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IMAGING OF PANCREATICOBILIARY TUMORS : MRI & CT EVALUATION

Radiology

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KEYWORDS:

INTRODUCTION

Pancreaticobiliary tumors are a common clinical disease. Currently, the only potential cure for pancreaticobiliary tumors is surgery. Early diagnosis and accurately preoperative assessment of tumor resectability are fundamental to achieve a successful treatment. The role of radiologist in pancreaticobiliary tumors is to diagnose biliary and pancreatic duct obstruction, delineate the level of obstruction, the cause of obstruction, help in staging and to determine resectability of tumor.

Now a days, commonly used methods for evaluation of pancreaticobiliary tumors are USG, CT scan and MRI.

USG is initial screening method of choice for pancreaticobiliary tumors, however it is limited due to suboptimal imaging window and artefacts due to bowel gases.

Contrast enhanced CT with arterial and venous phase study can show the extent of neoplastic growth with the associated lymphadenopathy, metastasis and vascular invasion.

Magnetic resonance (MR) cholangiopancreatography, which combines the advantages of projectional imaging with those of cross-sectional imaging, is an established diagnostic technique that can be substituted for endoscopic retrograde cholangiopancreatography (ERCP) in most clinical settings.1

Two unique properties of bile that are exploited to aid visualization with nearly all MR cholangiopancreatographic sequences are its relatively high water content and stasis in comparison with blood flowing through adjacent vessels in the portal tracts1. MRI is especially suited for detection of small non-organ deforming pancreatic ductal adenocarcinomas, detection of islet cell tumors and differentiation of focal fatty infiltration of pancreas from tumors.

AIMS AND OBJECTIVES

1. To evaluate the roles of 3 Tesla MRI and MDCT in imaging of pancreaticobiliary tumors- in detection and characterization of various lesions seen in the same.
2. To study the range of imaging findings in pancreaticobiliary tumors using CT and MRI.
3. To correlate MRI and CT scan findings in pancreaticobiliary tumors

LITERATURE REVIEW:

1. GALL BLADDER CARCINOMA:

Though an uncommon malignancy, it is the fifth commonest gastrointestinal malignancy. Although it is reported to be rare in India, the incidence of gallbladder cancer in north and central India is very high. It is the commonest gastrointestinal cancer in women.
US is the preferred initial imaging investigation, but will usually be supplemented with a combination of CT, MRI & MRCP, direct cholangiography. Gallbladder carcinoma may appear at any of these imaging techniques as a mass completely occupying or replacing the gallbladder lumen, focal or diffuse asymmetric gallbladder wall thickening, or an intraluminal polypoid lesion.[2]
MDCT has a reported accuracy of up to 84% in determining local extent of primary gallbladder carcinoma [3] and 85% in predicting resectability through its ability to delineate hepatic and vascular invasion, lymphadenopathy, and distant metastases [4]
Because small hepatic, peritoneal, and omental tumor implants can be missed at preoperative imaging, thorough laparoscopic or open exploration should precede aggressive surgery.5

2. CHOLANGIOCARCINOMA:

It is the second most common primary liver tumor after hepato cellular carcinoma [6-8]

Cholangiocarcinomas can be classified anatomically as intrahepatic (peripheral), perihilar, or extrahepatic. Perihilar cholangio carcinoma arises at the bifurcation of the hepatic ducts, whereas intrahepatic (peripheral) cholangiocarcinoma arises from beyond second-order bile ducts[9,10]

CT has become the noninvasive diagnostic test of choice for detailed evaluation and staging of cholangiocarcinomas. After the intravenous administration of contrast material, most cholangio carcinomas remain hypoattenuating during the arterial and portal venous phases and show enhancement during the delayed phase, findings that reflect their hypovascular desmoplastic composition[11].
However, by virtue of its superior contrast resolution, MR imaging with MR cholangiography has been found to be superior to CT for the assessment of intraductal lesions.

Surgery has been found to be the only curative therapy.

