

# A pictorial essay - Imaging in Surgical Jaundice

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## Introduction

Surgical jaundice may be due to disease of the bile duct system itself or the disease of the pancreas[1,2]. Patients with surgical jaundice represent a complex and challenging problem. Despite the fact that considerable advances have been made, the results of several studies have not shown improved survival of patients with malignant cause of jaundice[3]. Ideally the initial steps in the approach to malignant obstructive jaundice should establish whether the patient is a candidate for surgery and whether the tumour is potentially resectable[4]. All the imaging techniques have their advantages and limitation and there is no universally accepted consensus on the imaging procedure of choice in the management of biliary obstruction[5].

Sepsis and multiple organ failure are among the most important causes of mortality in obstructive jaundice. An accompanying cellular immunity dysfunction and immunosuppression aggravate septic complications in jaundiced patients[6-8]. Primary diagnosis of the cause of obstructive jaundice can be evaluated by primary radiological investigations like ultrasonography, PTC, hypotonic duodenography and CT scanning.

## Imaging procedure in surgical jaundice

Distinguishing between biliary tract obstruction and hepatocellular disease by means of history, physical examination, and laboratory studies is often impossible, so primary radiological imaging becomes crucial[9]

Malignancy, choledocholithiasis and biliary stricture account for most cases of biliary obstruction[1-3]. These lesions can be very well diagnosed by primary radiological investigations. Appropriate radiological evaluation of biliary tract and adjacent structures is crucial for the management of patients with biliary ductal obstruction in defining the

location in the biliary tract. Exploratory laparotomy is unnecessary nowadays as a diagnostic procedure following the development of noninvasive and invasive techniques. Multiple new imaging techniques have been introduced for evaluation of patients with surgical jaundice[10-12].

## Non invasive imaging

Ultrasonography (US) remains the least invasive initial imaging modality for evaluation of surgical jaundice[13]. When used properly, CT and MR imaging can provide valuable information about the extent of local tumor involvement and distant metastases[14]. Hilar lesion are among the most difficult to evaluate with conventional cholangiography. MRCP has been reported to be an accurate technique for determining both the level and site of malignant pancreaticobiliary obstruction[15].

## Invasive imaging

Percutaneous transhepatic cholangiography (PTC) and endoscopic retrograded cholangiography (ERCP) may need to be done to locate the level of obstruction, which may be at the level of papilla, or porta hepatis. PTC has a 70% success rate for bile duct opacification. Its reported accuracy in defining the level of duct obstruction is 90%, and the cause of obstruction 75-80%. ERCP is technically successful in 85% to 95% of cases and allows confirmatory evidence of the lesion by allowing brushing, biopsy, or needle aspiration at the time of study. The diagnostic accuracy has been reported to be nearly 90%. Invasive technique should be avoided for diagnostic purposes[12]. Amouyal et al found that EUS was significantly more sensitive (95%) in the diagnosis of choledocholithiasis than US (25%), or CT scanning (75%). EUS has a reported sensitivity (94.4%), specificity (97.8%) and accuracy (95.9%) for detection of common bile duct stones[16].

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National institute of health (NIH) state of science conference on ERCP agreed that ERCP is indicated for diagnosis and palliation of patients with known or suspected pancreatic or biliary malignancy. For staging, however, less invasive test such as CT, MRCP and EUS are preferred to ERCP. In-patients with unrespectable tumour, tissue acquisition for diagnosis and planning of chemotherapy should obtain via ERCP[17].

In a recent study comparing MRCP and ERCP in malignant pancreaticobiliary obstruction, it has been suggested that MRCP might be optimal diagnostic test with high sensitivity and specificity and may help to direct the appropriate intervention[18].

Various types of pathology causing surgical jaundice.

