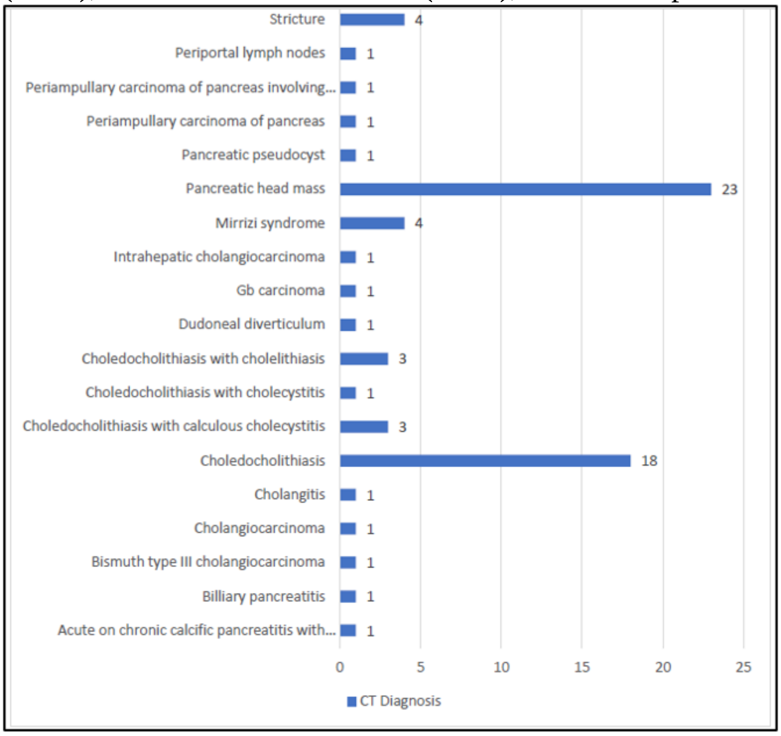

Figure 1: Distribution of various CT diagnosis among participants

The Figure 1 shows pancreatic head mass was the most frequent finding, seen in 23 participants (33.8%). Choledocholithiasis accounted for 18 cases (26.5%). Associated Conditions like Choledocholithiasis with calculous cholecystitis and Choledocholithiasis with cholelithiasis were observed in 3 cases each (4.4%). Mirizzi syndrome and Stricture were noted in 4 cases each (5.9%). Conditions such as Acute on chronic calcific pancreatitis with peripancreatic collections, Biliary pancreatitis, Bismuth type III cholangiocarcinoma, Cholangiocarcinoma, Cholangitis, and Duodenal diverticulum were each seen in 1 participant (1.5%). Pancreatic pseudocyst, Gallbladder carcinoma, Periampullary carcinoma involving the pancreas or duodenum, and Periportal lymph nodes were also rare, with 1 case (1.5%) each.

Table 3: Distribution of final diagnosis among participants

	Frequency	Percent
Final diagnosis		
Benign	40	58.8%
Malignant	28	41.2%
Distribution of various final diagnosis		
Adenocarcinomaof ampullaofvater	1	1.5%
Adenocarcinomaofgallbladder	1	1.5%
Adenomatouspolypwith highgradedysplasia	1	1.5%
Benignserouscystadenoma	1	1.5%
CBDstricture	1	1.5%

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Cholangiocarcinoma	1	1.5%
Cholangitis	1	1.5%
Choledocholithiasis	23	33.8%
Choledocholithiasiswithcholelithiasis	3	4.4%
Cholelithiasis	4	5.9%
Chroniccalcificpancreatitis	1	1.5%
DistalCBDstricture	3	4.4%
Dudonealdiverticulum	1	1.5%
GIST	1	1.5%
Hilarcholangioacarcinoma	1	1.5%
Metastaticadenocarcinomaofliver	1	1.5%
Metastaticperiportallymphnodes	1	1.5%
Mucinouscarcinomaof pancreas	1	1.5%
Neuroendocrinetumorofpancreas	2	3.0%
Pancreaticadenocarcinoma	17	25.0%
Pancreaticcarcinoma	1	1.5%
Pseudocyst	1	1.5%
Total	**68**	**100.0 %**

Table 3 shows benign cases were more frequent, representing 40 participants (58.8%) and malignant cases accounted for 28 participants (41.2%). Choledocholithiasis was the most prevalent diagnosis, observed in 23 cases (33.8%). Pancreatic adenocarcinoma was the leading malignant diagnosis, found in 17 cases (25.0%). Associated Conditions such as Choledocholithiasis with cholelithiasis and Distal CBD stricture were seen in 3 cases each (4.4%). Cholelithiasis was present in 4 cases (5.9%). Neuroendocrine tumor of pancreas was noted in 2 cases (3.0%). Adenocarcinoma of ampulla of Vater, Adenocarcinoma of gall bladder, Benign serous cystadenoma, Chronic calcific pancreatitis, Mucinous carcinoma of pancreas, and several others, were rare, with 1 case (1.5%) each. Rare metastatic conditions included Metastatic adenocarcinoma of liver and Metastatic periportal lymph nodes, each seen in 1 case (1.5%).

