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Radio-Diagnosis

ROLE OF MAGNETIC RESONANCE CHOLANGIOPANCREATOGRAPHY, COMPUTED TOMOGRAPHY AND ULTRASOUND IN OBSTRUCTUVE JAUNDICE

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ABSTRACT Obstructive Jaundice has been documented as one of the leading cause of increased morbidity. The main goals of any imaging procedure in obstructive jaundice are to confirm the cause of obstructive jaundice, its location, extent, probable cause, and it should also attempt to obtain a map of biliary tree that will help the surgeon to determine the best approach to each individual case. Among these Ultrasonography (USG) and Helical Computed Tomography (CT) are initial modalities of investigations. Magnetic Resonance Imaging with Magnetic Resonance Cholangiopancreatography (MRI with MRCP) is an exciting tool as it is non invasive evaluation for patient with obstructive jaundice, which gives good anatomical details of Hepato-biliary structure. In this present study we have evaluated patients by MR with MRCP, Helical CT and ultrasonogrpahy who were suffering from various diseases of biliary tract and/or pancreas and try to evaluate the efficacy of MR with MRCP , CT and ULTRASOUND in diagnosing the cause of the Obstructive jaundice.

Aims and objectives:

1) To interpret the diagnostic yield of MR with MRCP, Helical CT and Ultrasonography in diagnosing the causes of Obstructive Jaundice, associated biliary tract anomalies.

2) To assess the Accuracy of MRCP, CT and Ultrasound in diagnosing Obstructive jaundice compared to per operative finding.

Materials and methods: A prospective observational study was conducted in a tertiary care centre using SIEMENS ACUSON X 300 units, convex probe of 2 to 5 Mhz, and linear probe of 5-10 Mhz for ultrasound evaluation, SIEMENS SOMATOM Sensation 64 CT Scanner for contrast enhanced computed tomography and 1.5T MRI for Magnetic resonance cholangiopancreatography for a sample size of 34 individuals. Analysis was done by three individuals which are confirmed with intra operative diagnosis. **Conclusion:** During our study we observed that imaging modalities like USG, CECT and MRI with MRCP has more accuracy in finding the cause of obstructive jaundice. Compared with USG and Helical CT, MRI with MRCP is equally sensitive and more specific in differentiating the causes of obstructive jaundice as benign or malignant. On comparison with the intra operative diagnosis, most of the imaging diagnosis are accurate MRI with MRCP is very accurate than CT/USG in identifying the various benign pathologies, and this modality has shown a dramatic role in identifying anatomic variants including choledochal cysts. With the help of conventional MRI, MRCP has added its advantage of diagnosing malignant pathologies to a extent that it was even possible to stage the malignant tumors. The most accurate diagnosis with the help of these imaging modalities will give a proper road map for the surgeons to approach the case with decreased complications.

KEYWORDS :

INTRODUCTION:

One of the leading causes of increased morbidity is obstructive jaundice. The majority of patients are diagnosed with it through imaging modalities. In order to determine the best approach to each individual case of obstructive jaundice, any imaging procedure should attempt to confirm the presence, location, extent, and probable cause of obstruction, as well as obtain a map of the biliary tree. It is recommended that patients undergo Ultrasonography (USG) and Helical Computed Tomography (CT). A new tool for noninvasive evaluation of patients with obstructive jaundice is Magnetic Resonance Imaging with Magnetic Resonance Cholangio pancreatography (MRI with MRCP). A relatively new magnetic resonance imaging technique, magnetic resonance cholangio pancreatography has revolutionized MR imaging of the biliary and pancreatic ducts. It is an accurate, noninvasive way to visualize the biliary tree and pancreatic ducts without injecting contrast.

Since Wallner et al introduced MR Cholangiopancreatography in 1991, it's evolved a lot. With the development of higher magnetic field strength and newer pulse sequences like HASTE (Half Fourier Acquisition Single Shot Turbo Spin Echo) and RARE (Rapid Acquisition and Relaxation Enhancement), Magnetic Resonance Cholangiopancreatography (MRT) is now the imaging of choice for these patients because it has a high contrast resolution, is fast, has multiplanar capabilities, and almost no artifacts.

