

1 Introduction to radiological Imaging in jaundice

- Jaundice is yellow discoloration of skin and sclera due to elevated serum bilirubin levels over 3 mg/dl or 50 mic/l This is a clinical finding, not a single disease entity.
- The first task of the clinician caring for the jaundiced patient is to determine if jaundice is caused by bile duct obstruction.
- Obstructive jaundice is resulting from obstruction to the flow of bile from the liver to the duodenum. In adults, extrahepatic (mechanical) obstruction accounts for 40% of patients presenting with jaundice as the primary symptom [1], and this likelihood increases with advancing age.
- For situations in which the pre-imaging probability of obstruction is high, it is also appropriate to consider a second question: whether the obstruction is likely to be benign or malignant and categorize accordingly
- In the absence of a high likelihood of biliary obstruction, jaundice could be due to a third category of intrahepatic cholestasis of paranchymal liver disease or metabolic disease of liver.
- Cholestatic jaundice of new born and pre hepatic jaundice due to excessive haemolysis are considered as two other separate categories of jaundice.
- Therefore the radiological workup and appropriateness of imaging tests are considered under five categories as follows:

Category 1

Jaundice with high likelihood of benign biliary obstruction

Common bile duct stones
Pancreatitis, Recurrent cholangitis
Mirizzi's syndrome, Sclerosing cholangitis

Category 2

Jaundice with high likelihood of malignant biliary obstruction

Carcinoma of the head of pancreas,
Malignant porta hepatis lymphodesnodes,
Peri ampullary Carcinoma, Cholangiocarcinoma

Category 3

Cholestatic jaundice due to Hepatocellular disease

Viral hepatitis, Drugs, alcoholic hepatitis,
cirrhosis, Wilsons disease,
Gilbet syndrome, Budd chiaris syndrom

Category 4

Jaundice of newborn

Biliary atresia,
Choledochal cyst, neonatal hepatitis
Metabolic liver disease

Category 5

Haemolytic Jaundice

Thalasaemia,
Sickel cell disease

*Detailed history, thorough clinical examination and basic bio chemical investigations are recommended for the clinician to categorize the patient in to any of the above mentioned groups. **Grade (X)***

1.1 Radiological imaging methods used in evaluating the jaundiced patient include:

1. Ultrasound (US)
2. Computed tomography (CT),
3. Radionuclide cholescintigraphy (CS),
4. Magnetic resonance imaging (MRI)
5. Magnetic resonance cholangiopancreatography (MRCP)
6. Percutaneous transhepatic cholangiography (PTC)
7. Endoscopic retrograde cholangiopancreatography (ERCP)
8. Endoscopic ultrasound
9. Image guided biopsy.
10. Biliary stenting

- **These examinations are effective to varying degrees in assessing both the *cause* and the *site* of obstruction.**

- **Percutaneous or Endoscopic biopsy is helpful to obtain a pathological sample of an obstructing primary lesion.**
- **ERCP or PTC also can relieve the obstruction in a significant portion of cases by stenting**

It is recommended to consider the local conditions and availability of expertise when following up these guidelines to evaluate a jaundice patient.

Grade (X)

2. Jaundice with high likelihood of Benign biliary obstruction (Category 1)

Sign and symptoms

- Jaundice and acute abdominal pain of short duration.
- Prior history of gallstones documented by sonography
- Prior biliary surgery.

Biochemistry

Serum bilirubin		—
Total	high	
Direct	high	
Indirect		
SGPT (AST)	normal or slightly high	
SGOT (ALT)	normal or slightly high	
S. alkaline phosphatase (liver)	normal or slightly high	
Prothombin time	normal	
Serum albumin	normal	
Urine		
Conjugated bilirubin	present	
Urobilinogen	absent	

A.

Sonography is recommended due to its high sensitivity and specificity, wide availability and low cost to diagnose biliary obstruction **Grade (X)**

- It can detect dilated intrahepatic bile ducts and the common bile duct (CBD) at the hepatic hilum, with a sensitivity of 55%-95% and a specificity of 71%-96% [1].
- Normal CBD is 6mm in diameter. CBD over 6mm suggest extrahepatic cholestasis.

