

Biliary system anatomy, physiology & investigations

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ANATOMY

GALL BLADDER

PEAR SHAPED SAC

Located in fossa on inferior surface of liver

Between right & quadrate lobes

Relations

Anteriorly inferior surface of liver &
anterior abdominal wall

Posteriorly transverse colon & 1st , 2nd parts
of duodenum

- Dimensions
- 7-10 cm long
- 30 - 50 ml capacity
- When obstructed - upto 300 ml
- 4 anatomic parts
- Fundus
- Corpus
- Neck
- infundibulum

- **Fundus** -round ,blind end 1-2 cm beyond liver margin,contains more of smooth muscle
- **Body**-main storage area,more of elastic tissue
- **Neck**- funnel shaped area connecting body to duct
- **Infundibulum**- between body & neck - dilated part is called hartmann pouch

- Layers
- Mucosa- lined by columnar epithelium
- crypts of Luschka
- Lamina propria
- Muscularis propria- circular, longitudinal & oblique fibres arranged criss crossly
- Subserosa- contains connective tissue, nerves, lymphatics, vessels
- Serosa- covered all over gb except on embedded area
- Submucosa & muscularis mucosa absent

- Small ducts (**ducts of luschka**) may drain directly from liver to gallbladder
- If not recognised during cholecystectomy
Bile leak with accumulation of bile in abdomen occurs (**bilioma**)

- Blood supply - cystic artery
- CALOTS triangle
 - superiorly- inferior surface of liver
 - laterally- cystic duct
 - medially- common hepatic duct
- Contents - cystic artery & lymph node of lund

- Venous drainage-
- 1)veins may drain directly into quadrate lobe of liver
- 2)or may form pericholedochal plexus
- 3)finally enter hepatic veins
- 4)occasionally a vein may be found passing along with cystic artery into portal vein

Lymphatic drainage

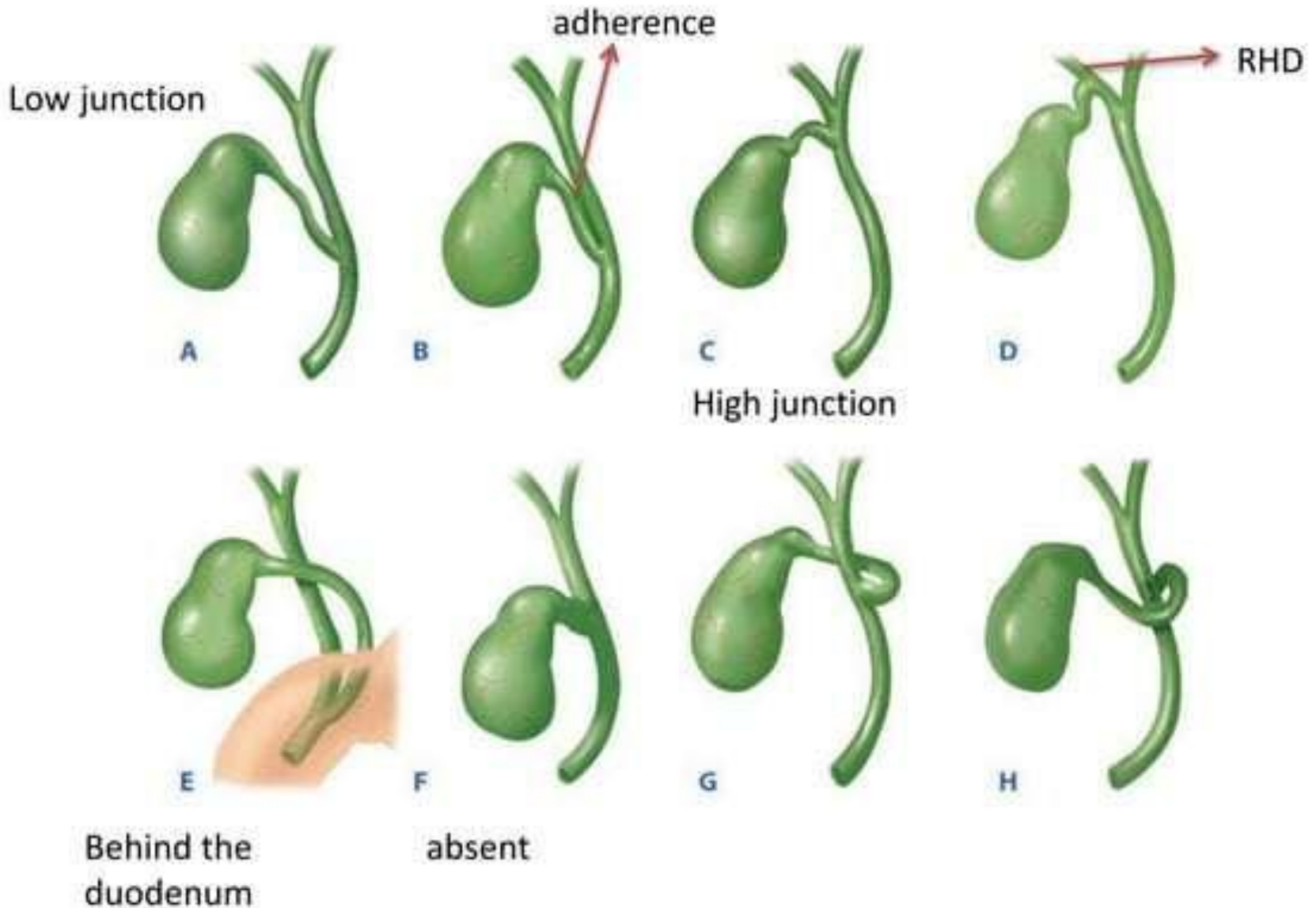
- Subserosal
- Submucosal
- Both of them drain into cystic lymphnode of lund
- Efferents from here go to celiac group of lymph nodes
- subserosal lymphatic vessels of the gall bladder also connect with the subcapsular lymph channels of the liver, (responsible for spread of gb cancer to liver)

- Shoulder tip pain
- In acute cholecystitis pain is referred to skin over lying acromion
- Phrenic nerve arises from c3,4,5 of spinal cord, similar to supraclavicular nerve c3,4
- Irritation of diaphragmatic peritoneum supplied by phrenic nerve accounts for pain referred to distribution of supraclavicular nerve