3. PANCREATIC TUMORS:

The incidence of pancreatic cancer in India is low. Men are at a slightly greater risk compared to women.

High-resolution dual-phase (arterial and portal) contrast material–enhanced CT is the established technique for evaluating pancreatic adenocarcinoma.

CT has an accuracy of 85%–95% for tumor detection, a positive predictive value of 89%–100% for unresectability, and a negative predictive value of 45%–79% for resectability[12].

Magnetic resonance imaging (MRI) can be used in imaging of pancreatic carcinoma in patients with equivocal findings at ultrasound or MDCT. There is however no significant diagnostic advantage of MRI over contrast- enhanced CT (sensitivity of 86% on CT vs. 84% on MRI) [13].

MRCP is better than CT for defining the anatomy of the biliary tree and pancreatic duct, has the capability to evaluate the bile ducts both above and below a stricture, and can also identify intrahepatic mass lesions. It is reportedly as sensitive as ERCP in detecting pancreatic cancers and unlike conventional ERCP, does not require contrast material to be administered into the ductal system [14].

MATERIALS AND METHODS

Study Design:

A prospective study of 25 patients who presented to the OPD or Emergency department or admitted with suspected pancreaticobiliary tumors underwent imaging tests like Ultrasonography, CECT abdomen. MRI of abdomen was done on an elective basis. They presented with predominant complaints of abdominal pain with jaundice with raised direct bilirubin or raised pancreatic enzymes. Presenting complaints included are pain in abdomen, generalized weakness, anorexia itching all over the body, pale color stool fever, palpable distended gallbladder (Courvoisier's sign).

Standard tests (history taking, physical examination, relevant blood investigations, chest radiograph) were directed to all patients, whereas, the mode of additional imaging (ultrasonography by a radiologist or CECT abdomen) was selected by the clinician according to a risk-benefit ratio-based management algorithm. MRI abdomen was done in selected patients who didn't require emergency intervention.

The CT abdomen studies were performed on 64 slice MDCT scanner (Philips Brilliance, Philips Medical Systems). MRI abdomen studies were done on a 3 Tesla Philips Achieva Medical Systems.

INCLUSION CRITERIA

- Clinical examination of patient suggestive of obstructive jaundice.
- Biochemical examination suggestive of deranged LFT and biliary obstruction.
- Patient diagnosed on USG suggestive of pancreaticobiliary malignancy.

EXCLUSION CRITERIA:

- Patients not consenting for the study
- Intracranial aneurysm clips (Unless the referring physician is certain that it is made of non-ferromagnetic material such as titanium)
- Intra-orbital metal fragments
- Any electrically, magnetically or mechanically activated implants
  - including cardiac pacemakers, biostimulators, neurostimulators,
  - Cochlear implants and hearing aids.
- Pregnancy (Risk Vs benefit ratio to be assessed).
- Known h/o contrast allergy.
- Other implanted medical devices (eg. Swan Ganz catheter).
- Metal shrapnel or bullet.
- Patients with surgery of uncertain type where the presence of metal clips or wires cannot be excluded.
- Patients who require emergency intervention based on CT findings alone.
- For use of MR contrast (gadolinium):

1. Lactating women
2. Patients with haemoglobinopathies
3. Patients with moderate to severe renal insufficiency (i.e. with GFR<30ml/min or a S. creatinine> 2mg/dl).

The entire CT examination lasted for 10-15 min. Patient was observed for 30 min for any contrast related reactions.

The following MRI sequences were performed. Breath holding was required in few sequences. 0.1 mmol/kg Gadolinium based contrast (Gadopentate Dimeglumine) was injected at rate of 2.5 ml/sec followed by saline flush.

