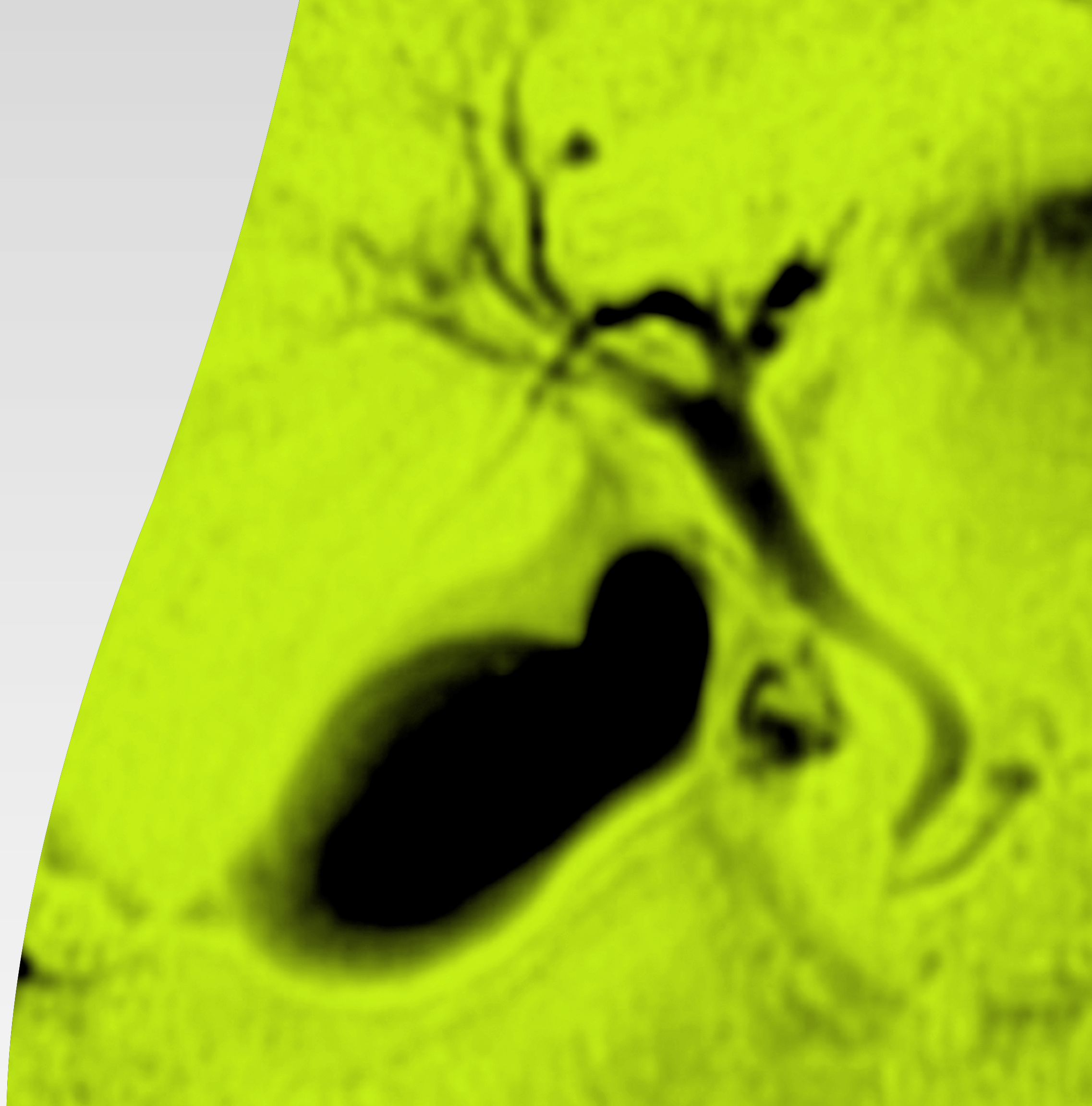
MODERN RADIOLOGY eBook

Bile Ducts



EUROPEAN SOCIETY OF RADIOLOGY

Preface

Modern Radiology is a free educational resource for radiology published online by the European Society of Radiology (ESR). The title of this second, rebranded version reflects the novel didactic concept of the ***ESR eBook*** with its unique blend of text, images, and schematics in the form of succinct pages, supplemented by clinical imaging cases, Q&A sections and hyperlinks allowing to switch quickly between the different sections of organ-based and more technical chapters, summaries and references.

Its chapters are based on the contributions of over 100 recognised European experts, referring to both general technical and organ-based clinical imaging topics. The new graphical look showing Asklepios with fashionable glasses, symbolises the combination of classical medical teaching with contemporary style education.

Although the initial version of the ***ESR eBook*** was created to provide basic knowledge for medical students and teachers of undergraduate courses, it has gradually expanded its scope to include more advanced knowledge for readers who wish to 'dig deeper'. As a result, ***Modern Radiology*** covers also topics of the postgraduate levels of the ***European Training Curriculum for Radiology***, thus addressing postgraduate educational needs of residents. In addition, it reflects feedback from medical professionals worldwide who wish to update their knowledge in specific areas of medical imaging and who have already appreciated the depth and clarity of the ***ESR eBook*** across the basic and more advanced educational levels.

I would like to express my heartfelt thanks to all authors who contributed their time and expertise to this voluntary, non-profit endeavour as well as Carlo Catalano, Andrea Laghi and András Palkó, who had the initial idea to create an ***ESR eBook***, and - finally - to the ESR Office for their technical and administrative support.

Modern Radiology embodies a collaborative spirit and unwavering commitment to this fascinating medical discipline which is indispensable for modern patient care. I hope that this ***educational*** tool may encourage curiosity and critical thinking, contributing to the appreciation of the art and science of radiology across Europe and beyond.

Minerva Becker, Editor
Professor of Radiology, University of Geneva, Switzerland

Bile Ducts

CHAPTER OUTLINE:

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/ Signage

CORE KNOWLEDGE

FURTHER KNOWLEDGE

ATTENTION

COMPARE

QUESTIONS

HYPERLINKS

REFERENCES

CHAPTER OUTLINE:

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Bile Ducts

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/ **Bile** Ducts

CHAPTER OUTLINE:

Chapter Outline

/ Anatomy

CHAPTER OUTLINE:

/ 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.

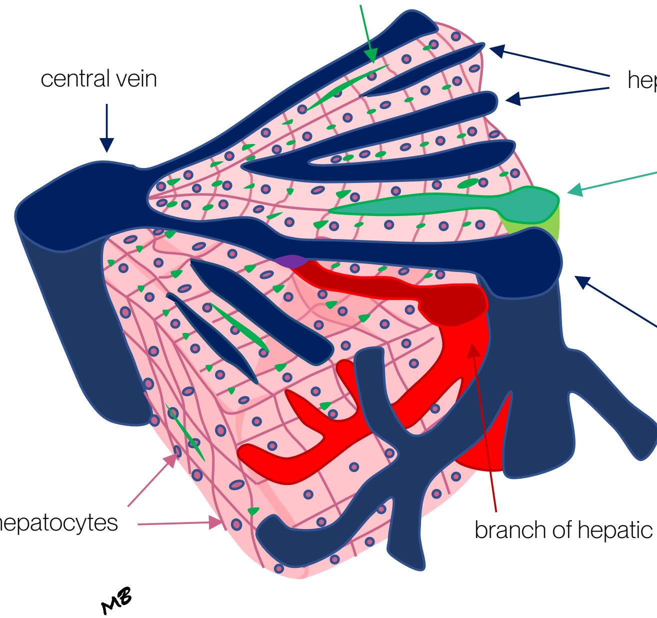


FIGURE 1

Schematic illustration of the portal triads.

/ Bile Ducts

CHAPTER OUTLINE:

/ 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

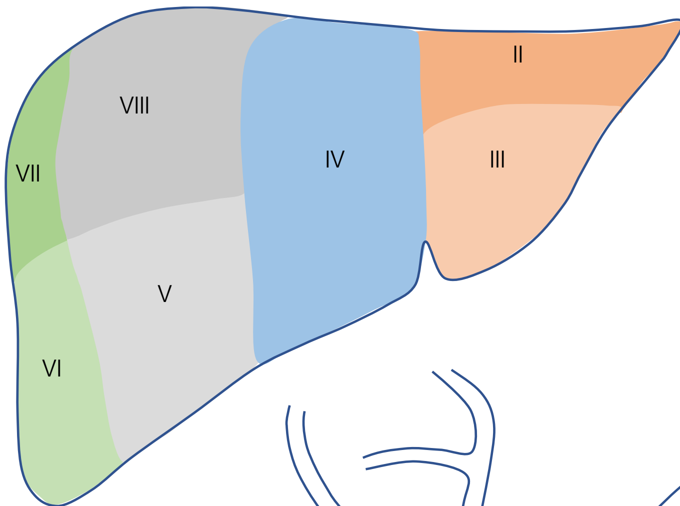


FIGURE 2

Liver segments.

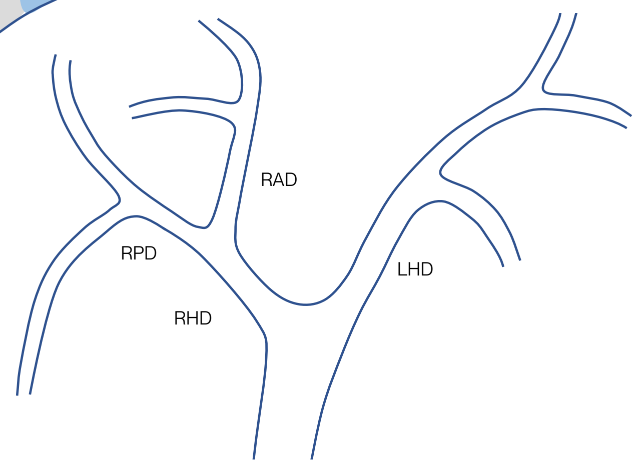


FIGURE 3

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

/ **Bile** Ducts

CHAPTER OUTLINE:

/ 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 extrahe-patic 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

