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KEY WORDS: Obstructive jaundice, MRI, magnetic resonance cholangiopancreatography (MRCP).

ROLE OF MAGNETIC RESONANCE CHOLANGIO PANCREATOGRAPHY IN OBSTRUCTIVE JAUNDICE

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ABSTRACT

Background: Obstructive jaundice is a frequently encountered clinical condition in gastroenterology, arising from various causes such as gallstones, strictures, and malignancies. Early diagnosis and precise identification of the level and cause of obstruction are crucial for effective management. Magnetic Resonance Cholangiopancreatography (MRCP) has emerged as a reliable, non-invasive diagnostic tool in evaluating the underlying causes of obstructive jaundice. This study aims to assess the diagnostic accuracy of MRCP in patients with obstructive jaundice by correlating MRCP imaging findings with histopathological results. **Methods:** An analytical cross-sectional study was conducted over 18 months at the Department of Radiodiagnosis, SAIMS & PG Institute, Indore. Fifty patients clinically suspected of obstructive jaundice underwent MRCP using a Siemens 1.5 T MRI system. MRCP results were correlated with histopathological findings to evaluate its diagnostic effectiveness. Data were analyzed using descriptive statistics and statistical tests, with a p-value of <0.05 considered significant. **Results:** Cholelithiasis (46%) and choledocholithiasis (38%) were the most common benign conditions diagnosed by MRCP, while adenocarcinoma of the gallbladder (12%) and cholangiocarcinoma (10%) were the most frequently identified malignant conditions. Statistically significant correlations were observed between MRCP findings and histopathological results for conditions such as CBD strictures and bile duct stones (p-value < 0.05). MRCP also proved particularly effective in detecting distal bile duct stones and malignant lesions. **Conclusion:** MRCP is a highly accurate, non-invasive imaging modality for diagnosing obstructive jaundice. It surpasses ultrasonography and CT in identifying benign causes like cholelithiasis and choledocholithiasis, as well as malignant causes such as adenocarcinoma and cholangiocarcinoma. MRCP's strong correlation with histopathological findings underscores its essential role in preoperative diagnosis and treatment planning, contributing to improved patient outcomes.

INTRODUCTION

Obstructive jaundice is a prevalent issue encountered in both medical and surgical gastroenterology practices. It can arise from various underlying conditions. [1] Surgical jaundice typically results from the obstruction of the bile duct, which may be caused by gallstones, strictures, or malignancies such as cholangiocarcinoma, periampullary carcinoma, gallbladder carcinoma, and pancreatic head carcinoma. [2,3] Additionally, some rare conditions like Castleman disease, Caroli's syndrome, and metastatic liver tumors have also been documented. [4]

Patients with obstructive jaundice often present with a range of symptoms, including jaundice (with or without accompanying pain), dark urine, pruritus, pale stools, weight loss, and anorexia. This condition represents one of the most serious forms of hepatobiliary disease, leading to complications such as ascending cholangitis, malabsorption, and hepatorenal syndrome, which may necessitate urgent surgical intervention. Therefore, it is critical to achieve not only early diagnosis but also precise identification of the level and cause of obstruction to effectively manage these patients. [5]

Endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC) are invasive procedures that allow for tissue diagnosis and therapeutic interventions; however, they are limited by their inability to provide extra-luminal information, have a failure rate of 3–10%, and pose risks of serious complications such as pancreatitis and gastrointestinal perforation. [6] In contrast, ultrasonography (USG) is a non-invasive, cost-effective, and widely accessible first-line investigation for obstructive jaundice, with a sensitivity of 55% to 95% and specificity of 71% to 96%. While USG is effective for initial screening, it can direct further imaging with multidetector computed tomography (MDCT), magnetic resonance cholangiopancreatography (MRCP), or ERCP for more precise diagnosis. [7,8]

Multidetector computed tomography (MDCT) has become a fast and effective non-invasive imaging option for obstructive jaundice, utilizing advanced techniques like Multiplanar Reconstruction (MPR) and Minimal Intensity Projection (MinIP) to enhance diagnostic accuracy for detecting biliary calculi and distinguishing between benign and malignant lesions. These techniques significantly improve the visualization of biliary ducts compared to traditional axial CT imaging. [5,9]