Table 4: Comparison of the CTdiagnosis withfinal diagnosisof theparticipants

		FinalDiagnosis		**Chi- square (p-value)**
		Malignant	**Benign**	
CT Diagnosis	**Malignant**	28 (100.0%)	1 (2.5%)	64.014 (0.001)*
	Benign	0	39 (97.5%)	
Total		**28**	**40**	

Sensitivity :100.00% (95% CI - 96.38% to 100.00%)
Specificity :97.50% (95% CI - 86.84% to 99.94%)
Positive Predictive Value (*) :99.01% (95% CI - 93.52% to 99.86%)
Negative Predictive Value (*):100.00% (95% CI - 90.97% to 100.00%)
Diagnostic Accuracy (*) :99.29% (95% CI - 96.08% to 99.98%)

Table 4 shows all 28 malignant cases from the final diagnosis were correctly identified as malignant by CT (100%). Among the 40 benign cases, 39 (97.5%) were accurately identified as benign by CT, with only 1 case being misclassified as malignant. The comparison yielded a Chi-square value of 64.014, with a p-value of 0.001, indicating a highly significant correlation between CT diagnosis and final diagnosis. Sensitivity: 100.00% (95% CI: 96.38% to 100.00%) shows CT was perfect in detecting malignant cases. Specificity: 97.50% (95%

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CI: 86.84% to 99.94%) indicate CT was highly effective in identifying benign cases. Positive Predictive Value (PPV): 99.01% (95% CI: 93.52% to 99.86%) shows almost all cases diagnosed as malignant by CT were confirmed as malignant. Negative Predictive Value (NPV): 100.00% (95% CI: 90.97% to 100.00%) shows all cases diagnosed as benign by CT were confirmed benign. Diagnostic Accuracy: 99.29% (95% CI: 96.08% to 99.98%) indicate CT showed exceptional accuracy in differentiating malignant from benign conditions.

DISCUSSION

Obstructive jaundice, characterized by yellowing of the skin and eyes due to bile flow obstruction, presents a diagnostic challenge due to its varied etiology, including both benign and malignant conditions [8, 15]. Effective evaluation is critical for timely and accurate management. Multidetector computed tomography (MDCT), especially the advanced 128-slice variant, offers significant advantages in the detailed assessment of obstructive jaundice. This imaging modality, particularly when combined with contrast enhancement, enables comprehensive visualization of the biliary tree, identification of mass lesions, and precise delineation of anatomical abnormalities. This study is aimed at assessing the usefulness of plain and contrast-enhanced 128-slice MDCT in diagnosing the underlying causes of obstructive jaundice at a tertiary care center, highlighting its role in differentiating between malignant and benign pathologies, and guiding clinical decision-making [16, 17]. In present study total of 68 patients fulfilling inclusion criteria with mean age of 57.98 ± 12.90 years. Among them 47.1% were male and 52.9% were female with marginal preponderance of female. In concordance to present study Khadka S *et al.*, documented mean age of patients to be 54.9 ± 19.8yrs with 60% were female and 40% were male showing female preponderance in their study 58. In study by Darwish N *et al.*, include total of 30 patients with mean age of 55yrs and among them 17 were male and 13 were female patients [10].

CT scans revealed various significant findings: A substantial percentage of patients exhibited CT masses, enhancements, and signs of calcification. Mass was present in 47.1%, enhancement in 45.6% and calcification in 45.6%. Location-wise, periampullary obstructions were prevalent, followed by extrahepatic and intrahepatic bile duct obstructions. On assessment of CT, the most common diagnosis was 33.8% with pancreatic head mass, 26.5% with Choledocholithiasis, 5.9% with strictures, Mirizzi syndrome, and 4.4% with Choledocholithiasis with calculous cholecystitis and Choledocholithiasis with cholelithiasis. In study by Singh S *et al.*, presence of Choledocholithiasis was the most frequent cause of blockage (45.61%) [11].