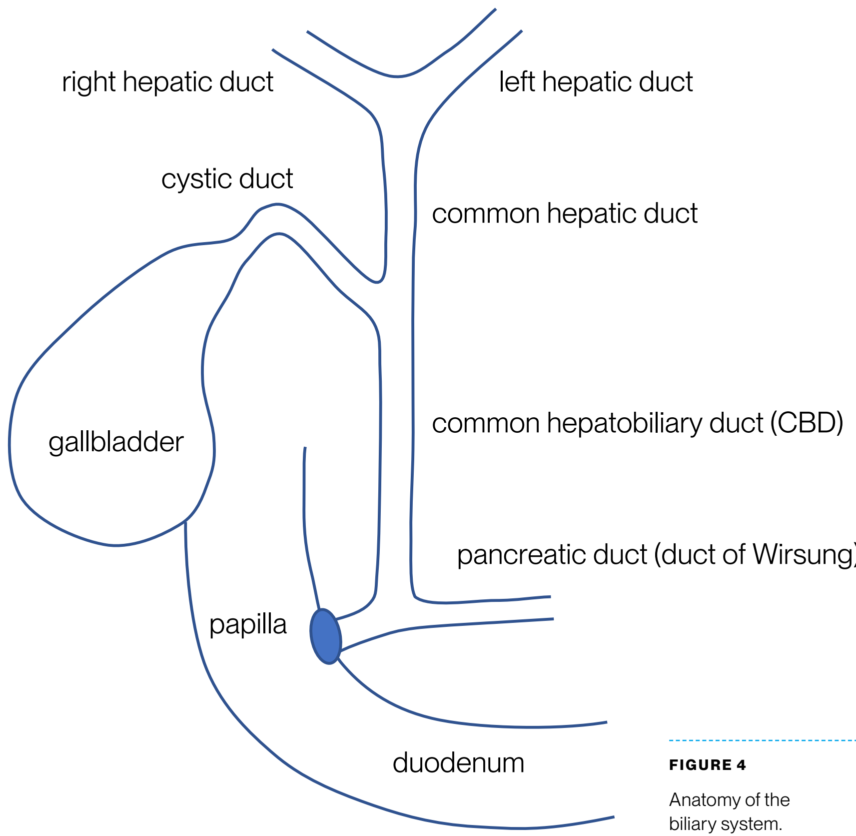
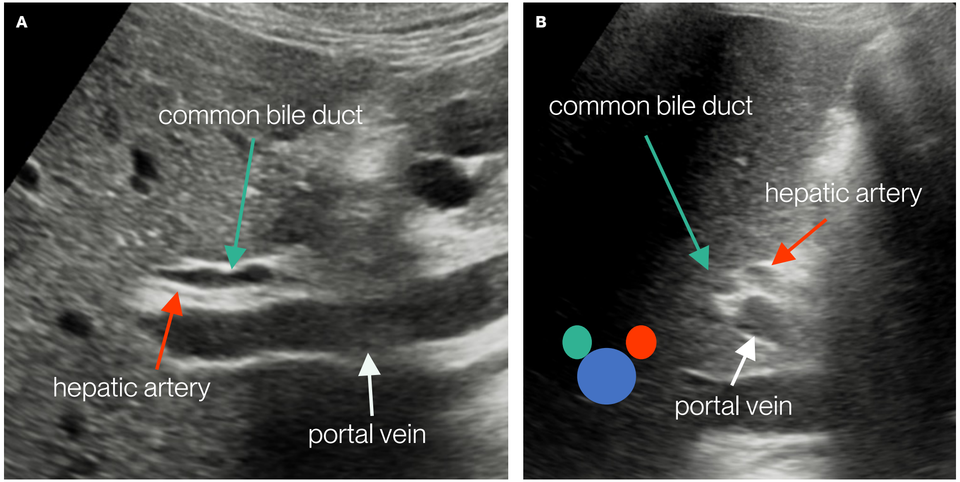
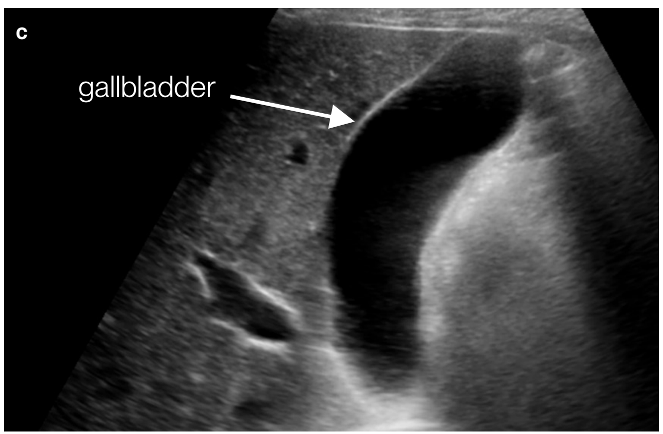


FIGURE 4

Anatomy of the biliary system.

CHAPTER OUTLINE:





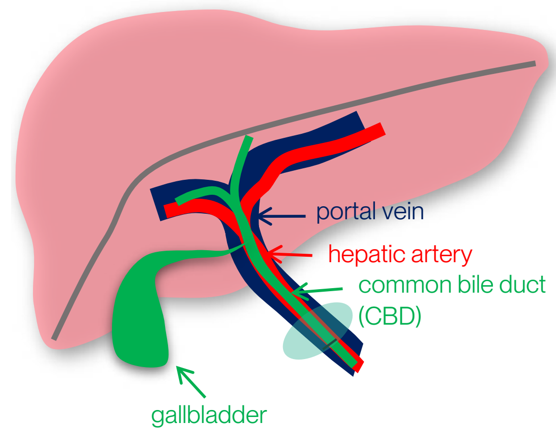


FIGURE 5

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 ≤ 4 mm 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 < 3 mm.

Images courtesy of Gyorgi Varnay, MD, University Hospital Geneva

CHAPTER OUTLINE:

Anatomical Variants

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 of complications associated to cholecystectomies, like transection of the extrahepatic bile duct.

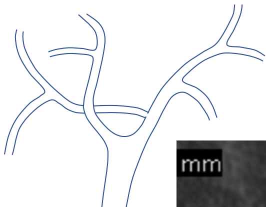
/ Anatomical Variants of the Intrahepatic Bile Ducts

- 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%)

CHAPTER OUTLINE:

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

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



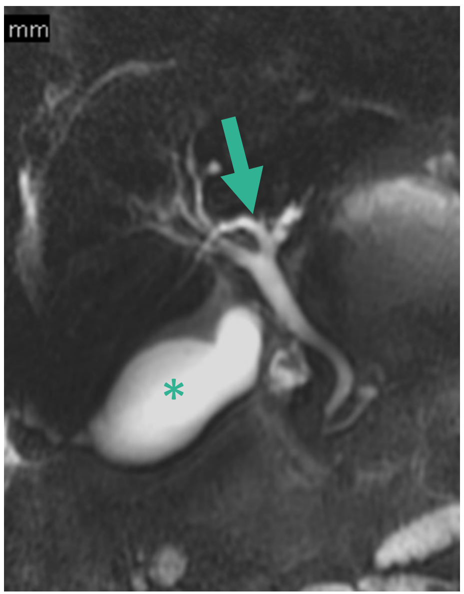


FIGURE 6

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

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

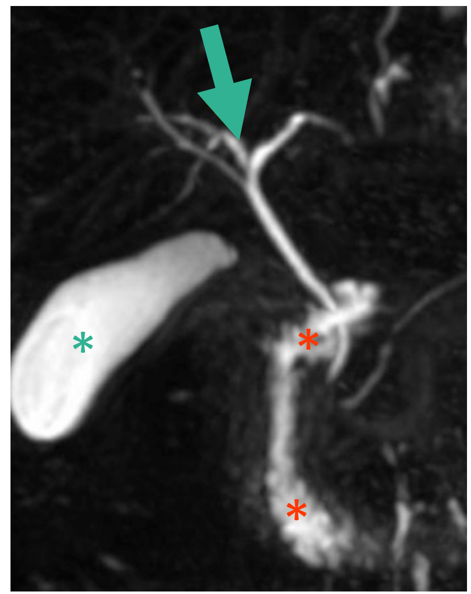


FIGURE 7

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

CHAPTER OUTLINE:

/ 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%)

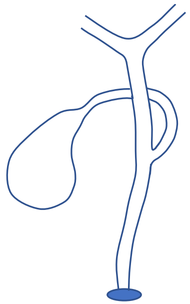


FIGURE 8

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

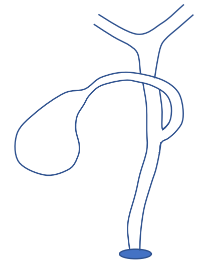


FIGURE 9

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

CHAPTER OUTLINE:

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%)

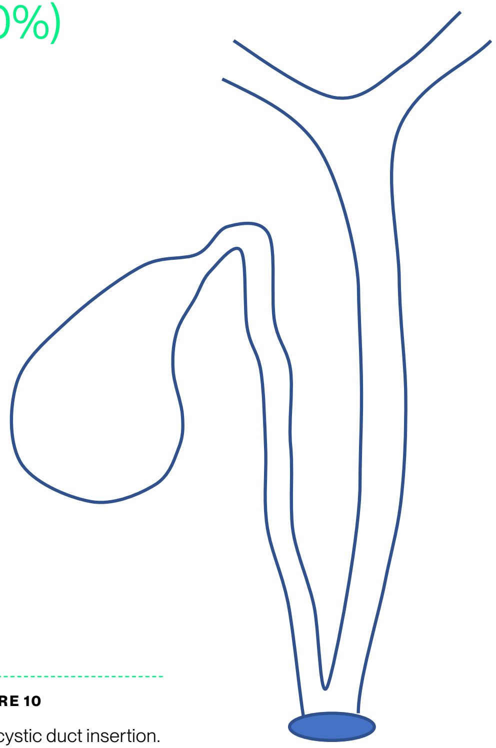


FIGURE 10

Low cystic duct insertion.

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

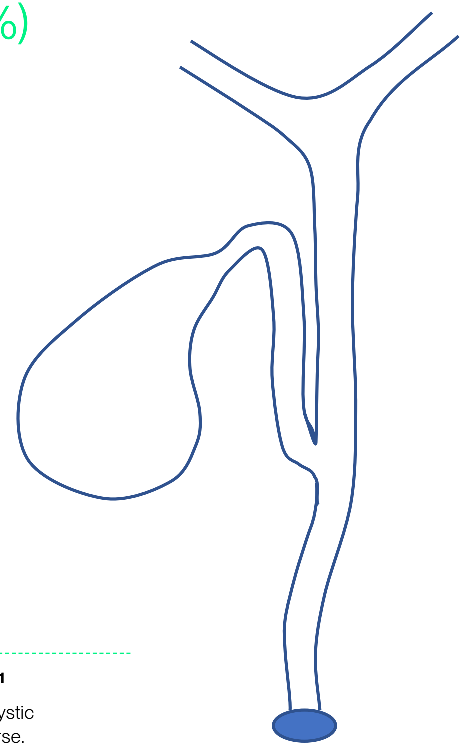


FIGURE 11

Parallel cystic duct course.