T2W TSE –axial, coronal
T2W TSE SPAIR-axial, coronal
T1W TFE – axial
Dual FFE breath hold – axial
bTFE breath hold - axial
e-THRIVE post contrast – axial and coronal
MRCP 3D Navigated free breathing
MRCP thick slab breath hold-coronal

OBSERVATION AND RESULTS

I) Incidence of pancreaticobiliary tumors:

The patients included in the study were referred from surgical and medicine department out of which 15 were indoor patients and 10 were outdoor.

Out of 25 patient studied following diagnoses were made.

Diagnosis	No of patient
Carcinoma of gall bladder	9
Chronic cholecystitis	1
Cholangiocarcinoma	6
Pancreatic tumor	8
Focal chronic pancreatitis	1

Table 1: Showing distribution of pancreaticobiliary tumors (n=25)

Out of n=25 cases studied for pancreaticobiliary tumors, 1 case was having combined features of gall bladder carcinoma and cholangiocarcinoma. (for study purpose, it was included in cholangiocarcinoma group)

II) Gender

Diagnosis	Female	Male
Carcinoma of gall bladder (n = 9)	6	3
Cholangiocarcinoma (n=6)	3	3
Pancreatic tumors (n=8)	5	3
Chronic cholecystitis (n=1)	1	0
Focal chronic pancreatitis(n=1)	0	1

Table 2: Showing gender distribution in pancreaticobiliary tumors.

III) Age distribution –Commonest age group included patients from 51-70 years.

VI) Presenting complaints

Out of n=25 cases of pancreaticobiliary tumors, abdominal discomfort was the main presenting complaint, followed by weight loss, obstructive jaundice and pruritus.

V) Computed tomography (CT) and Magnetic resonance imaging(MRI) findings:

The findings of CT and MRI were correlated and compared for every patient. The organ involved, and imaging characteristics of pathology with its enhancement pattern on both CT and MRI were studied.

1. GALL BLADDER CARCINOMA

In our study of pancreaticobiliary tumors, there were n=9 cases of gall bladder carcinoma on CT and MRI. Three morphological type of gall bladder carcinoma are

1. Mass replacing gall bladder type [n= 5 (55%)]
2. Intraluminal polyp type [n = 3 (33%)]
3. Irregular focal or generalized wall thickening type [n = 1 (11%)]

n=1 case was diagnosed as chronic cholecystitis with IHBRD on CT and MRI but was diagnosed as chronic cholecystitis with calculi in cystic duct compressing the CHD (Mirizzi's syndrome) on MRI.

2. CHOLANGIOCARCINOMA

Cholangiocarcinoma is divided into three different anatomical types: Intrahepatic, Hilar, Extrahepatic depending on it location.

In our study, there were n=6 cases of cholangiocarcinoma diagnosed on CT and MRI. All were hilar cholangiocarcinoma.

Hilar cholangiocarcinoma (Klatskins Tumors) are further divided according to Bismuth-classification.

Sr No.	Bismuth classification type	No. of patients (%)
1	Type I (involving CHD)	1(16%)
2	Type II(involving CHD, RHD and LHD)	2(32%)
3	Type IIIa (involving CHD and RHD up to secondary biliary radicle)	2(32%)
4	Type IIIb (involving CHD and LHD up to secondary biliary radicle)	0
5	Type IV (involving CHD , RHD and LHD up to secondary biliary radicle)	1(16%)

Table 3: Showing distribution of hilar cholangiocarcinoma depending on Bismuth classification on CT & MRI.

Depending on the morphology, it can be mass forming (exophytic), periductal (infiltrative), and intraductal (papillary).

Sr No.	Morphological type	No. of patients (%)
1	Mass forming (exophytic)	1(20%)
2	Periductal (infiltrative)	4(60%)
3	Intraductal(papillary)	1(20%)

Table 4: Showing morphological type of cholangiocarcinoma on CT and MRI.

Out of n= 4 periductal type, n=3 were showing intrahepatic extension with intrahepatic mass formation. 1 case which was diagnosed as combined periductal and mass forming type was diagnosed as intraductal (papillary) and mass forming type on MRI.

