EUROPEAN SOCIETY OF RADIOLOGY

eBook for Undergraduate Education in Radiology

CHAPTER: Bile Ducts

Preface

Undergraduate teaching of radiology in Europe is provided according to national schemes and may vary considerably from one academic institution to another. Sometimes, the field of radiology is considered as a "cross-cutting discipline" or taught within the context of other clinical disciplines, e.g., internal medicine or surgery.

This e-book has been created in order to serve medical students and academic teachers throughout Europe to understand and teach radiology as a whole coherent discipline, respectively. Its contents are based on the *Undergraduate Level of the ESR European Training Curriculum for Radiology* and summarize the so-called ***core elements*** that may be considered as the basics that every medical student should be familiar with. Although specific radiologic diagnostic skills for image interpretation cannot be acquired by all students and rather belong to the learning objectives of the *Postgraduate Levels of the ESR Training Curricula*, the present eBook also contains some ***further insights*** related to modern imaging in the form of examples of key pathologies, as seen by the different imaging modalities. These are intended to give the interested undergraduate student an understanding of modern radiology, reflecting its multidisciplinary character as an organ-based specialty.

We would like to extend our special thanks to the authors and members of the ESR Education Committee who have contributed to this eBook, to Carlo Catalano, Andrea Laghi and András Palkó who initiated this project, and to the ESR Office, in particular Bettina Leimberger and Danijel Lepir, for all their support in realising this project.

We hope that this e-book may fulfil its purpose as a useful tool for undergraduate academic radiology teaching.

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Chapter Outline

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eBook for Undergraduate Education in Radiology

Based on the ESR Curriculum for Undergraduate Radiological Education

Chapter: **Bile Ducts**

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Anatomy

The bile ducts are divided into the **intrahepatic and extrahepatic** portions.

Intrahepatic Ducts

- The intrahepatic ducts run in the **portal triads** with the portal veins and hepatic arteries.
- Bile canaliculi unite to form segmental bile ducts that drain each liver segment. Segmental ducts combine to form sectional ducts.

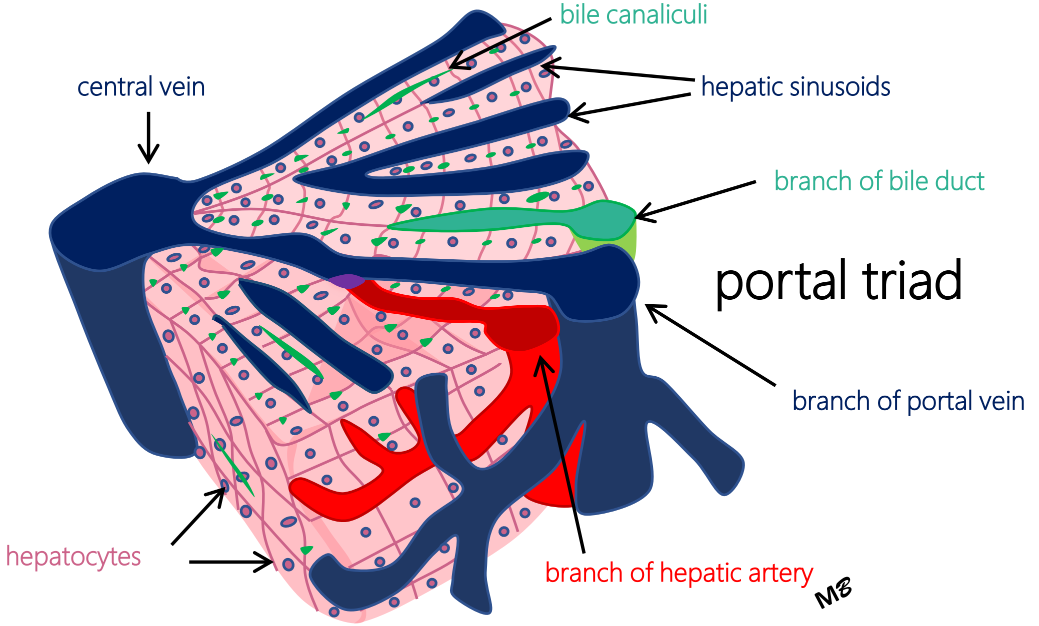


Figure 1. Schematic illustration of the portal triads.

Intrahepatic Ducts

- Left hepatic duct – divided into several branches responsible for draining the left liver (segments II-IV)
- Right hepatic duct – formed at the junction of the right posterior and anterior sectoral ducts
  - Right posterior sectoral duct - segments 6 and 7
  - Right anterior sectoral duct - segments 5 and 8

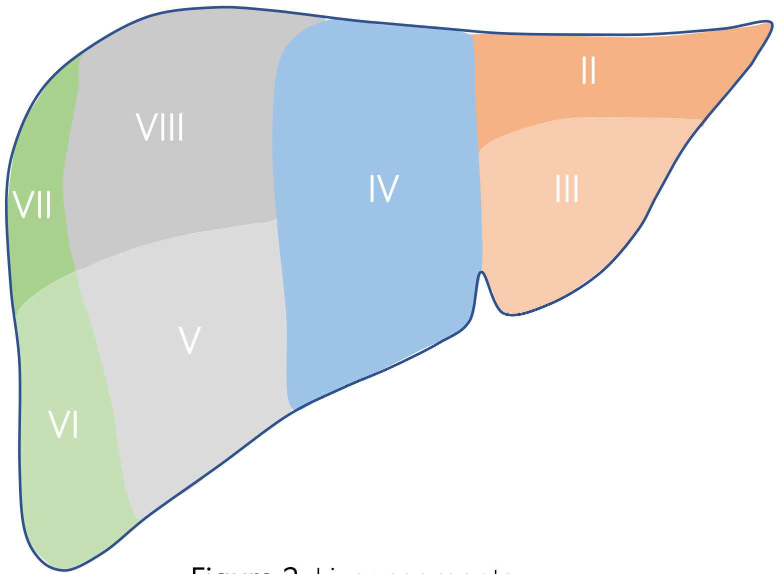


Figure 2. Liver segments.

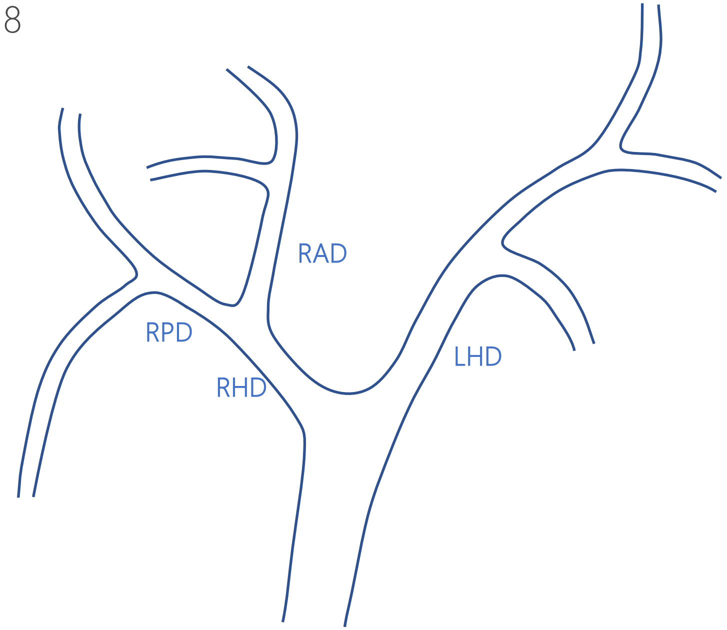


Figure 3. Biliary tree (branches). RHD, right hepatic duct; RPD, right posterior duct; RAD, right anterior duct; LHP, left hepatic duct.

Extrahepatic Ducts

- A portion of the central right and left ducts
- Common hepatic duct: results from the junction of the right and left bile ducts at the liver hilum at an extrahepatic level. It corresponds to the ductal portion above the cystic duct insertion.
- Common bile duct (CBD): the ductal segment below the cystic duct insertion.
- Inferiorly, the distal common duct enters the head of the pancreas and travels along the posterior-most aspect of the pancreatic head to drain with the main pancreatic duct into the major papilla.

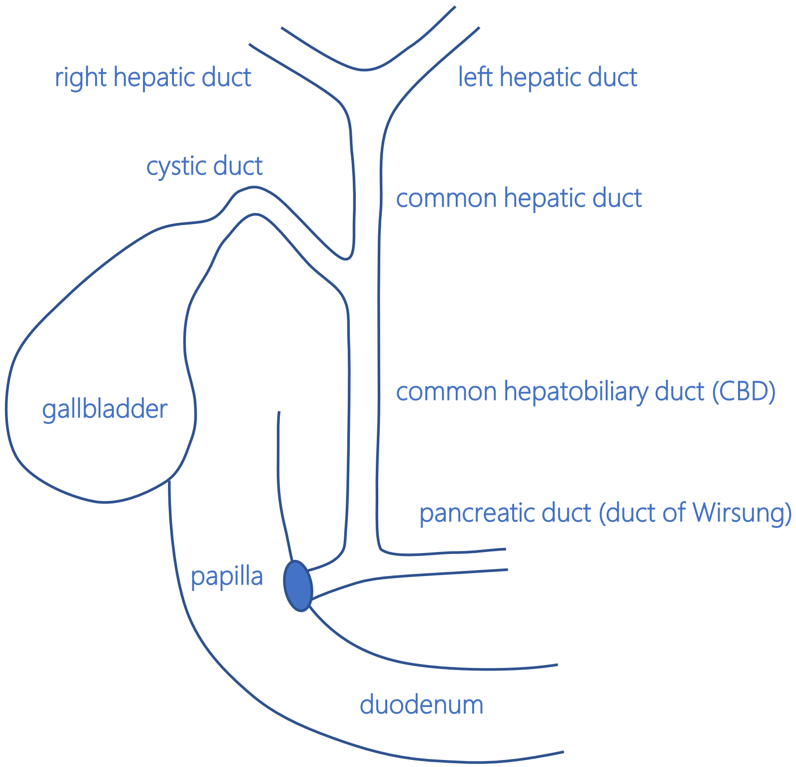
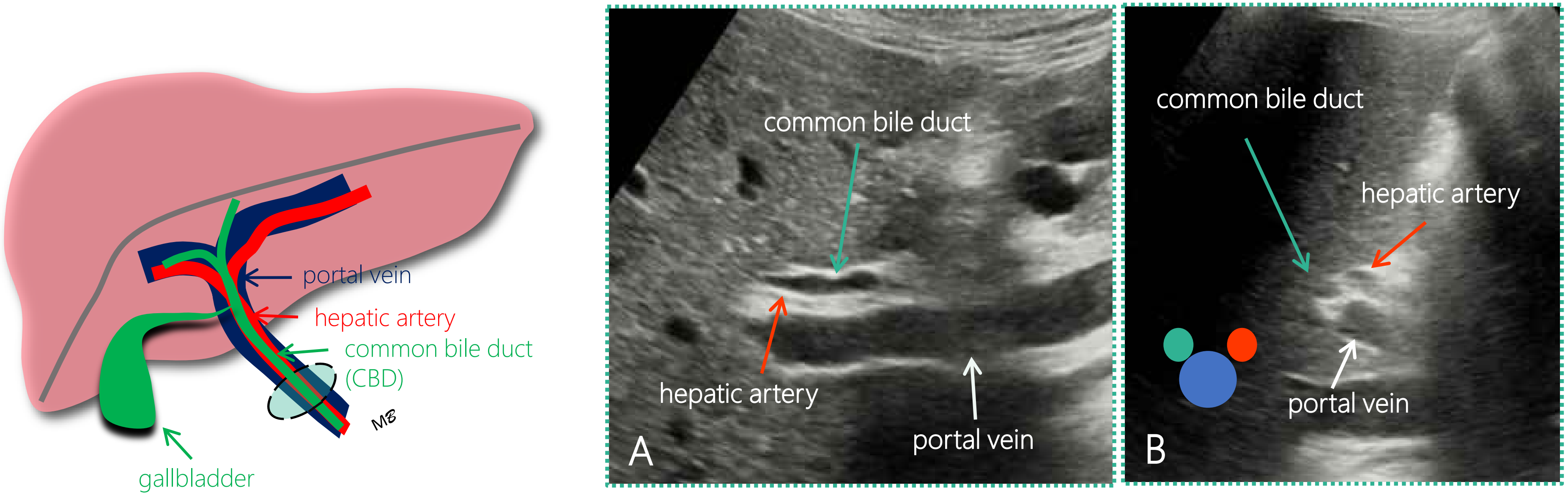


Figure 4. Anatomy of the biliary system



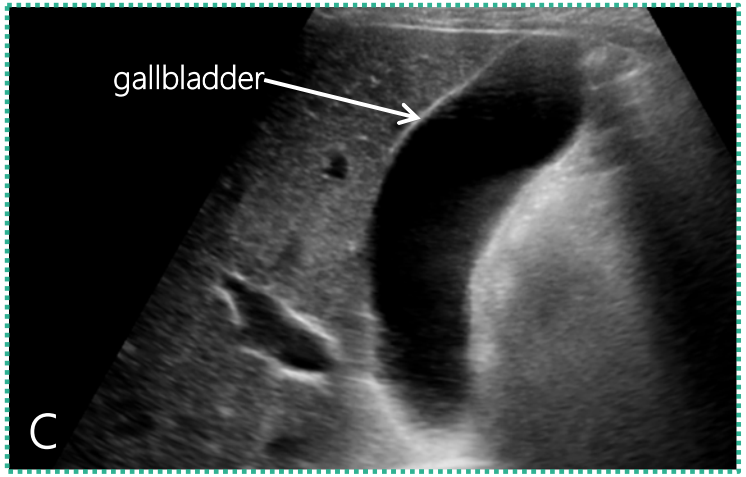


Figure 5. **Normal anatomy** of the extrahepatic ducts and gallbladder on ultrasound. Long axis (**A**) and short axis (**B**) of the portal triad. The normal width of the CBD (measured from the inner wall to inner wall) should be ≤4mm for patients <50 years with one additional mm allowed for every decade over 40. On the short axis view, the portal triad appears as three circles, referred to as the **Mickey Mouse sign**. Gallbladder imaged in long axis (C). The normal gallbladder wall measured at its thickest location should be <3mm.
Images courtesy of Gyorgi Varnay, MD, University Hospital Geneva

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Anatomical variants of the biliary tree are common!

Normal anatomy of the biliary tree is present in only 58% of the population.

Recognition of bile duct variants are important to biliary surgery!

For example... mapping the cystic duct route can diminish the risk complications associated to cholecystectomies, like transection of the extrahepatic bile duct.