/ Anatomical variants of the gallbladder

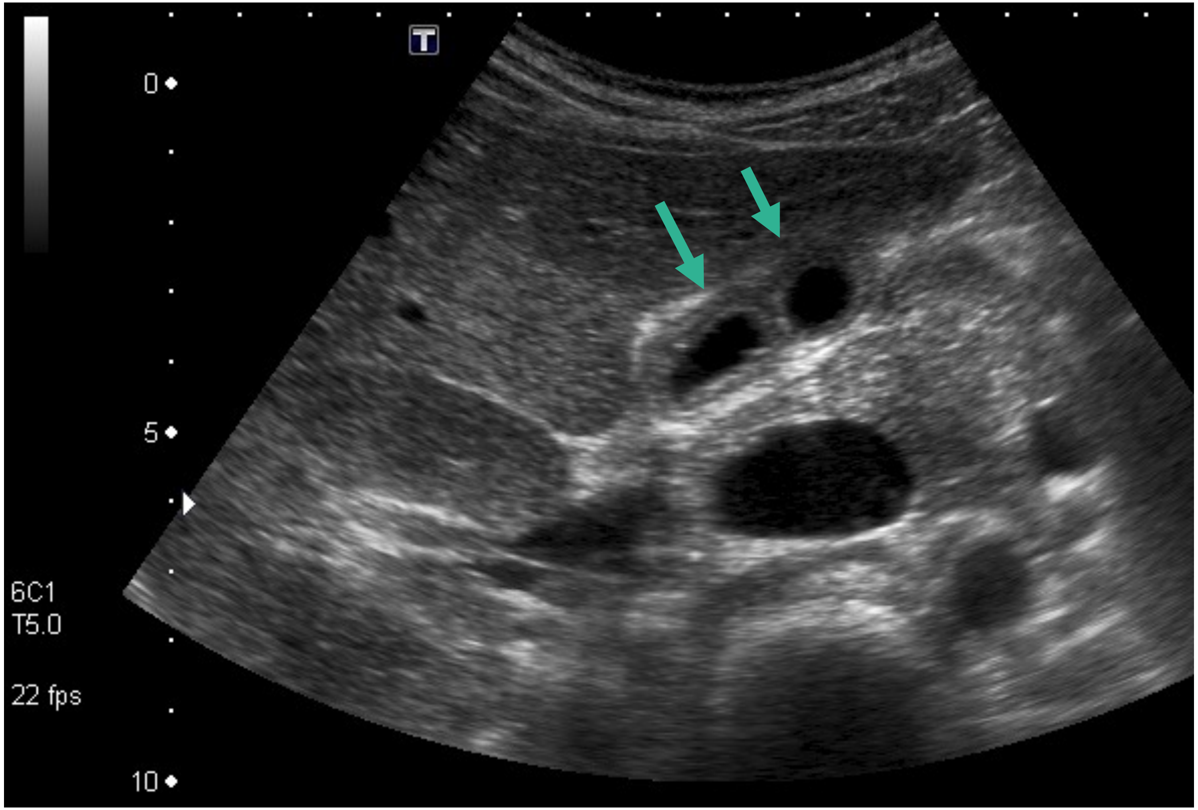


FIGURE 12

Ultrasound image showing gallbladder duplication (arrows).

CHAPTER OUTLINE:

Diagnostic Imaging Techniques

CHAPTER OUTLINE:

/ 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:

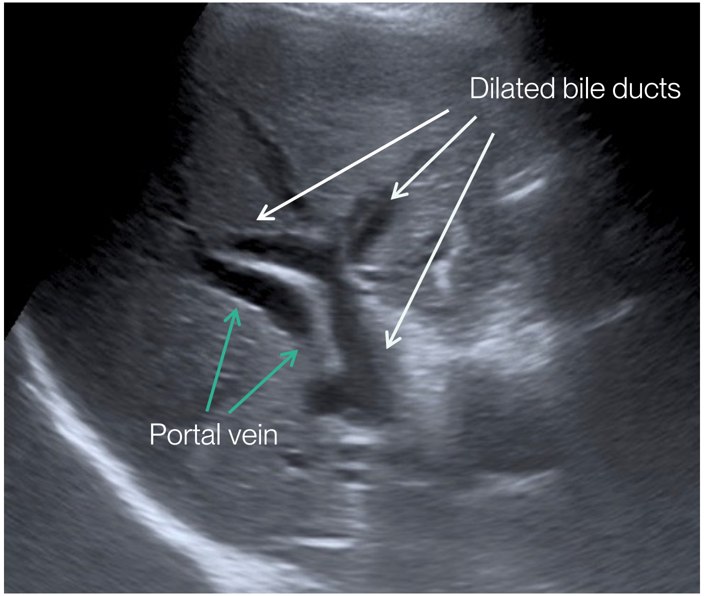
+ Low cost and availability.
+ Does not use ionising radiation.
+ High accuracy in detecting biliary dilatation.

DISADVANTAGES:

– Inconsistent visualisation of the distal common bile duct.
– Low sensitivity for determining the cause of obstruction.

FIGURE 13

US scan depicting bile duct dilatation (**arrows**).



<!> ATTENTION

Additional imaging may be required!

/ 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 visualise biliary stones (only 10-15% are radiopaque).

– Radiation exposure.

– Need to use i.v. contrast to clearly separate bile ducts from portal vein branches.

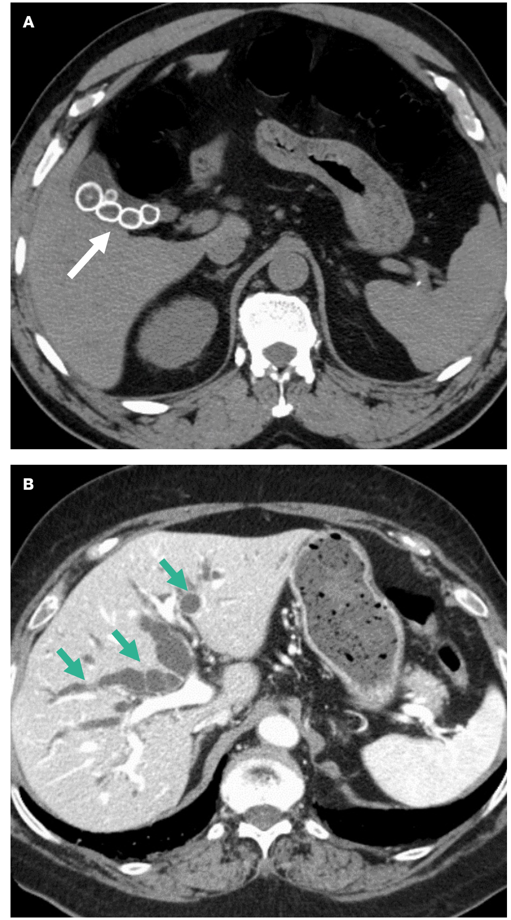


FIGURE 14

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.

/ **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 15

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**).

CHAPTER OUTLINE:

- 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 16

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

/ **Bile** Ducts

CHAPTER OUTLINE:

/ 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.

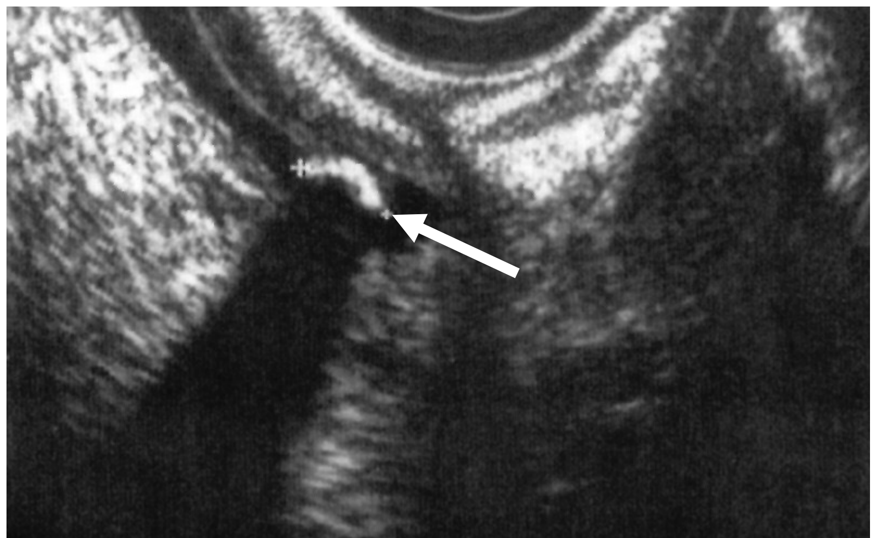


FIGURE 17

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

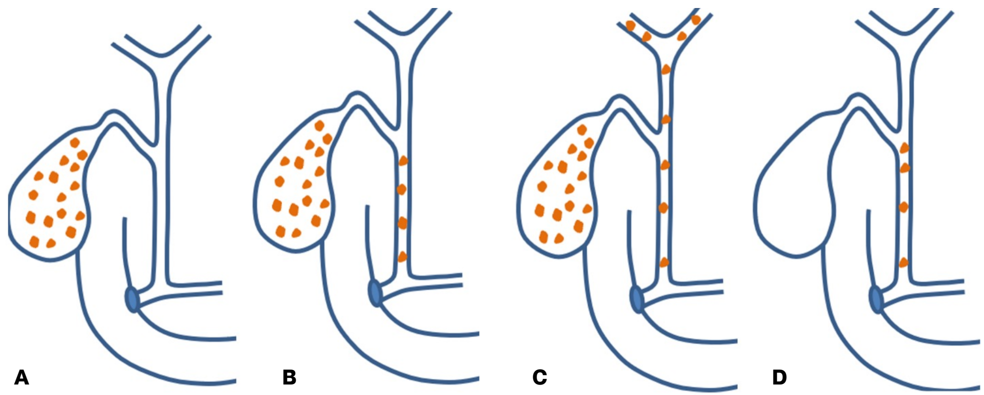
Diseases of the Biliary Tract

Bile Ducts

CHAPTER OUTLINE:

/ 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.



<!> ATTENTION

Choledocholithiasis is the most common cause of biliary obstruction!

FIGURE 18

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 visualise biliary stones, with a **sensitivity up to 95% for depicting stones within the gallbladder (chole-cystolithiasis).** 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.

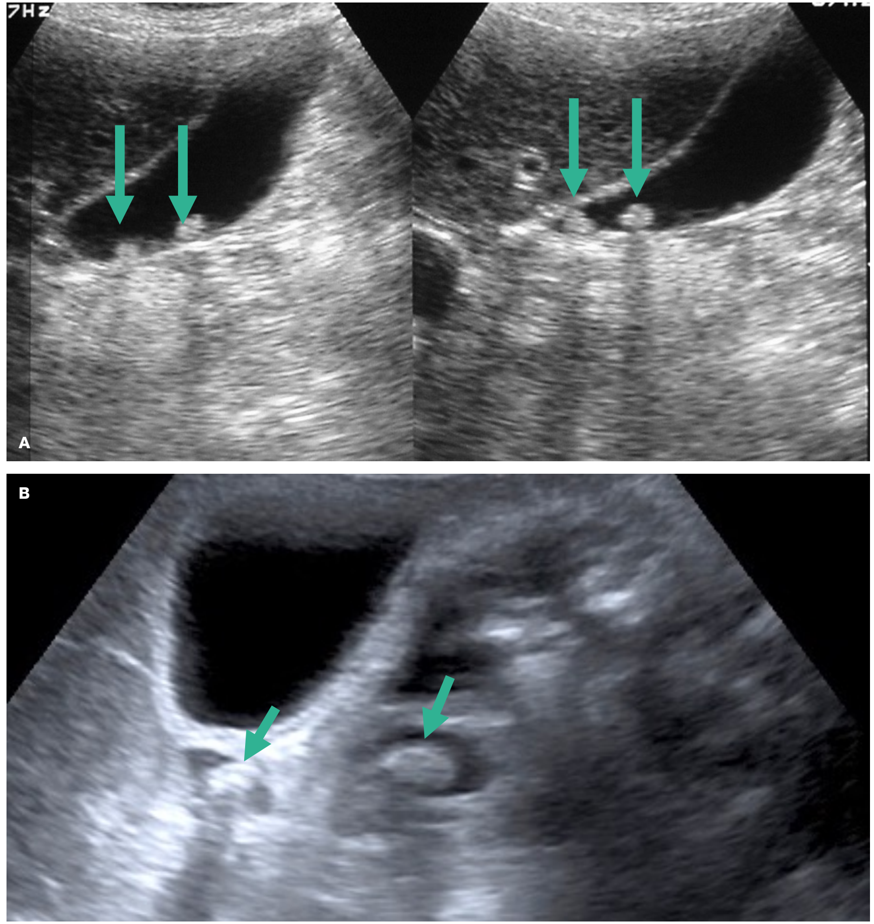


FIGURE 19

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**).