### 1 Choledocholithiasis

Primary common duct stones are ovoid and single or multiple. They are soft and readily crushed into fragments (biliary mud), may or may not cast acoustic shadowing on ultrasonographic examination[19]. Tumour, gas, calcification, worms, surgical clips all can be associated

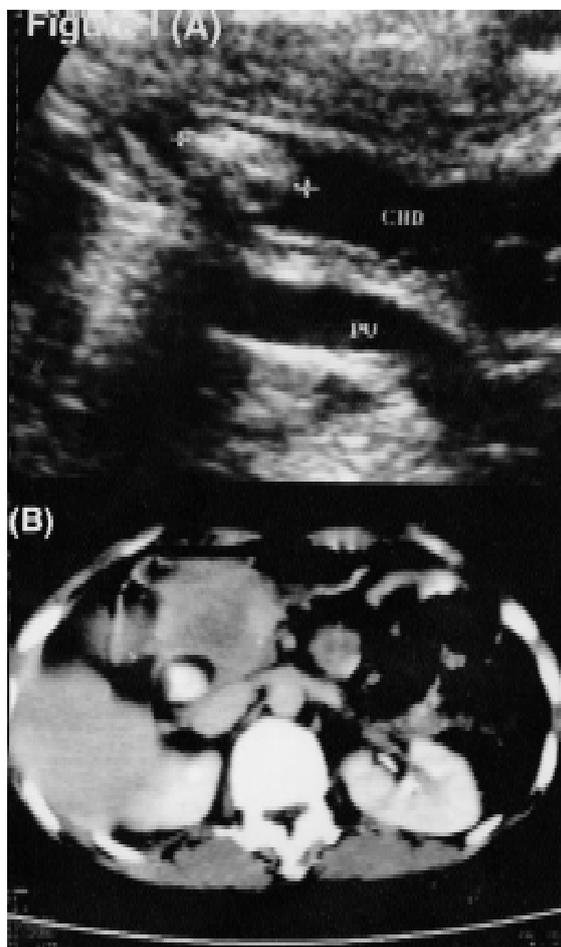


Fig 1 (A) Ultrasonography shows biliary calculi with dilated proximal CBD  
(B) CT scan examination shows large calculi in the CBD lumen.

with echogenic focus with or without acoustic shadowing resulting in false positive result[20] Secondary stones are composed of cholesterol and calcium. So on ultrasound they absorb and reflect the ultrasonic beam and the net ultrasonographic effect is a highly reflective echo originating from the anterior surface of the calculus with a prominent posterior acoustic shadow[19] (Figure I-A). The sensitivity of CT detection of choledocholithiasis ranges from 50% to 90%. Patients in whom choledocholithiasis is suspected should be scanned initially without oral contrast medium (Figure I-B). Other wise it might obscure a calculus lodged in the distal common bile duct[9].



Fig 2 (A) Ultrasonography shows large choledochal cyst with acoustic shadow due to stone within it.  
(B) Non-enhanced CT scan examination shows large laminated stone within the choledochal cyst.

### 2 Choledochal cyst

It is due to specific weakness in a part or whole of CBD musculature. Anomalous junctions of the biliary pancreatic junction are frequently observed, and long common channel result in high levels of biliary amylase in 80% of cases. Common pancreaticobiliary channels may be associated with repeated attack of pancreatitis[21].

Ultrasound is essential to accurately diagnose the cyst. Associated stones can be visualized on it (Fig.2-A), which is generally formed due to functional stasis of bile. On CT, choledochal cyst can have varying appearances depending on the extent of ductal involvement and the degree of dilatation. Complication of choledochal cyst usually involves bile stasis and stone formation (Fig 2-B)[22]. Preoperative ERCP is helpful for differentiating pancreatic duct from bile duct and exact location of cyst, while MRCP is a reliable method.

### 3 Sclerosing cholangitis

High association between Sclerosing cholangitis and inflammatory bowel disease is noted. An alteration in bile duct acid metabolism appears to be the underlying mechanism for stricture formation. Imaging plays a central role in the diagnosis and management of Sclerosing cholangitis. Ultrasonography is not very good at detecting sclerosing cholangitis because all the periductal fibrosis prevents the biliary tree from dilating. Ultrasonography also requires the presence of dilatation to diagnose obstruction. Sonography may occasionally detect "pockets" of biliary obstruction surrounded by relatively echogenic fibrosis involving the duct wall. Both PTC (Fig. 3) and ERCP have merits in evaluating sclerosing cholangitis[23].