While MRCP is considered the most reliable non-invasive method for imaging, it has limitations, including higher costs, longer examination times, and restricted availability. Certain patients, such as those with pacemakers or claustrophobia, cannot undergo this imaging method. [9-11] Recently, MRCP has gained importance as a non-invasive tool for preoperative evaluation in obstructive jaundice, replacing invasive techniques like ERCP and PTC. Its technological advancements have made it a reliable choice for imaging the biliary tract and aiding in surgical planning. [8,12] Magnetic Resonance Cholangiopancreatography (MRCP) employs heavily T2-weighted sequences to highlight static fluid in dilated pancreatic and biliary ducts. With advancements in ultrafast and 3D imaging techniques, MRCP images can resemble direct cholangiograms obtained through ERCP or percutaneous transhepatic cholangiopancreatography. [13]

This study aims to evaluate the effectiveness of MRCP in diagnosing obstructive jaundice, focusing on its diagnostic accuracy in identifying the underlying causes. The objectives include exploring the imaging spectrum of MRCP in obstructive jaundice, examining histopathological findings in affected patients, and correlating MRCP results with histopathology.

MATERIAL AND METHODS

Following approval from the institutional ethical committee, an analytical cross-sectional study was conducted over a period of 18 months, from 1st September 2022 to 29th February 2024, in the Department of Radiodiagnosis at SAIMS

& PG Institute, Indore. 50 Patients of both sexes and age groups with clinical suspicion of hepatic lesions referred from various department of our institute to Department of Radiodiagnosis of SAIMS & PG Institute, Indore for MRCP were included. Patients were enrolled based on the inclusion and exclusion criteria, and informed consent was obtained from the patients or their guardians after explaining the study protocol

Inclusion Criteria

- Patients of all age groups, regardless of gender, with clinical suspicion of obstructive jaundice, undergoing MRCP during the study duration will be eligible for inclusion.
- Patient who gave consent for the study.

Exclusion Criteria

- Patients who are not willing to give consent;and
- Patients in whom Magnetic resonance imaging is contraindicated were excluded.

Methodology

A pre-structured proforma was employed for collecting baseline data. The study comprehensively assessed patients suspected of obstructive jaundice through detailed clinical histories, including symptoms and relevant lab investigations, which helped identify potential confounding factors and evaluate the accuracy of magnetic resonance cholangiopancreatography (MRCP).

Utilizing a Siemens 1.5 T MAGNETOM Symphony MRI machine known for its high-quality imaging, the MRI protocol incorporated various optimized pulse sequences to enhance diagnostic accuracy. Images were acquired using phased-array head coils, allowing for detailed visualization of the biliary and pancreatic ducts, while findings were systematically recorded by radiologists on a pre-structured proforma to ensure consistency and minimize bias. Additionally, histopathological examinations were conducted to support the findings from the imaging study

Statistical Analysis

The data was coded and entered into Microsoft Excel 2010, and analyzed using both Excel and SPSS 22.0 for Windows. The study results were organized into tables and subjected to statistical analysis. Descriptive statistics were employed to identify characteristics and features of the collected data, with mean and percentage utilized for representation. A Chi-square test was applied to assess associations between two qualitative variables and earson and Spearman rank correlation coefficients was used to measure correlations between variables considering a p-value of less than 0.05 as statistically significant.

RESULTS

The results showed that the highest percentage of patients (32%) were in the 46-55 age group, followed by 20% in the 56-65 age group and another 20% under 35 years. Additionally, 18% of patients were aged 36-45, while 10% were over 66 years. In terms of gender distribution, 54% of the patients were female, compared to 46% who were male. The clinical findings revealed that 62% of patients presented with abdominal pain, 36% experienced abdominal pain accompanied by jaundice, and the remaining patients had jaundice without abdominal pain. (Table 1)

Table 1: Clinico-demographic distribution of the patients with Obstructive jaundice patients.