Without any intervention and without the use of oral or IV contrast, MRCP shows the entire biliary tract and pancreatic duct. As a result of the ERCP procedure, which is considered as the standard of reference in ductal pathology, the image quality obtained is comparable to that of direct cholangiography. Due to its diagnostic accuracy, MRCP has the potential to replace more invasive procedures such as diagnostic ERCP, which should be used only if intervention is contemplated. The method can be used to demonstrate dilatation, stricture, and choledocholithiasis.

In patients with biliary-enteric obstruction or stenosis, proximal dilation, presence and size of biliary stones, as well as associated findings, this noninvasive imaging technique can be utilized. As well as ultrasonography and computed tomography, IV cholangiography, endoscopic retrograde cholangio-pancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC) are also used to diagnose the biliary tree and pancreatic duct. There are advantages and disadvantages to each modality for patients with suspected ductal pathology.

Ultrasonography and CT have limitations because they don't tell you where and how big the biliary strictures are. Ultrasonography has limitations in diagnosing choledocholithiasis, but MRCP has >90% accuracy. A IV cholangiography has limitations, as 30-40% of the time the biliary system isn't opacified. ERCP and PTC require biliary intervention and use of contrast media.

Magnetic Resonance Cholangiopancreatography (MRCP) has few added advantage as follow:-

Non-invasive imaging modality
No ionizing radiation needed
No need of contrast media
Multiplanar imaging capability
No post procedure complications
It can be performed in critically ill patients

MRCP plays a major role in the overall evaluation of biliary & pancreatic duct lesions. It can be used to identify disease (infection, tumor, calculus & others), determine location and extent, identify the

pathology, guide biopsy and drainage procedures, indicate treatment method (medical or surgical), suggest surgical approach, and help determine response

In this present study was conducted to study patients by MR with MRCP, Helical CT and ultrasonogrpahy who were suffering from various diseases of biliary tract and/or pancreas and tried to evaluate the efficacy of imaging modalities for a proper pre-operative diagnosis.

MATERIALS AND METHODS:

Type of study: Prospective study

Study area:
Department of Radio diagnosis, Sri Venkateshwaraa Medical College Hospital and Research Centre (SVMCH&RC) , a tertiary care teaching hospital located in Ariyur, Pondicherry.

Study Population:
Patients referred to the Radiology Department (CT, ULTRASOUND AND MRI) for the evaluation of biliary colic, obstructive jaundice.

Study Design: Observational study

Sample Size: 34 (Calculated with Open Epi version 3)

Period of study: February 2021 to August 2022

Inclusion Criteria:

- Patients with Jaundice
- pale coloured stools
- cholecystitis
- Cholangitis
- Choledocolithiasis
- symptoms of biliary obstruction
- Pancreatic carcinoma
- Direct Bilirubin greater than 5mg/dl

Exclusion Criteria

- MRI incompatible patients (patients with MRI incompatible implants)
- Patients who are claustrophobic
- Patients who refuse for the MRI, CT and Ultrasound study
- Post operative cases
- Subjects who are unable to cooperate because of pain.

In case of obstructive jaundice patient may need USG, MRCP and CT as each modality has its own advantage and disadvantage. All the patients will undergo USG examination first followed by MRCP and finally CT. This order is followed so that there is no interference of image quality from the previous study.

Ultrasound:
Transabdominal ultrasonography was done with SIEMENS ACUSON X 300 units, convex probe of 2 to 5 Mhz, and linear probe of 5-10 Mhz.

CT:
A Three phase (Non contrast, pancreatic parenchymal phase and hepatic phase) protocol was performed on a SIEMENS SOMATOM Sensation 64 CT Scanner. Unenhanced and enhanced (with 130ml IOHEXOL) CECT with 5mm collimation of the upper abdomen was performed. The scans will be taken from diaphragm to pubic symphysis, with slice thickness 2-3mm.