Anatomical Variants of the Intrahepatic Bile Ducts

Right posterior duct draining into the left hepatic duct (13-19%)

Right posterior duct joining with the right anterior duct by its lateral (right) aspect (12%)

Triple confluence, with the right posterior, right anterior and left hepatic ducts joining at the same point to form the common hepatic duct (11%)

Right posterior duct draining directly into the common hepatic or cystic duct (6%)

Right anterior duct draining into the left hepatic duct (6%)

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Illustration of the most common anatomical variants of the intrahepatic bile ducts

- Right posterior duct draining into the left hepatic duct (most common variant)

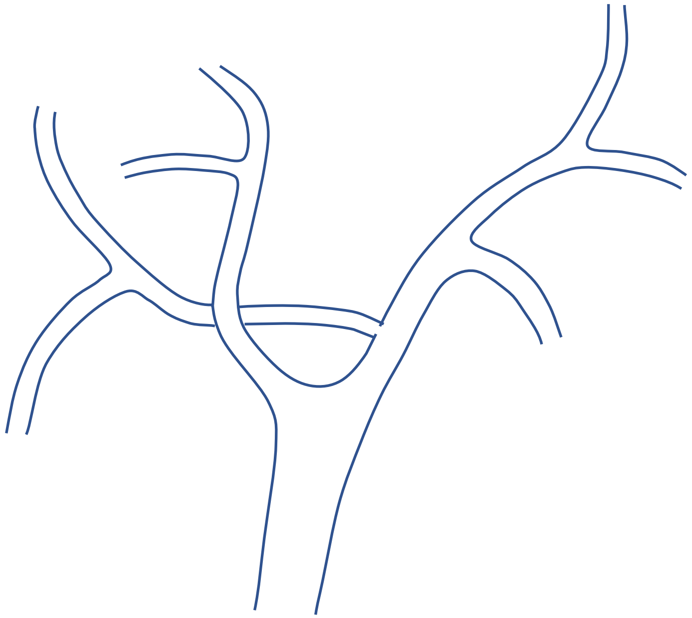
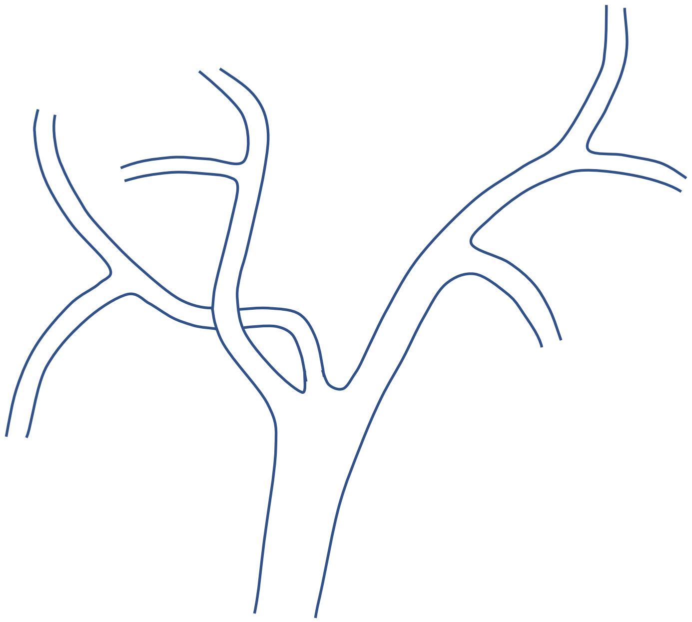


Figure 6. Magnetic Resonance Imaging showing right posterior duct (arrow) draining into the left hepatic duct (anatomical variant). Gallbladder (asterisk)

Illustration of the most common anatomical variants of the intrahepatic bile ducts

- Triple confluence, with the right posterior, right anterior and left hepatic ducts joining at the same point to form the common hepatic duct



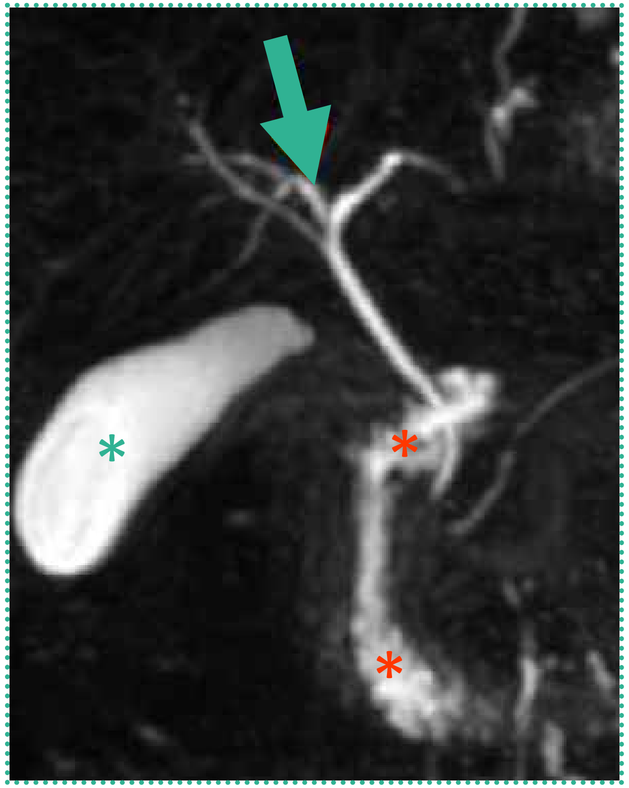


Figure 8. Magnetic Resonance Imaging showing showing triple biliary confluence (arrow). Gallbladder (green asterisk). Duodenum (red asterisks).

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Anatomical Variants of the Extrahepatic Bile Ducts

Three main variations of the cystic duct:

- Medial cystic duct insertion: joining the common hepatic duct at its medial aspect (rather than lateral side) (15%)
- Low cystic duct insertion: into the distal-third of the common hepatic duct, near the ampulla of Vater (10%)
- Parallel cystic duct course: courses parallel to the common hepatic duct for at least 2 cm (10%)

Illustration of common anatomical variants of the extrahepatic bile ducts:

- Medial cystic duct insertion: joining the common hepatic duct at its medial aspect (rather than lateral side) (15%)

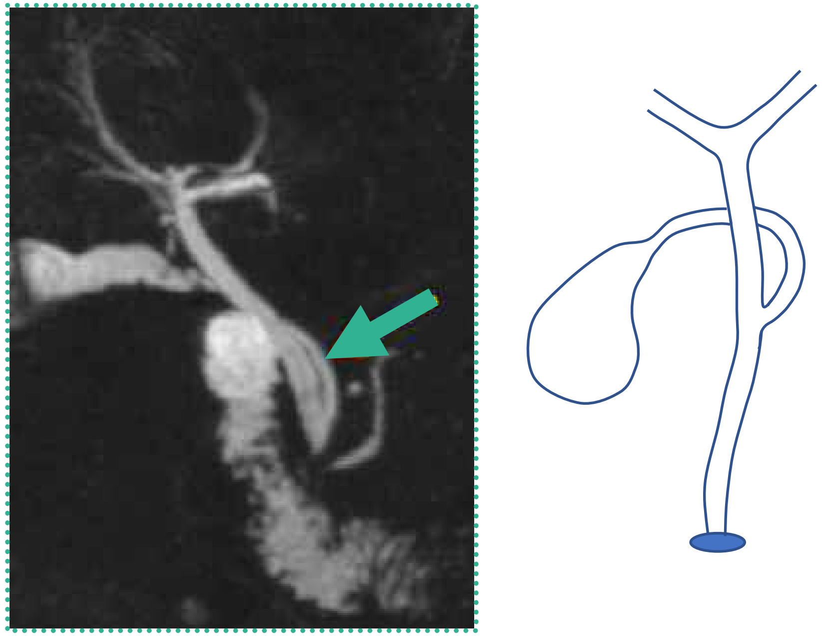

Figure 9. Magnetic Resonance Imaging showing the medial cystic duct insertion, passing posterior to the common hepatic duct.

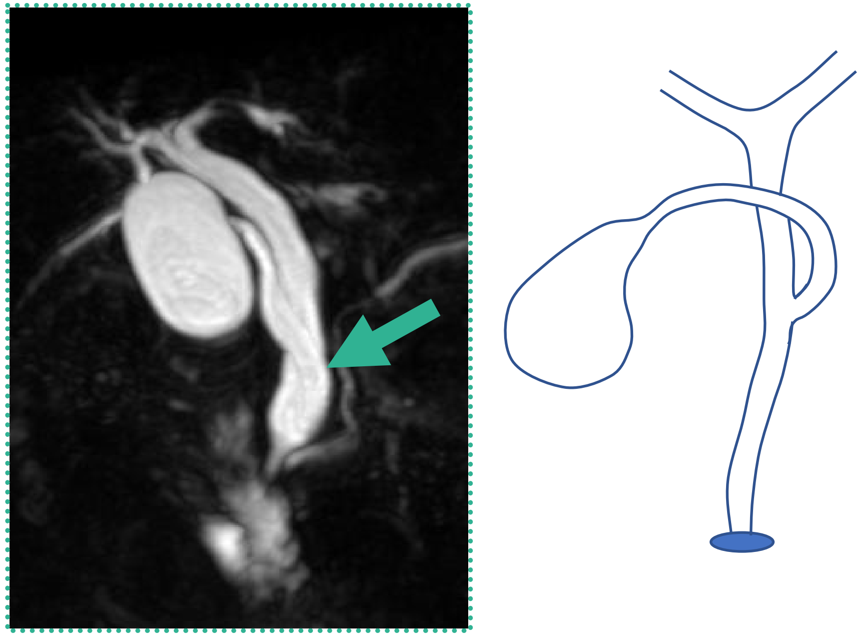

Figure 10. Magnetic Resonance Imaging showing the medial cystic duct insertion, passing anterior to the common hepatic duct.

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Illustration of common anatomical variants of the extrahepatic bile ducts:

- Low cystic duct insertion: into the distal-third of the common hepatic duct, near the ampulla of Vater (10%)

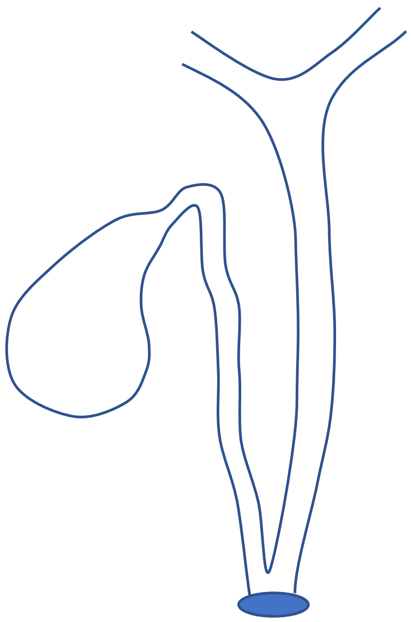

Figure 11. Low cystic duct insertion

Anatomical variants of the extrahepatic bile ducts: Examples

Three main variations of the cystic duct:

- Parallel cystic duct course: courses parallel to the common hepatic duct for at least 2 cm (10%)

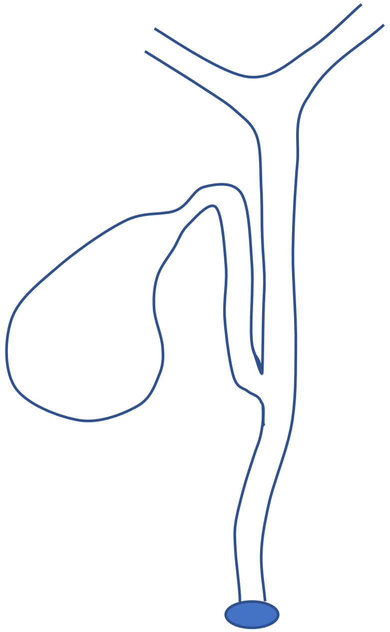

Figure 12. Parallel cystic duct course

Anatomical variants of the gallbladder

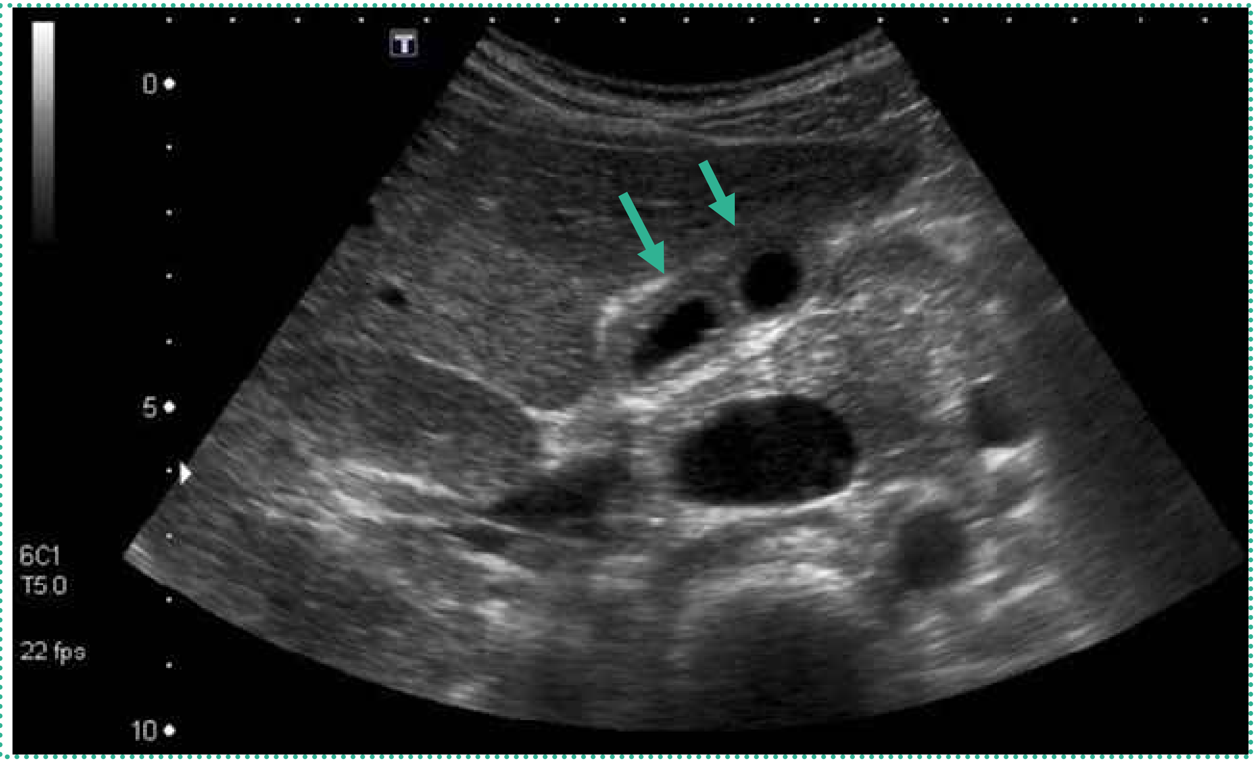

Figure 13. Ultrasound image showing gallbladder duplication (arrows)

Strengths, Weaknesses and Role of Imaging Modalities – Ultrasound

- Ultrasonography (US) is the primary and initial imaging modality of choice for patients presenting with right upper quadrant pain, especially for those with suspected diseases of the gallbladder and the biliary tract.

Advantages:

- Low cost and availability
- Does not use ionizing radiation
- High accuracy in detecting biliary dilatation

Disadvantages:

- Inconsistent visualization of the distal common bile duct
- Low sensitivity for determining the cause of obstruction

Additional imaging may be required!

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Strengths, Weaknesses and Role of Imaging Modalities – Ultrasound

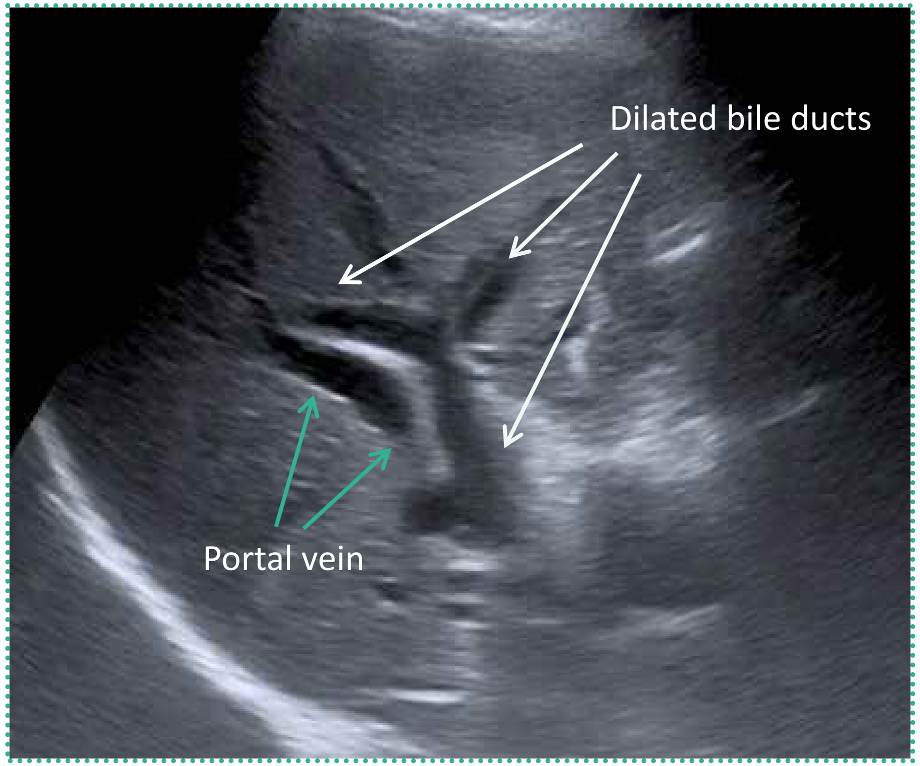

Figure 14. Ultrasound image depicting dilatation of intra-hepatic bile ducts.