3. PANCREATIC TUMORS

In our study, there were 9 cases of pancreatic tumors diagnosed on CT and MRI.

Sr No.	Type of tumor	No. of patients (%) CT	No. of patients (%) MRI
1	Ductal adenocarcinoma	5(55%)	3(33%)
2	Cystic tumors of pancreas	3(33%)	3(33%)
	Serous cystadenoma	1(11%)	1(11%)
	Mucinous cystadenoma	1(11%)	1(11%)
	Intraductal papillary mucinous tumor (IPMT)	0	1(11%)
3	Endocrine tumors of pancreas	0	0
4	Pancreatic metastasis	0	1(11%)
5	Pancreatic lymphoma	1(11%)	1(11%)
6	Focal chronic pancreatitis	0	1(11%)

Table 5: Showing distribution of pancreatic tumors on CT & MRI

VI) Presence of gall stones

Gall bladder carcinoma is commonly associated with gall stones. Out of 9 cases of gall bladder carcinoma 6 (67%) were associated with gall stones out of which only 4(67%) were detected on CT and 6(100%) were detected on MRI. The average size of gall stone was > 1.5 cm.

VII) Appearance on CT and MRI

On CT:

Most of pancreaticobiliary tumors diagnosed on CT and MRI (n=23) were Hypodense (n=14) to Isodense (n=9) on plain CT. All showed venous enhancement. Few had non-enhancing necrotic areas within. Arterial enhancement was seen in (n=6) cases. Delayed enhancement was seen in (n=3) cases.

Out of 6 cases of arterial enhancement, 2 cases were of gall bladder carcinoma, 3 case were of cholangiocarcinoma and 1 case was of pancreatic carcinoma.

Out of 3 cases of delayed enhancement, 1 case as of gall bladder carcinoma and 2 cases were of cholangiocarcinoma.

Out of all cases of venous enhancement, intraluminal polyp type of gall bladder carcinoma (n=3) and pancreatic lymphoma (n=1) was showing homogeneous contrast enhancement.

On MRI:

Signal intensity of pancreaticobiliary tumors are compared with that of liver. Most of pancreaticobiliary tumors are hypo to isointense on T1 weighted sequences and variable signal intensity on T2 weighted sequences (mostly T2 hyperintense) and show various enhancement pattern (arterial, venous and delayed).

Out of 6 cases of arterial enhancement, 2 cases were of gall bladder carcinoma, 3 cases were of cholangiocarcinoma and 1 case was of pancreatic carcinoma.

Out of 7 cases of delayed enhancement, 3 cases were of gall bladder carcinoma and 4 cases were of cholangiocarcinoma.

VIII) Mode of tumor spread (T staging):

1.GALL BLADDER CARCINOMA

CT Scan:

Out of various types of spread studied on CT, spread to liver bed was the most common type seen in n=6 (66%) cases.

Vascular involvement was studied as arterial, portal and venous involvement.

Out of n=3 cases of vascular involvement, all 3 were showing encasement of hepatic arteries (right > left) and 2 cases showed portal vein encasement.

MRI Scan:

Gall bladder calculus associated with gall bladder carcinoma is appreciated more in MRI (6 cases) than on CT (3 cases).

Rest of the findings on non-contrast and contrast enhanced abdominal MRI were consistent with CT finding with no significant difference in assessing the spread of tumors.

2. CHOLANGIOCARCINOMA

CT Scan:

In our study of n=6 cases of hilar cholangiocarcinoma, CHD was involved in all 6 cases.

And 3 cases were showing associated intrahepatic mass formation. Vascular involvement (encasement of hepatic artery and portal vein) was seen in 5 cases.

Right lobe hepatic atrophy was seen in 2 cases.

MRI Scan:

Biliary sludge seen as T2 hypo intensity and T1 hyper intensity was seen in 2 cases of minimally distended gall bladder which was not seen on CT.

MRCP: Biliary tract involvement is seen as dilated IHBR with it sudden cut off or irregular long segment narrowing of biliary track in MRCP sequences.