MRI: MRCP Protocol
Patient preparation with NPO nad proper bowel preperation

MRI sequences:

Sequences	TR	TE	Slice Thickness	Distance Factor
T1fl2d axial	145	4.76	5.0	0
T2 blade axial	4500	97	3.0	0
T2 FS blade axial	3000	97	3.0	0
Trufi axial	3.96	1.6	4.0	0
T2 haste coronal	2800	87	3.0	0
T2 space 3d coronal	2000	150 to 505	2.0	0

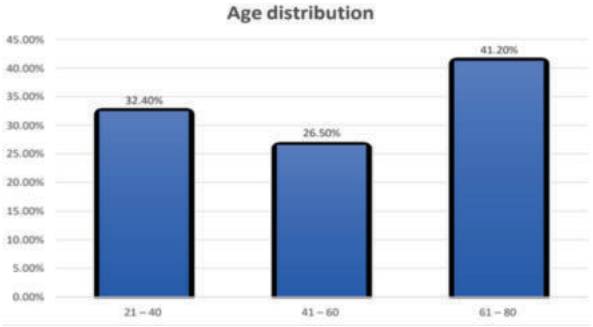
- With the consent of patient and the treating surgeon we will take the surgical per operative findings from the Case sheet from MRD.

Data Analysis:
Data was entered in excel and analysed by using SPSS version 23.0 software and the radiological diagnosis is analysed according to the age, gender, bilirubin levels, causes for the obstructive jaundice and intra operative diagnosis.

RESULTS:

Our study sought to define the role of Ultrasonography, Contrast enhanced computed tomography, MR with MRCP in evaluation of patients with obstructive jaundice. In our study, age ranged from 2 months to 85 years.

According to age :
In the present study 32.4% of the participants were aged 21-40 years, 26.5% of the participants were aged 41-60 years, 41.2% were aged 61-80 years and the age of the participants was 51.82 ± 16.97 years.

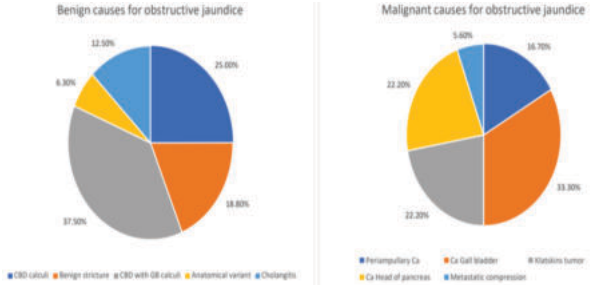


According to gender:
In the present study when we compare according to gender the results are 47.1% were male and 52.9% were female.

According to bilirubin levels:
In the present study direct bilirubin ranged between 1.6-13.6 and the mean was 5.99 ± 2.74, indirect bilirubin ranged between 2.4-9.30 and the mean indirect bilirubin was 5.35 ± 1.96 and total bilirubin ranged between 5.1-21.0 and the mean bilirubin levels was 11.35 ± 4.31.

	Minimum	Maximum	Mean ± SD
Direct	1.60	13.60	5.99 ± 2.74
Indirect	2.40	9.30	5.35 ± 1.96
Total	5.10	21.0	11.35 ± 4.31

According to cause:
In cases of obstructive jaundice, benign lesions are seen in 47.1% of the cases and malignant lesions are seen among 52.9% of the cases.



In the present study, CBD calculi was seen among 25% of the cases, 18.8% of the cases had benign stricture, 37.5% of the cases had CBD

with GB calculi, 6.3% of the cases were with anatomical variant and 12.5% of the cases had cholangitis.

In the present study it was observed that periampullary carcinoma, 33.3% of the cases had CA gall bladder, 22.2% of the cases had Klatskins tumor, 22.2% of the cases had Ca Head of pancreas, 5.6% of the cases had metastatic compression.

In the present study it was observed that there was a statistically significant association between age wise distribution of lesions and type of lesions.