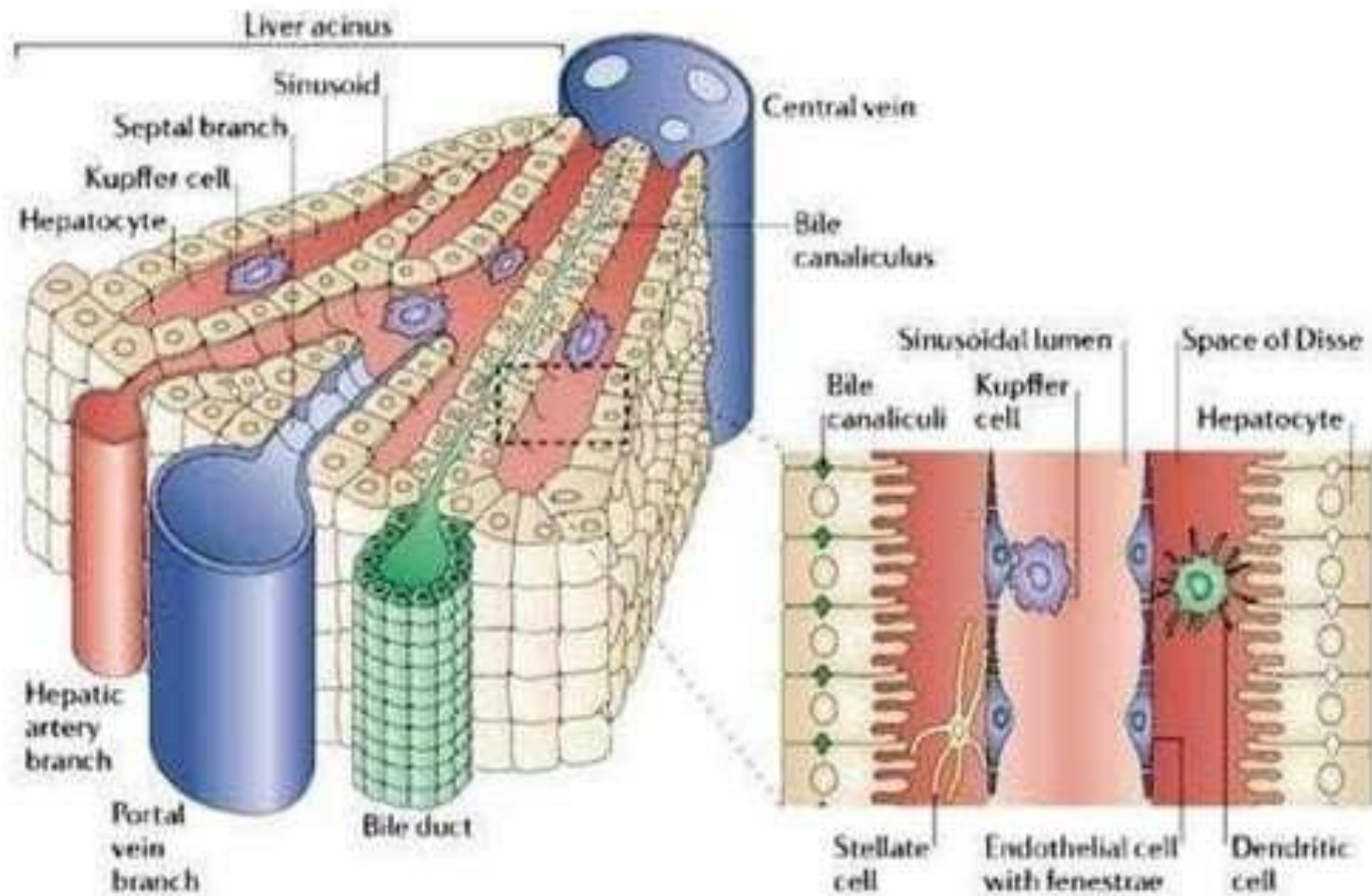
Cystic duct

- About 3cm in length, variable
- Diameter is 1-3 mm
- Mucosa arranged in spiral folds- *valves of heister*- no valvular function
- Its wall surrounded by sphincteric structure - *sphincter of lutkens*
- Joins common hepatic duct at variable positions
- 80 % - supraduodenal
- 20% - retroduodenal

Variations in cystic duct



Hepatic ducts



- Right & left hepatic ducts forms confluence outside liver
- Dissections in this area, it is necessary to push liver substance away to display confluence completely
- Common hepatic duct arises from confluence

Common hepatic duct

- Formed by right & left hepatic ducts
- 1- 4 cm length
- Diameter 4mm
- Lies in front of portal vein & right to hepatic artery

Common bile duct

- Formed by union of cystic duct & CHD
- 7 - 11 cm length
- 5- 10 mm diameter
- 4 parts
- **Supra duodenal part**- runs in free edge of hepatoduodenal ligament
- **Retroduodenal part**- behind 1st part of duodenum

- **Infraduodenal part** -runs behind head of pancreas, in a groove, traverses through it
- **Intraduodenal part**- runs obliquely 1-2 cm within wall of duodenum
- opens into papilla of ampulla of Vater, which is **10 cm distal to pylorus**
- This papilla is present posteromedially at junction of upper 2/3 & lower 1/3 of 2nd part of duodenum

- 70 %- CBD & Pancreatic duct ,unite outside the duodenal wall
- 20 % - ducts join within wall of duodenum
- 10 % - opens through 2 seperate openings

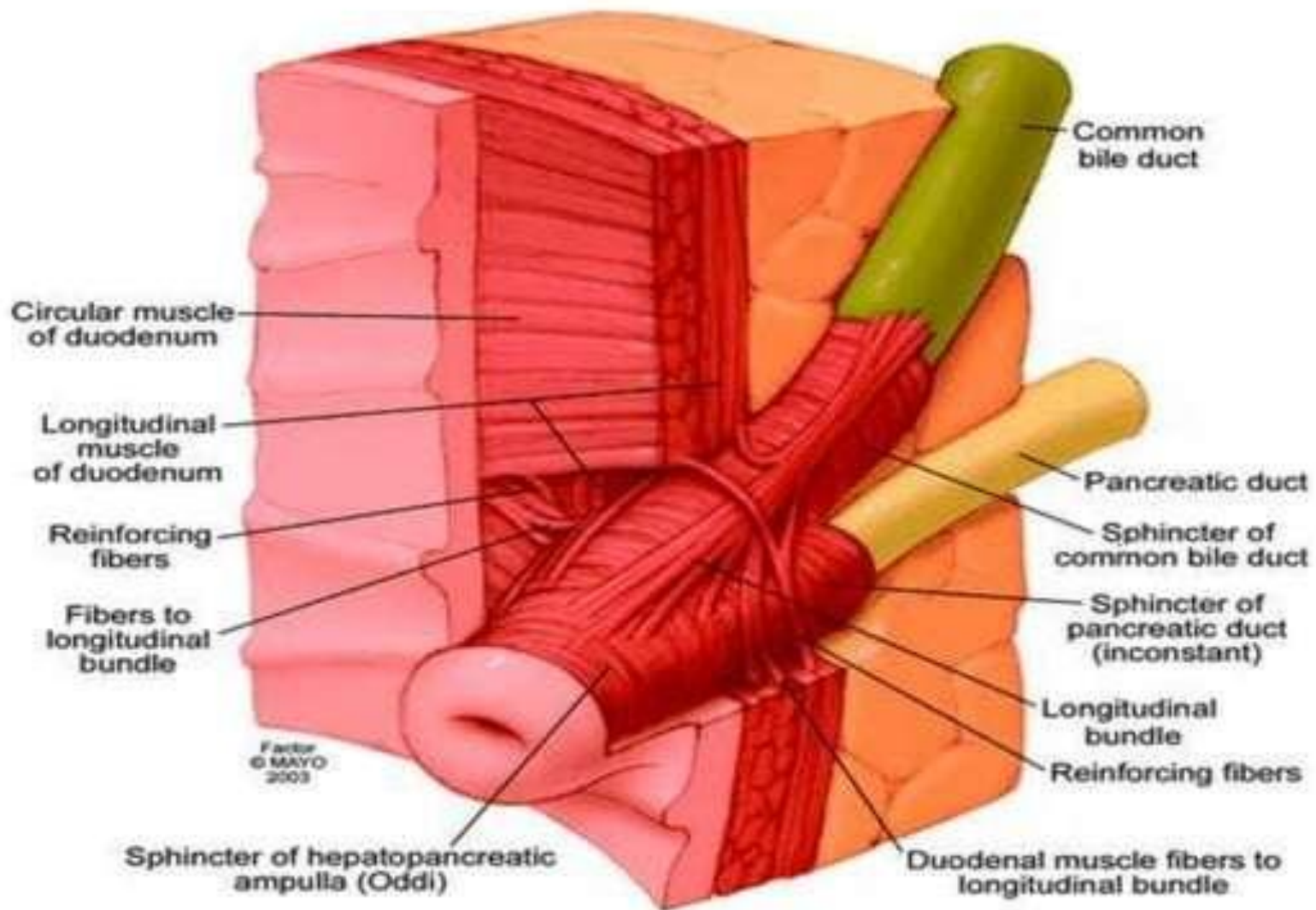
- Extrahepatic bile ducts- lined by columnar mucosa with numerous mucosal glands in cbd
- Fibroareolar tissue containing smooth muscle cells surrounds mucosa
- No muscle layer in CBD

