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 parenchymal 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:

<table>
<thead>
<tr>
<th>Category 1</th>
<th>Jaundice with high likelihood of benign biliary obstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Common bile duct stones</td>
</tr>
<tr>
<td></td>
<td>Pancreatitis, Recurrent cholangitis</td>
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<td></td>
<td>Mirrizi's syndrome, Sclerosing cholangitis</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Category 2</th>
<th>Jaundice with high likelihood of malignant biliary obstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carcinoma of the head of pancreas, Malignant porta hepatitis lymphodesnodes, Peri ampullary Carcinoma, Cholangiocarcinoma</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category 3</th>
<th>Cholestatic jaundice due to Hepatocellular disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Viral hepatitis, Drugs, alcoholic hepatitis, cirrhosis, Wilsons disease, Gilbet syndrome, Budd chiaris syndrom</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Category 4</th>
<th>Jaundice of newborn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biliary atresia, Choledochal cyst, neonatal hepatitis Metabolic liver disease</td>
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<thead>
<tr>
<th>Category 5</th>
<th>Haemolytic Jaundice</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Thalasaemia, Sickel cell disease</td>
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</table>
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
10. Biliary stenting

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

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**

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum bilirubin</td>
<td></td>
</tr>
<tr>
<td>Total               high</td>
<td></td>
</tr>
<tr>
<td>Direct               high</td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td>SGPT (AST)   normal or slightly high</td>
<td></td>
</tr>
<tr>
<td>SGOT (ALT)   normal or slightly high</td>
<td></td>
</tr>
<tr>
<td>S. alkaline phosphatase (liver) normal or slightly high</td>
<td></td>
</tr>
<tr>
<td>high</td>
<td></td>
</tr>
<tr>
<td>Prothrombin time</td>
<td>normal</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>normal</td>
</tr>
<tr>
<td>Urine</td>
<td></td>
</tr>
<tr>
<td>Conjugated bilirubin</td>
<td>present</td>
</tr>
<tr>
<td>Urobilinogen</td>
<td>absent</td>
</tr>
</tbody>
</table>

**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 previous 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 assess the distal CBD when it is widely available...**  
*Grade (Z)*
• ERCPs 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 scleroring cholangitis Grade (Y)

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

D. Percutaneous transhepatic Cholangiography (PTC) is recommeded 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 gastrointestinal 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.).

**Biochemistry**

<table>
<thead>
<tr>
<th>Test</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum bilirubin</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>very high</td>
</tr>
<tr>
<td>Direct</td>
<td>very high</td>
</tr>
<tr>
<td>Indirect</td>
<td>high</td>
</tr>
<tr>
<td>SGPT (AST) /SGOT (ALT)</td>
<td>high</td>
</tr>
<tr>
<td>Serum alkaline phosphatase (liver)</td>
<td>very high</td>
</tr>
<tr>
<td>Prothrombin time</td>
<td>prolonged</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>low</td>
</tr>
<tr>
<td>Urine</td>
<td></td>
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</table>

**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)**

- MRI is recommended in patients with contraindications to CT.
- MRI is superior to CT in evaluating the biliary tree and detecting small lesions.
• 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 prothrombin 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 intraabdominal 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

<table>
<thead>
<tr>
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<td>present</td>
<td></td>
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</tbody>
</table>

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 paraenchymal 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 e.g. 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 gastrointestinal 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 an 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.

**Biochemistry**

**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)

Preffered 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 parenchmal 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 persent.

**Bio chemistry**

<table>
<thead>
<tr>
<th>Serum bilirubin</th>
<th>Total</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>normal slightly high</td>
</tr>
</tbody>
</table>
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)

- Dominal 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 anaemia, 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 thalasaemia.

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 sickle cell anaemia.

Reference

13. NIH state-of-the-science statement on endoscopic retrograde cholangiopancreatography (ERCP) for diagnosis and therapy. NIH