Final radiological diagnosis is compared with then intraoperative diagnosis

	Frequency	Percentage
ACUTE PANCREATITIS SEQUELAE WITH CHOLELITHIASIS & CHOLEDOCHOLITHIASIS	1	2.90%
ADENOCARCINOMA OF GB	2	5.90%
ADENOCARCINOMA OF GB WITH CALCULUS CHOLECYSTITIS	1	2.90%
BENIGN STRICTURE - DISTAL CBD WITH CHOLANGITIS	4	11.80%
BENIGN STRICTURE OF DISTAL CBD	1	2.90%
CA HEAD OF PANCREAS WITH BILIARY OBSTRUCTION	1	2.90%
CA PANCREAS	1	2.90%
CA PANCREAS WITH FOCAL PANCREATITIS	1	2.90%
CHOLANGIO CARCINOMA	1	2.90%
CHOLANGIOCARCINOMA (DISTAL CBD) WITH CYSTIC DUCT CALCULI	2	5.90%
CHOLEDOCHOCELE WITH OBSTRUCTED CBD	2	5.90%
CHOLELITHIASIS	1	2.90%
CHOLELITHIASIS WITH CHOLEDOCHOLITHIASIS	3	8.80%
CHOLELITHIASIS WITH DISTAL CBD STRICTURE	1	2.90%
GB CALCULI WITH DISTAL CBD CAL	1	2.90%
GB CARCINOMA	2	5.90%
GB STONE WITH CHOLELITHIASIS	1	2.90%
HILAR CHOLANGIOCARCINOMA (KLATSKIN'S TUMOUR)	1	2.90%
KLATSKIN'S TUMOUR	2	5.90%
KLATSKIN'S TUMOUR WITH CHOLELITHIASIS & CHOLEDOCHOLITHIASIS	1	2.90%
MIRIZZI'S SYNDROME WITH CHOLELITHIASIS	1	2.90%
PERIAMPULLARY CA WITH METASTASIS	2	5.90%
PERIAMPULLARY CARCINOMA	1	2.90%
Total	34	100.00%

In case of CT Sensitivity was 68.7%, specificity was 72%, AUC 0.75, PPV of 68.7%, NPV of 72.2% and diagnostic accuracy of 70.5%

CECT and Histopathological diagnoses :

CT	Histopathology		Total
	Benign	Malignant	
Benign	11	5	16
Malignant	5	13	18
Total	16	18	34
Chi square test = 12.67, p=<0.0001*, Statistically significant			

MRCP and Histopathological diagnoses :

MRI with MRCP	Histopathology		Total
	Benign	Malignant	
Benign	16	1	17
Malignant	0	17	17
Total	16	18	34
Chi square test = 29.33, p=<0.0001*, Statistically significant			

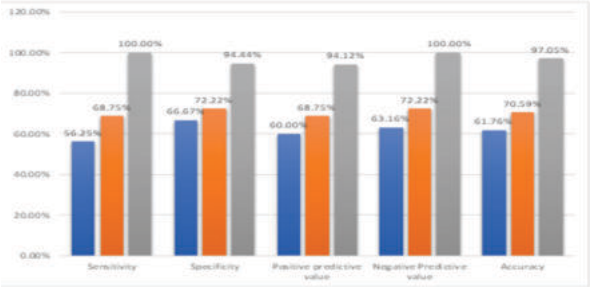
USG and Histopathological diagnoses :

USG	Histopathology		Total
	Benign	Malignant	
Benign	9	6	15
Malignant	7	12	19
Total	16	18	34
Chi square test = 3.02, p=0.22, Not Statistically significant			

In the present study, it was observed that there was a statistically significant association between MRI with MRCP and histo pathological findings. Sensitivity was 1000%, specificity was 72.06%, AUC was 0.972, PPV was 94.11%, NPV was 100%.

In the present study there was so statistically significant association between USG and histopathological diagnosis. Sensitivity was 56.2%, specificity was 66.6%, AUC of 0.615, PPV of 60%, NPV of 63% and diagnostic accuracy of 61.7%.

	USG	Helical CT	MRI with MRCP
Sensitivity	56.250%	68.750%	100.000%
Specificity	66.667%	72.222%	94.444%
Positive predictive value	60.000%	68.750%	94.118%
Negative Predictive value	63.158%	72.222%	100.000%
Accuracy	61.76%	70.588%	97.05%



Considering few limitations of Helical CT and USG and invasiveness and complications of ERCP, MRCP alone can become the imaging modality of choice in imaging patients with obstructive jaundice, and it becomes still more superior on adding conventional MRI sections to it because, it is Non-Invasive, No-Ionising radiation, Multiplanar imaging capability and no post procedure complications. It can show biliary tract proximal as well as distal to obstruction.

DISCUSSION:

Due to its high morbidity and mortality, obstructive jaundice presents a challenge to surgeons. An ill-chosen procedure could increase the morbidity of the disease, so preoperative evaluation is critical to determine the cause, nature, and extent of involvement of the disease.

During the last few decades, we have gained a greater understanding of pathophysiology, diagnosis, staging, and treatment effectiveness. Since the therapeutic options have increased, the role of radiologist has also increased. By knowing the etiology, location, level, and extent of a disease like biliary enteric anastomosis, a surgeon can choose a better plan of management.