- Blood supply- from **gastroduodenal & right hepatic arteries** with major trunks medial (3'oclock) & lateral (9'o clock) positions
- hence minimal dissection should be done around CBD at sides to prevent stricture formaton
- A **retroportal artery** arise from celiac axis/SMA, runs behind portal vein to reach posterior aspect of CBD
- Hence a thin fibrous layer should be left intact posterior to pancreatic head & portal vein ,during mobilisation of duodenum

- Venous plexus on wall of supraduodenal CBD
- Helps to recognise cbd at operation as it doesnt extend onto cystic duct

- Ampulla of Vater
- Union of CBD & pancreatic duct forms ampulla
- Point of junction of common bile & pancreatic ducts with duodenal papilla is also variable
- Sometimes open independently
- Normal papilla permits a dilator of 3 mm

- Sphincters
- Differ from duodenal musculature
- Circular smooth muscle around CBD & pancreatic duct- sphincter of oddi
- Sphincter of CBD- most constant ,best developed ,present just before entry into duodenal wall
- Pancreatic sphincter
- Ampullary sphincter



Variation in arterial supply to GB

CA from RHA 90%



A



B

CA from replaced RHA

2 CA from RHA,CHA



C



D

2 CA from RHA ,LHA

Anterior to CHD



E



F

2 CA from RHA

physiology

- Liver produces bile continuously & excretes into bile canaliculi
- Canaliculi coalesces into bile ducts
- Bile ducts → portal triad → hepatic lobule → hepatic ducts → common hepatic duct → common bile duct → duodenum

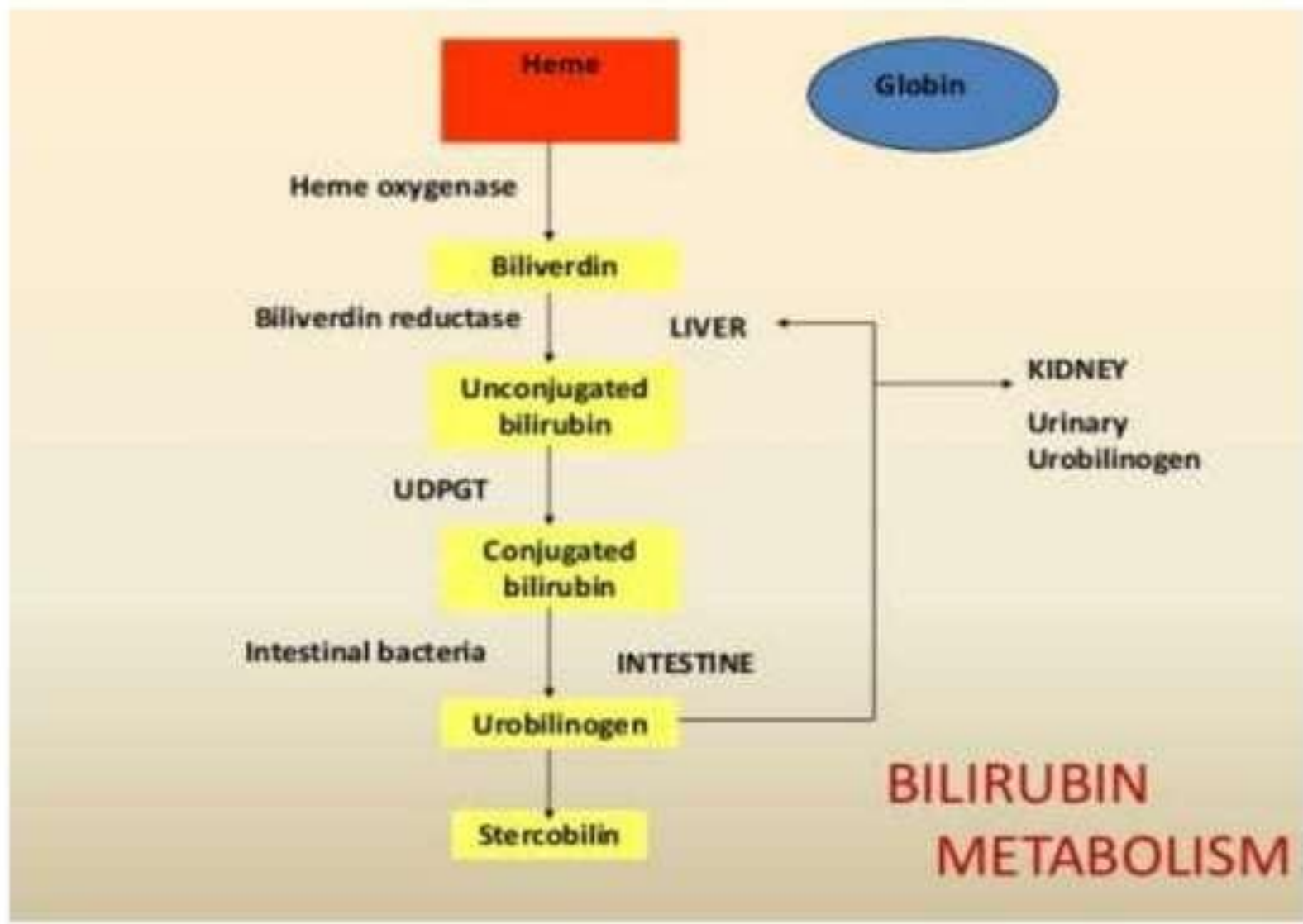
- 500 - 1000 ml /day bile - normal adult
- Secretion regulated by various factors
- Neurogenic
- Humoral
- Chemical
- Neurogenic -
- Vagal stimulation - increased secretion
- Sympathetic stimulation- decreased flow

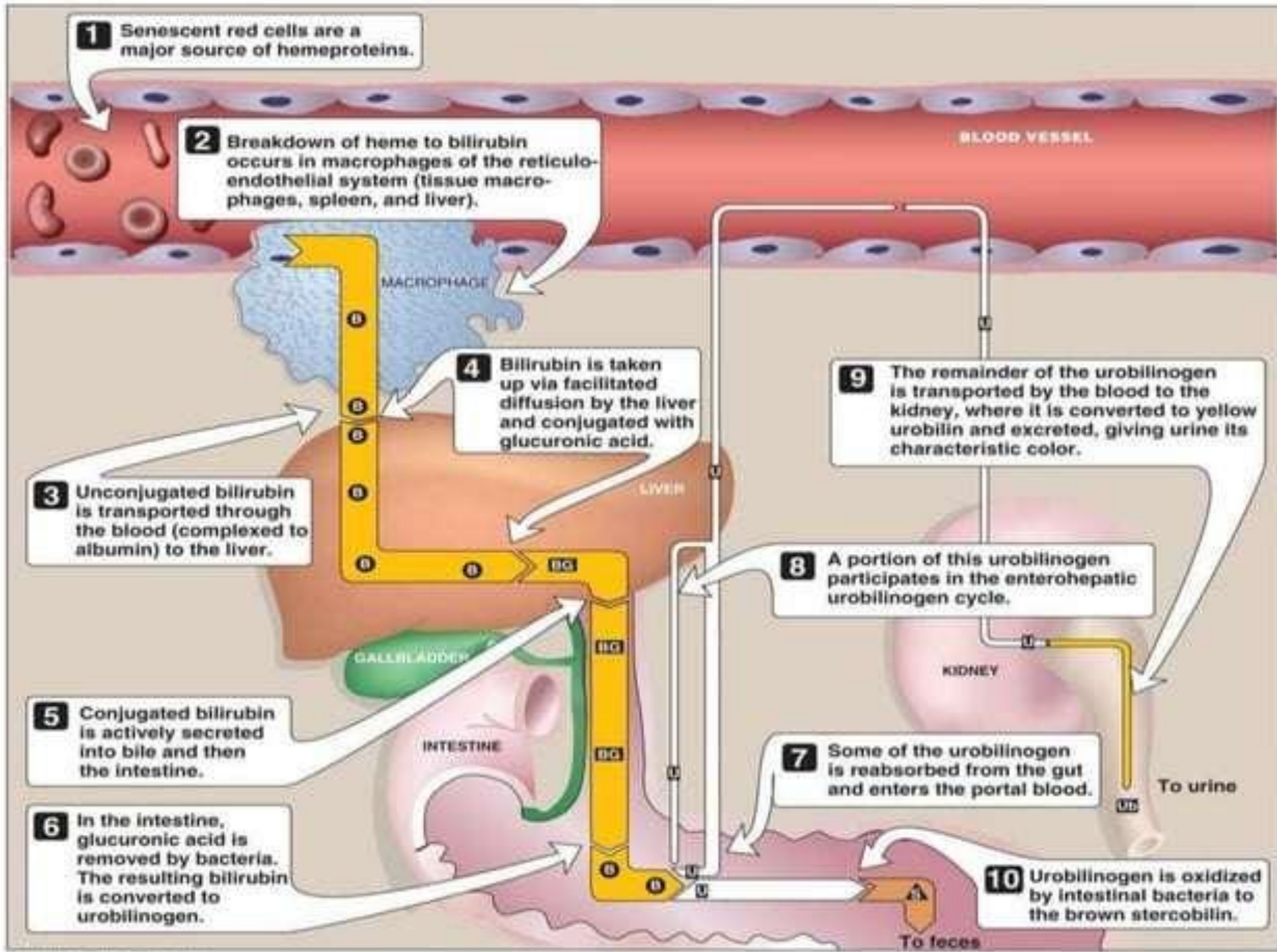
- Chemical-
- Hcl,protein ,fatty acid in duodenum
- Increased secretin production
- Increased production & secretion of bile
- Humoral-
- Cholecystokinin- gall bladder contraction wit sphincter relaxation