Parameter	No of patients	Frequency (%)
Age		
15-25years	5	10.0%
26-35years	5	10.0%
36-45years	9	18.0%
46-55years	16	32.0%
56-65years	10	20.0%
66-75years	3	6.0%
>75 years	2	4.0%
Gender		
Male	27	54.0%
Female	23	46.0%
Clinical finding		
Jaundice	1	2.0
Pain in abdomen	31	62.0
Pain in abdomen with jaundice	18	36.0

Among the patients, cholelithiasis was the most prevalent condition, affecting 46% of patients. Choledocholithiasis followed, impacting 38%, while strictures were observed in 28%. Gallbladder malignancy was diagnosed in 18% of patients, and both pancreatitis and bile duct tumors were present in 16%. Cholecystitis was identified in 10%, with the remaining patients diagnosed with pseudocysts and choledochal cysts. (Graph 1)

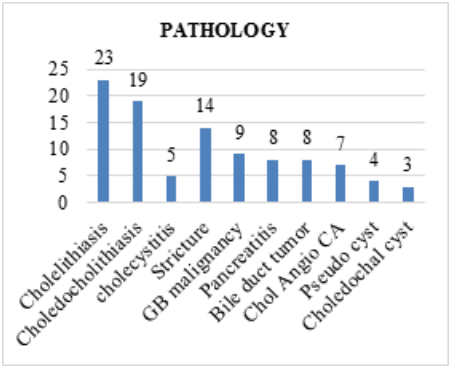


Figure 1. Distribution of patients with Obstructive jaundice patients depending upon pathological findings

In the MRI findings, 16% of patients showed T1 hypointensity, 46% exhibited T2 hyperintensity, and 50% displayed T2 hypointensity. Additionally, 4% had restricted diffusion on DWI, while 6% presented with hyperintensity on STIR sequences.

Table 2: Frequency and percentage of Appearance of MRI of obstructive jaundice patients (N=50)

Appearance of MRI	Hyperintense (%)	Hypointense (%)	Restriction (%)
T1	0 (%)	8 (16%)	0 (%)
T2	23 (46%)	25 (50%)	0 (%)
DWI	0 (%)	0 (%)	2 (4%)
STIR	3 (6%)	0 (%)	0 (%)

The histopathological findings showed that 60% of patients had benign results, while 36% had malignant findings, and 30% exhibited signs of infection. Among the patients, 48% had calculi retrieved, 12% were diagnosed with adenocarcinoma of the gallbladder, 10% with cholangiocarcinoma, and 8% with metastatic adenocarcinoma. The remaining patients had various malignancies, including periampullary carcinoma, CBD malignancy, and hepatocellular carcinoma (HCC).

Table 3: Frequency and percentage of HISTOPATH/Intro Op findings of obstructive jaundice patients

HISTOPATH/Intro Op findings	Frequency	Percentage %
Aden carcinoma of GB	6	12
Calculus retrieved	24	48
CBD malignancy	1	2
cholangiocarcinoma	5	10
HCC	1	2
Metastatic Adenocarcinoma	4	8

peri-ampullary CA	2	4
NA	7	14

The MRCT findings indicated that 92% of patients did not have a pseudocyst, while 8% exhibited this MRI finding. Additionally, 94% of patients had no choledochal cysts, with 6% showing this condition; intraoperative findings confirmed the presence of choledochal cysts in all cases where they were identified on MRCP. Regarding gallbladder stones, 54% of patients had no stones, whereas 46% were found to have gallstones, with 44% of those confirmed intraoperatively.

In terms of CBD tumors, 84% of patients had no tumors, while 16% did, with 12% of these tumors corroborated during surgery. Notably, 74% of patients showed CBD dilatation, while 26% did not. The location of CBD strictures was as follows: 72% had no strictures, 12% had distal strictures, 10% had mid strictures, and 6% had proximal strictures. Among the 28% with CBD strictures, 20% were malignant, and 8% were benign. Lastly, 62% of patients had no bile duct stones, while 24% had distal CBD stones, 8% had mid CBD stones, and 6% had proximal CBD stones.