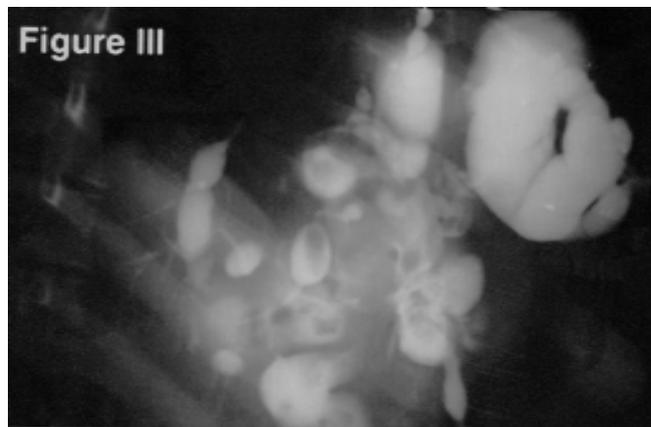


Fig III PTC examination(lateral view) shows alternate strictures and dilated "pockets" of the intrahepatic biliary channels.

### 4 Biliary parasites

The roundworm *Ascaris lumbricoides* infest about one quarter of the world's populations and especially common in parts of Asia, Africa and Central America. Five different signs have been describe in characterizing the worms' sonographic appearance. The strip sign occurs when worm is as a long, thin linear, echogenic strip within the lumen of the duct or the gall bladder. When the worm containing duct is viewed in cross-section a bull's-eye appearance of central specular echo within the duct is obtain. On occasion a central anechoic tube is seen within the worm (the inner tube sign), probably representing the worms digestive tract (Figure 4-A). With heavier infestation and many biliary worms, multiple overlapping longitudinal

interfaces may be present within duct, the spaghetti sign (Figure 4-B). Real time examination is useful in demonstrating worm motility; characteristic erratic, non-directional, zig-zag movements may be seen within the duct[9,24]. USG is a non-invasive, cheap and accurate modality to diagnose and follow-up cases of hepatobiliary ascariasis[25].

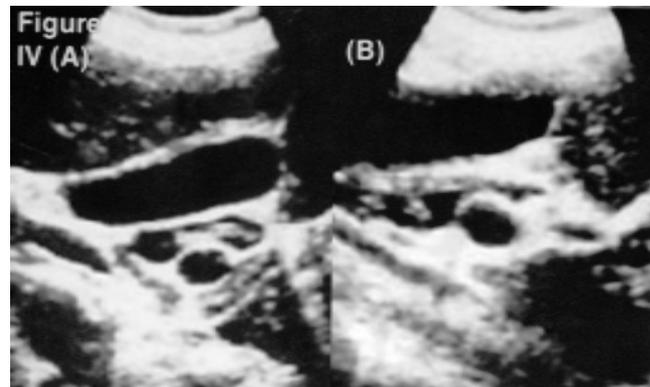


Fig. 4 (A) Ultrasonography shows tubular structure within the dilated CBD (Inner tube sign)  
(B) Multiple overlapping longitudinal interfaces present in CBD (Spaghetti sign)



Fig 5 PTC examination shows long stricture at the proximal CBD

### 5 Stricture of CBD

Stricture is the third most common cause of distal CBD obstruction. Apart from proximal dilatation of CBD and tapering lower end is characteristic feature. Stricture per se is not usually visible on ultrasonographic examination. Previous history of cholecystectomy or surgery near by

CBD favours the stricture formation. Cholangiography or PTC (Fig. 5) generally very well demonstrates the site and extent of stricture[19,25].

#### 6 Recurrent pyogenic cholangitis

Recurrent pyogenic cholangitis is characterized by formation of intrahepatic pigmented stones with recurrent exacerbation and remission of abdominal pain frequently associated with jaundice, chills, and fever[26]. The pigment stones are usually of medium echogenicity, with variable degrees of acoustic enhancement. For that reason and because of the associated presence of intraductal air ultrasound may in some instances be unable to visualize the ductal stones. Dilated bile ducts that are completely filled by mud or stones are also less well visualized on ultrasound (Figure 6-A). Because the stones are composed mainly from bile pigment with a variable degree of calcification, their attenuation on CT varies from hyper- to iso attenuation. However, CT will display the stones within the dilated bile ducts on the precontrast scan (Figure 6-B) in most patients more reliable than ultrasound[27,28].