Various noninvasive and invasive methods can be used to diagnose obstructive jaundice. Ultrasonography (USG), computed tomography (CT), and magnetic resonance cholangiopancreatography (MRCP) are noninvasive modalities, while endoscopic retrograde cholangio pancreatography (ERCP) is invasive. Physicians have always chosen ultrasound as the primary screening modality while CT and MRCP are considered diagnostics.

The present study titled "Role of Magnetic Resonance Cholangio pancreatography, Computed Tomography and Ultrasound in obstructive jaundice" was carried forward with the following objectives:

- To interpret the diagnostic yield of MR with MRCP, Helical CT and Ultrasonography in diagnosing the causes of Obstructive Jaundice, associated biliary tract anomalies.
- To assess the Accuracy of MRCP, CT and Ultrasound in diagnosing Obstructive jaundice compared to per operative finding.

Diagnostic accuracy of USG, CT and MRI with MRCP

Initially, ultrasound and CT are used for suspected obstructive jaundice. The ultrasound sensitivity for choledocholithiasis varies between 20 and 80%, and the specificity is approximately 98%.10 CT has a similar sensitivity of 23% and 97%, respectively. In ultrasound, it remains unclear what the diameter of the main bile duct is because

the normal diameter of the main bile duct varies from 6-10mm depending on the patient's age and investigator's criteria, and in only 40-50% of cases can the intrapancreatic segment be accurately detected. Approximately 40% of biliary strictures are correctly detected by ultrasound in cases where the diameter is less than 10mm, while 60%-75% of cases are correctly detected by CT. Ultrasound and CT are both limited when diagnosing biliary strictures.

When ultrasound and CT fail, repeat exams or endoscopic ultrasound (EUS) are often necessary. An ERCP is the standard for diagnosing biliary tract disease and can often be used in combination with other treatments. ERCP can detect direct or indirect signs of distal choledocholithiasis or main bile duct tumors, in addition to radiological features. The two disadvantages of ERCP are operator dependence and lowered rates for certain conditions, such as distal strictures, sphincter of Oddi strictures, papillotum and duodenal diverticula tumor. Pancreatitis (0.7-7.4%) is one of the risks associated with diagnostic ERCP, along with cardiovascular, pulmonary, and renal complications. Because of these risks, ERCP remains therapeutically preferred. For small stones less than or equal to 3mm, EUS is superior to ERCP when used as a workup for suspected biliary obstruction for extrahepatic diseases, with the same sensitivity and specificity as ERCP. A distal main bile duct tumor, a cephalic pancreatic tumor, and chronic pancreatitis can be diagnosed and staged with EUS.

In the present study there was so statistically significant association between USG and histopathological diagnosis. Diagnostic accuracy of USG observed in this study is Sensitivity was 56.2%, specificity was 66.6%, AUC of 0.615, PPV of 60%, NPV of 63% and diagnostic accuracy of 61.7%.

The study by Resident MSJ et al. showed an overall sensitivity, specificity, and accuracy of USG to diagnose collectively both benign and malignant causes of death of 79.55, 82.14, and 81% respectively.

According to the study by Amandeep et al., USG had 80.77, 95.83, and 88% sensitivity, specificity, and diagnostic accuracy for benign causes, and 79.17, 96.15, and 88% sensitivity, specificity, and diagnostic accuracy for malignant causes.

Karki et al. found that USG is 100% sensitive and 89% specific for detecting choledocholithiasis. USG was also found to have a sensitivity of 98.78% and a specificity of 83.33% in cases of cholangiocarcinoma and 97.59% and 66.67% in cases of pancreatitis. Ultrasound detected biliary tract dilation very accurately with 94.8% sensitivity and 100% specificity. As compared to ERCP, USG did not detect CBD stricture statistically significantly.

Similarly in a study performed by Upadhyaya et al,132 USG was able to identify the level in 83.50% and cause in 77% cases of obstructive jaundice In the present study there was a statistically significant association between CT findings and histopathological diagnosis. Diagnostic accuracy of Helical CT was Sensitivity was 68.7%, specificity was 72.2%, PPV of 68.7%, NPV of 72.2% and diagnostic accuracy of 70.5%.