- Vasoactive intestinal peptide - inhibits gb contraction
- Somatostatin - inhibits gb contraction

Composition of bile

- Water
- Electrolytes
- Bile salts
- Bile pigments
- Proteins
- Lipids
- Na^+ , K^+ , Cl^- , Ca^{++} - same concentration as that of plasma or Ecf
- Ph- slightly alkaline





1 Senescent red cells are a major source of heme proteins.

2 Breakdown of heme to bilirubin occurs in macrophages of the reticulo-endothelial system (tissue macrophages, spleen, and liver).

3 Unconjugated bilirubin is transported through the blood (complexed to albumin) to the liver.

4 Bilirubin is taken up via facilitated diffusion by the liver and conjugated with glucuronic acid.

5 Conjugated bilirubin is actively secreted into bile and then the intestine.

6 In the intestine, glucuronic acid is removed by bacteria. The resulting bilirubin is converted to urobilinogen.

9 The remainder of the urobilinogen is transported by the blood to the kidney, where it is converted to yellow urobilin and excreted, giving urine its characteristic color.

8 A portion of this urobilinogen participates in the enterohepatic urobilinogen cycle.

7 Some of the urobilinogen is reabsorbed from the gut and enters the portal blood.

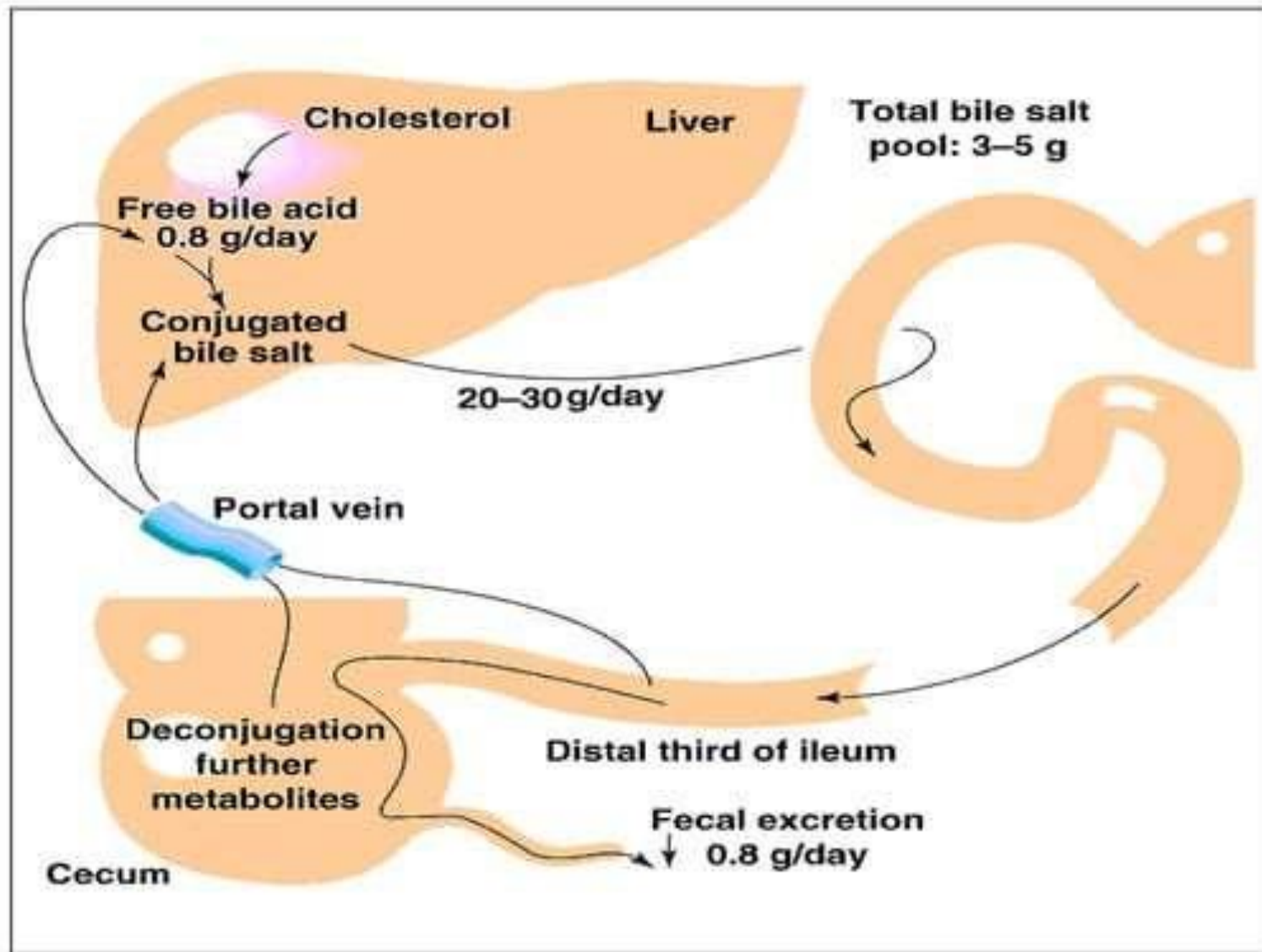
10 Urobilinogen is oxidized by intestinal bacteria to the brown stercobilin.