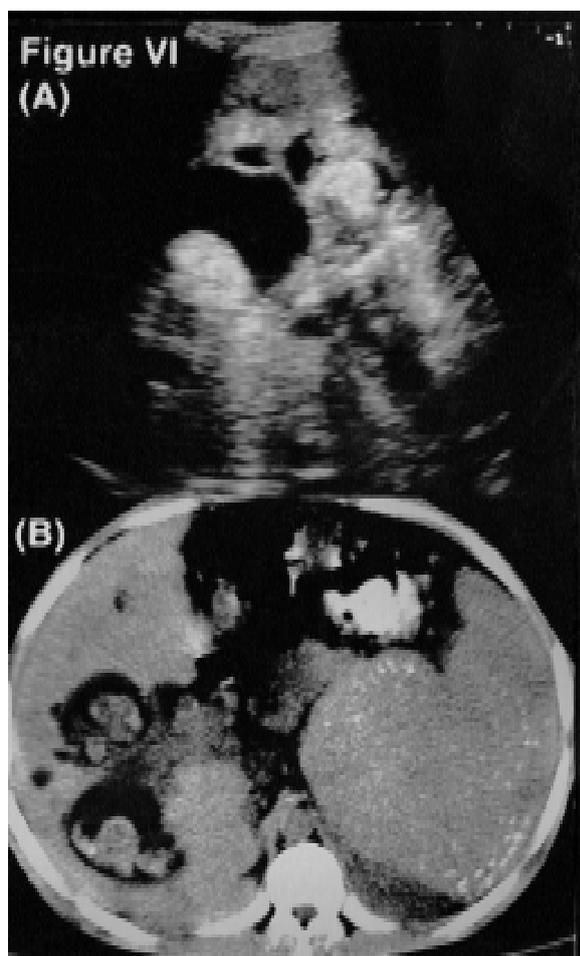


Fig 6 (A) Ultrasonography of liver shows dilated intrahepatic bile ducts filled with multiple calculi and changes of biliary cirrhosis.

(B) Precontrast CT scan shows dilated intrahepatic bile ducts with extensive hepatolithiasis

#### 7 Benign bile duct tumour

Papillomas and adenomas are the most common bile duct tumours. Sonographically, they are moderately echogenic, non-shadowing mass lesions (Figure 7). The lack of shadowing and a relatively low echogenicity suggest a tumor rather than a stone. Large lesions may cause obstruction. On the CT they are soft tissue masses. Fibromas have the same imaging characteristics as adenomas, but lipomas have low, fat density on CT[9].



Fig 7 Ultrasonography shows non-shadowing nodule arising from the CBD wall

#### 8 Cholangiocarcinoma

Cholangiocarcinoma is an uncommon tumor, with an autopsy incidence of 0.3 % to 0.5%. Sonography demonstrates biliary dilation proximal to the tumor in the vast majority of cases. Sonographic demonstration of dilation of intrahepatic ducts without any evidence of extrahepatic dilation prompts suspicion of a " klatskin tumor", with or without the demonstration of small tumor masses in the porta hepatis. A key finding is failure to demonstrate the confluence of the right and left hepatic ducts in the portal region with or without demonstration of a mass lesion on ultrasonography (Figure 8-A). Ultrasonographic examination of klatskin tumor varies, but definite mass lesion obstructing and narrowing the CBD lumen can also be noticed. CT manifestations of cholangiocarcinoma may include biliary dilation, metastatic disease, and least commonly, demonstration of the primary tumor itself. The mass, hypodense on precontrast (Figure 8-B) and early postcontrast scans but became hyperdense on delayed scans suggest Cholangiocarcinoma. Cholangiocarcinoma should be suspected on ultrasonographic examination when abrupt obstruction is seen and no stone or mass is demonstrated (Figure 8-C). Direct cholangiography has the advantage of providing pictorial presentation, and it does not exclude stones with greater certainty[29].