3. PANCREATIC TUMORS

CT scan:
On CT scan, out of 9 cases of pancreatic carcinoma, imaging feature of 5 cases were found to be adenocarcinoma of pancreas, 3 cases were of cystic tumor of pancreas (macrocytic serous cystadenoma, mucinous cyst adenoma and cystic lesion of pancreas of indeterminate etiology) and 1 case was of pancreatic lymphoma.

Pancreatic ductal carcinoma was evaluated for size of the lesion, local spread of the lesion and for vascular involvement by the lesion.
Commonest site- head of pancreas
Average size -4.5 cm

Local spread in the form of involvement of posterior wall of stomach was noted. Vascular involvement (encasement of splenic artery, splenic vein and portal vein)was seen in 4 cases.

MRI Scan:
Pancreatic ductal carcinoma mostly appears hypointense on T1 and hyperintense on T2 sequences with heterogeneous contrast enhancement on post contrast T1 sequences. The finding of local spread and vascular involvement was consistent with that of CT finding with few exceptions as follows-

Sr No.	CT diagnosis	MRI diagnosis	Final diagnosis
1	Pancreatic head carcinoma	Focal chronic pancreatitis	Focal chronic pancreatitis
2	Periampullary tumor	Metastasis	Metastasis
3	Cystic lesion of pancreas	Side branch IPMT	Side branch IPMT

Table 6: Showing difference in diagnoses made on CT and MRI

IX) Metastatic Lymphadenopathy (N):
Out of 23 cases of pancreaticobiliary tumors there were 12(52%) cases showing metastatic lymphadenopathy-necrotic and non-necrotic. Necrotic lymph node metastasis were seen in 4(33%) cases and non-necrotic lymph node metastasis were seen in 8(66%) cases.

In case of necrotic metastatic lymphadenopathy, non-contrast MRI shows higher sensitivity than non-contrast CT.

1. GALL BLADDER CARCINOMA
In case of gall bladder carcinoma, 6(66%) cases were showing lymph node metastasis with no e/o any lymph node metastasis in 3 cases. The average size of lymph node was 18mm in short axis.

In case of gall bladder carcinoma, pericholecystic and periportal (pericholedochal) group are considered as station 1 (N1) group of lymph nodes and celiac, SMA and retroperitoneal group of lymph nodes are considered as station 2 (N2) groups of lymph nodes.

2. CHOLANGIOCARCINOMA
In case of cholangiocarcinoma, 3 (50%) were showing metastatic lymphadenopathy. In all the cases, it was non-necrotic lymphadenopathy with average size of 12mm in short axis.

3. PANCREATIC DUCTAL CARCINOMA:
In case of pancreatic carcinoma, 3 (100%) cases were showing metastatic lymph nodes. In all the cases, it was non-necrotic lymphadenopathy with average size of 15mm in short axis.

Peripancreatic group of lymph nodes were involved in 3(100%) cases and periportal in 2(60%) cases. 1 case was showing metastasis in supra-diaphragmatic right cardiophrenic fat pad lymph node.

X) Metastasis (M):
The main sites for metastasis observed in our study were liver, peritoneum, spine and lung. Out of 23 cases of pancreaticobiliary tumors, 9(40%) cases were showing distant metastasis on CT and 12(52%) cases on MRI. Liver was the most common site for metastasis.

The number of metastatic lesions visualized on plain and contrast enhanced MRI was much higher than plain and contrast CT respectively.

XI) Determining the resectability of tumor on CT and MRI:
Based on imaging findings, CT and MRI are equally effective in determining the resectability of pancreaticobiliary tumor. In our study, out of 23 cases of pancreaticobiliary tumors, CT and MRI was in agreement in 21 cases and was in disagreement for 2 cases.