CHAPTER OUTLINE:

/ **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 recognised, but only corresponding to 20% of stones**), isoattenuation relative to bile because of cholesterol deposition, or hypoattenuation because of nitrogen gas.

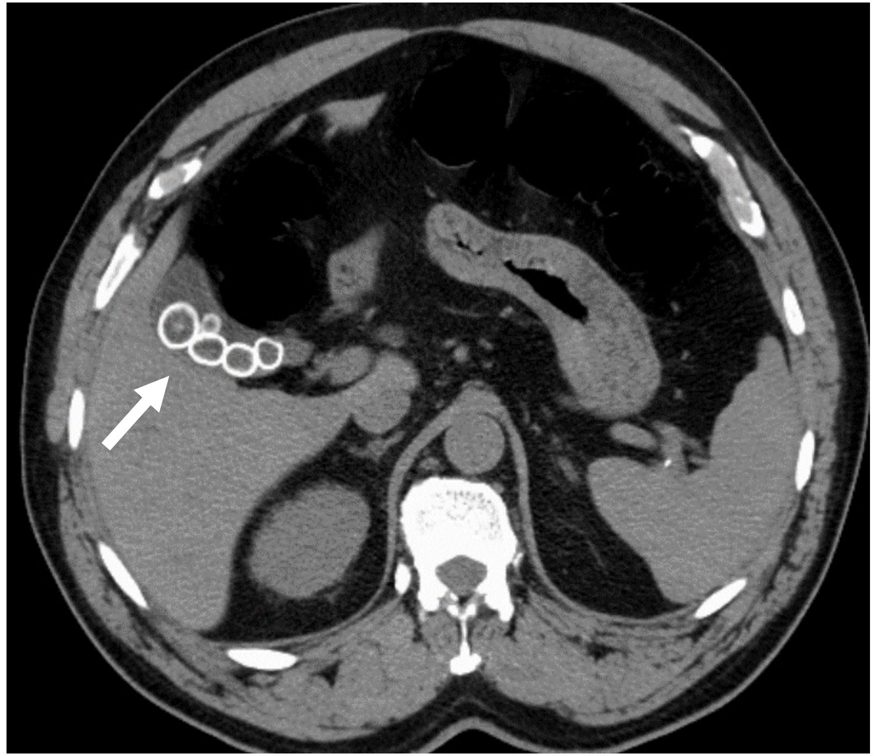


FIGURE 20

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

>|< COMPARE

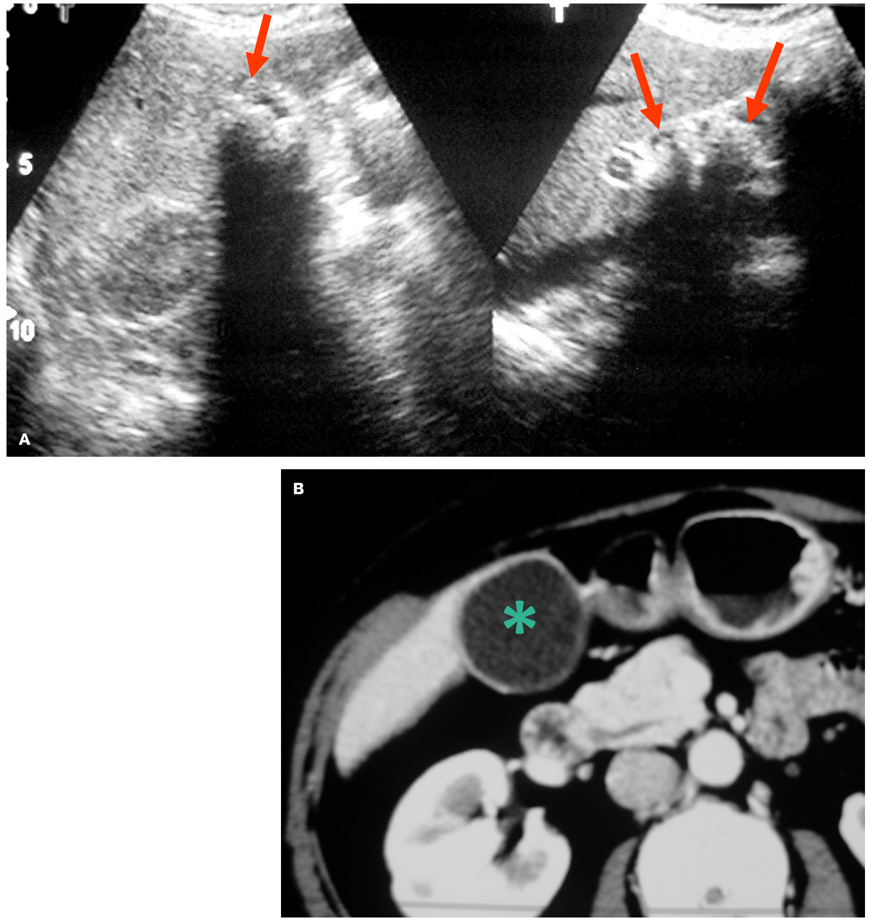


FIGURE 21

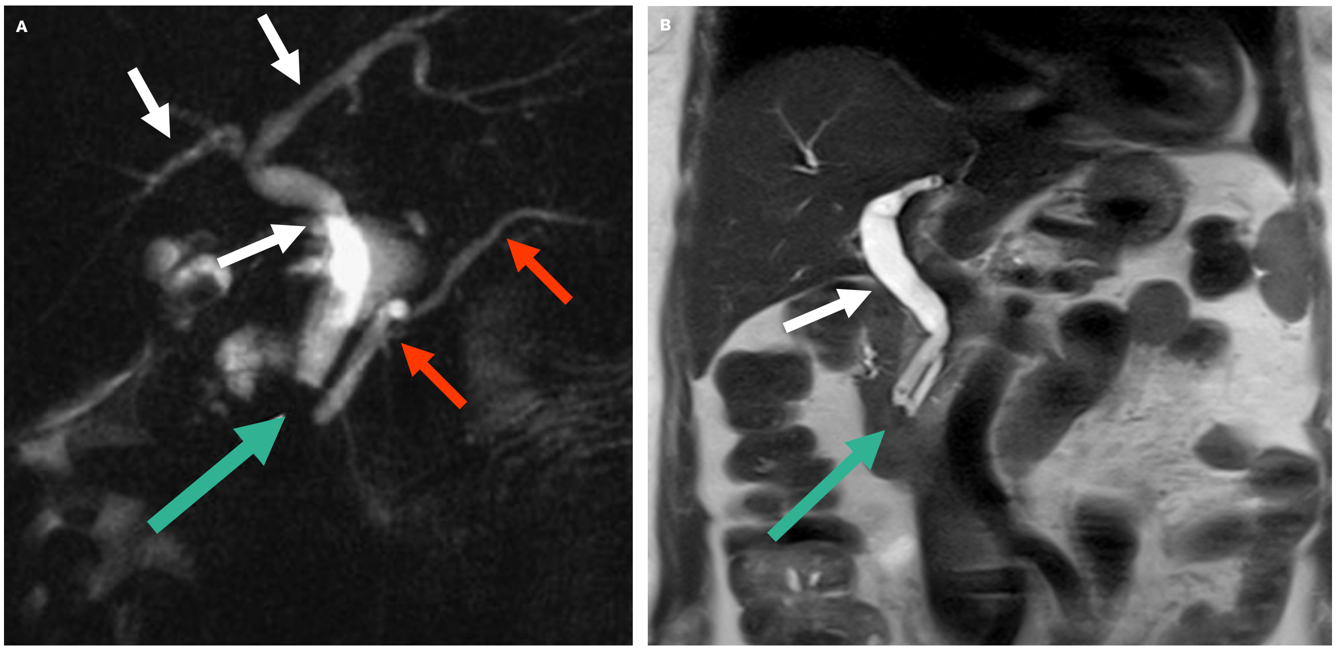
Ultrasound and CT performed in the same patient reveal the limitation of CT for the identification of stones. The US examination shows countless gallbladder stones (**arrows**), which are not identified on CT (**asterisk**).

/ 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 22

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

<=> CORE KNOWLEDGE

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 critically ill patients (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.

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.

>=< FURTHER KNOWLEDGE

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).

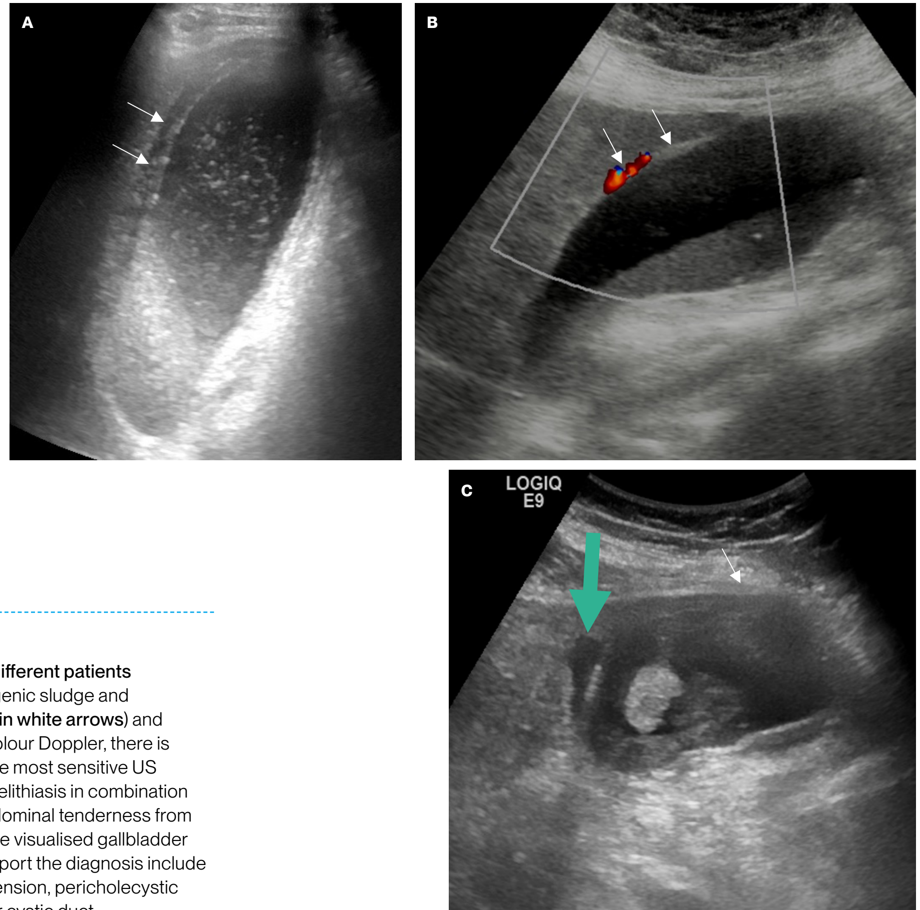


FIGURE 23

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 visualised 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.