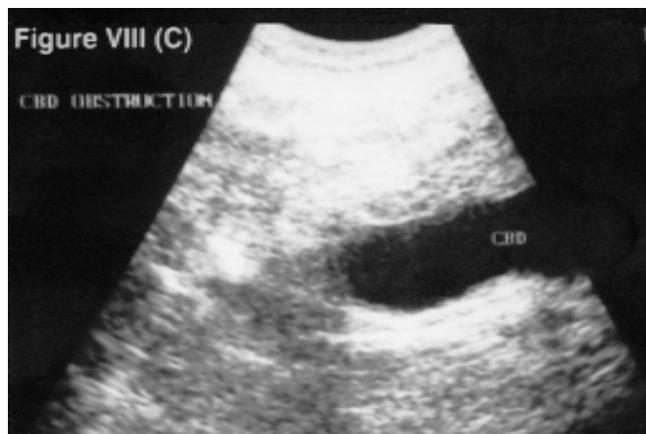
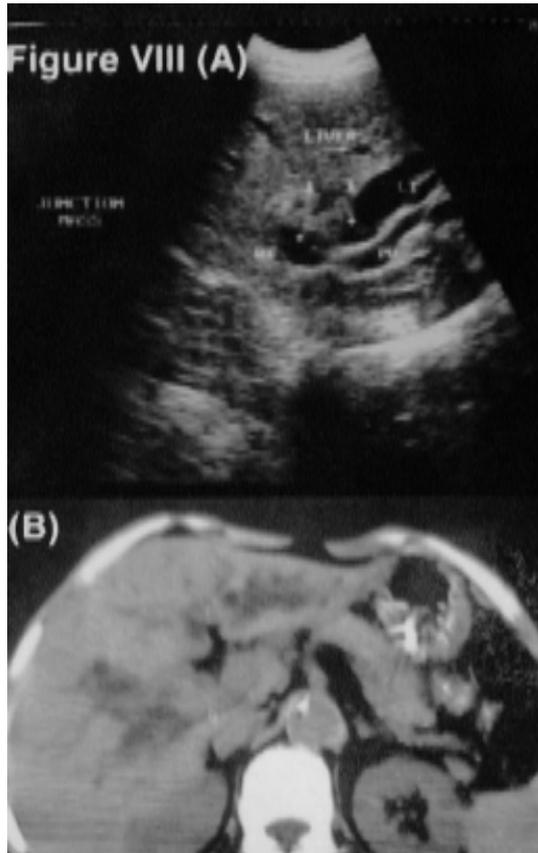


Fig 8 (A) Mass lesion at the confluence of right and left hepatic duct is seen on ultrasonographic examination.

(B) On CT scan examination failure to demonstrate confluence of right and left hepatic duct S/o klatskin tumor

(C) Abrupt termination of dilated CBD by Cholangiocarcinoma is seen on ultrasonographic examination

### 9 Gall bladder neoplasm

The most common type of gallbladder carcinoma is replacement of the gallbladder by a complex mass, seen in 40% to 50% of patients. Extension to the porta hepatis via the hepatoduodenal ligament causes biliary obstruction and dilation of the intrahepatic ducts. Gall bladder mass extending into CBD via cystic duct also causes proximal obstruction (Figure 9). The common duct may be dilated if the cause of obstruction is

peripancreatic nodes or direct duct invasion. The most common CT finding in carcinoma of the gallbladder is a slightly enhancing mass in the region of the gallbladder that replaces most or all of the gallbladder[9].



Fig 9 Gall bladder mass extending into CBD via cystic duct causing proximal obstruction.

### 10 Pancreatic head mass

Cancer of the pancreas is currently the ninth most common malignancy, but it represents the fourth most common cause of cancer-related death. The jaundice of pancreatic cancer is almost associated with pain and the concept of painless jaundice being typical for cancer of the pancreas should be abandoned[30]. Barium studies, although no longer routinely performed in patients with suspected pancreatic cancer, a barium study may still be the first radiological test in a patient present with jaundice. The frostberg 3 sign is a reversed 3 contour to the medial portion of duodenal sweep. The most common ultrasonographic finding in pancreatic carcinoma is poorly defined, homogeneous or inhomogeneous hypoechoic mass in the head of pancreas. Dilation of the pancreatic duct proximal to the pancreatic mass is a common finding (Figure 10-A). When obstructed, it loses its parallel nature, becomes tortuous, and ends or tapers abruptly. Bile duct dilation is commonly seen with lesion in the head of pancreas. The gallbladder and cystic duct may or may not be dilated. Cystic neoplasm of pancreas shows unilocular or multilocular smooth-surfaced cystic masses with occasional papillary projection or calcification[9]. While ultrasonography is widely used as an initial screening procedure, it has not been to be as sensitive in defining the entire constellation of important findings related to pancreatic malignancies including local nodal spread or involvement of the major arterial and venous structures. The CT appearance of pancreatic carcinoma is variable. If intravenous contrast medium is not administered, the attenuation value of the tumour generally is very similar to that of normal parenchyma, unless extensive necrosis or cystic change is present. If intravenous contrast medium is administered, using bolus technique and rapid, thin scanning, especially with helical CT, most carcinoma will be hypo enhancing with respect to the surrounding uninvolved pancreatic parenchyma[30].