Strengths, Weaknesses and Role of Imaging Modalities – Computed Tomography

- **Computed Tomography (CT)** is particularly useful when the diagnosis is **unclear** or when **alternative diagnoses** need to be excluded.

Advantages:
- CT is sensitive for detecting biliary ductal dilatation, the level of biliary obstruction, bile duct tumours and inflammatory complications.

Disadvantages:
- CT does not always visualize biliary stones (only 10-15% are radiopaque).
- Radiation exposure.
- Need to use i.v. contrast to clearly separate bile ducts from portal vein branches

Strengths, Weaknesses and Role of Imaging Modalities – Computed Tomography

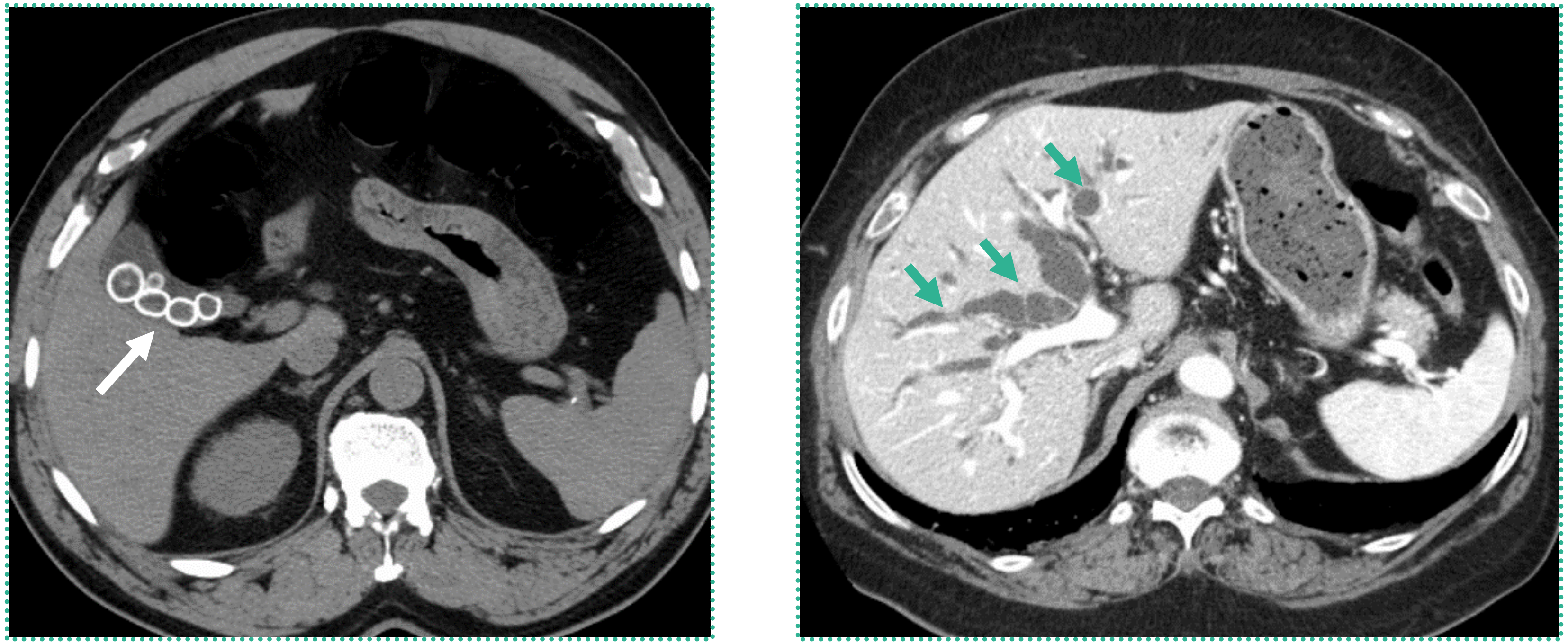

Figure 15.

A. Non-contrast-enhanced CT showing gallstones with a low-density cholesterol centre and a dense peripheral rim of calcium (arrow).
B. Contrast-enhanced CT revealing dilatation of intra-hepatic bile ducts (arrows)

Strengths, Weaknesses and Role of Imaging Modalities – Magnetic Resonance Imaging (MRI)

Magnetic Resonance Cholangiopancreatography (MRCP) is the best imaging modality to assess the biliary tract.

- Principle: Heavily T2-weighted MR sequences exploit the relatively high signal intensity of static fluids in the biliary tract, resulting in a very high bile-to-background contrast. Fat saturation is generally used to suppress the background fat signal allowing a better delineation of the biliary system.

Advantages:
- Non-invasive, no contrast medium and no radiation exposure
- Complete depiction of intra- and extrahepatic bile ducts with surrounding structures
- Bile duct display and morphology similar to Endoscopic Retrograde Cholangiopancreatoography (ERCP)

95% sensitivity for the detection of biliary dilatation, strictures and intraductal stones

Disadvantages:
- Cost and availability

Strengths, Weaknesses and Role of Imaging Modalities – Magnetic Resonance Imaging (MRI)

- Magnetic Resonance Cholangiopancreatography (MRCP) has a high accuracy to evaluate the bile ducts and, when combined with conventional MRI sequences, allows for detection of non-biliary disease.

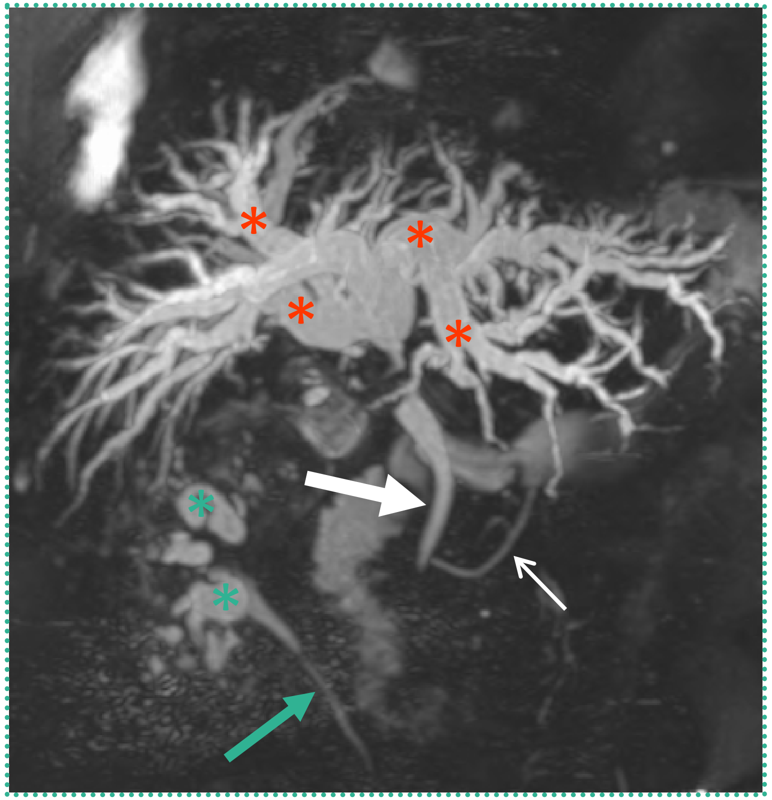

Figure 16.
MRCP images (3D sequence) after accidental ligation of the CHD on laparoscopic cholecystectomy: dilatation of the intra and extrahepatic bile ducts (asterisks). Note that the normal common bile duct remains normal (thick white arrow). Pancreatic duct (thin arrow). Renal calices and pelvis (green asterisks). Ureter (green arrow)

Strengths, Weaknesses and Role of Imaging Modalities – Magnetic Resonance Imaging (MRI)

- Hepatobiliary agents are gadolinium based intravenous MRI contrast agents which are partially excreted into bile - 50% of the administered dose is excreted by the hepatocytes.

- Contrast enhanced MR cholangiography provides functional information about the excretion of bile, biliary anatomical detail and help detect bile leaks and assess the patency of biliary-enteric anastomoses.

Figure 17.
Contrast-enhanced MR cholangiography obtained 20 min after i.v. injection of a hepatobiliary contrast agent

Strengths, Weaknesses and Role of Imaging Modalities – Endoscopic Ultrasound

- Endoscopic Ultrasound (EUS) is the standard procedure for the etiologic investigation of obstruction of the extrahepatic bile ducts. It provides detailed anatomical imaging features of the biliary tree and surrounding structures.
- It offers the possibility of performing EUS-fine needle aspiration for sampling masses, strictures or other type of bile ducts or pancreatic lesions.
- It is an invasive procedure and highly operator-dependent.

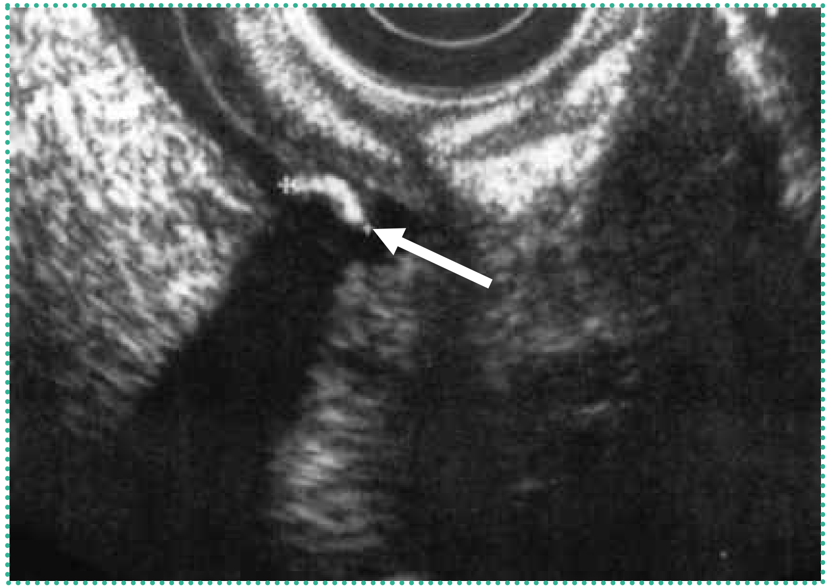

Figure 18.
EUS image depicting an echogenic rounded focus with acoustic shadows (posterior attenuation of ultrasound waves) within the bile duct, compatible with a stone (arrow).

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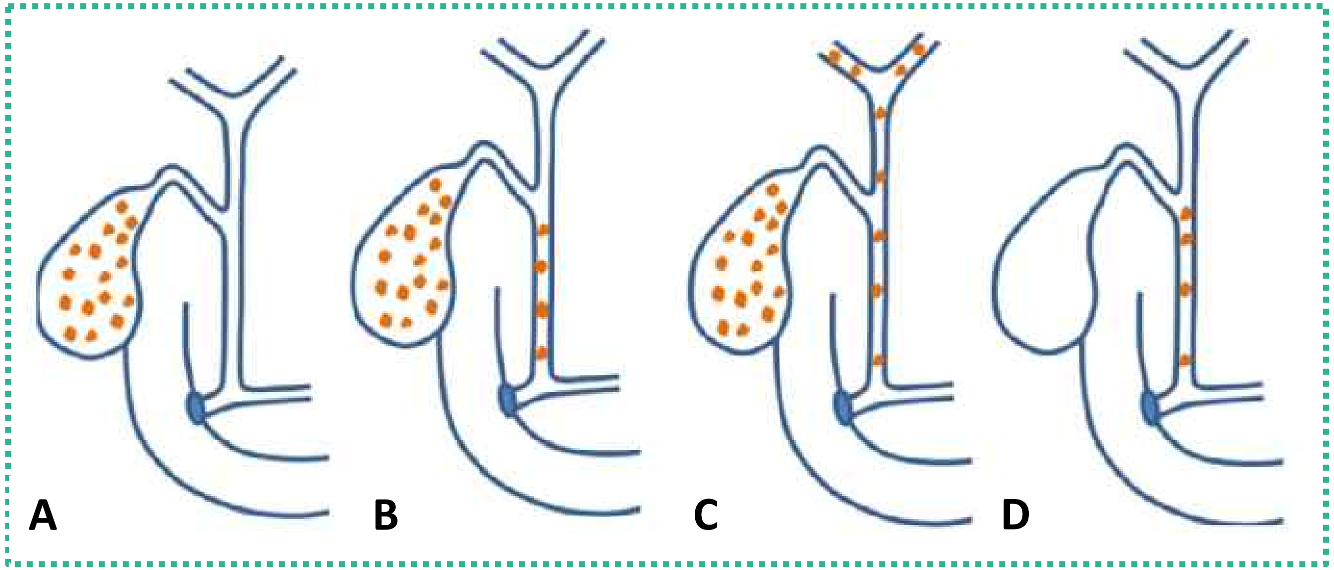
Diseases of the Biliary Tree

- Oversaturation and concentration of hepatic bile constituents, namely biliary acids, bilirubin and lipids (cholesterol, phospholipids), promote the formation of gallstones. About 80% of all gallstones are cholesterol stones mixed with components of bilirubin and calcium salts.

- Approximately 10 to 20% of the population have gallstones.



Choledocholithiasis is the most common cause of biliary obstruction!

Figure 19.
Gallbladder stones usually occur in numbers and are of various sizes (A), sometimes combined with common bile duct stones (B) and occasionally associated with intra-hepatic lithiasis (C). Common bile duct stones rarely occur in the absence of gallbladder stones (D).

- Ultrasound is usually the first method to visualize biliary stones, with a sensitivity up to 95% for depicting stones within the gallbladder (cholecystolithiasis). Its sensitivity decreases in the common bile duct (choledocholithiasis) to approximately 50%, due to superimposed intestinal gas, especially in the absence of significant biliary dilatation.

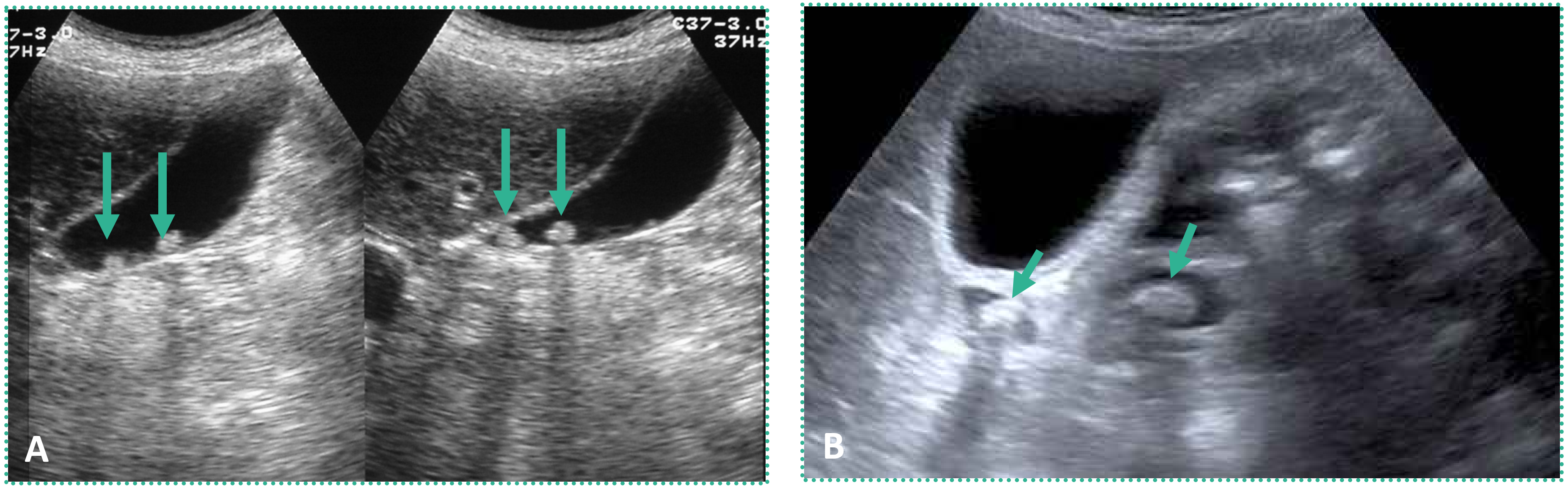


Figure 20.
Ultrasound images showing echogenic rounded foci with acoustic shadows (posterior attenuation of ultrasound waves), compatible with lithiasis. In image A there are stones within the gallbladder (arrows) and in image B we can identify two stones impacted in the common bile duct (arrows).