DISCUSSION

I) Incidence of pancreaticobiliary tumors:
In our study of 25 patients of pancreaticobiliary tumors, gall bladder carcinoma was the most common tumor (36%) in biliary tract this is followed by cholangiocarcinoma (24%), pancreatic ductal adenocarcinoma (12%) and rest was the cystic tumors of pancreas.

II) **Gender distribution:**
In our study of pancreaticobiliary tumors, gall bladder carcinoma incidence was more in females (n=6) as compared to males (n=3) in the ratio of 2:1. [15]

In case of cholangiocarcinoma, equal incidence of was noted among males (n=3) and females (n=3). [16]

Pancreatic ductal carcinoma was seen more common in males (n=2) as compared to females (n=1). [17]

III) Age group:
The highest incidence of pancreaticobiliary tumors was seen in the age group of 51 to 70 years (69%). These findings are consistent with various epidemiological studies which shows higher incidence of these tumors in elder age group [15,16,17].

IV) Presenting complaints:
Abdominal distension was the most common presenting complaint.

V) CT and MRI findings:

1.GALL BLADDER CARCINOMA:
In our study, gall bladder carcinoma was the most common type of tumor, mass replacing the gall bladder was the most common type, followed by intraluminal Polypoidal mass formation type and irregular diffuse or focal wall thickening type (n=1). [2]

2. CHOLANGIOCARCINOMA:
In our study of cholangiocarcinoma, anatomically, hilar type was the most common type 100% (n=6). and out of 6 cases, 3 cases were showing associated intrahepatic or hilar mass formation.

3. PANCREATIC TUMORS:
According to various literatures available about 90% of pancreatic tumors are ductal adenocarcinoma and 10 are cystic tumors, however in our study there was equal incidence of for ductal adenocarcinoma (n=3) and cystic tumors of pancreas (n=3).

VI) Gall Stones:
MRI was considered as gold standard for comparative study with CT for cholelithiasis and choledocholithiasis.

VII) Density, Intensity And Enhancement Pattern-Appearance on CT and MRI:
In our study, most of pancreaticobiliary tumors were hypo (60%) to Isodense (40%) on non-contrast CT. On MRI most of pancreaticobiliary biliary tumors were hypointense on T1 (82%) and hyperintense on T2 and T2- SPAIR (82%).

VIII) Mode Of Tumor Spread (T STAGING):
Hepatic hilum type of spread is most common in gall bladder carcinoma.[18]

Vascular involvement biliary tract involvement and associated liver

atrophy are three most valuable criteria for considering resectability of hilar cholangiocarcinoma. In our study, there were 6 cases of hilar cholangiocarcinoma with vascular involvement in 5 (83%) cases and associated liver atrophy in 2 (33%) cases.

In our study, there were 3 cases of pancreatic ductal adenocarcinoma. All 3 were located in the body of pancreas, however according to various literatures available the most common site for pancreatic adenocarcinoma is pancreatic head. This discrepancy was due to inadequate number of cases in our study.

IX) Metastatic Lymphadenopathy (N):

MRI has been detected more sensitive in detecting necrotic metastatic lymphadenopathy as compared to CT.

X) Metastasis (M):

Metastasis is one of the most important criteria for staging, deciding the resectability of tumor and for operative management. In our study of pancreaticobiliary tumors 52% (n=12) of the tumors were showing distant metastasis on MRI and 40 %(n=9) on CT at the time of diagnosis.

In our study, liver was the most common site for distant metastases (50%). Out of 23 cases of pancreaticobiliary tumors, 6 cases was showing liver metastasis on MRI as compared to CT which was showing metastasis only in 4 cases. [19]

XI) Resectability:

Almost uniform results were found with CT and MRI regarding the resectability of pancreaticobiliary tumors. In our study out of 23 cases of pancreaticobiliary tumors CT and MRI was in agreement for resectability and non resectability of tumors in 21 cases and was in disagreement only for 2 cases. [20]