Limitations of this study

- Normal CBD diameter increases with age and after pervious biliary surgery
- intrahepatic bile ducts may not be dilated in the early phase of acute obstruction or in patients with partial obstruction.
- US is less effective than CT or direct cholangiography (either PTC or ERCP) in determining the *site* and the *cause* of obstruction[1]
- Calculi within the bile ducts are not detected with the same sensitivity as gallbladder calculi.
- The sub hepatic part of the CBD is not visible in a high proportion of patients due to overlying bowel gas.

Endoscopic ultrasound will be a more useful tool to asses the distal CBD when it is widely available...

Grade (Z)

B. ERCP and stenting is recommended to confirm and to relieve the obstruction at the same time **Grade (X)**

- ERCP is invasive and expensive.
- ERCP requires a skilled endoscopist and , its complication rate is lower than or equal to PTC
- It provides a greater range and ease of therapeutic options for relief of the obstruction (stone extraction, internal biliary stent placement, Endoscopic sphincterotomy) [10, 11].
- Appropriate patient selection, based on established clinical criteria, significantly improves the diagnostic yield of ERCP [3-6].
- ERCP studies prior to elective cholecystectomy [3-6] assess the presence or absence of CBD calculi which need special surgical attention

C. CT Scan/MRI Scan/MRCP/ is recommended for selected patients eg: equivocal US scan, failed or contraindicated ERCP or in cases of sclerosing cholangitis **Grade (Y)**

- Plane Spiral CT scan of upper abdomen with reconstruction is satisfactory when the duct system is grossly dilated.

- Combined MRI and plain spiral CT abdomen reliably diagnose obstructing calculi even in the absence of gross duct dilatation.
- CT scan is useful to diagnose calcific pancreatitis
- MRI scan demonstrate both the site and cause of biliary obstruction.
- MR cholangiography is useful in depicting the three-dimensional anatomy of the biliary and pancreatic ducts.
- In patients with a history of prior surgery or suspected sclerosing cholangitis, in whom biliary stricture is a diagnostic consideration; MRCP is the preferred imaging test, avoiding the possibility of suppurative cholangitis that may be induced by endoscopic catheter manipulation into an obstructed biliary system.
- MRCP findings may guide directed approaches such as ERCP with brushing, percutaneous transhepatic biliary stenting or reconstructive surgery.

D. Percutaneous transhepatic Cholangiography (PTC) is recommended to confirm and treat the obstruction when ERCP is contraindicated or not available. **Grade (Y)**

- It is also more expensive than CT or US
- More invasive procedure than ERCP
- permits visualization of the intrahepatic and extrahepatic biliary tree with a high sensitivity and specificity for the diagnosis of level and cause of obstruction.
- Required in patients not suitable for ERCP due to previous gastro intestinal surgery or those following a failed ERCP.
- PTC also allows therapeutic intervention with temporary biliary drainage or stenting, if obstruction is found .Success is on the order of 90%-99% [1].

Relative contra indications to PTC are

- **Increased prothrombin time**
- **Raised INR over 1.2**
- **Ascitis**

Major complication rate of PTC is 3% - 5%

They includes

- Septicaemia
- Internal haemorrhage
- Biliary peritonitis / Biloma

E. Plain films are not recommended (X)

- Rarely provide any information on the site or the cause of obstruction and have no place in the evaluation of the jaundiced patient, in the presence of cross sectional imaging.
- 10-20% gall stones are radio-opaque
- Aerobilia can be detected on plain radiography

F. Cholescintigraphy is not recommended (X)

- is unreliable in differentiating intrahepatic cholestasis from obstructive jaundice and in depicting either the site or cause of obstruction, and it is no longer routinely used or recommended in the evaluation of jaundice [1]

2.1 Jaundice with high likelihood of malignant biliary obstruction. (Category 2)

Signs and Symptoms:

- Insidious development of jaundice
- older patients
- associated constitutional symptoms (weight loss, fatigue, etc.).