- **CT is only moderately sensitive to detect biliary stones** (approximately 65-88%), due to the variable content of calcium, requiring a pre-contrast acquisition.

- Depending on the composition, stones may show increased attenuation due to calcification (**easily recognized, but only corresponding to 20% of stones**), isoattenuation relative to bile because of cholesterol deposition, or hypoattenuation because of nitrogen gas.

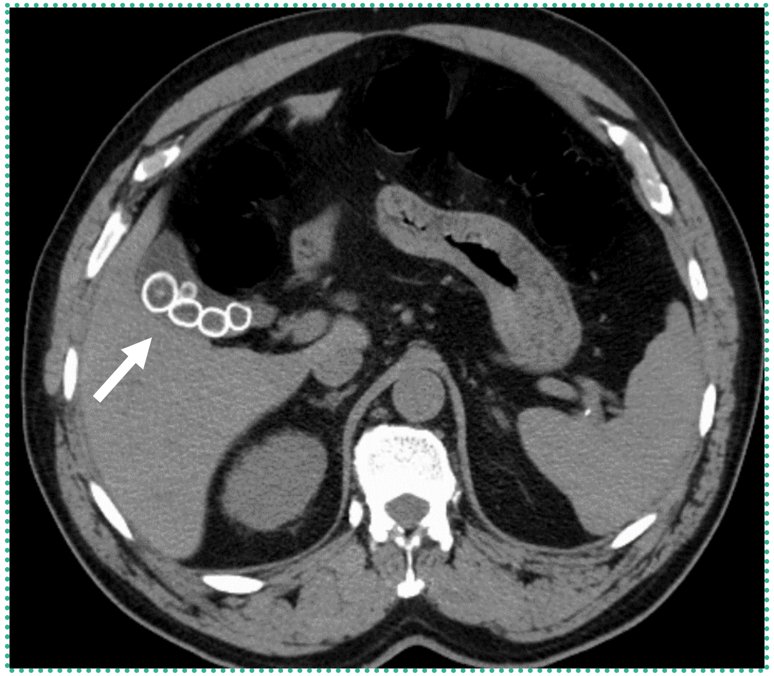


Figure 21
Non-contrast-enhanced CT showing gallstones with a low-density cholesterol centre and a dense peripheral rim of calcium.

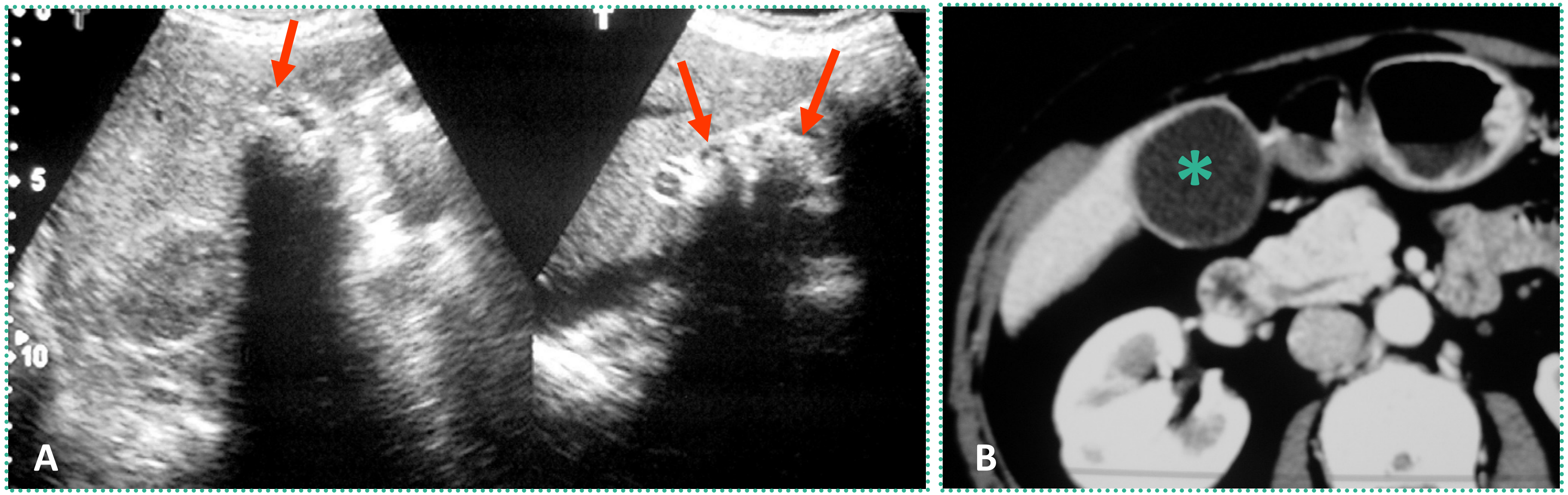


Figure 22.
Ultrasound and CT performed in the same patient reveal the limitation of CT for the identification of stones. The US examination shows countless gallbladder stones (arrows), which are not identified on CT (asterisk).

- MRCP has largely replaced ERCP as the gold standard for the diagnosis of choledocholithiasis, with similar sensitivity (90-94%) and specificity (95-99%).

- Stones are shown as signal void on T2-weighted MRI with variable signal on T1-weighted imaging (pigmented stones are hyperintense due to the presence of metal ions).

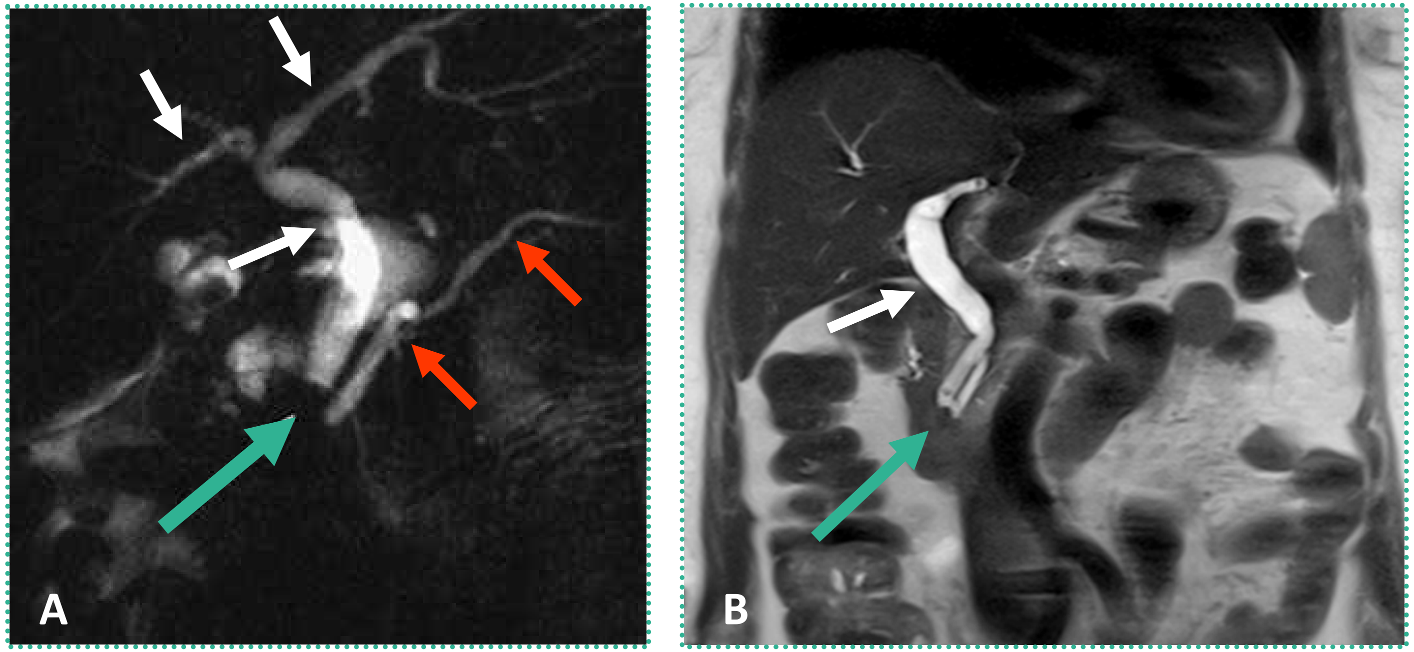


Figure 23.
MRCP images demonstrate a stone impacted at the ampulla seen as a signal void (green arrows), causing dilatation of the biliary tree (white arrows) and Wirsung duct in A (red arrows).

Complications of Cholecysto-Choledocholithiasis

Cholecystolithiasis

- Acute cholecystitis / perforation
- Chronic cholecystitis/porcelain gallbladder/carcinoma
- Biliodigestive fistula (biliary ileus; Bouveret syndrome)
- Mirizzi's syndrome

Choledocholithiasis

- Impacted stones/pancreatitis
- Cholangitis/liver abscesses

Acute cholecystitis is an inflammation/infection of the gallbladder, almost always due to complications of biliary stones (90-95%). The main cause is impacted infundibular/cystic stones with over-distension of the gallbladder and subsequent infection. It is the most common cause of acute pain in the right upper quadrant. In the absence of gallbladder stones, the condition is referred to as acalculous cholecystitis, that it is thought to occur due to biliary stasis and/or gallbladder ischemia in patients in critically ill (e.g. trauma, burns, sepsis).

Chronic cholecystitis is a consequence of recurrent cholecystitis, almost always seen in the setting of cholelithiasis (90%). The gallbladder becomes shrunken with dystrophic calcification in the wall ("porcelain gallbladder"). It has a risk of 10 to 20% to develop carcinoma.

Mirizzi's syndrome is an uncommon abnormality that consists of a common duct obstruction caused by a gallstone in the cystic duct or the gallbladder neck. The obstruction may be caused by the extrinsic compression of the stone or by an associated inflammatory reaction in the common bile duct. This is more likely to occur with a low-inserting cystic duct that travels in a common sheath with the common duct.

Biliodigestive fistulas may result after repeated inflammatory process associated with the chronic cholecystitis, leading the passage of gallstones into the lumen of duodenum (the most common) and consequent obstruction (gallstone Ileus/Bouveret syndrome).

Acute bacterial cholangitis is a potentially life-threatening infection of bile ducts, usually arising in the setting of bile duct obstruction (choledocholithiasis accounts for up to 80% of cases). It can complicated with development of liver abscesses.

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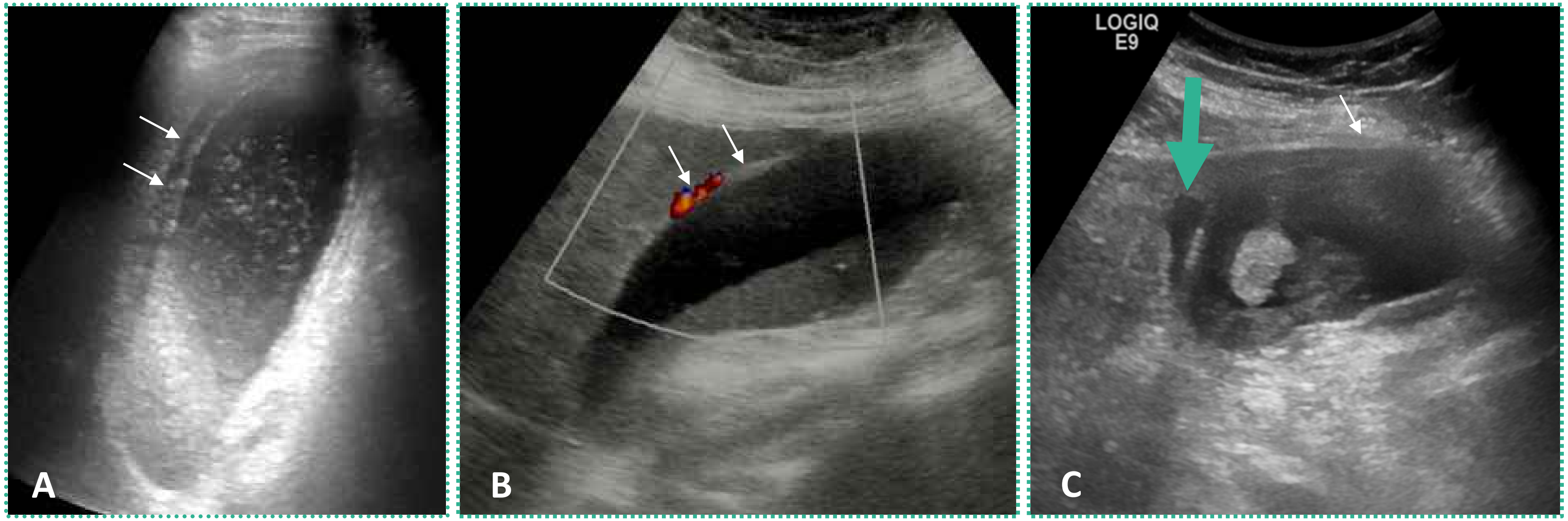

Figure 24. Ultrasound images – Acute cholecystitis in three different patients
Distended gallbladder (A, B and C) filled with echogenic sludge and gallstones, associated with thickening of the wall (thin white arrows) and pericholecystic collection (green arrow in C). On colour Doppler, there is increased vascularisation of the gallbladder wall. The most sensitive US finding in acute cholecystitis is the presence of cholelithiasis in combination with the sonographic Murphy sign (= maximum abdominal tenderness from applying pressure with the ultrasound probe over the visualized gallbladder during US). The other sonographic findings that support the diagnosis include gallbladder wall thickening (>4mm), gallbladder distension, pericholecystic fluid and a stone impacted in the gallbladder neck or cystic duct.