In their study, Bhutia KD *et al.* identified choledocholithiasis (bile duct stones) and carcinoma of the gall bladder as the leading benign and malignant causes of obstructive jaundice, respectively. They concluded that choledocholithiasis was the most frequent etiology of obstructive jaundice among the patients they studied. This finding highlights the predominance of bile duct stones in causing bile flow obstruction, which is consistent with global patterns of obstructive jaundice. Importantly, the study also determined that there was no significant correlation between obstructive jaundice and the ethnic composition of the population in Sikkim. This suggests that the occurrence of obstructive jaundice in the region is largely due to common pathophysiological mechanisms rather than ethnic-specific factors, emphasizing the need for a broad diagnostic approach irrespective of ethnic background.[5]

In concordance with Bhutia KD *et al.*[5] findings, another study by Khadka S *et al.* documented that the most common cause of obstructive jaundice was choledocholithiasis, accounting for 33.34% of cases. This aligns with the pattern observed by Bhutia KD *et al.*, reaffirming bile duct stones as a predominant factor in obstructive jaundice. Additionally, Khadka S *et al.* reported that cholangiocarcinoma (cancer of the bile ducts) was responsible

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for 20% of cases, while ampullary carcinoma and choledochal cysts each accounted for 13.33%. These findings underscore a diverse etiological spectrum for obstructive jaundice, highlighting choledocholithiasis as the leading cause, followed by significant contributions from malignancies and congenital anomalies. This reinforces the need for comprehensive diagnostic strategies to identify and manage various underlying conditions causing obstructive jaundice [5, 14].

On comparison of the CT diagnosis with the final diagnosis, there is significant association of the findings between the two. The CT diagnosis showing 28 cases as malignant and 1 case as benign in cases which were diagnosed as malignant on final diagnosis. The diagnostic characteristics showing CT with 100% sensitive, 97.5% specificity, 99.01% PPV, 100% NPV and overall accuracy of 99.29% in detecting the malignant and benign lesions. In line with present study Mathew RP *et al.*, documented with MDCT having accuracy of 96% in determining the etiology of the obstruction and accuracy of 98% when it came to distinguishing between a benign and a malignant lesion as a cause of obstructive jaundice. Choledocholithiasis was the most common cause of obstructive jaundice (22%) and pancreatic dudoneal aneurysm (2%) the least. When using appropriate reformatting techniques, MDCT may accurately assess the degree and source of blockage in obstructive jaundice [3]. In another study by Singh S *et al.*, they recorded with 32% malignant lesion and 68% were benign lesions[10]. In concordance to present study Yadav N *et al.*, documented MDCT was able to determine the cause of obstruction with a sensitivity of 100 % and accuracy of 91.9%. Also stated that while using appropriate reformatting procedures, MDCT may accurately assess malignant obstructive jaundice[1]. Another study by Alsowey AM *et al.*, the overall sensitivity for the malignancy was documented as 94%. When diagnosing various causes and degrees of biliary blockage, MDCT cholangiography is a non-invasive, quick, highly sensitive, and specific method. It can also be helpful in characterising the lesion in situations of malignant obstruction and distinguishing it from benign stricture. It can be applied as a successful substitute for PTC or ERCP[12].

In line with the present study findings, Khadka S *et al.*, documented with MDCT showing sensitivity of 100% and NPV of 100% for the non-neoplastic lesions causing obstructive jaundice. Similarly 10% specificity and PPV for detection of neoplastic causes of obstructive jaundice. The accuracy for either neoplastic or non-neoplastic detection was 96.67%.MDCT can differentiate the neoplastic and non-neoplastic lesion causing the obstructive jaundice[14]. Importantly, the CT diagnoses strongly correlated with the final clinical diagnoses, demonstrating CT's high diagnostic accuracy. With sensitivity at 100%, specificity at 97.5%, a positive predictive value of 99.01%, a negative predictive value of 100%, and an overall accuracy of 99.29%, CT proved to be a reliable non-invasive tool for differentiating between malignant and benign lesions. These results underscore the utility of CT in the precise assessment and management of obstructive jaundice, making it indispensable for early detection and treatment planning in clinical practice.

CONCLUSION

Based on the findings of our study evaluating obstructive jaundice using contrast- enhanced multidetector computed tomography (CT), we observed that CT imaging plays a crucial role in accurately diagnosing and differentiating between malignant and benign causes of obstructive jaundice. Our study included 68 participants with a mean age of 57.98 years, predominantly female. CT scans revealed various significant findings: a substantial percentage of participants exhibited CT masses, enhancements, and signs of calcification. Diagnosis distribution indicated that malignant causes accounted for 42.6%, with the most common being pancreatic adenocarcinoma, while benign conditions constituted 57.4%,

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predominantly choledocholithiasis. Location-wise, periampullary obstructions were prevalent, followed by extrahepatic and intrahepatic bile duct obstructions. The most frequent CT diagnoses included pancreatic head masses, choledocholithiasis, and various stricture patterns. The final diagnosis matched the CT findings in a statistically significant manner, affirming CT's reliability. Furthermore, in separating malignant from benign lesions, CT showed great sensitivity (100%), specificity (97.5%), positive predictive value (99.01%), negative predictive value (100%), and total accuracy of 99.29%. This highlights CT's effectiveness as a non- invasive imaging technique for a thorough evaluation and accurate diagnosis of obstructive jaundice. In conclusion, contrast-enhanced multidetector CT emerges as a robust tool in clinical practice, facilitating early detection, accurate diagnosis, and appropriate management decisions in patients presenting with obstructive jaundice.

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