Enterohepatic circulation

- **Primary bile salts** - synthesized in liver from cholesterol
- 500mg/day
- Cholic & chenodeoxycholic acid
- Conjugated with taurine , glycine
- Balanced with sodium
- These salts are excreted in bile , to help in fat absorption by forming micelle

- 80% of these conjugated bile acids are absorbed in terminal ileum-by active transport
- Remaining 20% dehydroxylated by gut bacteria
- Forms deoxycholate & lithocholic acid-
secondary bile salts
- Some of this again absorbed in colon-by passive transport
- So 95 % of bile acid pool gets reabsorbed & returned to liver through portal circulation

- Only 5 % excreted through liver
- Defect in any step of enterohepatic circulation causes steatorrhea



Defects in enterohepatic circulation

Process	Pathophysiological defect	Disease
synthesis	Decreased hepatic function	cirrhosis
Biliary secretion	Altered canalicular function	Primary biliary cirrhosis
Maintenance of conjugated bile acids	Bacterial overgrowth	Jejunal diverticulosis
reabsorption	Abnormal ileal function	Crohns disease, ileal resection

	Bile acid diarrhea	Fatty acid diarrhea
Ileal resection	limited	extensive
Compensation by hepatic synthesis	yes	no
Bile acid pool	normal	reduced
Intraduodenal bile acid	normal	reduced
steatorrhea	None/mild	> 20gm/day
Response to cholestyramine	yes	no
Response to fatty acid	No	yes

INVESTIGATIONS

- BLOOD INVESTIGATIONS
- Suspected disease of gall bladder or extrahepatic biliary tree- CBP,LFT usually evaluated
- Elevated WBC- cholecystitis
- Elevated direct/conjugated bilirubin with elevated ALP –cholestasis
- Elevated wbc ,bilirubin,ALP,aminotransferases-
CHOLANGITIS

X RAY

- 10 % of gb stones are radio opaque
- Centre of stone may contain radioluscent gas in triradiate/biradiate fissure- mercedes benz sign/ seagull sign

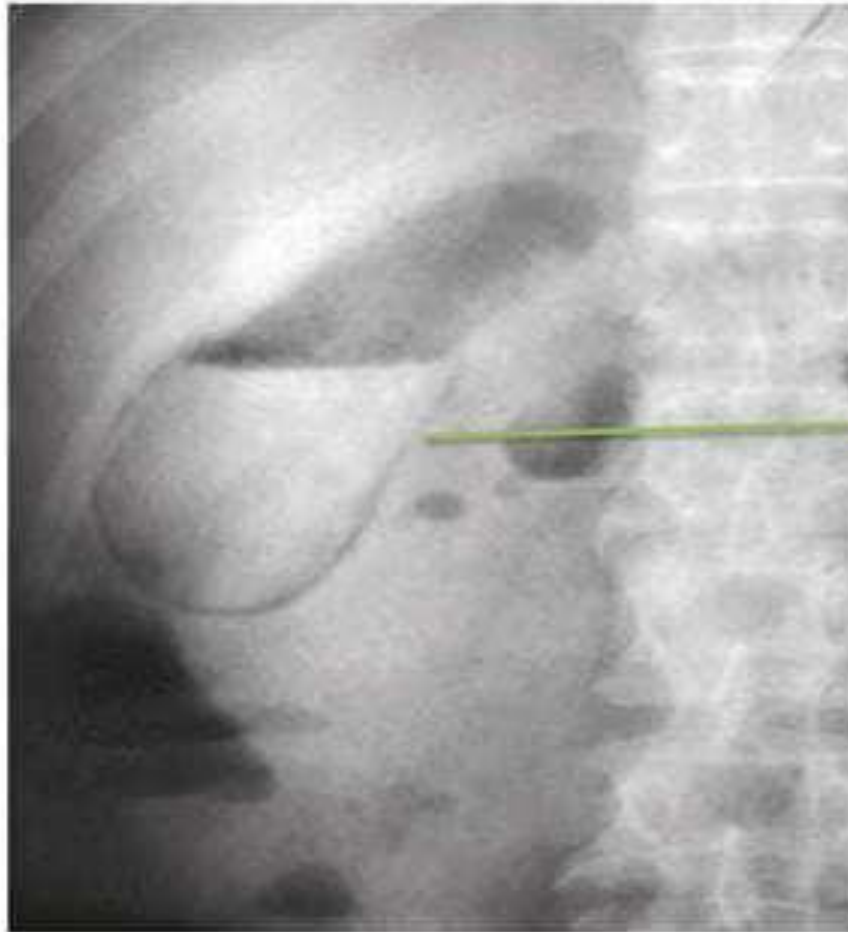


Porcelain gall bladder



calcifications

Emphysematous cholecystitis



Gas in gb

ultrasonography

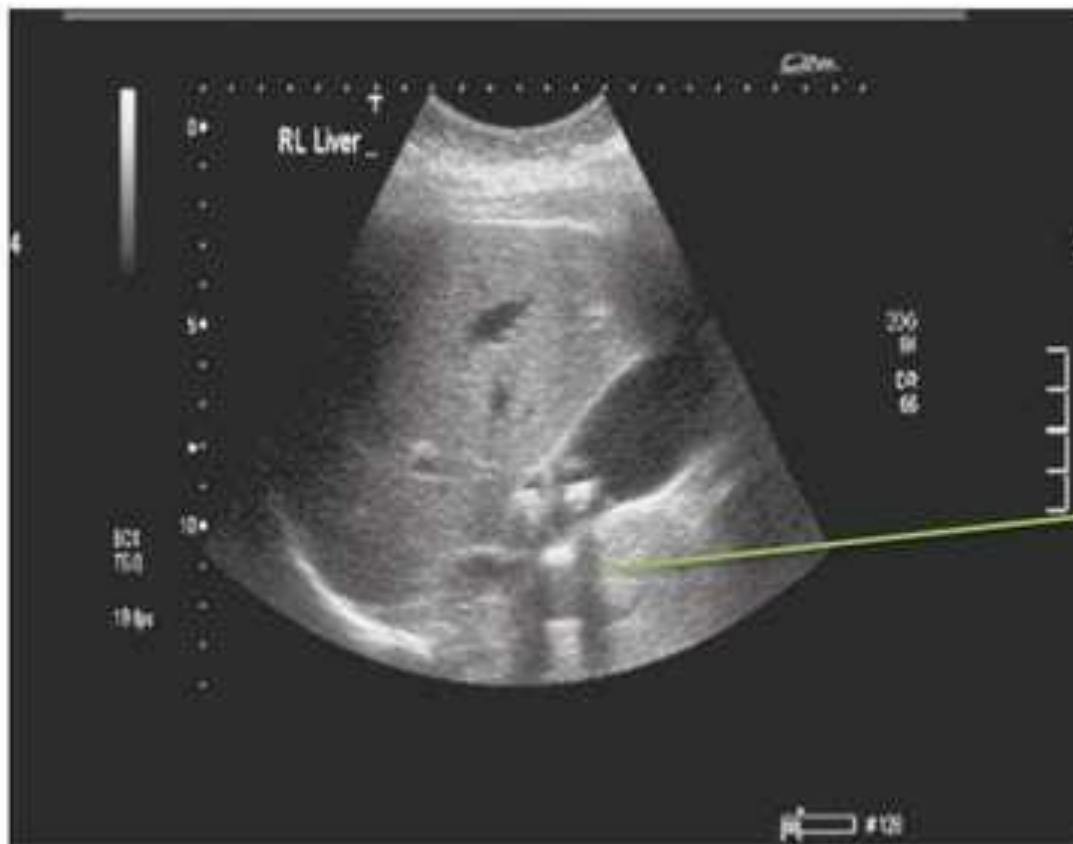
- Initial investigation of choice in suspected extrahepatic biliary disease
- Advantages
- Non invasive
- Painless
- No radiation
- Adjacent organs can be examined at same time

- Accurate identification of gall stones (sensitivity > 95 %)
- Not limited by jaundice or pregnancy
- Allows assessment of GB volume, contractility, inflammatory changes around GB
- Detects very small stones
- Accurate identification of dilated bile ducts
- Guidance for fine needle biopsy

- Other uses
- Detects tumour invasion
- Portal vein flow-

- Disadvantages
- Obese, ascites, distention – difficult to examine
- Partial obstruction cases
- Poor visualisation of distal cbd especially retroduodenal part

GB stones



Post acoustic shadow

d/d calcified polyp – doesn't change with position

Endoscopic ultrasound

- Endoscope with ultrasound transducer at tip
- Visualises biliary tree from within stomach & duodenum
- Accurate to detect ampullary & periampullary tumours & their resectability
- Accurate to detect stones in cbd