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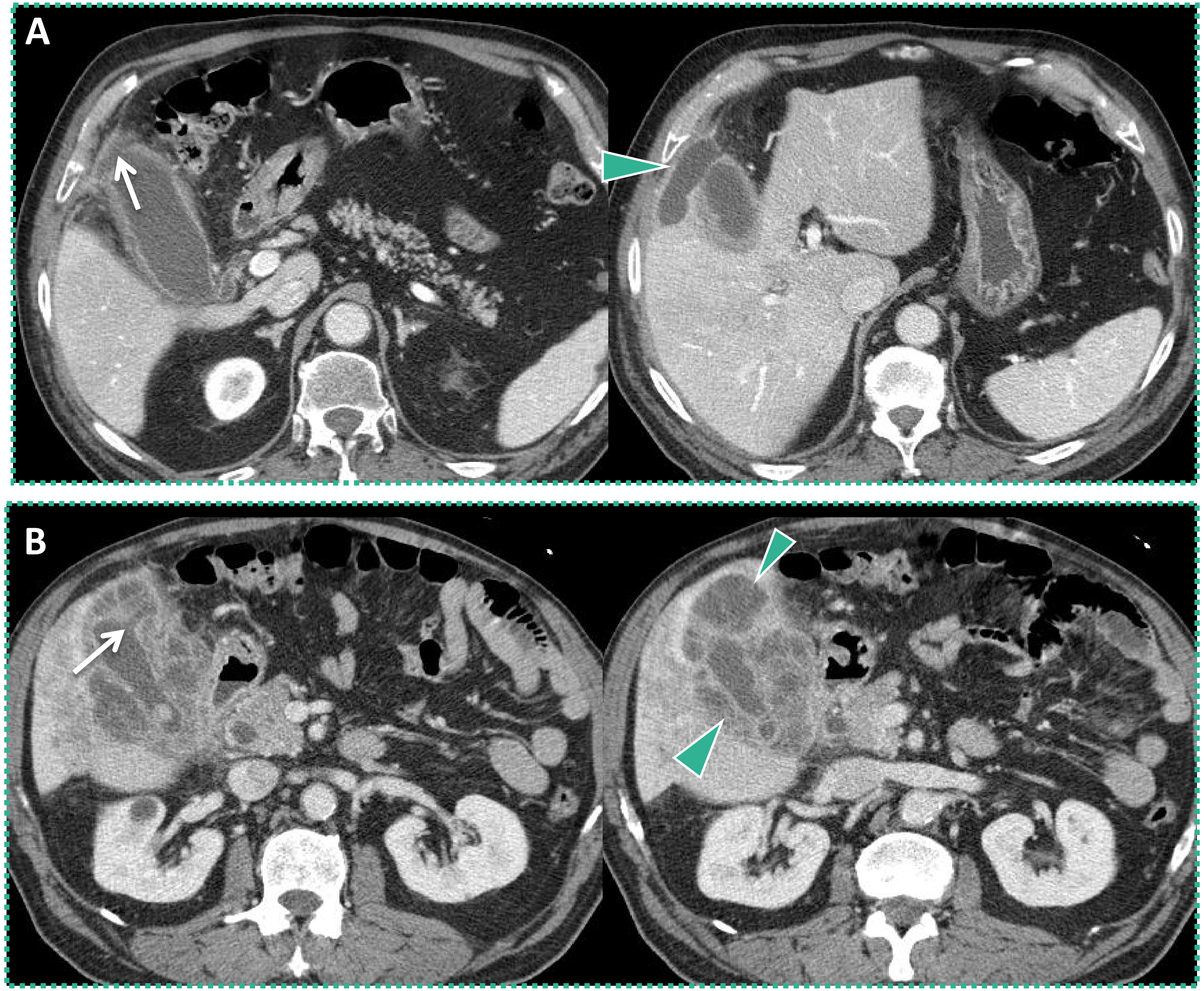

Figure 25.
Contrast-enhanced CT scan showing gallbladder perforation in two different patients (A and B) of acute cholecystitis complicated with wall perforation, with illustration of the focal wall defect (arrows) and pericholecystic abscesses (arrowheads)

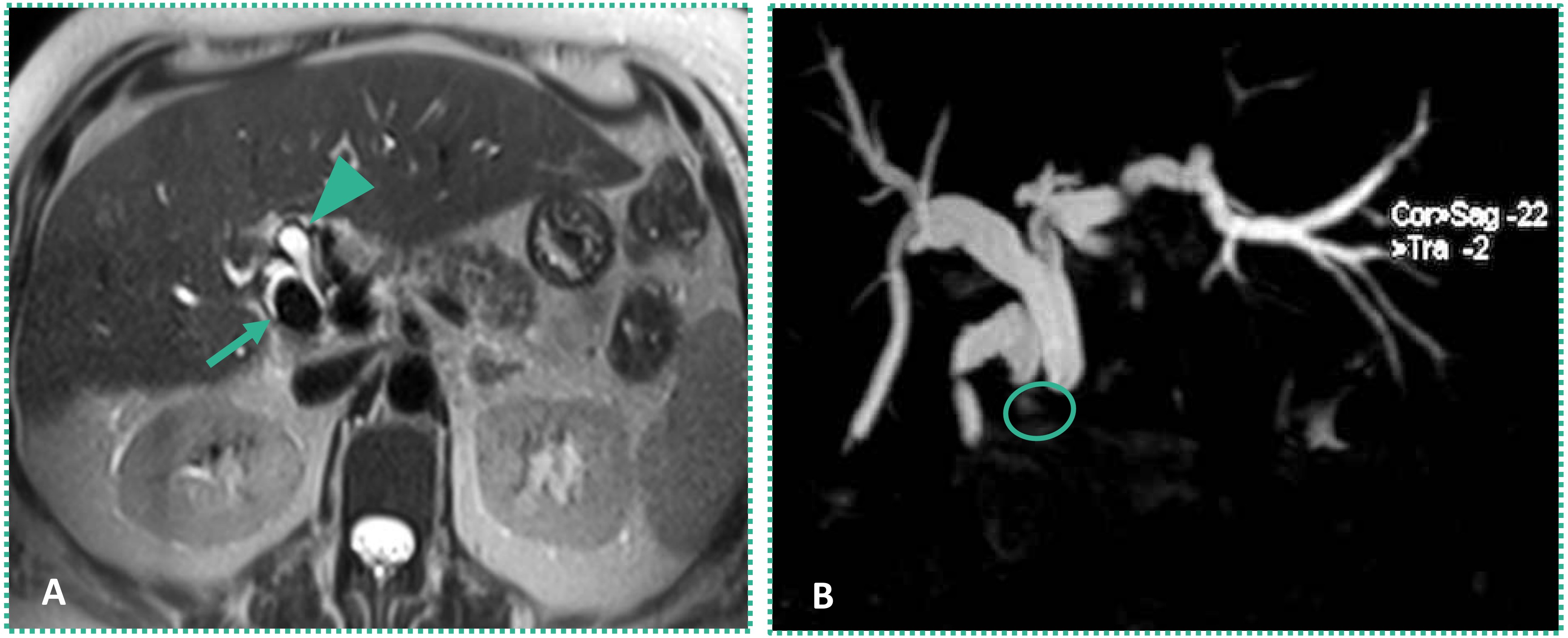

Figure 26. MRCP images – Mirizzi's Syndrome.
A. There is a stone impacted in the cystic duct (arrow), causing extrinsic compression in the common bile duct (arrowhead) and subsequent dilatation of the biliary tree (image B). In image B, the stone corresponds to the circle drawn where there is an abrupt stenosis of cystic duct and common bile duct.

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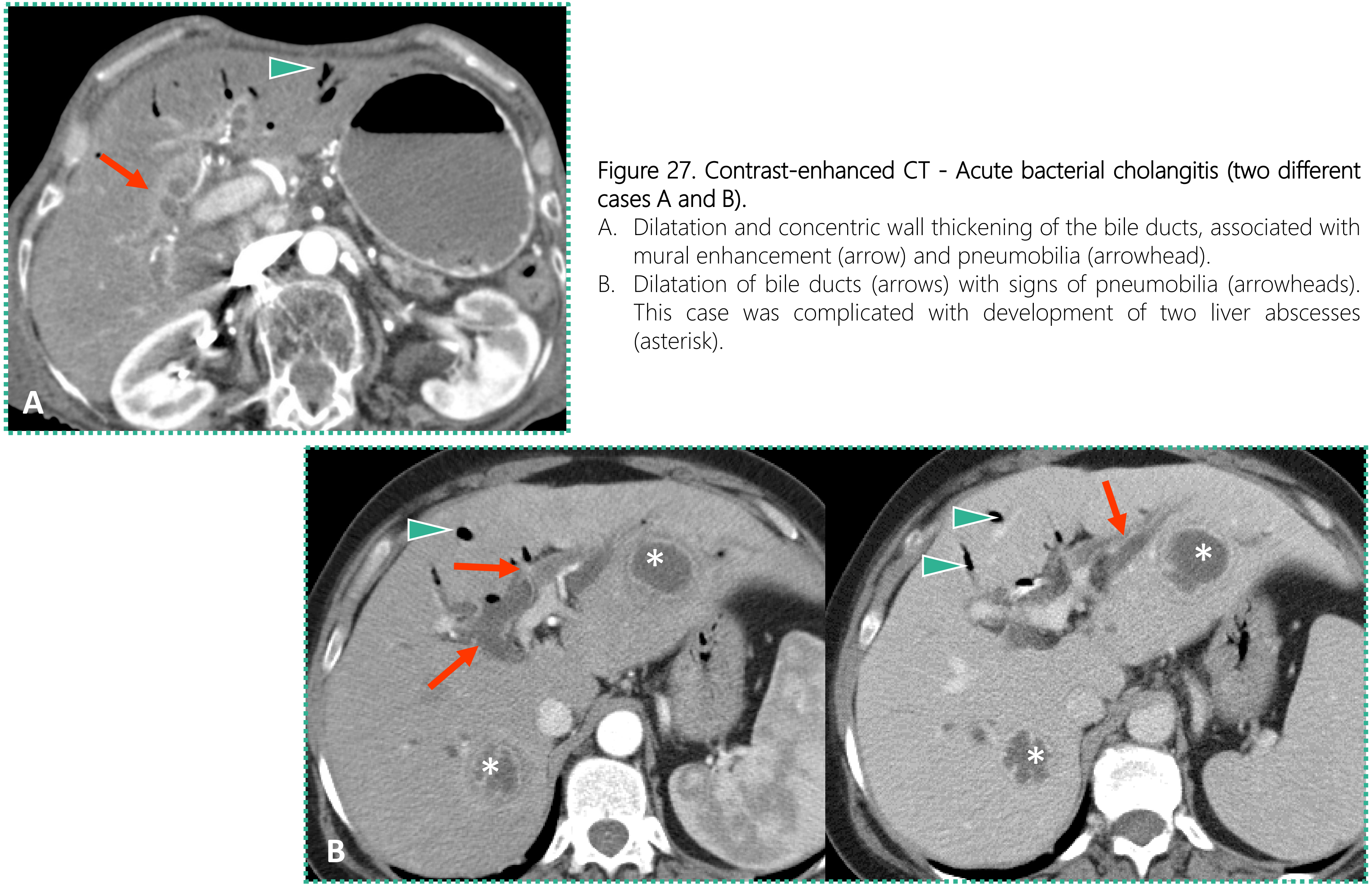


Figure 27. Contrast-enhanced CT - Acute bacterial cholangitis (two different cases A and B).

A. Dilatation and concentric wall thickening of the bile ducts, associated with mural enhancement (arrow) and pneumobilia (arrowhead).
B. Dilatation of bile ducts (arrows) with signs of pneumobilia (arrowheads). This case was complicated with development of two liver abscesses (asterisk).

Emphysematous cholecystitis is a rare form of acute cholecystitis, characterised by ischemia /gangrene of the gallbladder wall and infection by gas-producing bacteria. Diabetes mellitus is considered the commonest predisposing factor. This condition has a significantly increased rates of mortality and it is considered a surgical emergency.

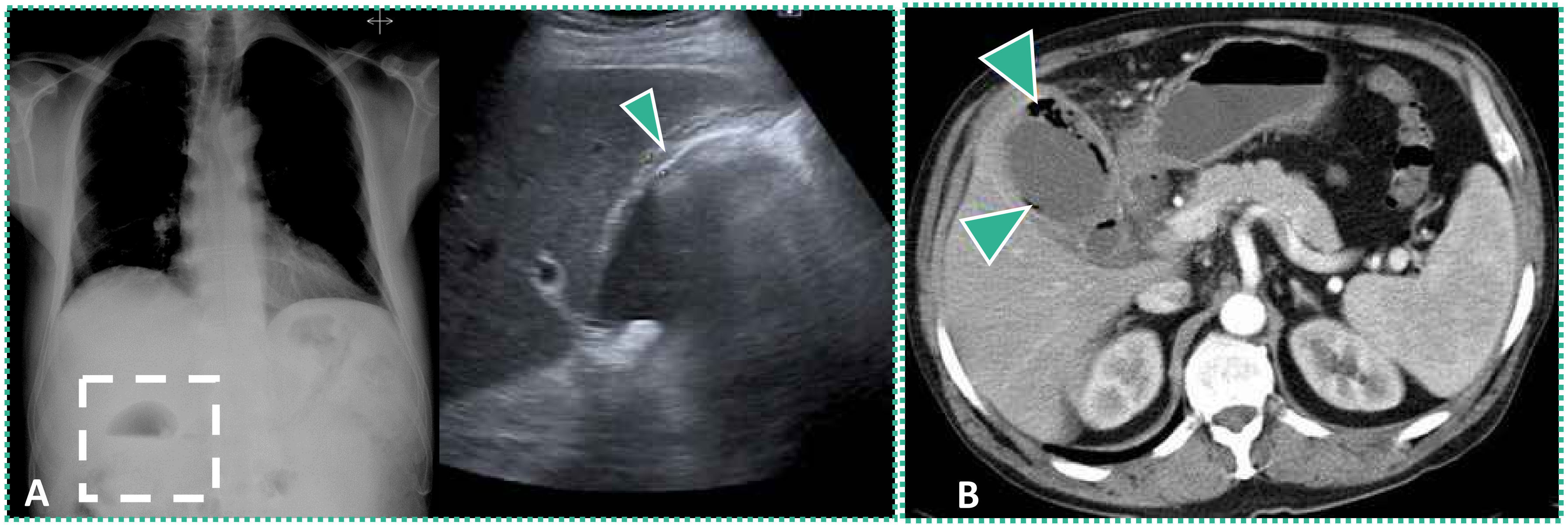


Figure 28. Emphysematous cholecystitis.
In image A, the conventional radiography shows gas in the right hypochondrium (square), compatible with air in the gallbladder. On ultrasonography, the air corresponds to highly echogenic material with dirty shadowing artefact (arrowhead).
In image B, computed tomography shows signs of cholecystitis (gallbladder distention, wall thickening, pericholecystic fat stranding) with presence of gas in the wall and lumen (arrowheads).

Primary sclerosing cholangitis is a specific type of cholangitis, corresponding to a progressive cholestatic disease characterized by inflammation and fibrosis of the bile ducts. It is commonly associated with inflammatory bowel disease (especially ulcerative colitis). Approximately 15% of patients with primary sclerosing cholangitis develop cholangiocarcinoma.

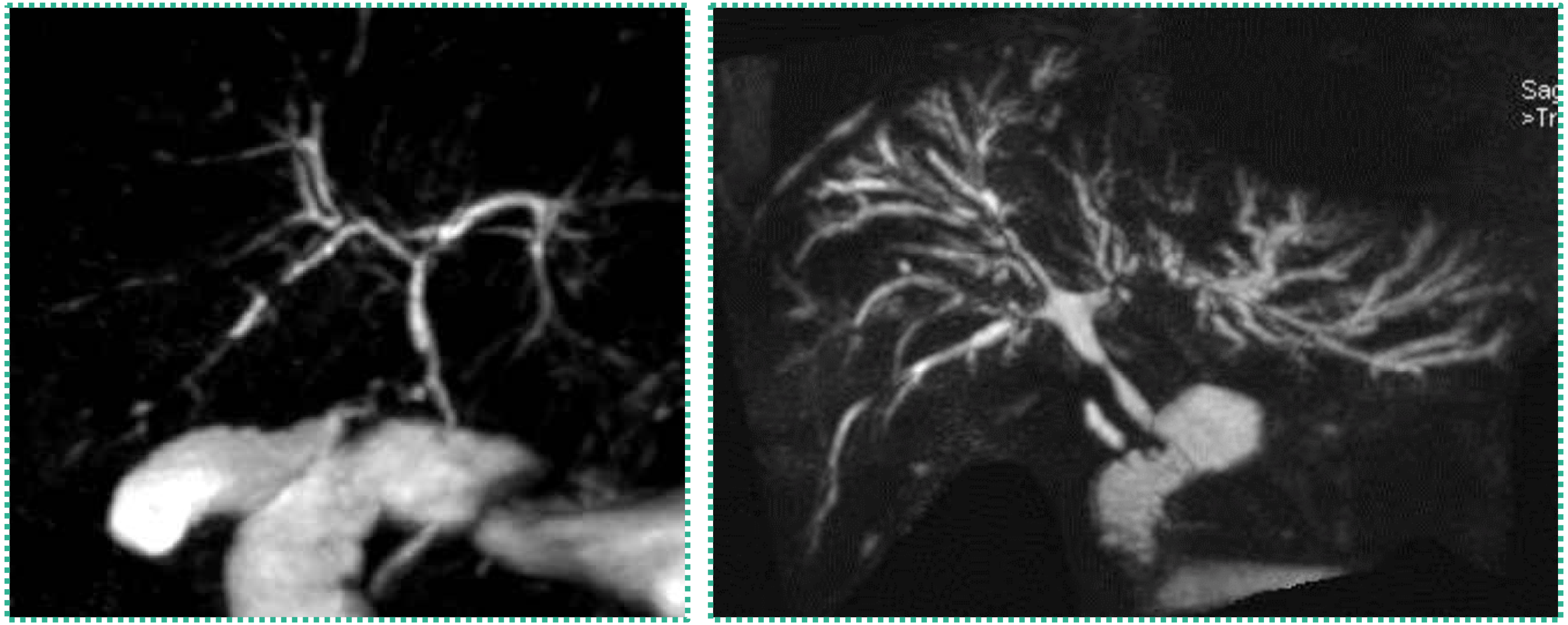


Figure 29. MRCP images – Primary sclerosing cholangitis.
Two cases with the typical multifocal short-segmental strictures (intra- and extrahepatic). There is mild dilatation of the intrahepatic bile ducts alternating with normal ducts, sometimes producing the well known “beaded” appearance.