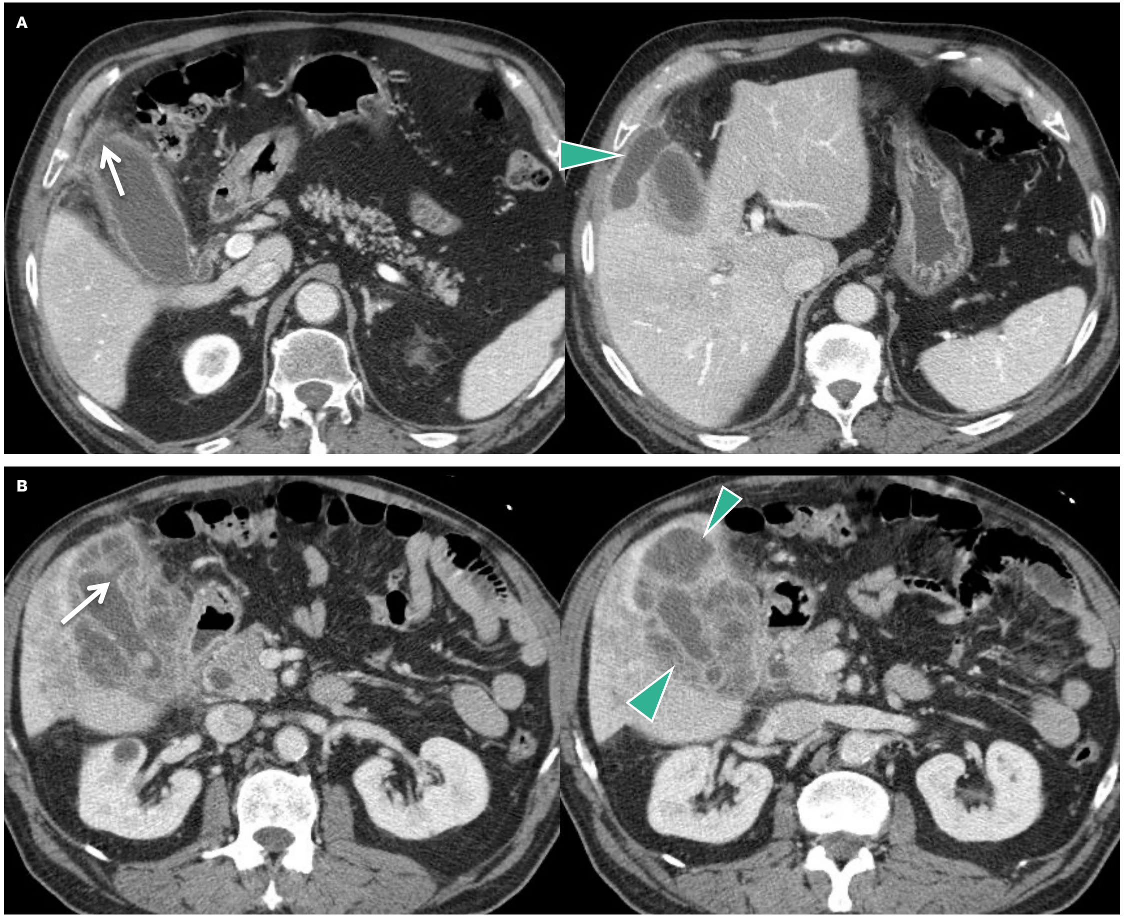


FIGURE 24

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**).

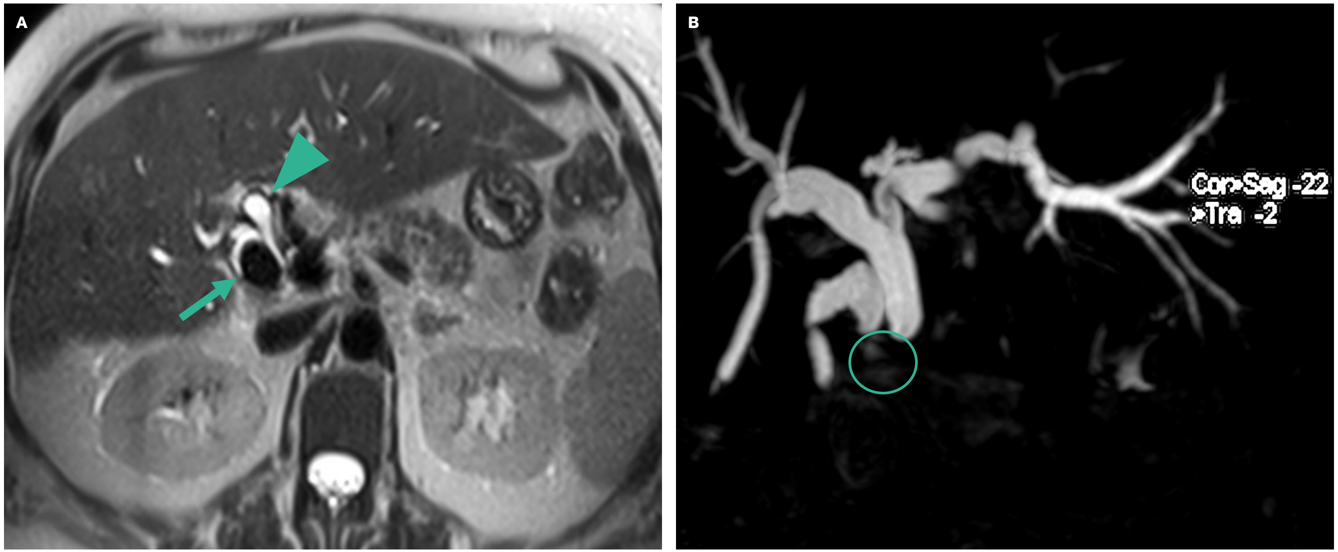


FIGURE 25

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.

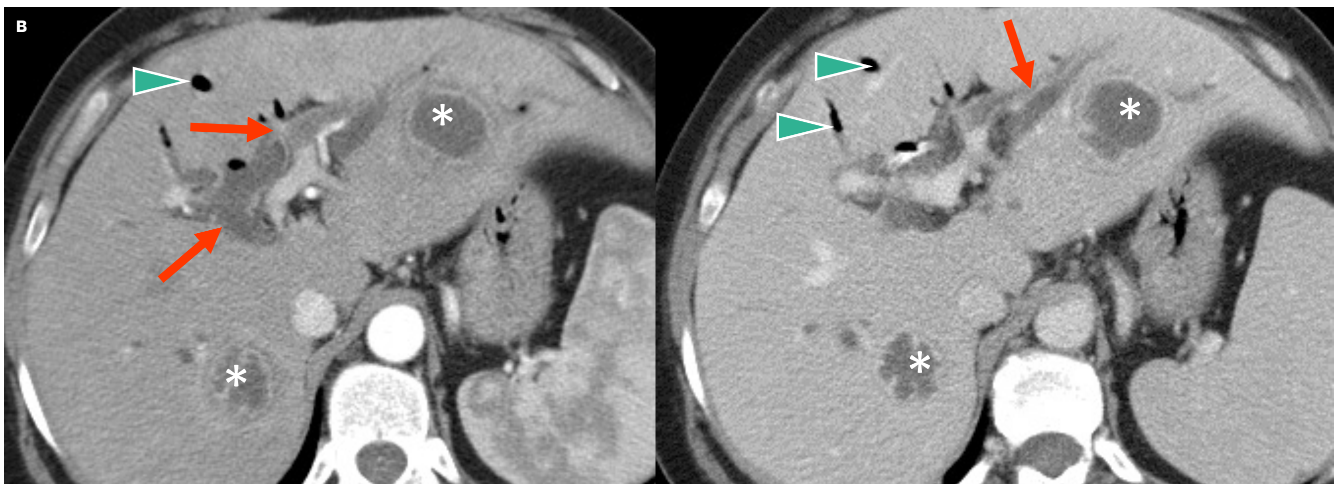


FIGURE 26

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

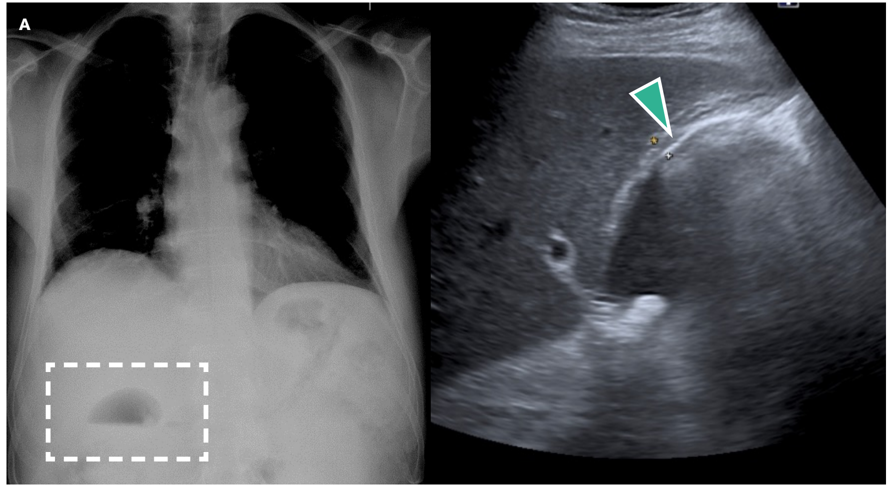
A: Dilatation and concentric wall thickening of the bile ducts, associated with mural enhancement (**arrow**) and pneumobilia (**arrowhead**).

B: Dilatation of bile ducts (**arrows**) with signs of pneumobilia (**arrowheads**). This case was complicated with development of two liver abscesses (**asterisk**).

/ Bile Ducts

CHAPTER OUTLINE:

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 rate of mortality and it is considered a surgical emergency.