Oral cholecystography

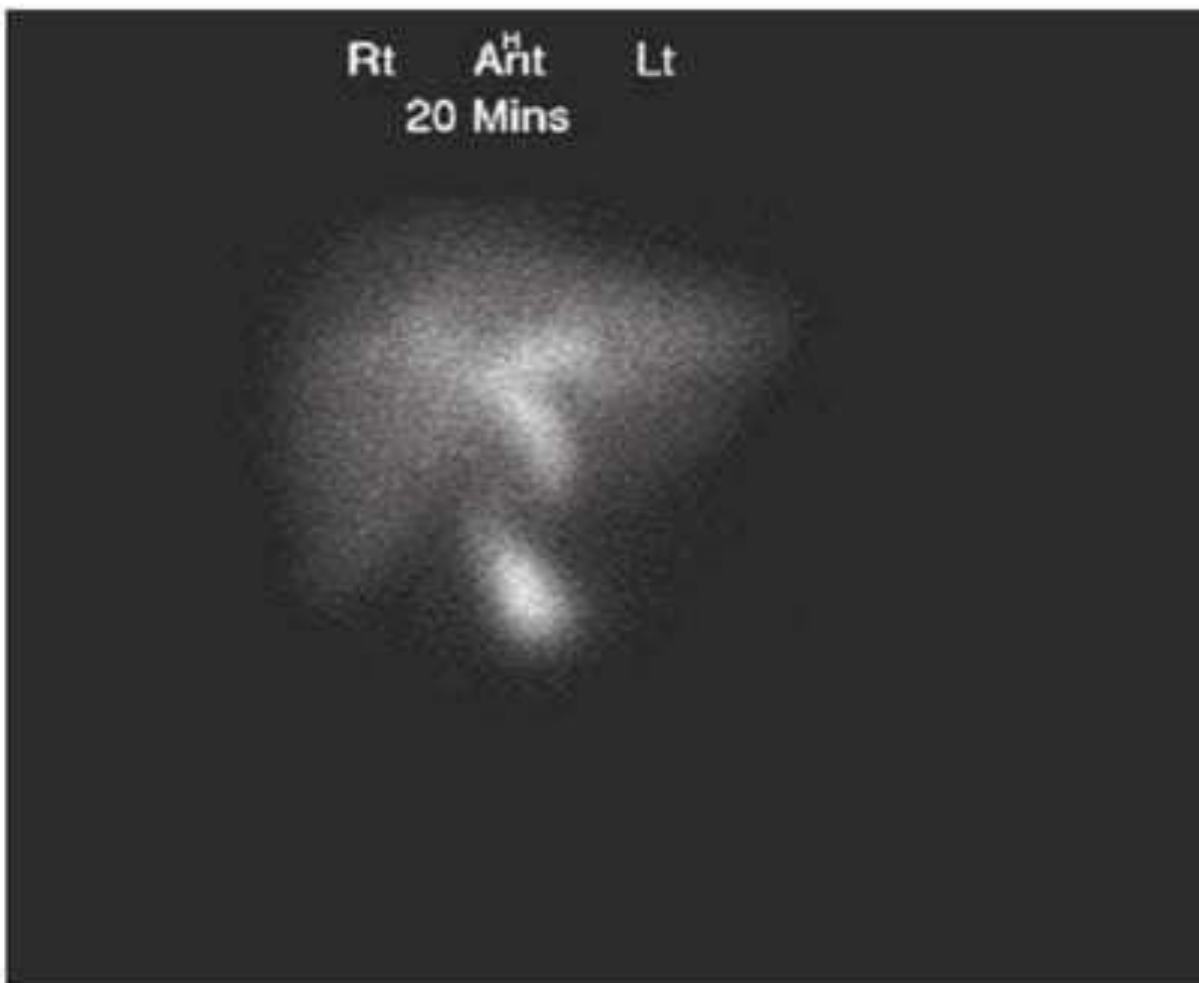
- Once considered the diagnostic procedure of choice for gallstones
- replaced by ultrasonography
- involves oral administration of a radiopaque compound that is absorbed, excreted by the liver, and passed into the gallbladder
- Stones- filling defects in opacified gall bladder
- No value in malabsorption, vomiting, obstructive jaundice, hepatic failure

- Pt advised to take fat free diet for 3 days
- Previous night 6 tabs of iopanoic acid given orally
- On day of ocg xray erect abdomen is taken to visualise gall bladder
- Latter fatty meal given & one more x ray taken to see change in size
- Smooth filling defect- non opaque stone
- Iv cholangiogram- meglumine used

Radioisotope scan

- a noninvasive evaluation of the liver, gallbladder, bile ducts, and duodenum
- gives both anatomic and functional information
- ^{99m}Tc derivatives of dimethyl iminodiacetic acid (HIDA) are injected intravenously
- cleared by the Kupffer cells in the liver, and excreted in the bile.
- Uptake by the liver is detected within 10 minutes,
- the gallbladder, the bile ducts, and the duodenum are visualized within 60 minutes in fasting subjects.

Rt A^{H} rt Lt
20 Mins



- Non visualisation of GB – acute cholecystitis
- Filling of the gallbladder, CBD with delayed or absent filling of the duodenum-obstruction at the ampulla
- Post operative biliary leaks can be identified & quantified
- GB visualisation delayed or reduced with contracted GB- chronic cholecystitis

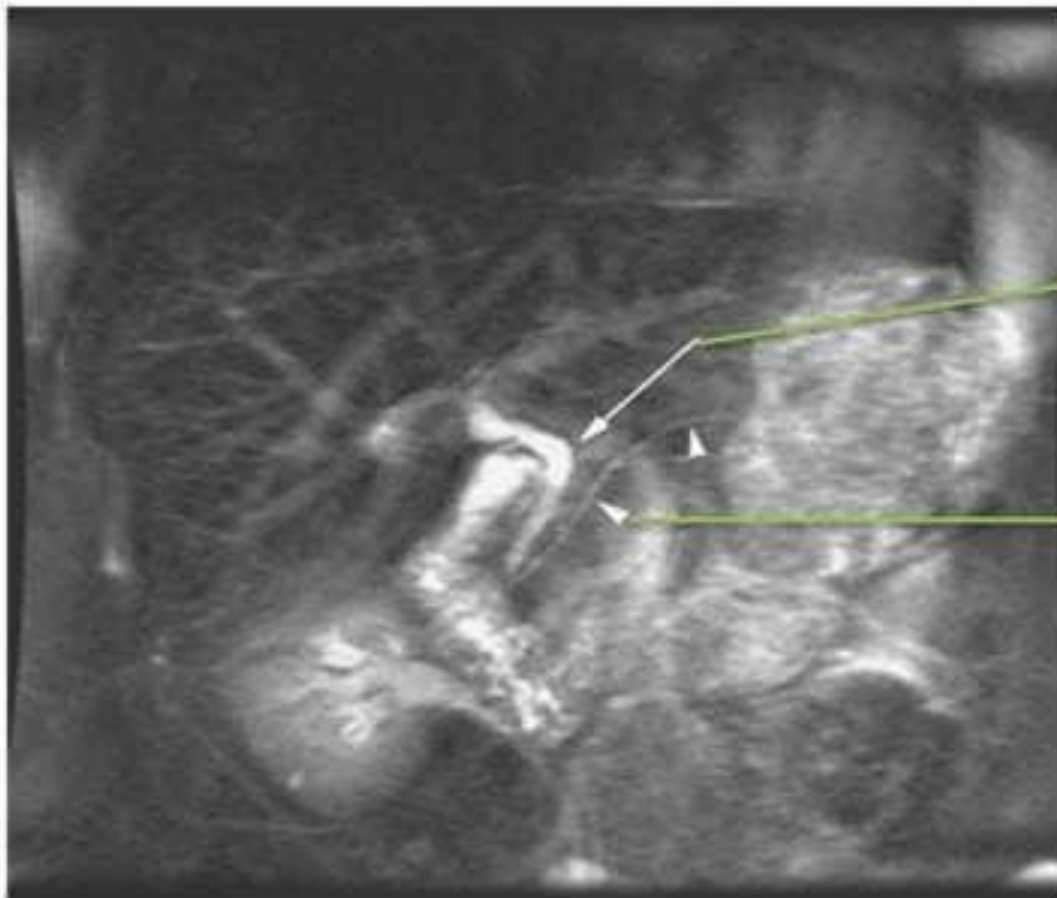
- Contraindicated in
- Pregnancy
- S.bilurubin > 6 – 12m g/dl