Invasion of surrounding structures can also be well visualized on CT Scan (Figure 10-B).

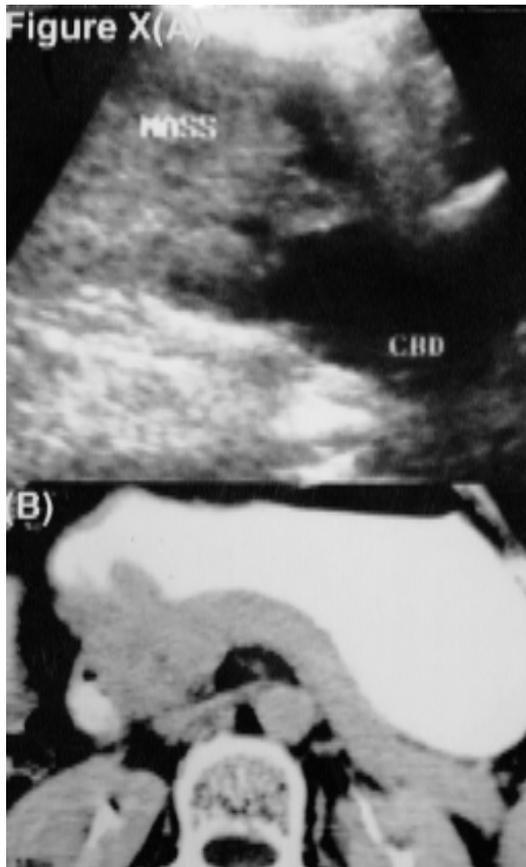


Fig 10 (A) Longitudinal section on ultrasonographic examination shows dilated tortuous CBD, obstructed by pancreatic head mass.

(B) Contrast enhanced CT scan examination shows iso-enhancing pancreatic head mass with duodenal wall invasion

### 11 Periampullary malignancy

Periampullary cancer includes group of neoplasm arising at or near the ampulla of Vater. Generally this small lesion at ampulla can cause very much dilation of biliary tract. Due to small growth and adjuvant duodenal gas, this lesion is difficult to visualize on ultrasonography (Figure 11-A). But indirect signs like CBD dilation up to lower end, entering into the duodenal wall with MPD joining nearby. So, here other investigation like CT scan (Figure 11-B), hypotonic duodenography (Figure 11-C) and EUS can help. Dramatic remission of the obstructive jaundice occurs very rarely after some times in follow up Sonography due to sloughing out of small periampullary growth [19, 25].

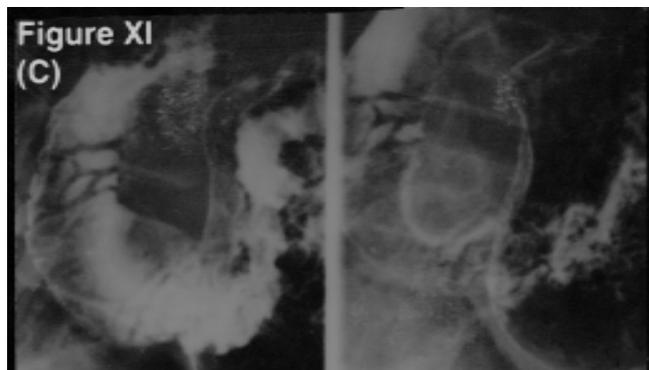
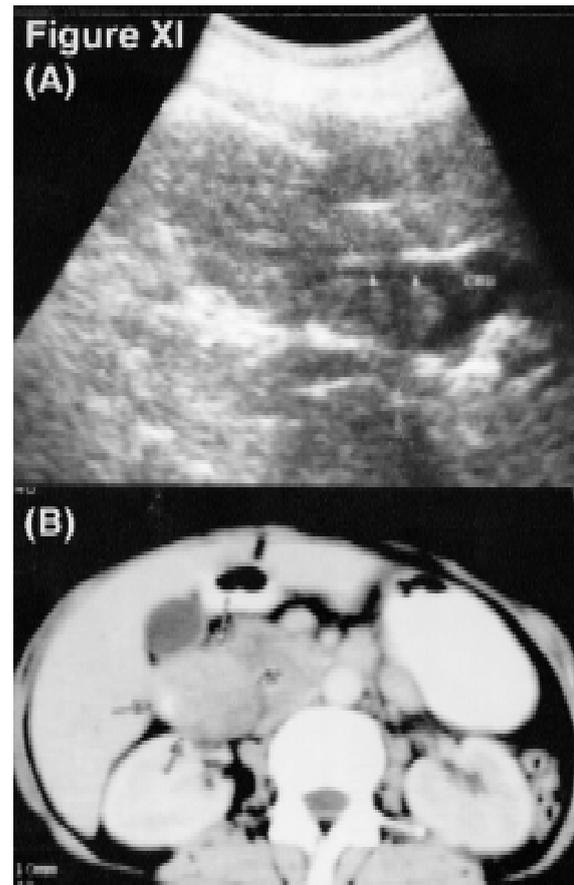