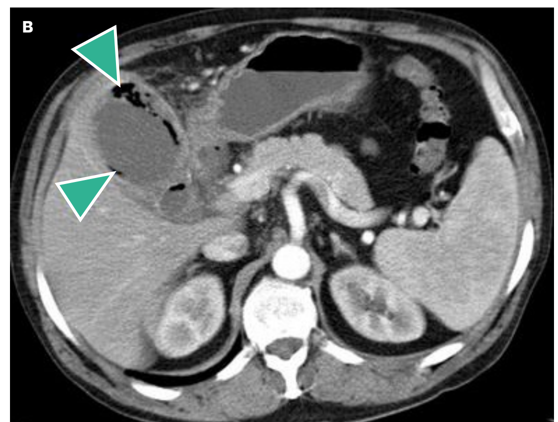


FIGURE 27

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**).

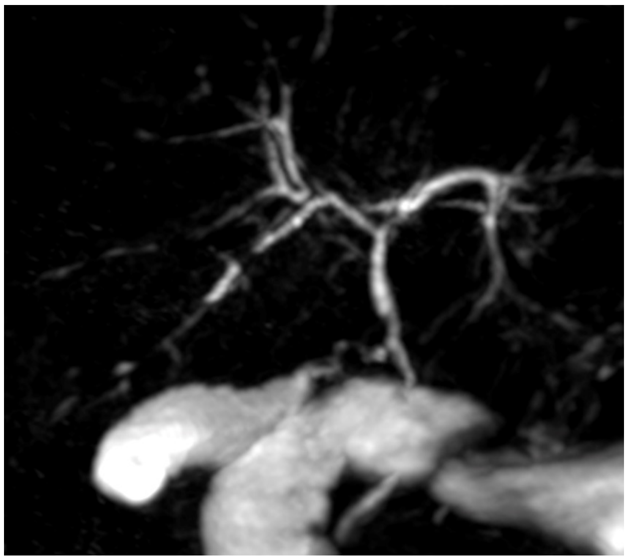
In image B, computed tomography shows signs of cholecystitis (gallbladder distention, wall thickening, pericholecystic fat stranding) with presence of gas in the wall and lumen (**arrowheads**).

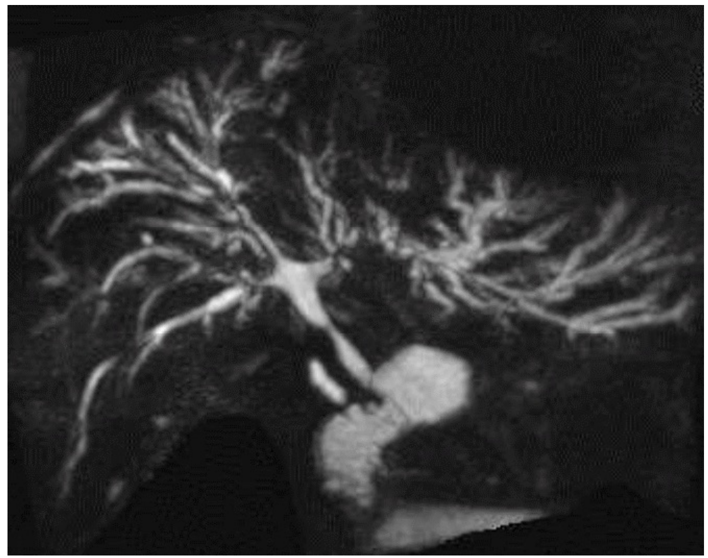
CHAPTER OUTLINE:

Primary sclerosing cholangitis is a specific type of cholangitis, corresponding to a progressive cholestatic disease characterised 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 28

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.

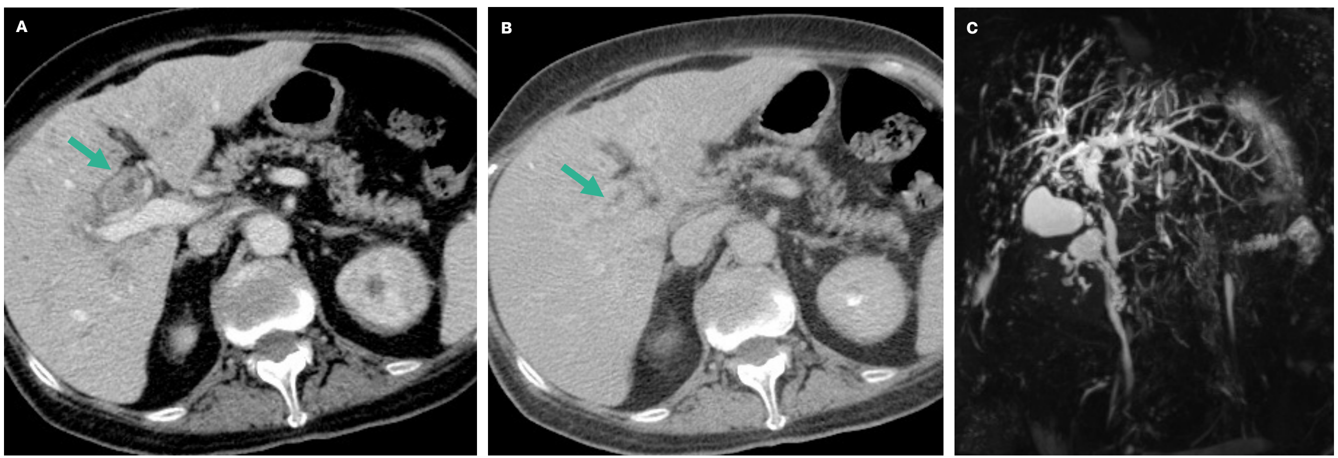




IgG4-related sclerosing cholangitis (ISC) is a rare chronic inflammatory disease of the biliary system that occurs in the context of a systemic disorder (IgG4-related disease) that can affect multiple organs. Autoimmune pancreatitis is seen in more than 90% of patients with ISC. ISC is frequently associated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

FIGURE 29

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.



<=> CORE KNOWLEDGE

Gallbladder carcinoma is a relatively rare malignant tumour and affects predominantly elderly women with long-standing cholecystolithiasis. On imaging, it is seen as a focal intraluminal mass, focal or diffuse irregular wall 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 (men older than 65 years are most commonly affected). Predisposing conditions include choledochal cyst, Caroli disease, recurrent pyogenic cholangitis, primary sclerosing cholangitis and viral infections (e.g. hepatitis B).

>=< FURTHER KNOWLEDGE

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 duct wall thickening, occurring most commonly at the bifurcation of the common hepatic duct, being referred to as **Klatskin tumour**.

/ The intraductal polypoid is characterised by alterations in duct calibre, usually duct ectasia with or without a visible polypoid mass.

CHAPTER OUTLINE:

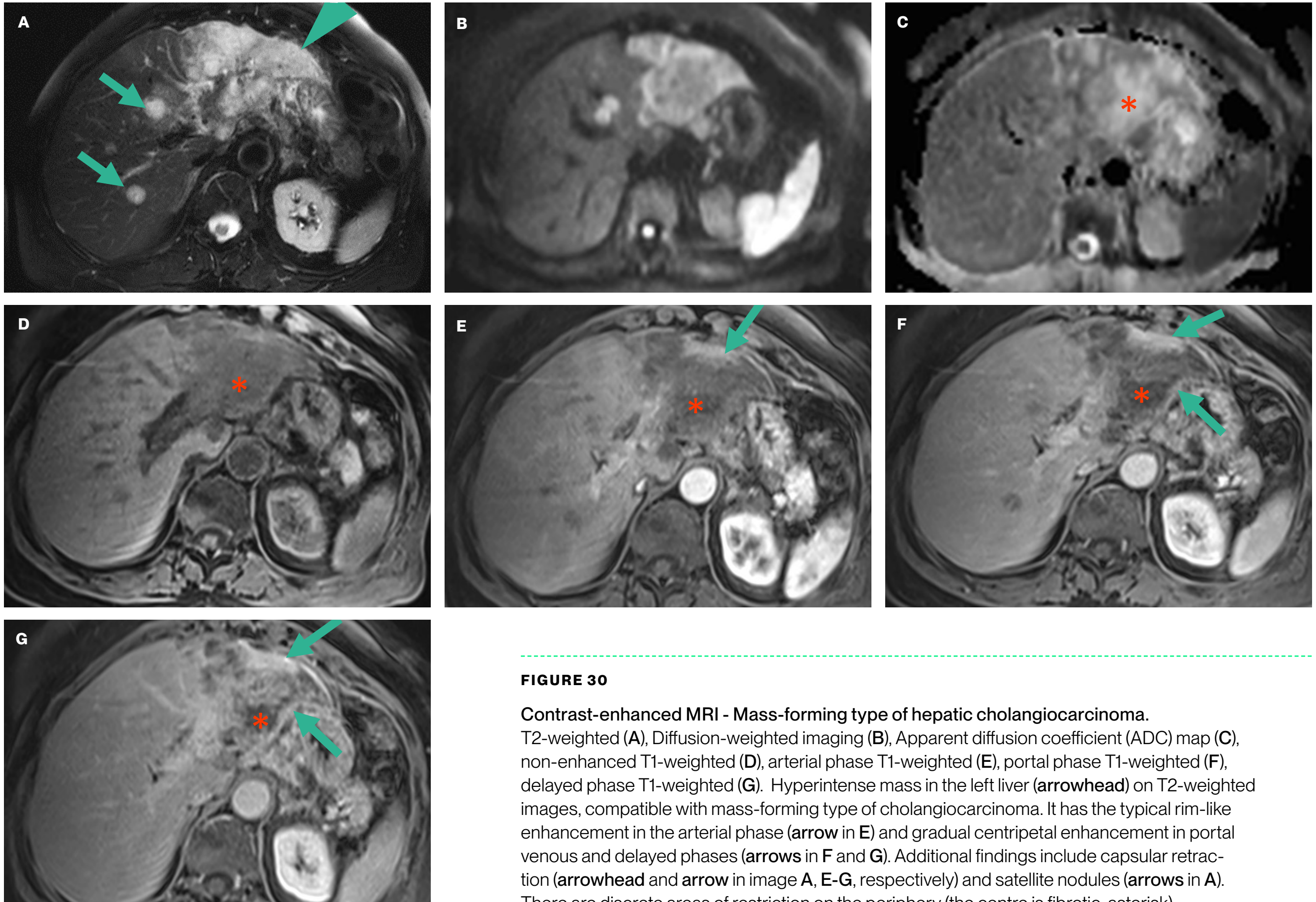


FIGURE 30

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).