Computerised tomography

- to define the course and status of the extrahepatic biliary tree and adjacent structures
- test of choice in suspected malignancy of the gallbladder, the extrahepatic biliary system, the head of the pancreas
- Spiral ct- detects vascular involvement in periampullary ca
- To detect metastasis & lymph nodes

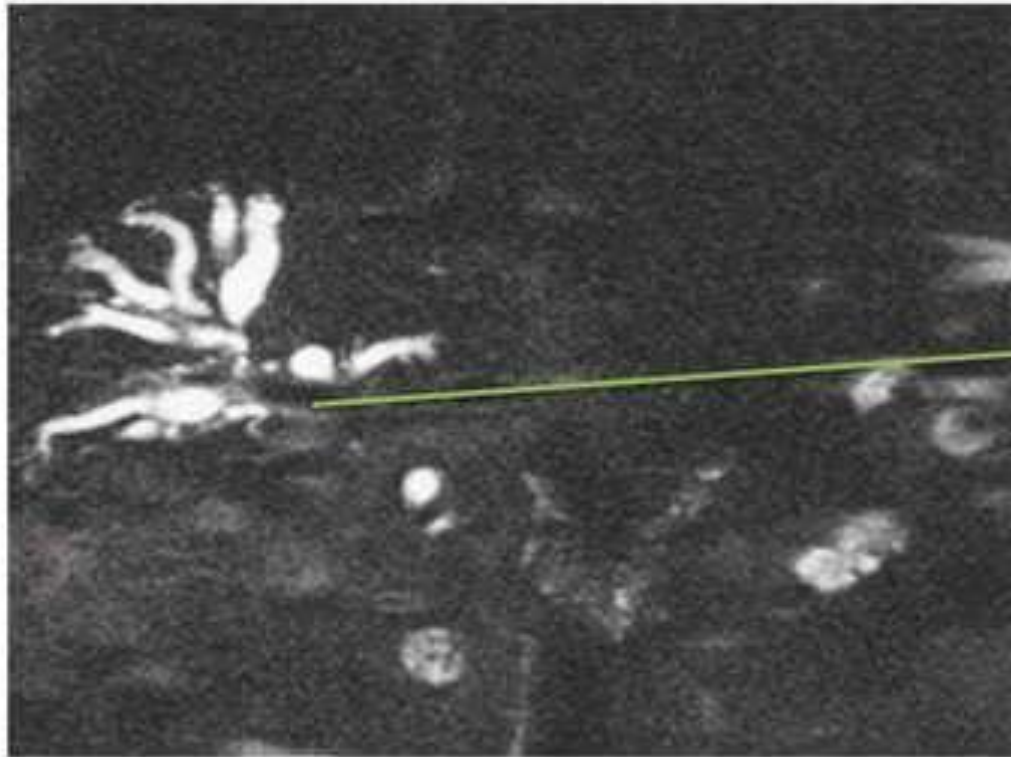
MRCP

- Magnetic resonance cholangiopancreatography
- Provides anatomic details of liver, gall bladder, pancreas
- Uses heavily weighted T2 images/ pulse sequences for anatomy of biliary tree & pancreatic duct
- Non invasive test for biliary tree & pancreatic duct pathology