Fig 11 (A) Ultrasonographic examination shows small portion of mass from duodenal lumen (periampullary malignancy) extending into the lower end of CBD

(B) CT scan examination shows mass arising from the medial wall of second part of duodenum causing narrowing of lumen.

(C) Hypotonic duodenography shows filling defect at the site of ampulla

### 12 Chronic pancreatitis and pseudocyst

The most common type is chronic calcifying pancreatitis. The hallmark of disease on any imaging study is the identification of calculi and or calcification in the pancreas (Figure 12-A). Jaundice may be a manifestation of partial common bile duct obstruction as the duct passes through the fibrotic head of the pancreas. The pseudocyst formation aggravates the obstruction to the CBD by compression effect (Figure 12-B). The ultrasonographic

findings include an enlarged pancreatic duct—more than 4 mm, gland enlargement up to twice normal, gland atrophy, irregular ducts, focal reduction in parenchymal echogenicity, echogenic foci in parenchyma, increased echogenicity of the wall of the pancreatic duct, and an irregular contour of the gland, particularly focal enlargement may or may not be associated with pseudocyst formation. Pancreatic ductal dilation, parenchymal atrophy, and pancreatic calcification are the most common CT manifestations of the chronic pancreatitis [9].

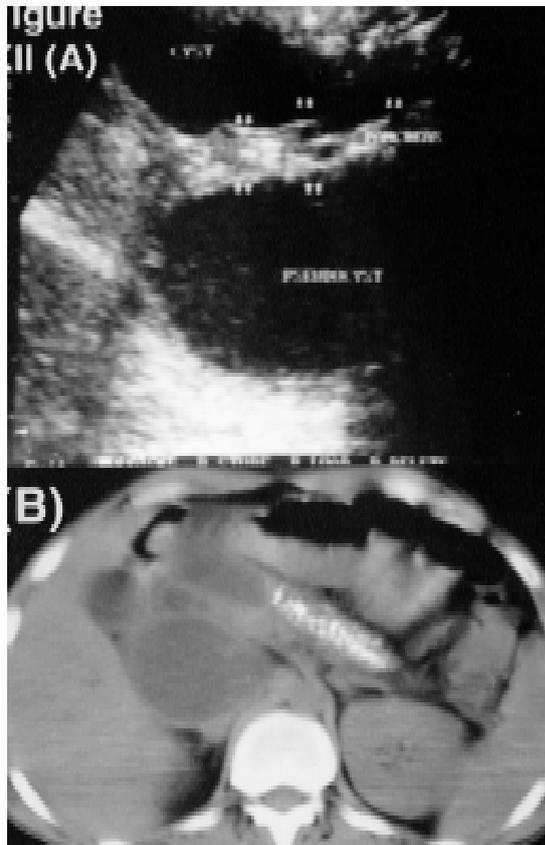


Fig 12 (A) Chronic pancreatitis in the form of pseudo cyst formation and fibrosis is seen on ultrasonographic examination

(B) CT scan examination confirms calcification in pancreas

### 13 Hepatocellular carcinoma

Ultrasonographically mass may be hypoechoic, complex, echogenic with central necrosis, diffuse or focal. A thin peripheral hypoechoic halo, which corresponds to a fibrous capsule, is seen most often in small HCC. With duplex and colour flow Doppler ultrasound we can see high velocity signals. Ultrasonography demonstrates dilation of biliary channels when mass is near by porta hepatis and compressing or invading the biliary pathway (Figure 13) 31.