Table 4: Frequency and percentage of various pathological findings for obstructive jaundice patients

Parameter	No of patients	Frequency (%)
Pseudocyst		
No	46	92.0
Yes	4	8.0
Choledochal cyst		
NO	47	94.0
On MRCP	3	6.0
Pancreatitis		
No	42	84.0
On MRCP	8	16.0
On Lab	6	12.0
GB stone		
No	27	54.0
On MRCP	23	46.0
Intra op	22	44.0
CBD Tumors		
No	42	84.0
On MRCP	8	16.0
Intra OP	6	12.0
CBD dilatation		
No	13	26.0
On MRCP	37	74.0
CBD Stricture		
Location		
No	36	72.0
Prox	3	6.0
Mid	5	10.0
Distal	6	12.0
Findings		
Benign	4	8.0
Malignant	10	20.0
Bile duct stone		
No	31	62.0
Prox CBD	3	6.0
Mid CBD	4	8.0
Distal CBD	12	24.0
IHBR dilatation		
Dilation +	39	78.0
Dilation -	11	22.0

A statistically significant association was observed between histopathological findings and both pathological findings and clinical findings, with a p-value of less than 0.05. Additionally, significant correlations were observed between histopathological findings and various MRI findings, including CBD stricture, bile duct stones, and CBD tumors, all showing p-values below 0.05. However, no significant associations were found between histopathological findings and other MRI findings, such as intrahepatic bile duct dilation, CBD dilation, pseudocysts, and pancreatitis, which had p-values greater than 0.05.

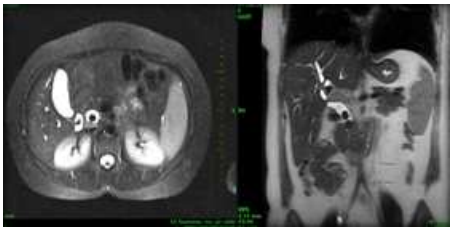


Figure 2. Two filling defects/calculi are seen in proximal, mid CBD with resultant proximal CBD dilatation with mild central as well as peripheral IHBR dilatation suggestive of choledocholithiasis.

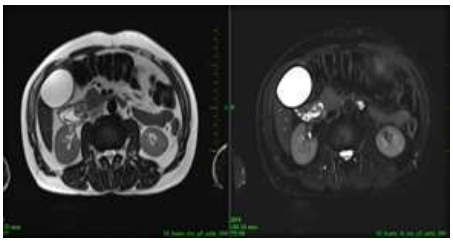
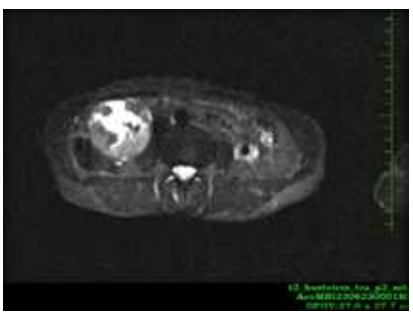


Figure 3. Abnormal signal intensity lesion noted in the distal CBD (periampullary region) lumen causing its luminal narrowing and upstream dilatation of the biliary channel suggestive of neoplastic etiology with resultant dilatation of biliary channels.



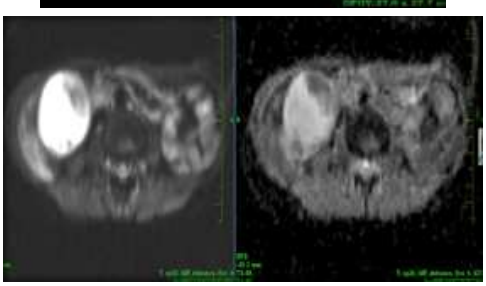


Figure 4. Heterogeneous signal intensity soft tissue mass lesion showing restriction diffusion is noted in the body ,neck of GB, extending in the cystic duct and proximal CBD-CHD junction with resultant dilatation of IHBR Few nodular skip lesions are also seen along the wall of body and fundus of gall bladder suggestive of gall bladder malignancy.

Table 5: Association between Histopathological finding and pathological and clinical finding for obstructive jaundice patients

Variables	Clinical findings			Pathology				
	jaundice	Pain in abdomen	Pain in abdomen with jaundice	Benign	Infective	Infective + Benign	Malignant	Malignant + Benign

Histopath finding	Adenocarcinoma of GB	0	0	6	0	0	0	5	1
	Calculus retrieved	0	22	2	15	0	9	0	0
	CBD malignancy	1	0	0	0	0	0	1	0
	Cholangiocarcinoma	0	2	3	0	0	0	5	0
	HCC	0	0	1	0	0	0	1	0
	Metastatic Adenocarcinoma	0	0	4	0	0	0	3	1
	NA	0	6	1	1	4	2	0	0
	peri-ampullary CA	0	1	1	1	0	0	1	0
Chi square test (P-value)		80.723 (0.001)			79.880 (0.001)				