Chapter Outline

IgG4-related sclerosing cholangitis (ISC) is a rare chronic inflammatory disease of the biliary system that occurs in the context of a systemic disorder (IgG4-related disease) that can affect multiple organs. Autoimmune pancreatitis is seen in more than 90% of patients with ISC. ISC is frequently associated with stenosis and upstream dilatation of the bile ducts. The most commonly involved segment is the intrapancreatic bile duct segment.

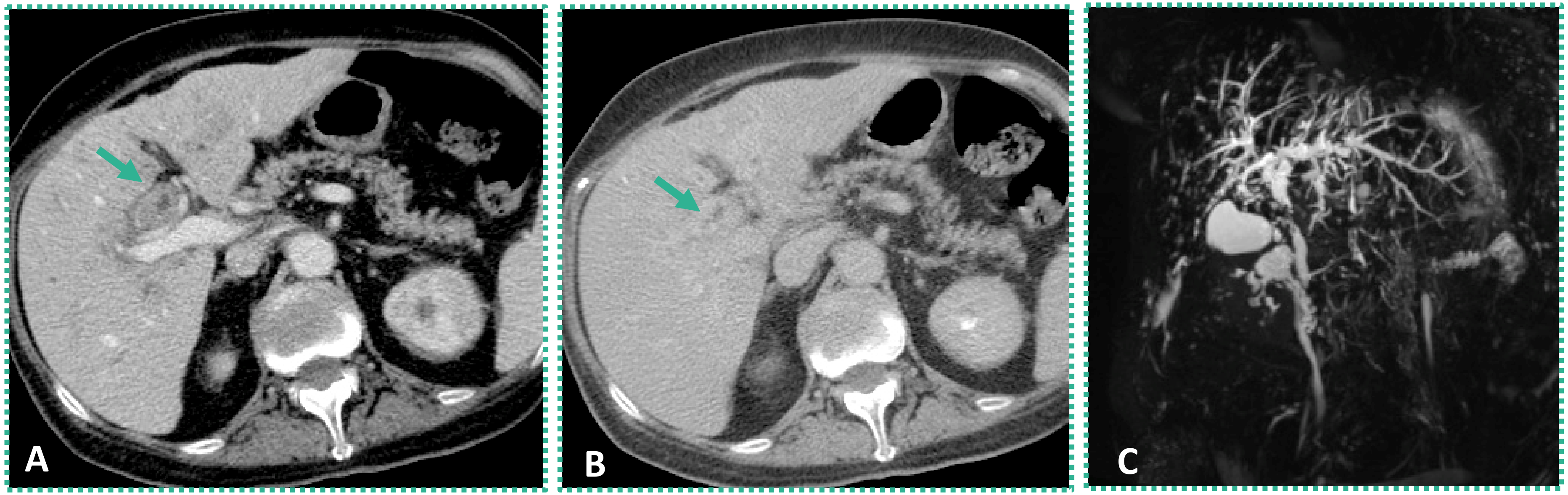


Figure 30. Contrast-enhanced CT (A, portal phase; B, delayed phase), MRCP (C) - ISC
Marked circumferential symmetric wall thickening of the bile ducts, with smooth outer and inner margins and progressive homogeneous contrast enhancement, most evident in the delayed phase, as seen in images A and B (arrows). In image C, we can see typical dilatation of the intrahepatic and extrahepatic biliary tree with many areas of stenosis of variable length.

Chapter Outline

- **Gallbladder carcinoma** is a relatively rare malignant tumour and affects predominantly elderly women with long-standing cholecystolithiasis tract. On imaging, it is seen as a focal intraluminal mass, focal or diffuse wall irregular thickening or a large mass replacing the entire gallbladder, which contains gallstones in 90% of the cases. Differentiating between gallbladder carcinoma and chronic cholecystitis may be difficult in the absence of invasion of adjacent organs (especially liver) or other signs of metastatic disease.

- **Cholangiocarcinoma** is a primary malignant tumour (adenocarcinoma) originating from the bile duct epithelium. There may be a slight male predilection and affects most commonly the elderly (mean age of 65 years). Predisposing conditions include choledochal cyst, Caroli disease, recurrent pyogenic cholangitis, primary sclerosing cholangitis and viral infections (e.g. hepatitis B).

- **Growth patterns of cholangiocarcinoma** include mass-forming, periductal infiltrating, and intraductal polypoid:
  - Mass-forming type presents as an intra-hepatic mass
  - The periductal infiltrating type presents as a duct wall thickening, occurring most commonly at the bifurcation of the common hepatic duct, being referred as **Klatskin tumour**
  - The intraductal polypoid is characterized by alterations in duct calibre, usually duct ectasia with or without a visible polypoid mass.

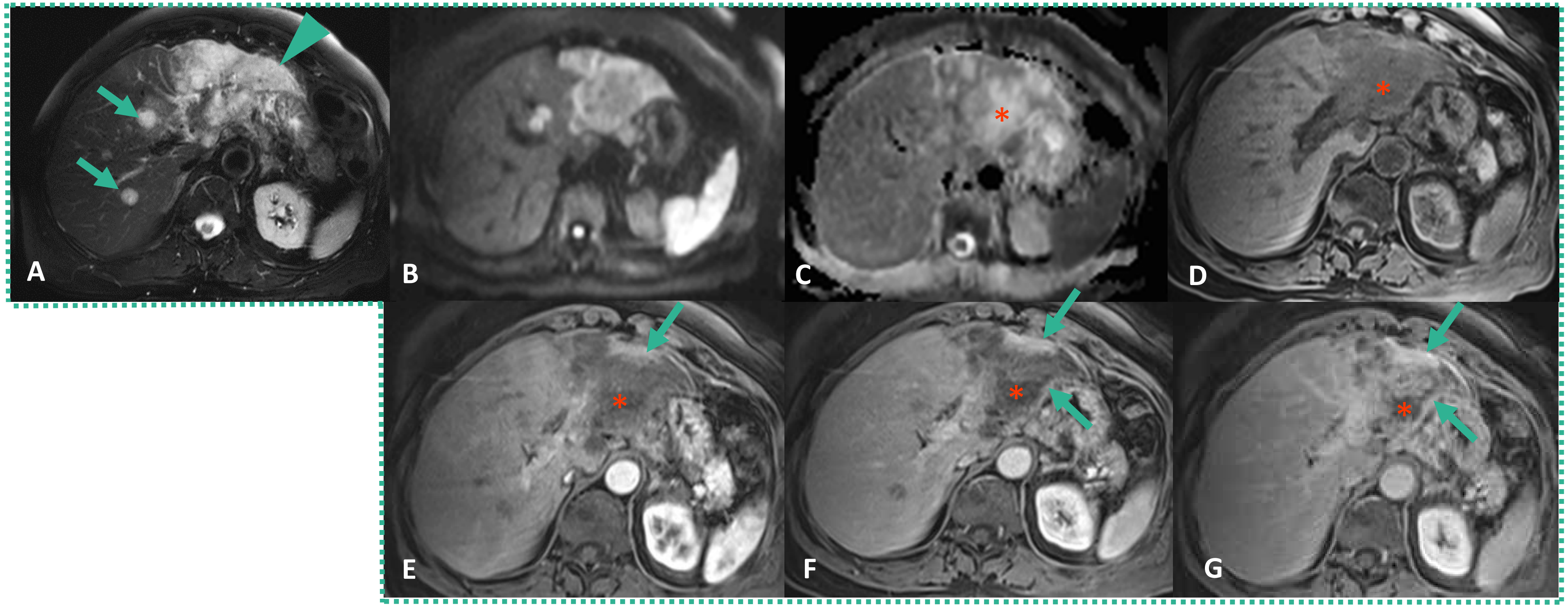
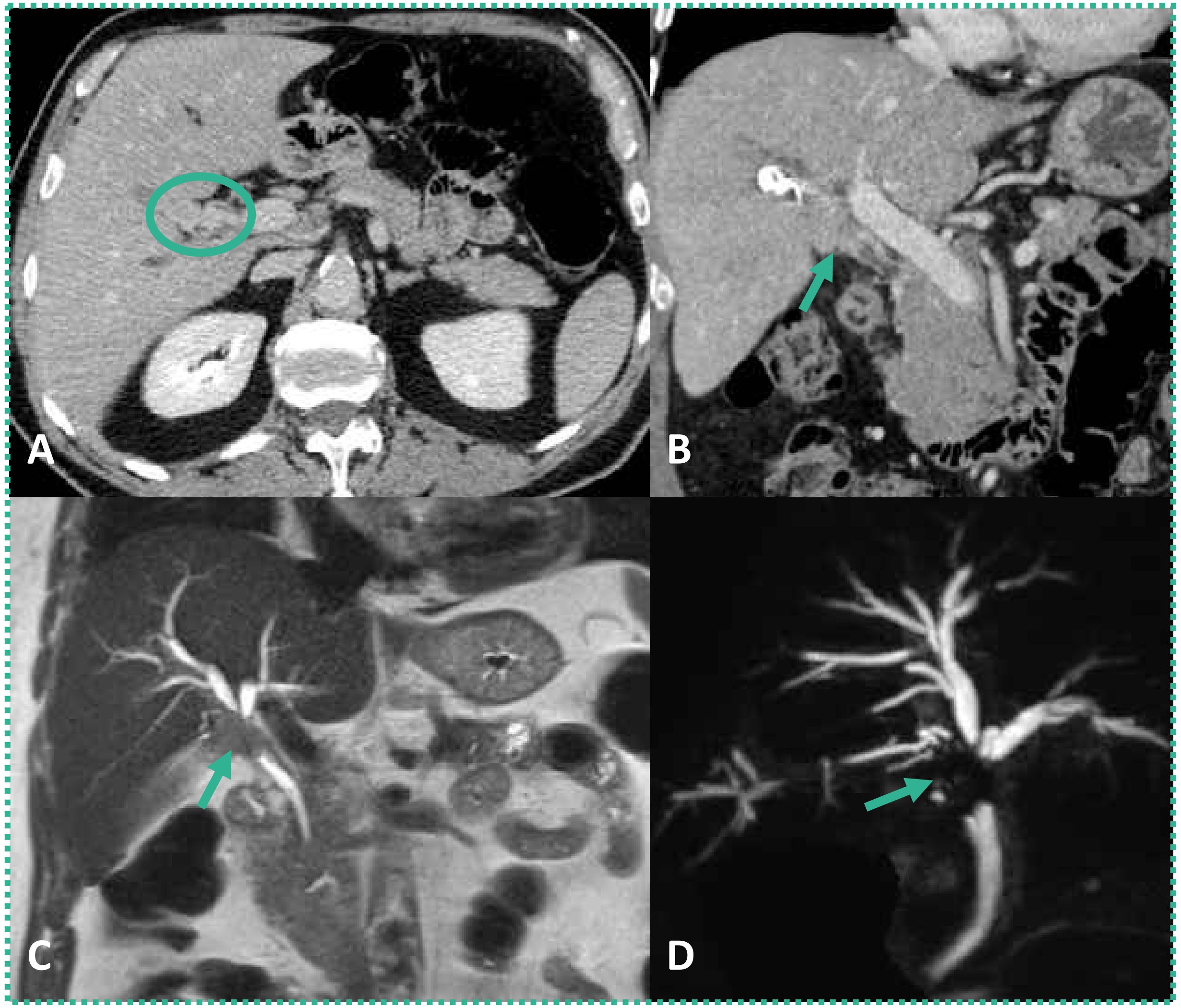


Figure 31. Contrast-enhanced MRI - Mass-forming type of hepatic cholangiocarcinoma.
T2-weighted (A), Diffusion-weighted imaging (B), Apparent diffusion coefficient (ADC) map (C), non-enhanced T1-weighted (D), arterial phase T1-weighted (E), portal phase T1-weighted (F), delayed phase T1-weighted (G). Hyperintense mass in the left liver (arrowhead) on T2-weighted images, compatible with mass-forming type of cholangiocarcinoma. It has the typical rim-like enhancement in the arterial phase (arrow in E) and gradual centripetal enhancement in portal venous and delayed phases (arrows in F and G). Additional findings include capsular retraction (arrowhead and arrow in image A, E-G, respectively) and satellite nodules (arrows in A). There are discrete areas of restriction on the periphery (the centre is fibrotic, asterisk).

Figure 32. Contrast-enhanced CT, MRCP – Periductal Infiltrating type of Cholangiocarcinoma (Klatskin tumour).
There is bile duct wall thickening with contrast enhancement (circle in A, arrow in B), compatible with Klatskin tumour, causing dilatation of intra-hepatic biliary ducts. The tumour (arrows) invades only the confluence of the right and left hepatic ducts (C, D) and hence is a type II (Bismuth Corlette classification). The Bismuth-Corlette classification is used to determine the extent of ductal infiltration and assess resectability. It is also important to evaluate the involvement of the portal vein and hepatic artery.