Extrahepatic
bile ducts

Pancreatic duct



Hilar
obstruction

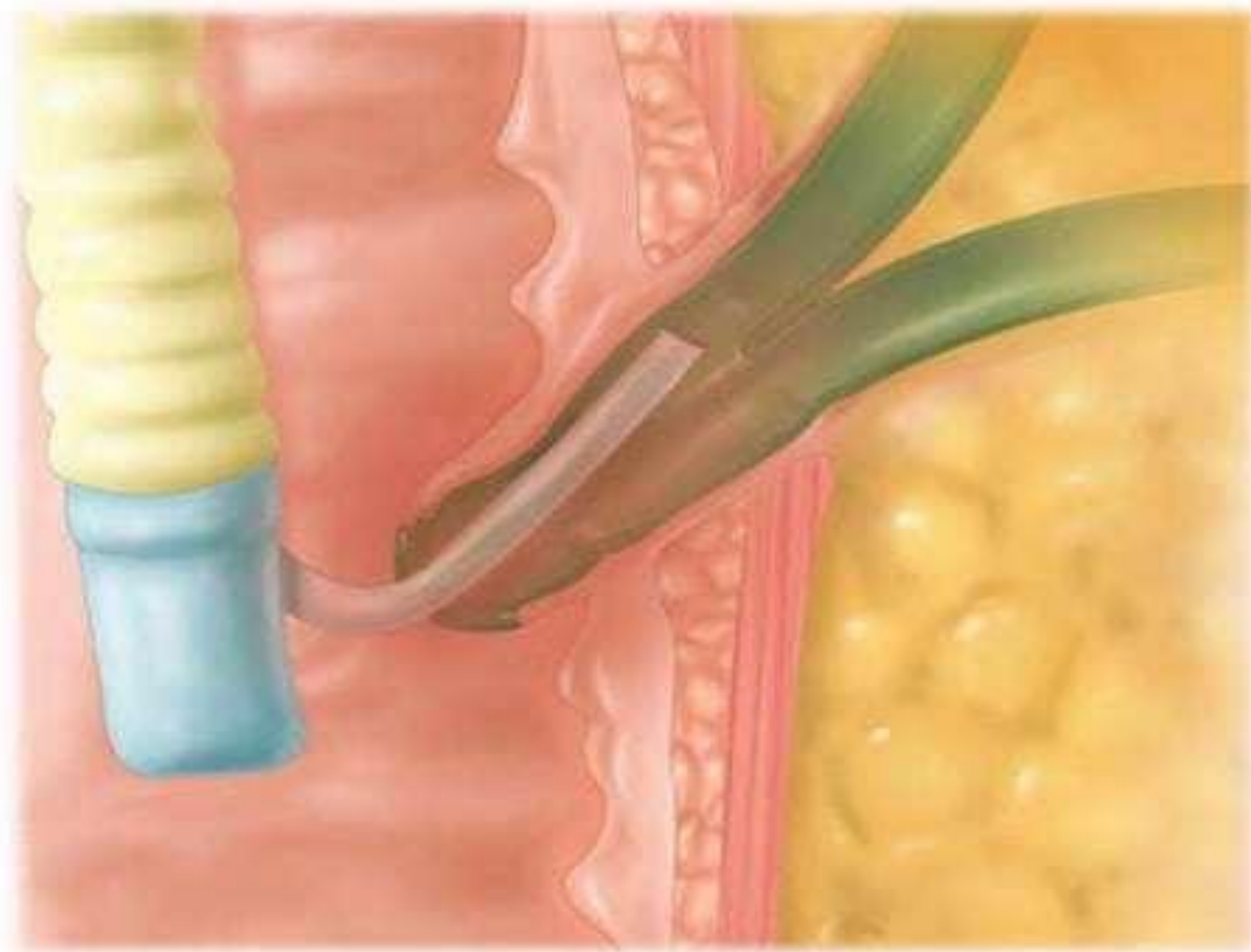
ERCP

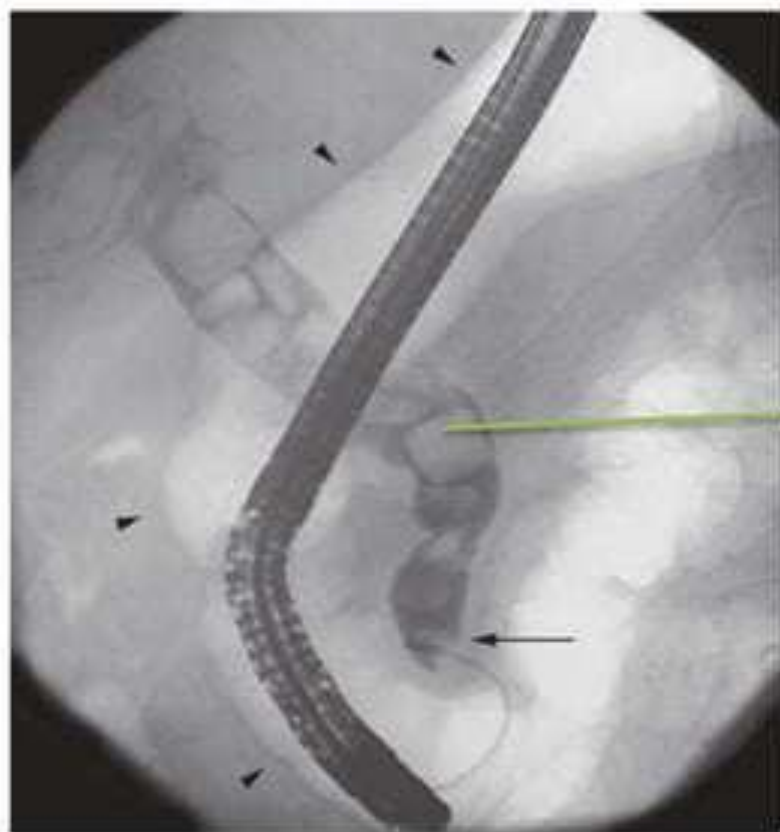
- Using a side view endoscope,cbd cannulated,& cholangiogram is done using fluoroscopy
- requires intravenous sedation
- Advantages
- direct visualization of the ampullary region
- access to the distal common bile duct,
- possibility of therapeutic intervention.

- Bile or pancreatic cytology can be taken
- For endoscopic sphincterotomy & stone removal

- Indications
- stones in the common bile duct, associated with obstructive jaundice, cholangitis, or gallstone pancreatitis, ERC is the diagnostic and often therapeutic procedure of choice
- Complications
- Cholangitis
- Pancreatitis in 5% cases
- Infected pancreatic pseudocyst

- Limitation – cannot be done in gastroduodenal obstruction
- Contraindicated
- Pregnancy
- Acute pancreatitis





Stones in cbd

Percutaneous Transhepatic Cholangiography

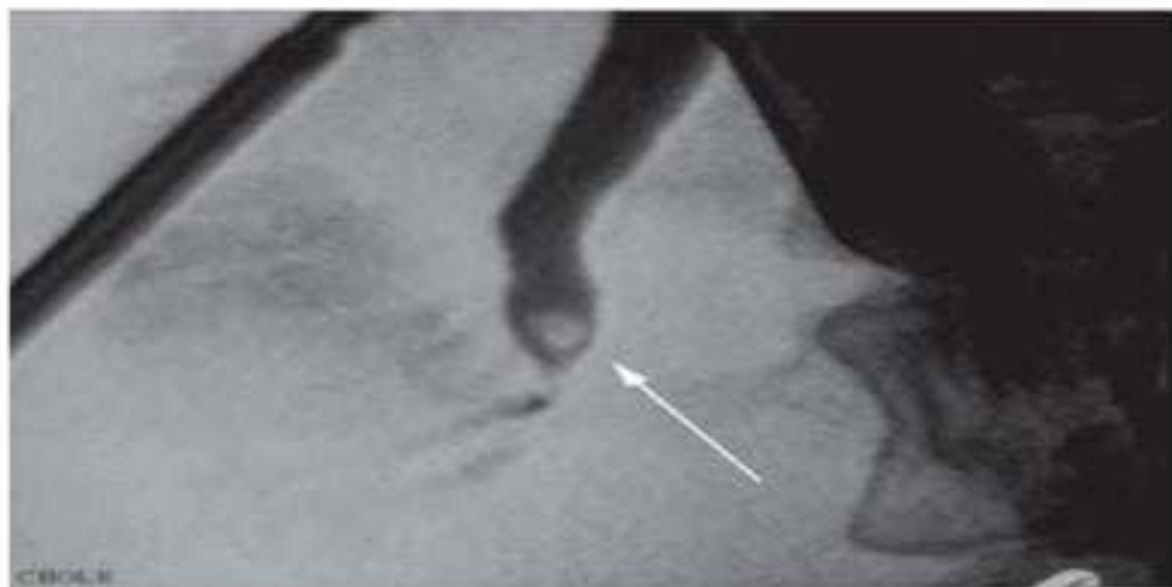
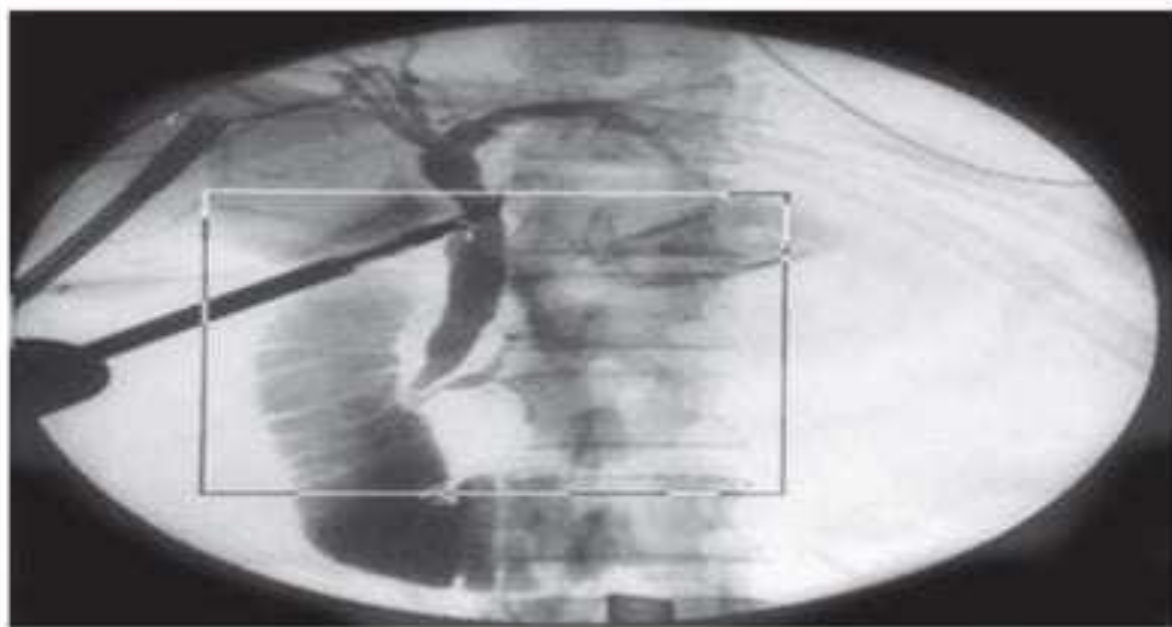
- To assess intrahepatic bile ducts percutaneously with a small needle under fluoroscopic guidance
- Once position is confirmed, guide wire is passed
- Then catheter is passed
- Then cholangiogram can be performed
- Therapeutic interventions like stenting, biliary drainage can be done

- useful in patients with bile duct strictures and tumors, as it defines the anatomy of the biliary tree proximal to the affected segment
- Extremely useful in dilated ducts
- Limitations
- Non dilated/sclerosed ducts

- Contraindications
- Pregnancy
- Coagulopathy
- Massive ascites
- Hepatic abscess
- Complications
- Bleeding
- Hemobilia
- Bile peritonitis, sepsis

Intraoperative Cholangiogram

- Bile ducts are visualized under fluoroscopy by injecting contrast through a catheter placed in the cystic duct
- Bile ducts size assessed & cbd stones are detected
- Can be selectively performed on patients with
 - abnormal liver function tests,
 - pancreatitis,
 - jaundice,
 - a large duct and small stones,
 - a dilated duct on preoperative ultrasonography



THANK U