SUMMARY AND CONCLUSION

- In our study, gall bladder carcinoma was found to be more common than cholangiocarcinoma and pancreatic ductal adenocarcinoma
- The most common age group involved in pancreaticobiliary tumors in our study was 50-70 years
- Gall bladder carcinoma is more common in females, female to male ratio being 2:1.
- Mass forming type is the most common morphological type of gall bladder carcinoma (5 of 9 cases, 55%).
- 67 % of gall bladder carcinoma were associated with cholelithiasis with average size >1.5 cm.
- Local spread of gall bladder carcinoma most commonly involves adjacent liver. Vascular involvement is most commonly seen with mass forming type of gall bladder carcinoma.
- In our study all the cases of cholangiocarcinomas were hilar cholangiocarcinomas. Morphologically periductal (infiltrative) pattern is the most common in hilar cholangiocarcinoma.
- MRCP gives added advantage in MRI for accurate detection of level of obstruction without use of intravenous contrast and in cases of failed ERCP.
- Periportal or pericholedochal group of lymph nodes were most commonly involved in gall bladder carcinoma and cholangiocarcinoma. The peripancreatic group of lymph nodes was most commonly involved in pancreatic adenocarcinoma.
- Liver was the most common site for metastasis, involved in 50% of cases of pancreaticobiliary tumors showing metastasis.
- CT and MRI were in agreement in 84 % of cases of pancreaticobiliary tumors for deciding resectability of tumor.
- MRI scores over CT, as it has no radiation hazard and has superior soft tissue resolution, better demonstration of obstruction caused by the lesion, its communication with pancreaticobiliary tract and liver and / or spinal metastasis, without use of contrast. Thus, in patients with contraindication for intravenous contrast, non-contrast MRI is far better than non-contrast CT.
- CT scores over MRI in being a quicker and cheaper investigation with better spatial resolution, lesser artifacts and simultaneous evaluation of chest, abdomen and pelvis in a single examination.
- Thus, in conclusion, both CT and MRI can accurately determine resectability of tumors preoperatively, with high sensitivity and specificity, and can improve operative management of patient. The investigation of choice in pancreaticobiliary tumors should be decided on the basis of multiple factors like cost, availability, patient compliance, clinical acuity and renal function in every patient.

IMAGE GALLERY

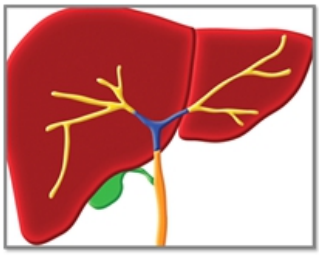

Fig 1 : Drawing illustrates the locations of the 3 types of cholangiocarcinomas : Intrahepatic or peripheral (yellow), perihilar (blue), extrahepatic (orange)

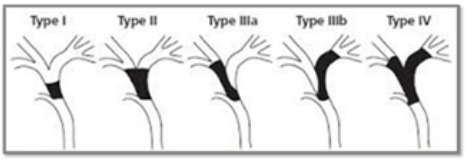

Fig 2 : Drawings illustrate the Bismuth-Corlette classification of perihilar cholangiocarcinomas.

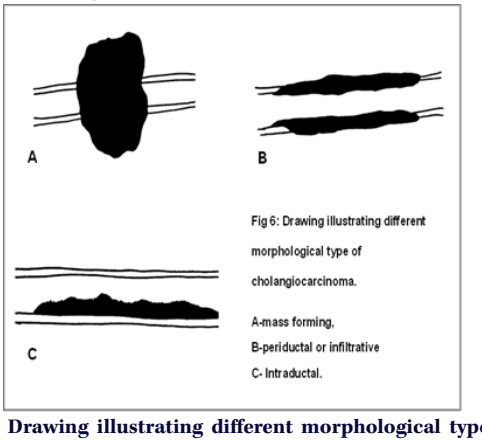

Fig 3 : Drawing illustrating different morphological types of cholangiocarcinoma-
A : mass forming
B : periductal/infiltrative
C : intraductal