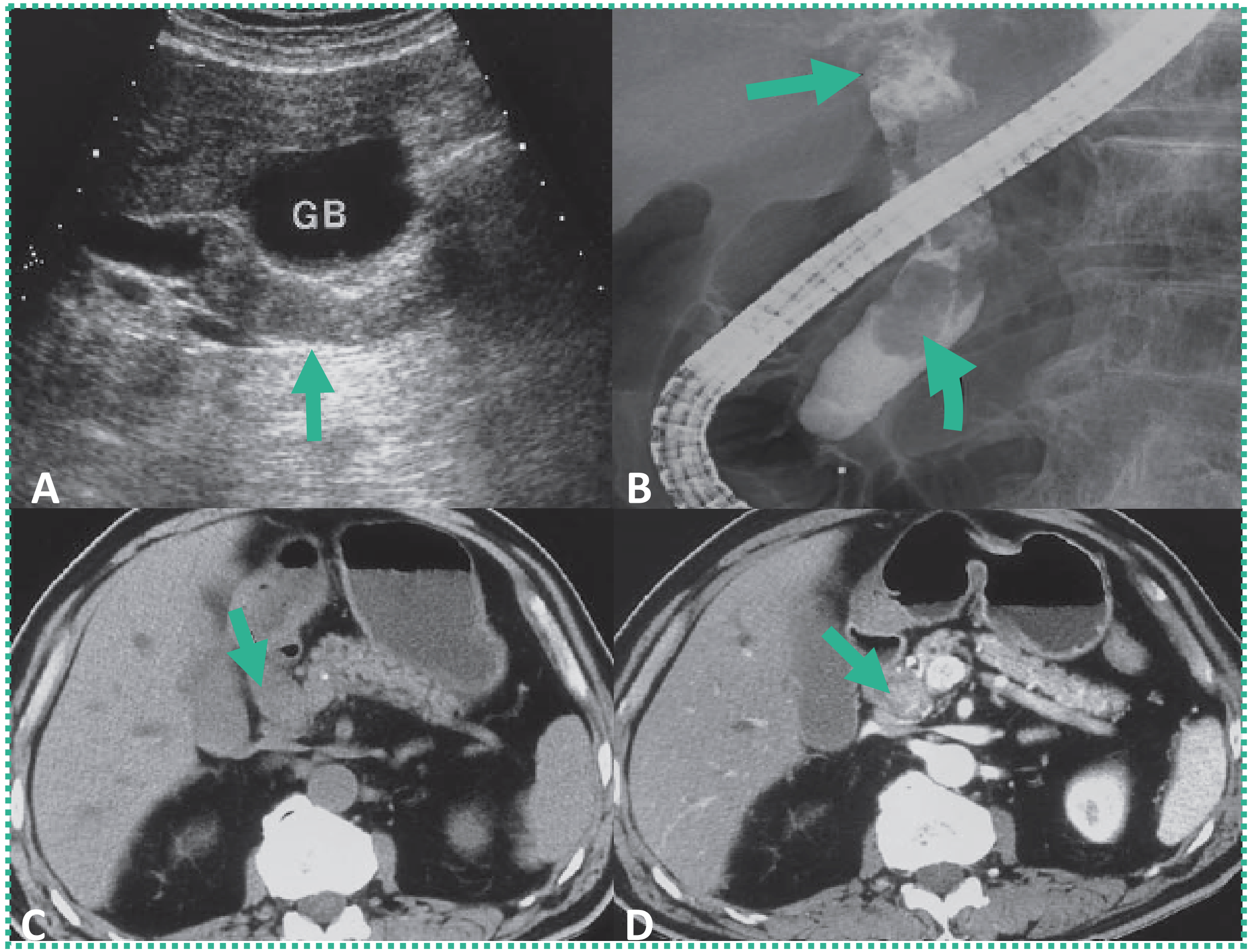


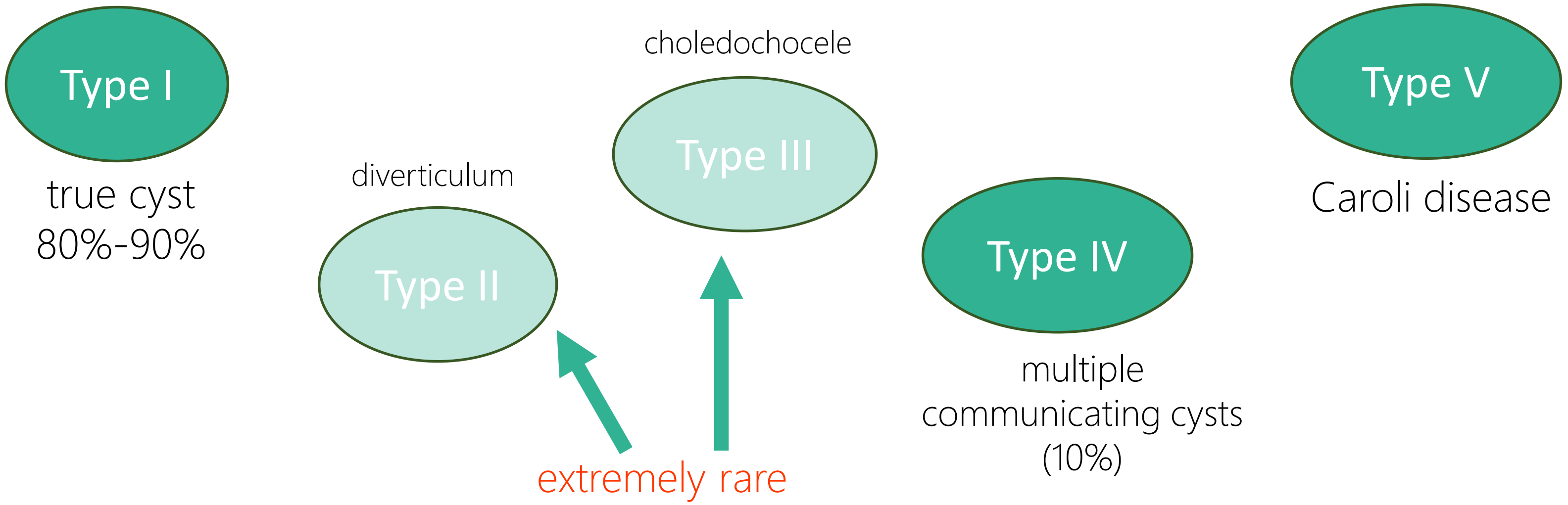
Figure 33. Ultrasound (A), ERCP (B), CT (C=non-contrast-enhanced, D=contrast-enhanced images) – Intraductal polypoid cholangiocarcinoma.
There is an echogenic filling of the bile duct on US (arrow), corresponding to a solid endoluminal lesion with contrast enhancement on CT (C and D, arrows). It appears as a repletion defect on ERCP (arrows). Biopsy confirmed the diagnosis of intraductal polypoid cholangiocarcinoma.

- **Anomalous junction of the pancreaticobiliary ductal system** is defined as a union of the distal common bile duct and the pancreatic duct proximal to the duodenum whose length is greater than 1.5 cm.

- The presence of a long common channel may allow **reflux of pancreatic secretions** into the biliary system, possibly resulting in:

- Bile duct cyst
- Cholangiocarcinoma
- Gallbladder carcinoma
- Choledocholithiasis
- Chronic pancreatitis

- The **bile duct cyst** is a relatively **rare congenital cystic dilation** of the biliary tree that most commonly involves the **extrahepatic bile duct.**
- The manifestation of the bile duct cyst in adults is nonspecific, which often leads to a delay in diagnosis. The triad of abdominal pain, right upper quadrant mass, and jaundice is more prevalent in the paediatric population and is reported to occur in 2%-38% of patients
- According to the **Todani classification**, there are five types of bile duct cysts:



Chapter Outline

Type I

- The most common type of bile duct cyst (accounting for 80-90%) is a type I cyst
- Type I cysts can be further subdivided into:
    - Type Ia – dilatation of the entire extrahepatic bile duct
    - Type Ib – segmental dilatation of the extrahepatic bile duct
    - Type Ic – fusiform dilatation of the common bile duct (only)

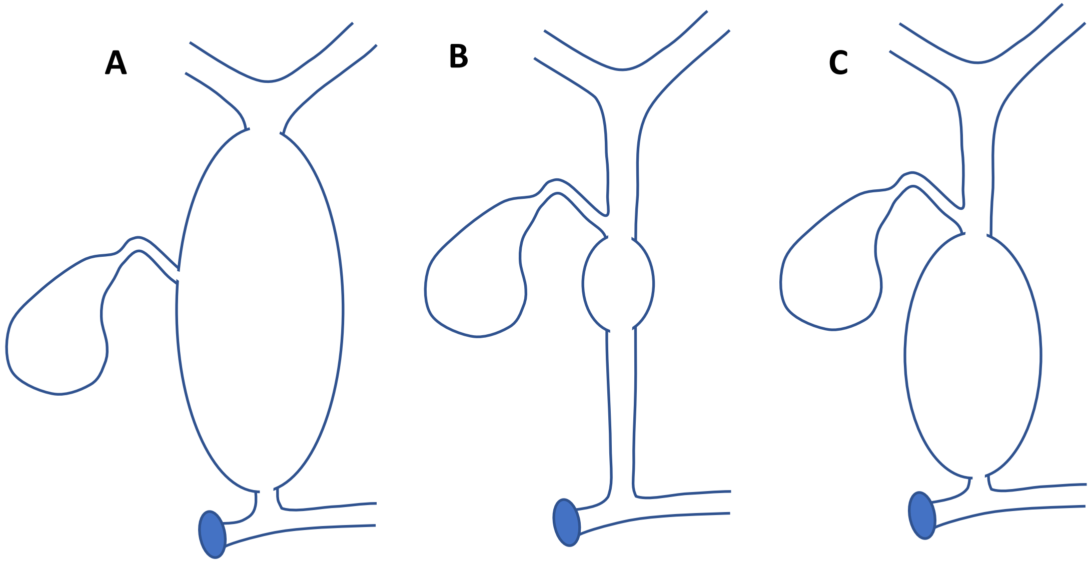


Figure 34. A. Bile duct cyst type Ia; B. Bile duct cyst type Ib; C. Bile duct cyst type Ic

Type V

- Type V corresponds to the **Caroli disease**, a rare congenital cystic dilatation of the **intrahepatic bile ducts (IBDs)** that may diffusely involve the right and left hepatic ducts. We know now that Caroli disease is thought to be a different type of disease than type I-IV cysts as it is caused by a congenital malformation of the ductal plate (=precursor of intrahepatic bile ducts).
- **Intrahepatic saccular or fusiform dilated cystic structures of varying sizes that communicate with the biliary tree.** The presence of a tiny dot with contrast enhancement within the dilated IBDs ("**central dot sign**") is considered highly suggestive of Caroli disease. This sign is produced by enhancing portal branches surrounded by cystic alterations of the IBDs.
- There is an increased **risk of cholangiocarcinoma**, which develops in 7% of patients.
- Caroli disease is associated with different forms of renal cystic disease.

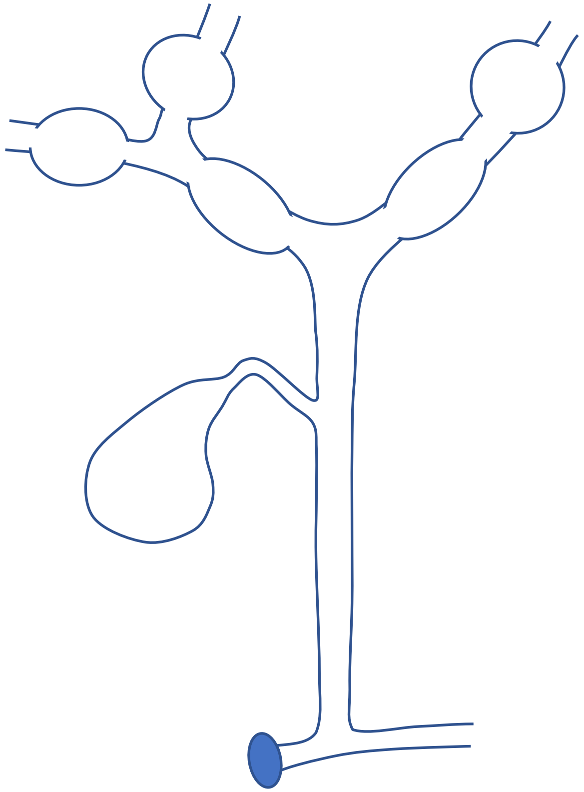


Figure 35. Bile duct cyst type V

Type V

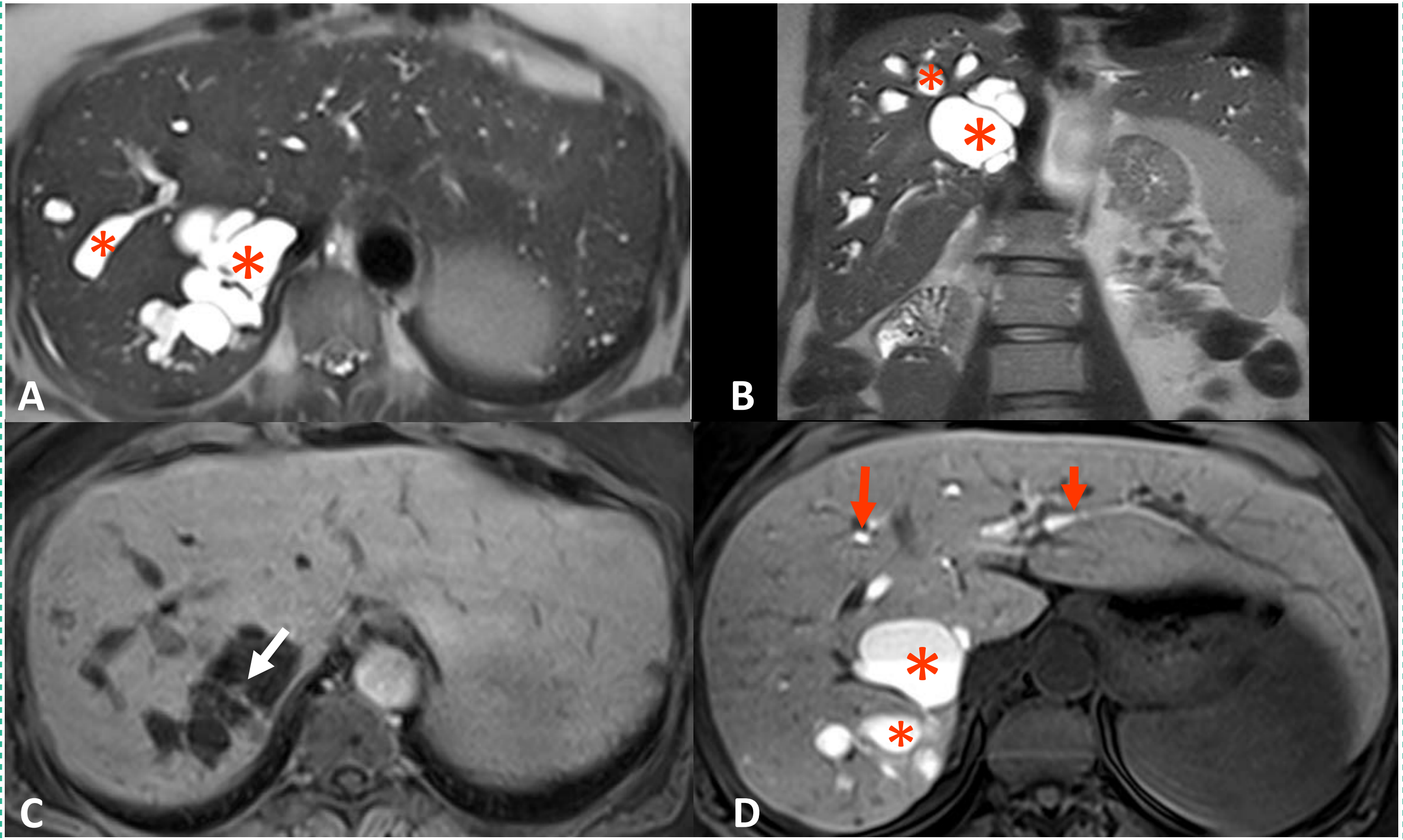


Figure 36. Contrast-enhanced MRI (with hepatobiliary contrast) – Caroli disease.
Axial T2 fat saturated (FS)-weighted (A), coronal T2 FS-weighted (B), axial portal phase T1-weighted (C), axial hepatobiliary phase T1-weighted (D). Several intrahepatic saccular cystic structures (asterisks) which communicate with the biliary tree. On image C there is a tiny dot (white arrow) with contrast enhancement within the saccular biliary dilatation (central dot sign). The hepatobiliary phase (D) shows excretion of contrast by biliary ducts (red arrows) as well as filling the cystic structures (asterisks), proving its communication with the biliary system. The fluid-fluid level reflects biliary stasis.

Interventional Procedures

- Endoscopic Retrograde Cholangiopancreatography (ERCP) is a diagnostic and interventional procedure technique using both endoscopy and fluoroscopy for examination and treatment of the biliary tree and pancreatic ducts. It consists passing an endoscope to the descending duodenum and subsequently cannulating the ampulla of Vater, after which contrast can be injected outlining the biliary tree and various therapeutic interventions can be performed.

Indications:

- Biliary and pancreatic ductal dilatation of unknown cause
- Pancreatitis of unknown cause
- Tissue sampling of ductal system disease
- Manometry for sphincter of Oddi
- Drainage of pancreatic pseudocysts
- Stone removal
- Biliary stenting for strictures and leakage
- Balloon dilation of the duodenal papilla and ductal strictures

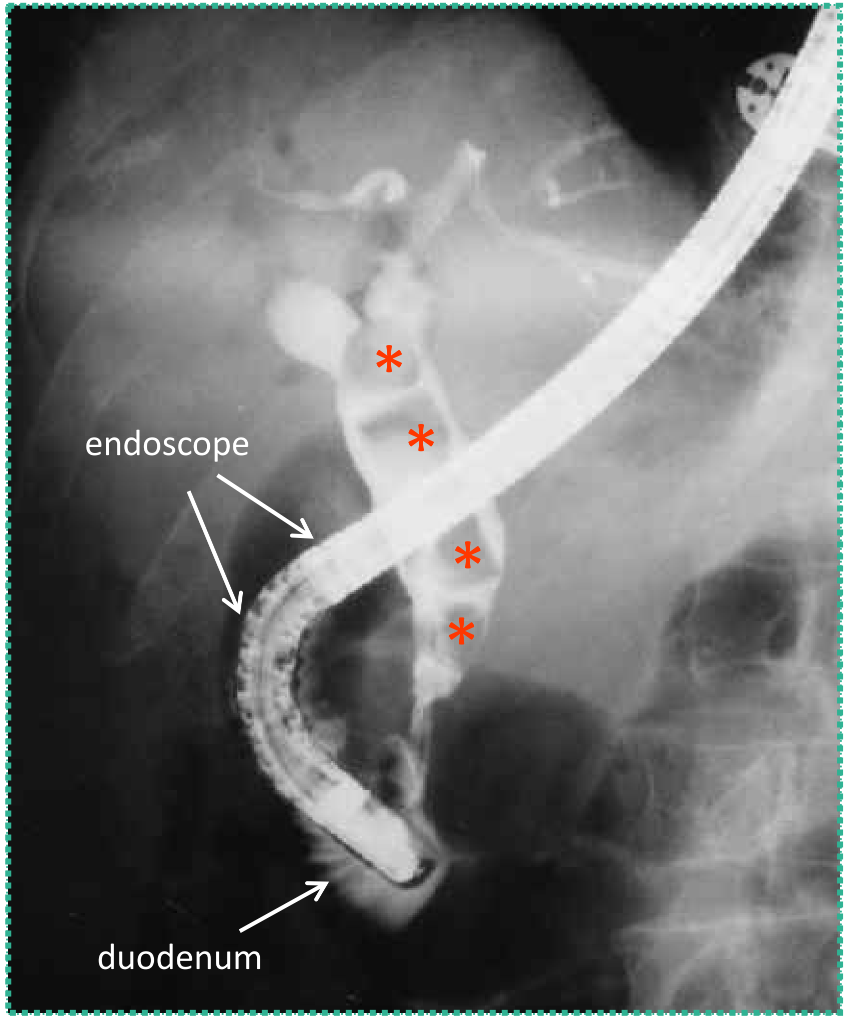


Figure 37.
Endoscopic Retrograde Cholangiopancreatography (ERCP) showing dilated bile ducts containing multiple biliary stones (repletion defects in the CBD, asterisks).