Table 6: Association between Histopathological finding and different MRI finding for obstructive jaundice patients

Variables	Categories	HISTOPATH Finding								Chi square test (P-value)
		Adenocarcinoma of GB	Calculus retrieved	CBD malignancy	cholangiocarcinoma	HCC	Metastatic Adenocarcinoma	NA	peri-ampullary CA	
IHBR	Dilated +	5	17	1	5	1	4	5	1	5.010 (0.659)
	Dilated -	1	7	0	0	0	0	2	1	
CBD Dilated	No	1	6	0	2	0	1	2	1	2.121 (0.953)
	Yes	5	18	1	3	1	3	5	1	
CBD Stricture	Distal	1	1	1	1	1	0	1	0	35.999 (0.022)
	Mid	2	0	0	2	0	1	0	0	
	No	3	22	0	2	0	2	5	2	
	Prox	0	1	0	0	0	1	1	0	
Bile duct stone	Distal	0	12	0	0	0	0	0	0	39.673 (0.008)
	Mid	0	2	0	0	0	2	0	0	
	No	6	8	1	5	1	2	7	1	
	Prox	0	2	0	0	0	0	0	1	
Pancreatitis	No	5	22	1	5	0	3	4	2	11.823 (0.107)
	Yes	1	2	0	0	1	1	3	0	
Pseudo cyst	No	6	22	1	5	1	4	5	2	5.681 (0.577)
	Yes	0	2	0	0	0	0	2	0	
CBD Tumors	No	5	23	1	1	1	2	7	2	23.276 (0.002)
	Yes	1	1	0	4	0	2	0	0	

DISCUSSION

The study explored the diagnostic utility of Magnetic Resonance Cholangio-Pancreatography (MRCP) in managing obstructive jaundice by correlating its findings with existing literature. Obstructive jaundice, a condition marked by yellowing of the skin due to

impaired bile flow, presents diverse causes like gallstones, tumors, and inflammation. While clinical evaluations can hint at the cause, biochemical and radiological imaging like MRCP are crucial for confirming obstruction and determining its cause and location.

MRCP stands out as a non-invasive, effective tool for visualizing the biliary and pancreatic ducts, gaining preference over ERCP in certain cases due to its advantages: no radiation, less dependence on the operator, and better visualization of ducts, particularly when traditional imaging is inconclusive. The study reviewed 50 patients, 54% female and 46% male, with the majority aged 46-55 years. Similar observations were reported by Aggag, M et al. [14] It was observed that biliary ductal obstruction was more common in female; this was in concurrence with study done by Coucke E et al. [15]; however, this is in contrast with the study of Patel VB et al. [1] which showed female preponderance.

Abdominal pain was the most common symptom, present in 62% of cases, with 38% also reporting jaundice. The findings underscore MRCP's value in diagnosing and managing obstructive jaundice effectively.

The study evaluated various causes of biliary ductal obstruction, with cholelithiasis (46%), choledocholithiasis (38%), stricture (28%), and gallbladder (GB) malignancy (18%) as the most common finding in ascending order. Cholelithiasis and choledocholithiasis were the leading benign causes, while GB malignancy was the predominant malignant cause. These findings align with previous studies, such as those by Patel VB et al. [1] and Owen J. O'Connor et al. [16] which also identified gallstones as a common benign etiology.

MRI results indicated that 50% of patients had hypointense appearances on T2-weighted images, 46% were hyperintense on T2, and 16% were hypointense on T1-weighted images, with T2 images being the most indicative of disease presence.

Histopathologically, most patients had benign conditions, with 48% showing calculus retrieval, 12% diagnosed with adenocarcinoma of the GB, and 10% with cholangiocarcinoma. The findings were similar to those of Irom P et al. [17] who identified periampullary carcinoma and cholangiocarcinoma as common malignancies.

Regarding MRCP findings, 8% of patients had pseudo cysts, 6% had choledochal cysts confirmed intraoperatively, 16% had pancreatitis, 46% had GB stones (with 44% confirmed intraoperatively), 16% had CBD tumors (12% confirmed), and 74% had CBD dilatation. These results were consistent with findings from Obaidi et al. [18] and Patel VB et al. [1], who also observed a significant prevalence of CBD stones, tumors, and strictures.