Bio chemistry

Serum bilirubin

Total very high

Direct very high

Indirect high

SGPT (AST) /SGOT (ALT) high

Serum alkaline phosphatase (liver) very high

Prothombin time prolonged

Serum albumin low

Urine

Conjugated bilirubin present

Urobilinogen absent

A. CT Scan is recommended as the first line imaging method in this category (X)

- CT is generally more frequently used than MRI scan due to availability
- Malignant obstruction could be due to pancreatic carcinoma, Periampullary carcinoma, cholangiocarcinoma of either the proximal or distal duct or periductal nodal compression.
- A contrast-enhanced multiphase spiral CT examination with multiplanar reformation has high sensitivity to lesion detection and 70% accuracy in discrimination of resectable and unresectable disease and tumor staging [2].
- Important information in tumor staging includes tumor contiguity or invasion of the superior mesenteric and portal vein, peripancreatic tumor extension, regional adenopathy, and hepatic metastases

B .Ultrasonography is recommended when CT scan facilities is not freely available

Grade (X)

- Mechanical biliary obstruction can be confirmed by sonography.
- There is high operator dependency in detecting level and cause of obstruction

C. MRI Scan and MRCP is recommended for patients with contraindications to CT

Grade (Y)

- MRCP is valuable in patients with hilar biliary obstruction due to ductal tumor or periductal compression [7-9].
- Also accurate in tumor detection and staging. There are no wide scale comparative studies of CT and MRI in the evaluation of malignant biliary obstruction.

D. ERCP or PTC is recommended to relieve obstruction in non- operable patients or in patient preparation for definitive surgery

Grade (X)

- Invasive and more expensive than CT or MRI, has equivalent sensitivity in tumor detection, but does not provide staging information for operability.
- Tissue diagnosis can be obtained by endoscopically or fluroscopically directed brushings.
- In patients with pancreaticobiliary cancer who are surgical candidates, there is no established role for preoperative biliary drainage by ERCP [13]. However, endoscopic biliary drainage may be used for operative candidates in whom there is delay prior to surgery.
- Endoscopic or percutaneous transhepatic biliary drainage is appropriate for patients who are not candidates for surgery.

- The choice between the two depends on the availability of necessary equipment and expertise of the radiologist and the endoscopists.
- Percutaneous transhepatic technique is preferred for patients with proximal or hilar biliary obstruction [10, 11].

E. EUS Recommended as an adjunct procedure to ERCP

Grade (Z)

- In patients with suspected malignant biliary obstruction and negative or equivocal CT or MRI studies, ERCP with EUS may provide an imaging and cytologic diagnosis (FNA) [12].
- Cytological tumor diagnosis in non operative candidates can be obtained either by EUS directed brushings or FNA eg: periampullary neoplasm

F. Image guided biopsy is recommended for pathological sampling of the lesion

Grade (X)

- US directed nodal biopsy can be done using fine needles and/or core biopsy needles.
- CT guidance especially useful for lesions which cannot be reached via US guidance.

- Focal chronic pancreatitis may mimic pancreatic carcinoma on all imaging tests and only be conclusively diagnosed on operative exploration and biopsy.
- Periductal nodal compression may result from metastatic disease or malignant lymphoma.
- Combined FNA and core biopsies are more informative than either alone. Semi or fully automated core biopsy needles are preferred.
- These are in ward patients procedures using 22 or 23 gauge LP needles and 16-18 gauge core biopsy needles

Relative contraindications to percutaneous needle biopsy

1. Prolonged prothombin time INR>1.2
2. Platelets < 150,000
3. Ascites
4. Extrahepatic biliary obstruction

Post procedure bed rest and observation of the patient is recommended over the next 12-24 hours

Grade (X)

- Look for any suspicion of intraabdominl haemorrhage.

It is recommended to obtain a Haematologists opinion prior to biopsy, in the presence of a haematological derangement.

Grade (X)

1.2 Cholestatic jaundice of Hepato cellular disease (Category 3.)

Signs and symptoms

- In this clinical situation, the patient’s presentation is confusing, and the imaging workup frequently is geared to the dominant clinical symptom.

Bio chemistry

Serum bilirubin	Total	high
	Direct	high
	Indirect	high
SGPT (AST) /SGOT(ALT)	very	high
Serum alkaline phosphatase (liver)	normal or	high
Prothombin time	prolonged	
Serum albumin	low	
Urine		
Conjugated bilirubin	present	
Unconjugated bilirubin	present	

A. Ultrasonography is recommended as a first line imaging method

(X)

- US is an inexpensive, relatively accurate method, certainly appropriate to exclude biliary obstruction.
- Useful to assess and monitor the liver size
- However has a low sensitivity in diagnosing and differentiating parenchymal liver disease

B. CT is recommended for a selected groups as mentioned below (Y)

- In cases in which most of the abdominal organs need to be assessed, either CT or MRI can be used. E.g. Cirrhosis and portal hypertension.
- To assess equivocal findings on ultrasound scan eg: Fatty liver

C. MRI or MRCP is recommended for selected cases as mentioned below (Y)

- When CT evaluation is compromised (e.g. in patients unable to receive iodinated intravenous contrast material), the combination of MRI and MRCP is a reliable alternative.