Chapter Outline

Complications directly attributed to ERCP in approximately 5-10% of cases:

- Acute pancreatitis (3,5%)
- Haemorrhage (1,3%)
- Infection (e.g. cholangitis) (1,4%)
- Duodenal and biliary perforation (0,6%)
- Other complications (1,3%)

- Percutaneous Transhepatic Cholangiography (PTC) is an interventional radiology procedure to diagnose and treat blockages or narrowing of the biliary ducts. A congested bile duct is probed by percutaneous puncture and a guidewire is introduced into the duodenum/jejunum through the stenosis. An x-ray procedure that involves injection of contrast material directly into the ducts is performed to evaluate the bile ducts.

- PTC is almost exclusively performed in patients with a malignant obstruction, such as cholangiocarcinoma, ampullary and pancreatic malignancies, when retrograde access via endoscopic retrograde cholangiopancreatography (ERCP) is not amenable.

Indications:

- Biliary stent placement or balloon dilatation (in the absence of criteria for surgery)
- Insertion of catheter to drain bile

Chapter Outline

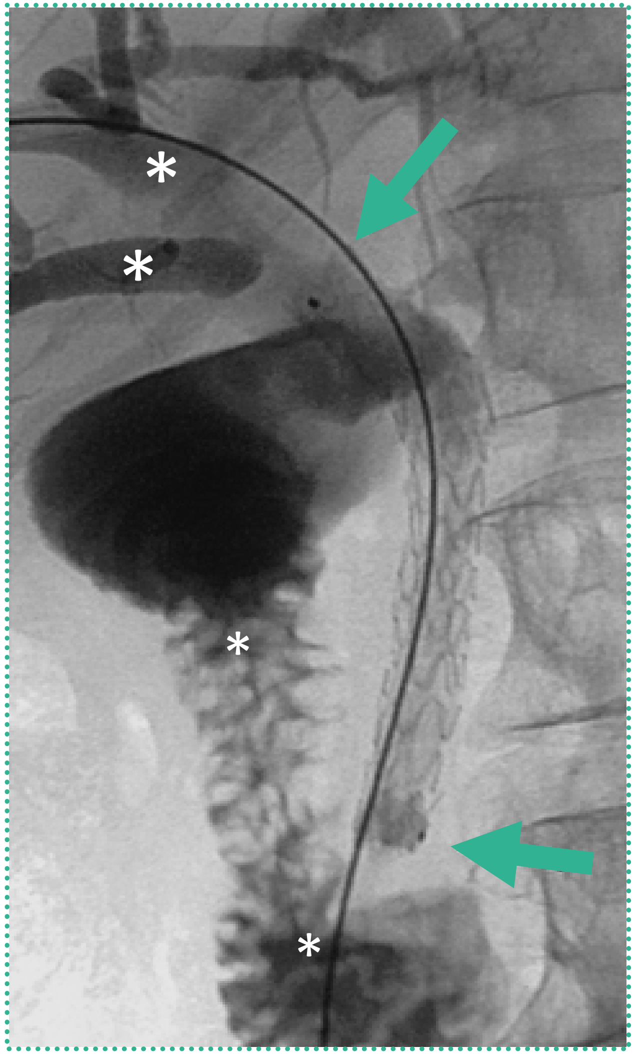


Figure 38.
Percutaneous transhepatic cholangiography (PTC) depicting a malignant stricture treated by a permanent metallic stent (upper arrow points at the trans-hepatic biliary guide wire used to deploy the stent in the CBD, lower arrow points at the distal stent extremity). Large asterisks show the dilated contrast-filled biliary ducts. Small asterisks show the duodenum outlined by contrast material from the CBD.

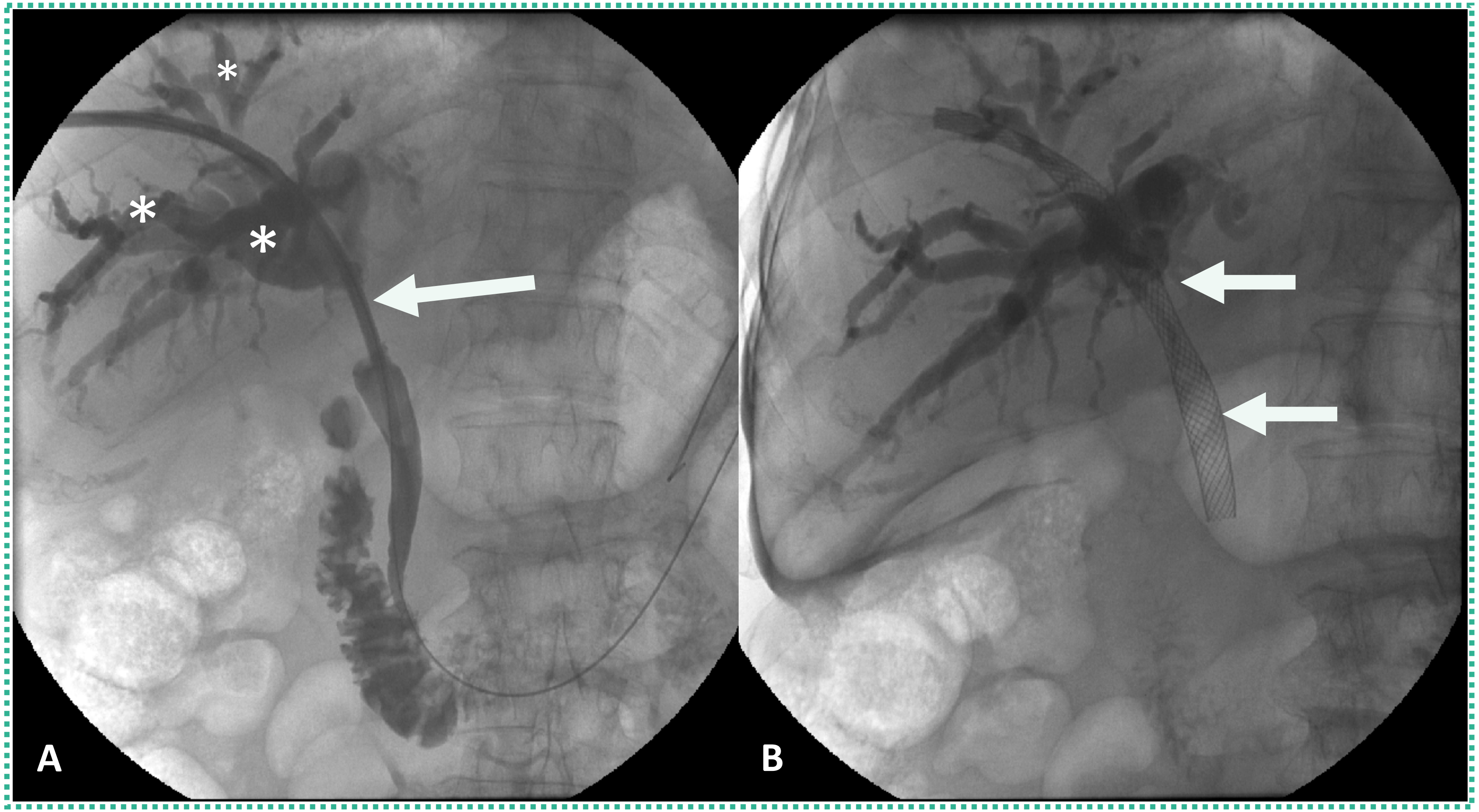


Figure 39.
Percutaneous transhepatic cholangiography (PTC) depicting the dilated bile ducts (asterisks) due to a long stenosis in the extrahepatic duct caused by a cholangiocarcinoma (arrow in A). In image B, after the procedure, it is possible to identify the stent (arrows), which was placed through the stricture allowing the bile to drain.

Chapter Outline

Take-Home Messages (1)

- Diseases of the gallbladder and the biliary tract are the most common causes of symptoms in the right-sided upper abdomen.
- Biliary imaging often requires a multimodality approach.
- Irrespective of imaging technique, an appreciation of the pathologic basis of biliary disease, combined with careful inspection of the imaging appearances is vital for the correct interpretation of biliary studies.
- Ultrasound is the first-line imaging tool for investigation of suspected biliary obstruction.
- MRI, in particular MRCP is the most sensitive test and has changed our practice.
- ERCP should be reserved for therapeutic purposes.

Take-Home Messages (2)

- The evaluation of biliary strictures or filling defects is best performed with thin-section imaging.
- Smooth, concentric long-segment strictures favour a benign cause, whereas abrupt, eccentric short-segment strictures favour a malignancy.
- A stone is the most common biliary filling defect and may occur in the absence of dilated ducts.

References

- Madhusudhan KS, Das P, Gunjan D, Srivastava DN, Garg PK. IgG4-Related Sclerosing Cholangitis: A Clinical and Imaging Review. AJR Am J Roentgenol. 2019 Dec;213(6):1221-1231
- Venkatanarasimha N, Damodharan K, Gogna A, Leong S, Too CW, Patel A, Tay KH, Tan BS, Lo R, Irani F. Diagnosis and Management of Complications from Percutaneous Biliary Tract Interventions. Radiographics. 2017 Mar-Apr;37(2):665-680
- Malay Sharma, Amit Pathak, Abid Shoukat, Chittapuram Srinivasan Rameshbabu, Akash Ajmera, Zeeshn Ahamad Wani, and Praveer Rai. Imaging of common bile duct by linear endoscopic ultrasound. World J Gastrointest Endosc. 2015 Oct 25; 7(15): 1170–1180.
- O'Connor OJ, O'Neill S, Maher MM. Imaging of biliary tract disease. AJR Am J Roentgenol. 2011 Oct;197(4):W551-8
- Yeh BM, Liu PS, Soto JA, Corvera CA, Hussain HK. MR imaging and CT of the biliary tract. Radiographics. 2009 Oct;29(6):1669-88
- Mortelé KJ, Rocha TC, Streeter JL, Taylor AJ. Multimodality imaging of pancreatic and biliary congenital anomalies. Radiographics. 2006 May-Jun;26(3):715-31
- Aubé C, Delorme B, Yzet T, Burtin P, Lebigot J, Pessaux P, Gondry-Jouet C, Boyer J, Caron C. MR cholangiopancreatography versus endoscopic sonography in suspected common bile duct lithiasis: a prospective, comparative study. AJR Am J Roentgenol. 2005 Jan;184(1):55-62
- Baillie J, Paulson EK, Vitellas KM. Biliary imaging: a review. Gastroenterology. 2003 May;124(6):1686-99
- Pannu HK, Fishman EK. Complications of endoscopic retrograde cholangiopancreatography: spectrum of abnormalities demonstrated with CT. Radiographics. 2001 Nov-Dec;21(6):1441-53
- Levy AD, Murakata LA, Rohrmann CA Jr. Gallbladder carcinoma: radiologic-pathologic correlation. Radiographics. 2001 Mar Apr;21(2):295-314
- S. Kreuzer, J. Kettenbach. Gallbladder and biliary tract. Textbook of Clinical Radiology

Test Your Knowledge

1 - Anatomical variants of the biliary tree are rare.

- True
- False

Chapter Outline

Test Your Knowledge

1 - Anatomical variants of the biliary tree are rare.

- True
- ✓ False

Test Your Knowledge

2 - Which is the most common anatomical variant of the intrahepatic bile ducts?

- Right posterior duct joining with the right anterior duct by its lateral (right) aspect
- Triple confluence, with the right posterior, right anterior and left hepatic ducts joining at the same point to form the common hepatic duct
- Right posterior duct draining into the left hepatic duct
- Right anterior duct draining into the left hepatic duct

Chapter Outline

Test Your Knowledge

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- Right anterior duct draining into the left hepatic duct

Test Your Knowledge

3 - What is the best imaging modality to depict cholelithiasis?

- US
- CT
- MRCP
- EUS

Chapter Outline

Test Your Knowledge

3 - What is the best imaging modality to depict cholelithiasis?

- US
- CT
- ✓ MRCP
- EUS

Test Your Knowledge

4 – What is the most sensitive US finding in acute cholecystitis?

- Cholelithiasis + gallbladder wall thickening
- Cholelithiasis + sonographic Murphy sign
- Gallbladder wall thickening + gallbladder distension
- Gallbladder distension + pericholecystic fluid

Test Your Knowledge

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Test Your Knowledge

5 – Which of the following statements is/are correct ?

- US is the most sensitive imaging modality to detect cholecystolithiasis
- CT is the most sensitive imaging modality to detect cholecystolithiasis
- US has a limited sensitivity to detect calculi in the common bile duct
- CT is the most sensitive imaging modality to detect calculi in the common bile duct

Chapter Outline

Test Your Knowledge

5 – Which of the following statements is/are correct ?

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- ✓ US has a limited sensitivity to detect calculi in the common bile duct
- CT is the most sensitive imaging modality to detect calculi in the common bile duct

Test Your Knowledge

6 - Which is not a cause of pneumobilia?

- Recent biliary instrumentation
- Incompetent sphincter of Oddi
- Biliary-enteric fistula
- Infection (e.g. Emphysematous Cholecystitis)
- Cholangiocarcinoma

Test Your Knowledge

?

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- Biliary-enteric fistula
- Infection (e.g. Emphysematous Cholecystitis)

✓ Cholangiocarcinoma

Chapter Outline

Test Your Knowledge

7 - Select the predisposing conditions for cholangiocarcinoma:

- Choledochal cyst
- Caroli disease
- Primary sclerosing cholangitis
- Hepatitis B

Test Your Knowledge

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- ✓ Primary sclerosing cholangitis
- ✓ Hepatitis B

Test Your Knowledge

8 - Which is not a typical imaging feature of mass-forming type of cholangiocarcinoma?

- Rim-like enhancement in arterial phase and consequent gradual centripetal enhancement
- Capsular retraction
- Satellite nodules
- Hypointensity on T1-weighted images

Test Your Knowledge

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- Capsular retraction
- Satellite nodules
- ✓ Hypointensity on T1-weighted images

Test Your Knowledge

9 - Which is not a typical feature of Caroli disease?

- It is a congenital cystic dilatation of the intrahepatic bile ducts (type V)
- The dilated cystic structures communicate with the biliary tree
- “Central dot sign” on CT/MRI
- It affects both intrahepatic and extrahepatic bile ducts

Test Your Knowledge

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Chapter Outline

Test Your Knowledge

10 - Percutaneous Transhepatic Cholangiography :

- Is a radiologic interventional procedure to diagnose blockages or narrowing of the biliary ducts
- Uses both endoscopy and fluoroscopy for the examination and treatment of the biliary ducts
- Requires percutaneous puncture of a bile duct
- Necessitates injection of contrast material directly in the bile ducts

Chapter Outline

Test Your Knowledge

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Chapter Outline