In the present study, it was observed that there was a statistically significant association between MRI with MRCP and histo pathological findings. Diagnostic accuracy of MRI with MRCP was Sensitivity was 100%, specificity was 94.4%, PPV of 68.7%, NPV of 72.2% and diagnostic accuracy of 70.5%.

According to Resident MST et al., MRCP is 93.18, 94.64, and 94%, respectively. With sensitivity, specificity, and diagnostic accuracy of 76.32, 83.87, and 81%, ultrasonography can distinguish benign from malignant, while its diagnostic accuracy, sensitivity, and specificity are 82.69, 81.25, and 82%, respectively. Similar findings were also found in this study.

According to Amandeep et al., MRCP was 100, 95.83, and 98% sensitive, specific, and accurate for benign lesions, respectively, while 95.83, 100, and 98% for malignant lesions.

CBD stones can be detected using ultrasonography with sensitivity of 20 to 80% in literature. The significant differences in sensitivity between the various cases are partly a result of the impossibility of reaching the distal CBD and ampullary regions in obese patients and the variability of ultrasonography techniques used. Most of the studies with poor results are older studies conducted when ultrasound machines had poor resolution and was still a new technique.

During our study we observed that imaging modalities like USG, CECT and MRI with MRCP has more accuracy in finding the cause of obstructive jaundice. Compared with USG and Helical CT, MRI with MRCP is equally sensitive and more specific in differentiating the causes of obstructive jaundice as benign or malignant. On comparison with the intra operative diagnosis, most of the imaging diagnosis are accurate.

MRI with MRCP is very accurate than CT/USG in identifying the various benign pathologies, and this modality has shown a dramatic role in identifying anatomic variants including choledochal cysts.

With the help of conventional MRI, MRCP has added its advantage of diagnosing malignant pathologies to a extent that it was even possible to stage the malignant tumors.

This single modality(MRI with MRCP) apart from demonstrating the causes of obstructive jaundice, can be used to demonstrate the involvement of vascular structures with different sequences at a single setting with MR angiography thus saving time and discomfort to the patient.

MR Cholangiopancreatography is very accurate in demonstrating calculi at the distal end of CBD as an area of signal void, also in demonstrating strictures as the cause of dilatation of biliary radicals. It showed the length of stricture segment very well and differentiated stricture as malignant and benign. The benign strictures were smooth tapered margins, where as in malignant strictures there was an abrupt and irregular character of narrowed segment with or without shouldering. MRCP is superior to CT in this regard. With the help of source image, we can very well show the exact location and extent of malignant tumours (like Ca GB, Klatskin tumour, Cholangi ocarcinoma, Ca pancreas), and provide a guide map for segmental resection. Adding conventional axial T1 and T2 weighted sequences it is easy to stage the tumor.

In the present study the most common malignant etiology is periampullary carcinoma, while the most common benign cause is choledocholithiasis.

CONCLUSION:

Based upon our study following conclusions can be drawn; USG, CECT and MR with MRCP are accurate, non invasive means of evaluating the patients with obstructive jaundice and delineating the causes of the obstruction. It is useful in children, critically ill patients with ease.

It is useful in failed ERCP cases and it also shows biliary tree very well proximal as well as distal to the level of obstruction. It is better to Helical CT and USG in showing the distal CBD as well as pancreatic duct.

The diagnostic accuracy of these imaging modalities suggests that it has the potential to replace or limit the use of invasive procedures like diagnostic ERCP, which should be used only in cases where intervention is being contemplated. With the help of these imaging modalities the cause of the obstructive jaundice can be determined and in case of malignancy the extension of the lesion can be delineated prior to the surgery which will be helpful for the surgeon to approach the case. The imaging diagnosis is correlated with the intra operative diagnosis.

The most common malignant etiology is periampullary carcinoma, while the most common benign cause is choledocholithiasis. In most cases of obstructive jaundice, MRI- MRCP is the modality of choice for optimal characterization of the causative lesions. It is better to study benign and malignant lesions with MRI-MRCP than with ultrasound or CT scan.

In future with interventional MRI, MRCP should play an important role in diagnostic and therapeutic applications in biliary tract and pancreatic pathology.

The most accurate diagnosis with the help of these imaging modalities will give a proper road map for the surgeons to approach the case with decreased complications.

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