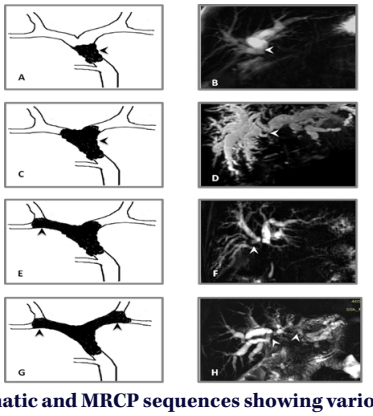

Fig 4 : Schematic and MRCP sequences showing various types of hilar cholangiocarcinomas

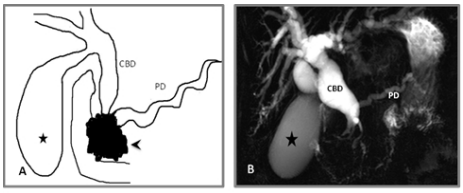

Fig 5 : A) Schematic representation B) single shot MRCP showing dilated CHD and PD (double duct sign) in pancreatic head mass or Periampullary tumour(arrow head) with overdistended gall bladder (Star)

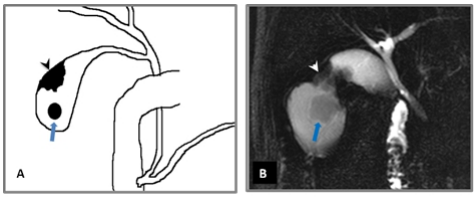

Fig 6 : A) Schematic representation B) single shot thick slab MRCP showing polypoidal intraluminal mass (arrow head) with associated cholelithiasis (Star)

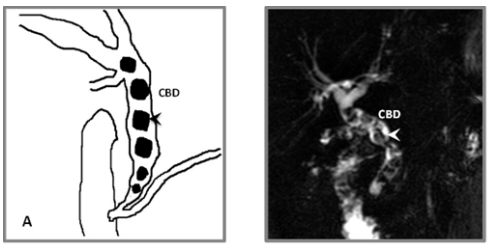

Fig 7 : A) Schematic representation B) single shot thick slab MRCP showing multiple CBD calculi (arrow)

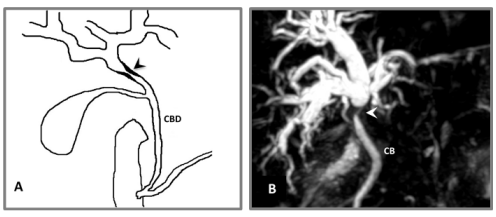

Fig 8 : A) Schematic representation B) MIP 3D MRCP showing short length benign stricture involving CHD (arrow)

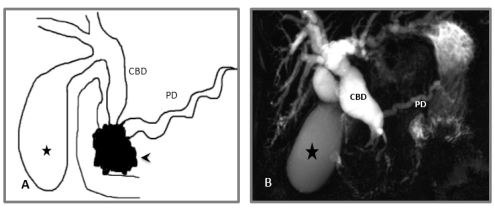

Fig 9: A) schematic presentation, B) single shot MRCP showing dilated CHD and PD (double duct sign) seen in case of pancreatic head mass lesion or periampullary tumor (arrow head) associated with over distended gall bladder(black star)

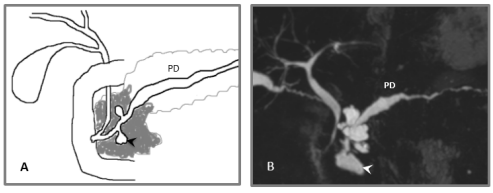

Fig 10: A) schematic presentation, B) MIP 3D MRCP showing focal chronic pancreatitis in the region of pancreatic head with mildly narrowed PD in the region of pancreatic head however not completely obscured (duct penetrating sign) with few small pseudocyst (yellow arrow) communicating with PD. PD is mildly dilated in the region of pancreatic body.

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