In this study, 14 patients were found to have CBD strictures, with distal and mid-locations being the most common. Ten of these were malignant, while four were benign, further highlighting the common patterns of biliary obstruction causes. Further, 38% of the patients had common bile duct (CBD) stones, with the distal CBD being the most frequent location (63.16%). This finding is consistent with previous studies, including those by Raju P et al.[19], Goyani B et al. [20], Obaidi SA et al. [18] , and Kalode R R et al. [21], who also identified the distal bile duct as a common site of obstruction. Additionally, 39 patients had confirmed intrahepatic bile duct (IHBR) dilatation on MRCP, while 11 had no dilatation, with the majority showing positive IHBR dilatation.

The study also found a significant correlation between MRCP and histopathology results, particularly for CBD strictures, bile duct stones, and CBD tumors, with a P-value of less than 0.05. These findings support the role of MRCP in accurately diagnosing obstructive jaundice, similar to previous research

by Irom P et al. [17] which showed that histopathological diagnoses were associated with imaging techniques like helical CT, MRI, and MRCP. The MRCP results in this study were strongly related to clinical and pathological findings, reinforcing its diagnostic value.

The future direction of research should focus on expanding the sample size to further substantiate the findings and explore MRCP's diagnostic accuracy across a broader range of clinical scenarios. Additionally, conducting comparative studies with other imaging modalities such as CT and ultrasound would help delineate specific contexts where MRCP proves most advantageous. By identifying the strengths and limitations of MRCP relative to other techniques, such studies would refine its clinical application and maximize its benefit for patient care.

Technological advancements in MRCP hold the potential to significantly enhance its diagnostic utility. Innovations in imaging sequences and the development of more targeted contrast agents could enable MRCP to detect smaller lesions and early-stage diseases with greater precision. These improvements could enhance the visibility of small stones and early tumors, leading to an increase in the overall diagnostic accuracy of the procedure. Furthermore, such advancements would provide earlier and more reliable diagnoses, particularly in complex cases where non-invasive diagnostic techniques are critical.

In addition to improvements in contrast agents, enhanced imaging software that offers better resolution and greater image clarity could help radiologists interpret MRCP results more accurately. This would lead to more precise diagnoses, allowing clinicians to devise more effective treatment plans. Ultimately, the combination of advanced technology and accurate interpretations would result in better patient outcomes, as healthcare providers could more confidently manage obstructive jaundice cases and related conditions.

In conclusion, this study's findings, corroborated by the literature review, underline the pivotal role MRCP plays in diagnosing obstructive jaundice. Although there are some limitations, MRCP continues to be a highly accurate, non-invasive diagnostic tool. Its strengths, extensively supported by previous research, underscore its potential to improve clinical decision-making and patient management in obstructive jaundice cases. The insights garnered from this study contribute to the growing body of evidence supporting MRCP's clinical utility, paving the way for ongoing research and technological enhancements that will further improve its diagnostic capabilities.

The integration of MRCP into routine clinical practice, as reinforced by this and other studies, has the potential to transform the approach to diagnosing and managing obstructive jaundice. By doing so, it will not only improve patient outcomes but also advance the field of diagnostic radiology, promoting more efficient and accurate methods for handling complex biliary conditions.

CONCLUSION

In conclusion, our study demonstrates that Magnetic Resonance Cholangio-Pancreatography (MRCP) is a highly effective and reliable imaging tool for diagnosing obstructive jaundice. The diagnostic accuracy of MRCP, particularly when combined with MRI, surpasses that of both ultrasonography and CT scan, especially in detecting benign causes such as cholelithiasis and choledocholithiasis, which are often missed by other modalities. MRCP also excels in identifying distal bile duct stones, which are challenging to visualize using ultrasound. Among malignant causes, adenocarcinoma of the gallbladder and cholangiocarcinoma were the most common findings, further emphasizing MRCP's utility in detecting a broad range of pathologies.

Moreover, the significant correlation between histopathological and pathological findings underscores the value of MRCP as an essential tool in preoperative diagnostics and treatment planning. Overall, MRCP proves to be a highly accurate, non-invasive method for diagnosing obstructive jaundice, offering clinicians a powerful resource for improving patient outcomes.

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