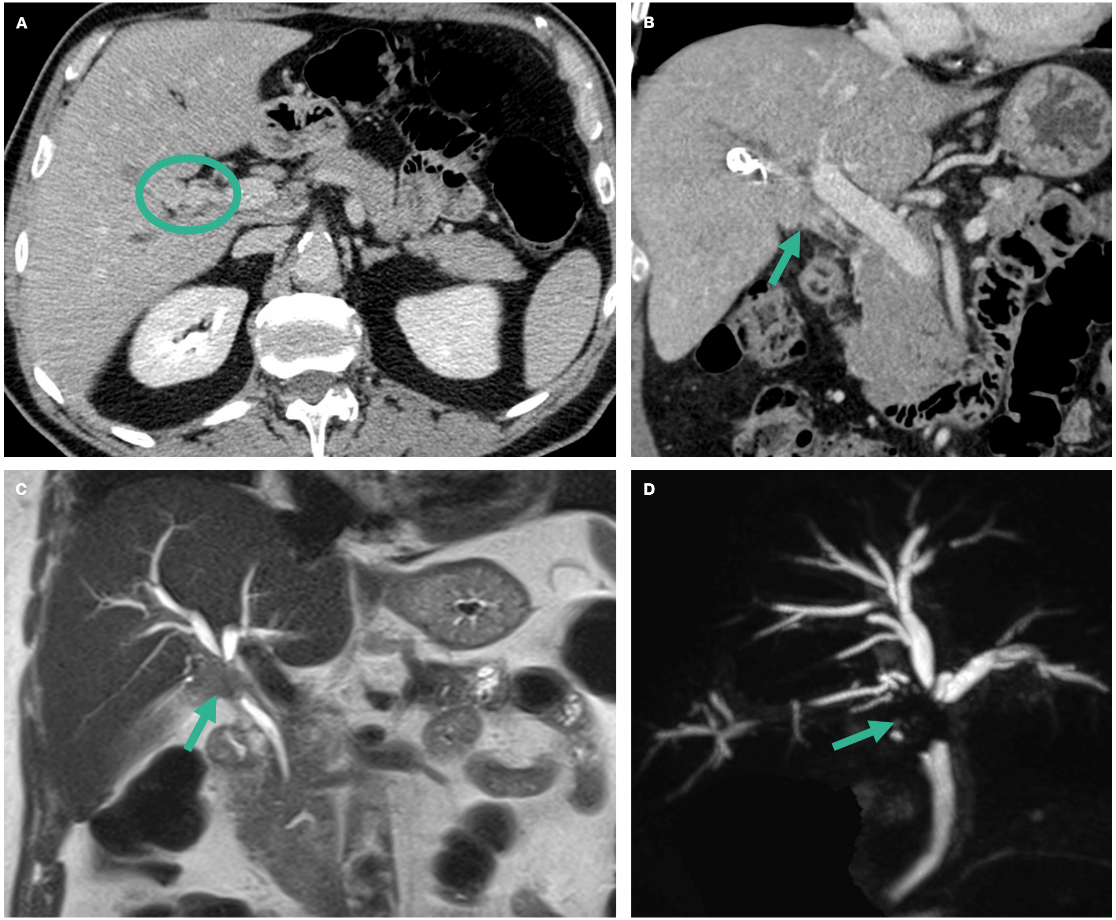


FIGURE 31

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.

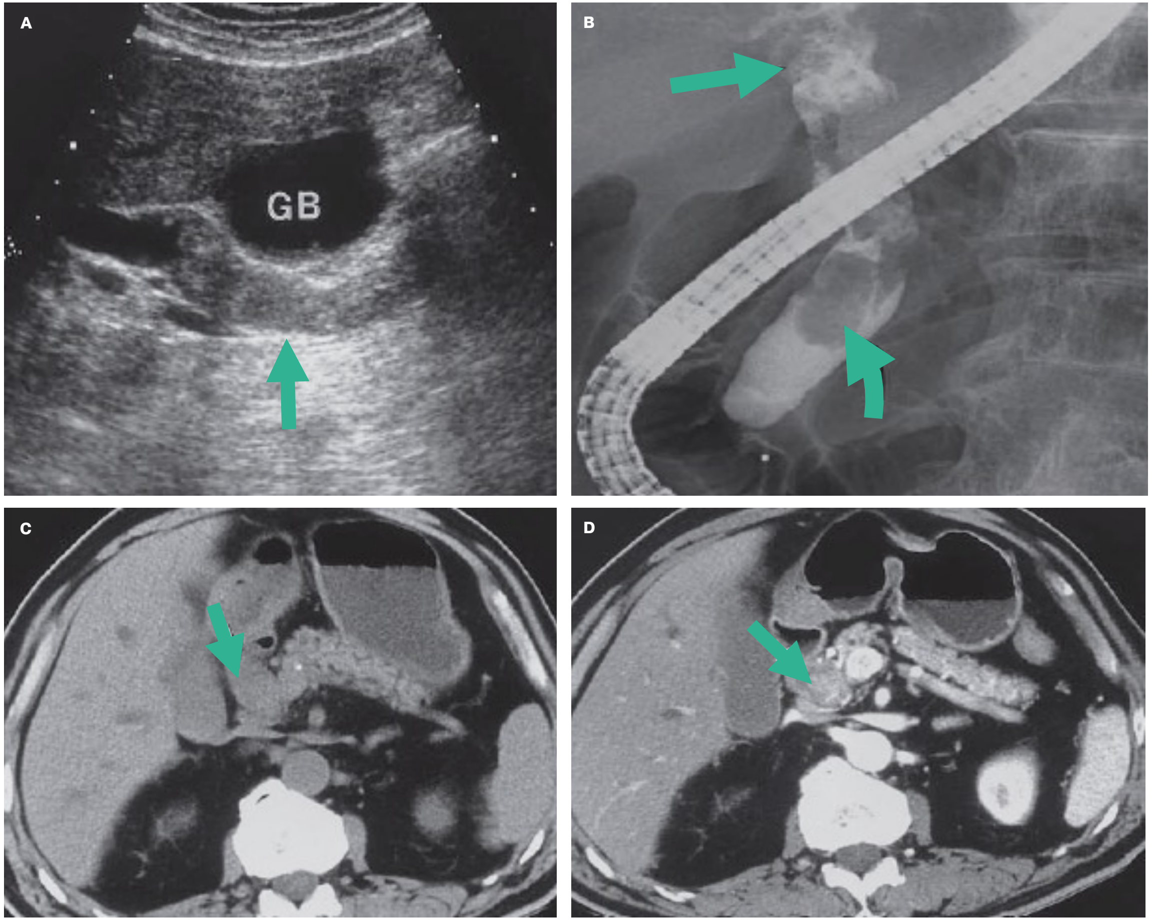


FIGURE 32

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.

CHAPTER OUTLINE:

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:

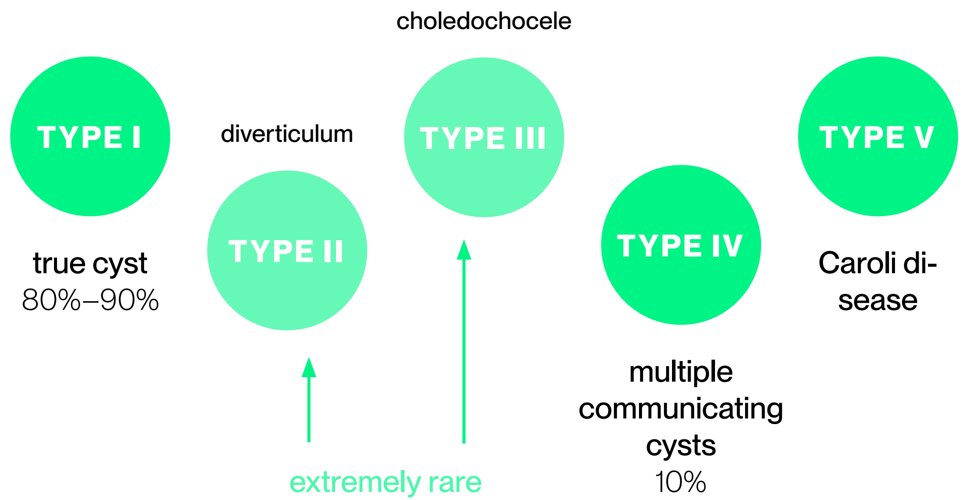
<!> ATTENTION

- 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:

The most common type of bile duct cyst (accounting for 80-90%) is a type I cyst.

TYPE I

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).

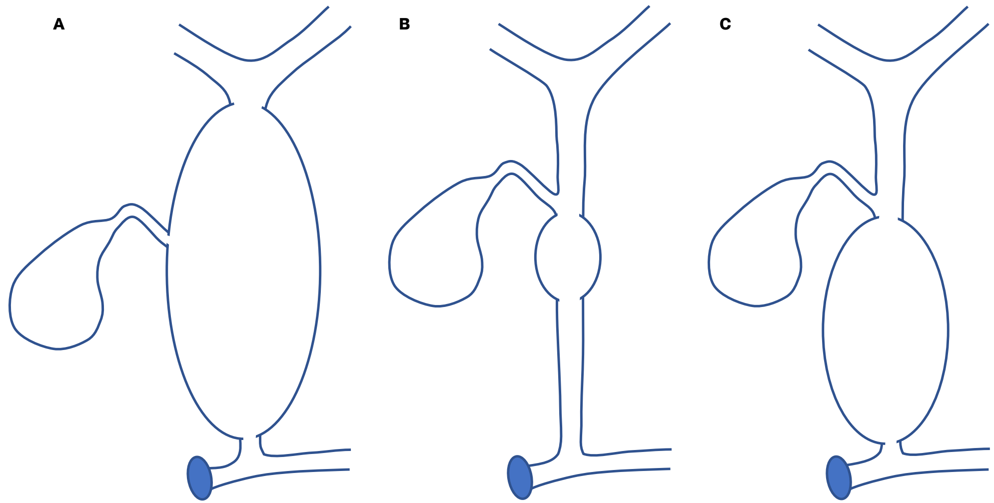


FIGURE 33

A: Bile duct cyst type Ia;

B: Bile duct cyst type Ib;

C: Bile duct cyst type Ic.

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).

TYPE V

- **Intrahepatic saccular or fusiform dilated cystic structures of varying sizes that communicate with the biliary tree are typical.** 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.

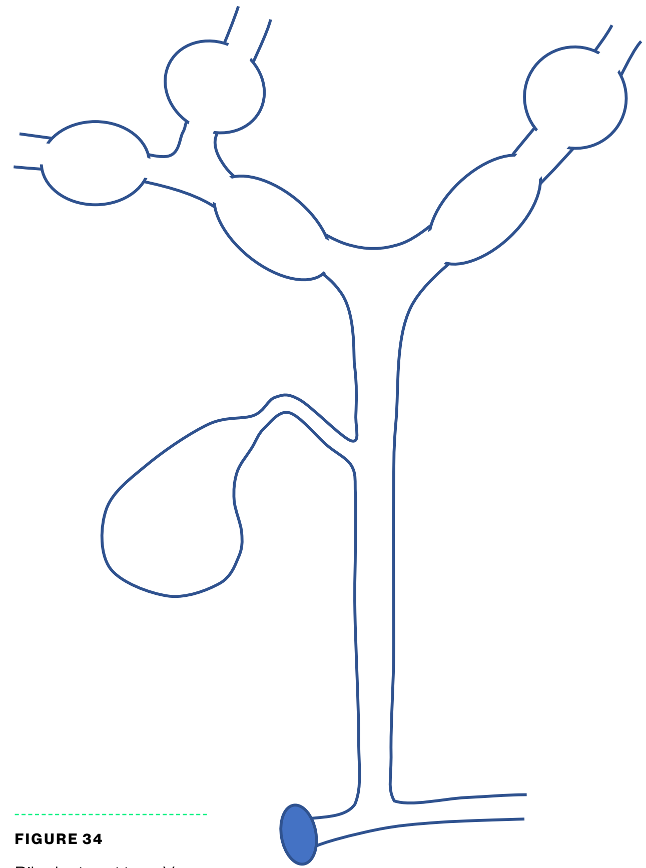


FIGURE 34

Bile duct cyst type V.