D. Image guided biopsy sampling is recommended for definitive diagnosis, in the absence of radiological evidence of biliary obstruction on US or CT (X)

Histological examination of the liver using core biopsy samples are valuable in the differential

diagnosis of diffuse or localized parenchymal disease.

- Percutaneous liver biopsy can be performed by radiologists, under ultrasound guidance or by a specialist in gastro intestinal and hepatobiliary disease, on a blind approach, in cases of diffuse liver disease.

E. Trans Jugular liver biopsy is recommended for patients with ascitis, thrombocytopenia, haematological malignancy or coagulopathy (Z)

This is a useful biopsy procedure via an angiographic route

2.3 Jaundice of new born

Signs and symptoms

- Consider 2 to 8 weeks old infants with cholestatic jaundice in primary care outpatient settings or in specialty centres [This is not intended for the care of the ill premature infant in the intensive care setting]
- Cholestasis of pregnancy, consanguinity, urine color, stool color are important considerations in the history.

Bio chemistry

Serum bilirubin

Total high

Direct variable

Indirect variable

(Category 4)

- Need to keep the baby off feeds for 4-6 hours prior to the scan and should take measures to prevent dehydration
- High frequency ultrasound probe should be used.
- In Biliary atresia there will be an absent gall bladder or a micro gall bladder measuring less than 1.5cm in length. Presence of a triangular cord sign (echogenic remnant of CBD adjacent to portal vein) is a more definite radiological sign. Dilated or cystic intrahepatic bile ducts could be an additional finding.
- Dilated CBD in choledochal cyst or multiple liver cysts in carolis disease can be diagnosed on ultrasound.

B. Scintigraphy is recommended as a useful second line imaging method (X)

- Tc^{99m} HIDA SCANS are done on babies
- Poor tracer uptake by the liver can be due to parenchymal liver disease as neonatal hepatitis or damage to hepatocytes due to long standing biliary obstruction.
- Normal tracer uptake by the liver followed by non excretion of tracer into the gastro intestinal tract within 24 hours is in favour of biliary obstruction as in biliary atresia.

C. Per operative cholangiogram is recommended for equivocal cases (Y)

Preferred by Paediatric Surgeons at the time of surgery for mapping of intra hepatic bile duct system

D. Percutaneous liver biopsy is recommended for most infants with cholestasis of unknown origin.

(Y)

It will diagnose biliary atresia if not confidently diagnosed on imaging.

- All the other parenchymal liver diseases and metabolic liver disease can be diagnosed on biopsy specimen.

E. Magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP) not routinely recommended.

2.4 Haemolytic Jaundice (Category 5.)**Signs and Symptoms:**

- Children with jaundice and anaemia.
- Family history of Haemolytic anaemia may persist.

Bio chemistry

Serum bilirubin

Total high

Direct normal slightly high

Indirect high	
Urine	
Conjugated bilirubin	nil
Urobilinogen	excess

Imaging is recommended in follow up of diagnosed patients to assess the development and severity of complications.

A. Ultrasonography of abdomen is recommended in follow up (Y)

- abdominal ultra sound scan is indicated to assess the liver and biliary tract
- Useful to monitor the liver enlargement and development of haemochromatosis on sequential scans
- Presence of biliary calculi and biliary obstruction can be assessed.
- Also useful to follow up the splenic enlargement, development of splenic infarctions and calcifications

B. Plain radiography is also recommended in patient follow up (Y)

- Chest x ray will help to assess the cardiomegaly of hyperdynamic circulation in anemia, mediastinal masses due to extra medullary haemopoiesis and skeletal changes of marrow hyper activity.
- X rays of spine and extremities too show changes of marrow hyper activity in cases like thalassaemia.

Appendicular skeletal changes will be more prominent in children when compared to adults.

- Generalized osteopenia, bone within bone appearance, bone infarctions, osteomyelitis, aseptic dactylitis and splenic calcifications due to infarctions will be seen in Sickel cell anaemia

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