Fig 13 Ultrasonographic examination demonstrates dilation of biliary channels due to large Hepatocellular carcinoma compressing or invading biliary pathway.

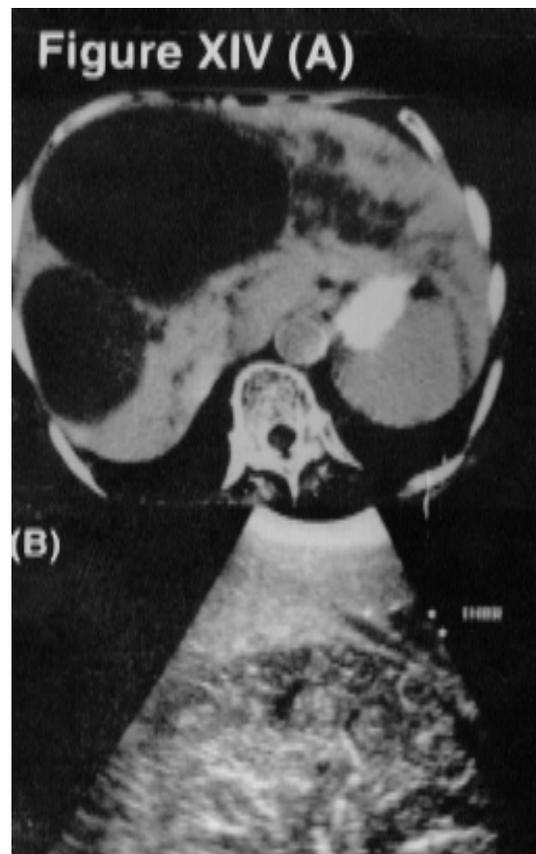


Fig 14 (A) Multiple large hydatid cyst compressing the biliary channels at the porta causing proximal dilatation.

(B) Large infected hydatid cyst with internal membrane and daughter cyst causing compression over biliary channels.

#### 14 Hydatid cyst or abscess of liver

Large hydatid cyst or abscess can compress the adjacent biliary radicals, CHD OR CBD (Figure 14-A). Sonographic features of hydatid cyst include simple cyst containing no internal architecture except sand, cyst with detached endocyst secondary to rupture (water lily sign), cyst with daughter cysts, matrix or both, densely calcified mass or dead hydatid cyst. If hydatid cyst ruptures into biliary channels or in to CBD then daughter cyst and its sand can cause obstruction to bile flow until they pass from ampulla of vater in to duodenum 19. After intrabiliary rupture, high-density material may be seen in a dilated common bile duct 32 (Figure 14-B).

#### 15 Lymph node at porta

Ultrasonography shows well-defined rounded, hypoechoic lesion, multiple and or matted at porta causing compression or invasion of bile duct and obstruction (Figure 15). Lymph nodes at porta should be differentiated from "klatskin tumour"19.

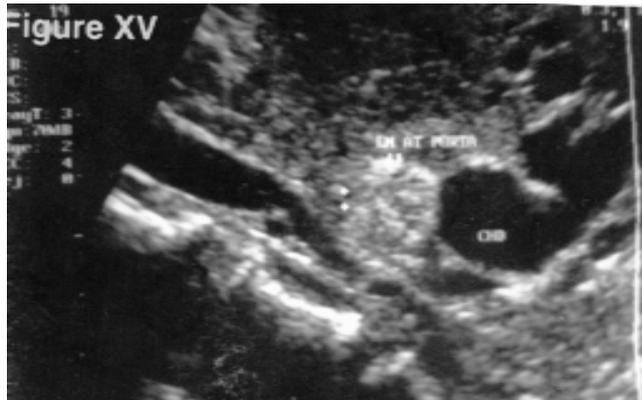


Fig 15 Calcified lymphnode at porta obstructing CHD

#### 16 Biliary Atresia

It presents in 1 per 14,000 live births, as it is very rare condition. Atresia is classified in three types:

Type I Atresia of CBD

Type II Atresia of CHD

Type III Atresia of right and left hepatic ducts (commonest).

Usually presents at birth with jaundice, which progressively deepens, muconium and stool are pale. Ultrasonography will be helpful in evaluating type of atresia[19, 25].

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