CHAPTER OUTLINE:

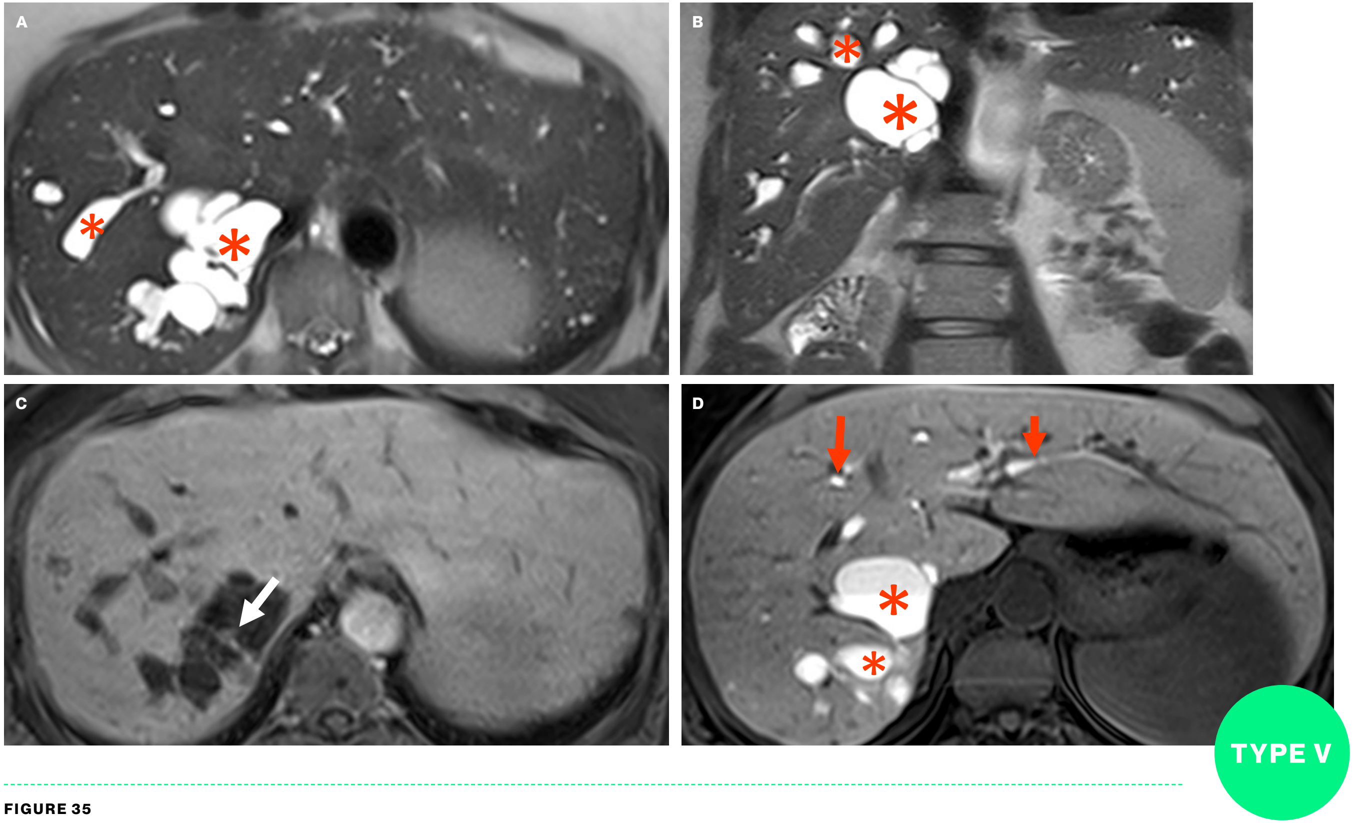


FIGURE 35

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

CHAPTER OUTLINE:

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 in 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

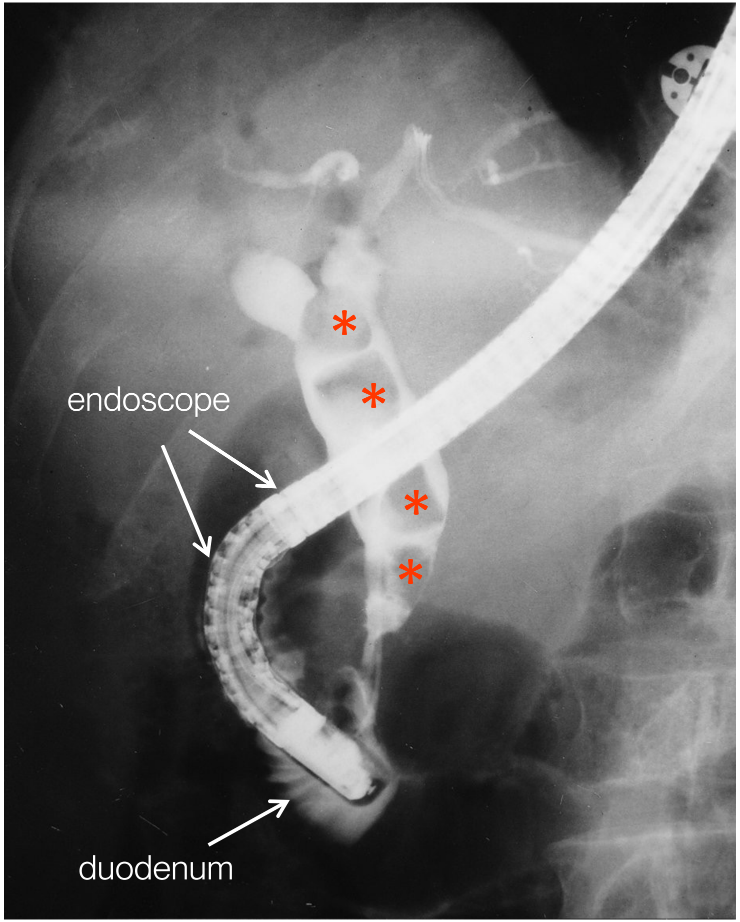


FIGURE 36

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

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%)

<∞> REFERENCE

CHAPTER OUTLINE:

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

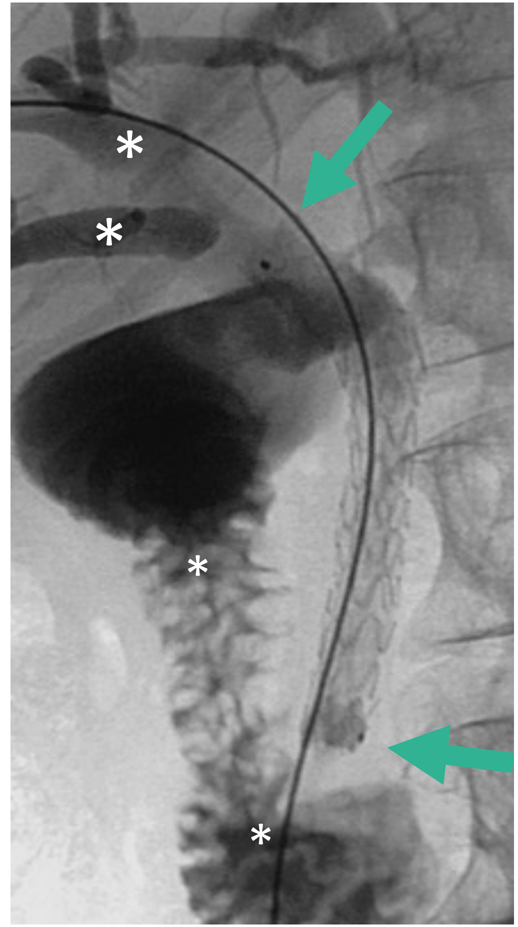


FIGURE 37

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 38

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.

/ Take-Home Messages

- / 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.
- / 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.

CHAPTER OUTLINE:

/ References

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CHAPTER OUTLINE:

Test Your Knowledge

Bile Ducts

CHAPTER OUTLINE:

/ Test Your Knowledge

<?> QUESTION

1 Anatomical variants of the biliary tree are rare.

- ☐ True
- ☐ False

/ Test Your Knowledge

<?> ANSWER

1 Anatomical variants of the biliary tree are rare.

- ☐ True
- ■ False

/ Test Your Knowledge

<?> QUESTION

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

/ Test Your Knowledge

<?> ANSWER

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
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- ☐ Right anterior duct draining into the left hepatic duct

/ Test Your Knowledge

<?> QUESTION

3 What is the best imaging modality to depict cholelithiasis?

- ☐ US
- ☐ CT
- ☐ MRCP
- ☐ EUS

/ Test Your Knowledge

<?> ANSWER

3 What is the best imaging modality to depict cholelithiasis?

- [ ] US
- [ ] CT
- [x] MRCP
- [ ] EUS

/ Test Your Knowledge

<?> QUESTION

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

<?> ANSWER

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

<?> QUESTION

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

/ Test Your Knowledge

<?> ANSWER

5 Which of the following statements is/are correct?

- [x] US is the most sensitive imaging modality to detect cholecystolithiasis
- [ ] CT is the most sensitive imaging modality to detect cholecystolithiasis
- [x] 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

<?> QUESTION

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

<?> ANSWER

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- ☐ Incompetent sphincter of Oddi
- ☐ Biliary-enteric fistula
- ☐ Infection (e.g. Emphysematous Cholecystitis)
- ■ Cholangiocarcinoma

/ Test Your Knowledge

<?> QUESTION

7 Select the predisposing conditions for cholangiocarcinoma:

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

/ Test Your Knowledge

<?> ANSWER

7 Select the predisposing conditions for cholangiocarcinoma:

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

/ Test Your Knowledge

<?> QUESTION

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 T2-weighted images

/ Test Your Knowledge

<?> ANSWER

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 T2-weighted images

/ Test Your Knowledge

<?> QUESTION

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

<?> ANSWER

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
- [x] It affects both intrahepatic and extrahepatic bile ducts

/ Test Your Knowledge

<?> QUESTION

10 Which of the following conditions can be diagnosed or evaluated using Percutaneous Transhepatic Cholangiography?

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

/ Test Your Knowledge

<?> ANSWER

10 Which of the following conditions can be diagnosed or evaluated using Percutaneous Transhepatic Cholangiography?

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

/ Acknowlegments

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