

A comprehensive review of the sonographic findings of gallbladder variants and pathological conditions

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Learning Objectives

The aim of this presentation is to:

- Discuss and illustrate the ultrasonographical anatomy of the gallbladder and its most common variants;
- Provide a pictorial review of the wide range of pathological entities affecting this organ;
- Establish ultrasound imaging of the gallbladder as the first-choice imaging method for assessment of the gallbladder due to its high accuracy in the diagnosis of pathological entities like gallstones or acute inflammatory disease.

Background

Normal anatomy of the gallbladder

- Oval/Pear-shaped organ;
- Partially sunk in a fossa beneath the right hepatic lobe;
- Extends forward from a point near the portal vein to the anterior margin of the liver;
- Adjacent to the interlobar fissure (can be used as a landmark between right and left liver lobes);

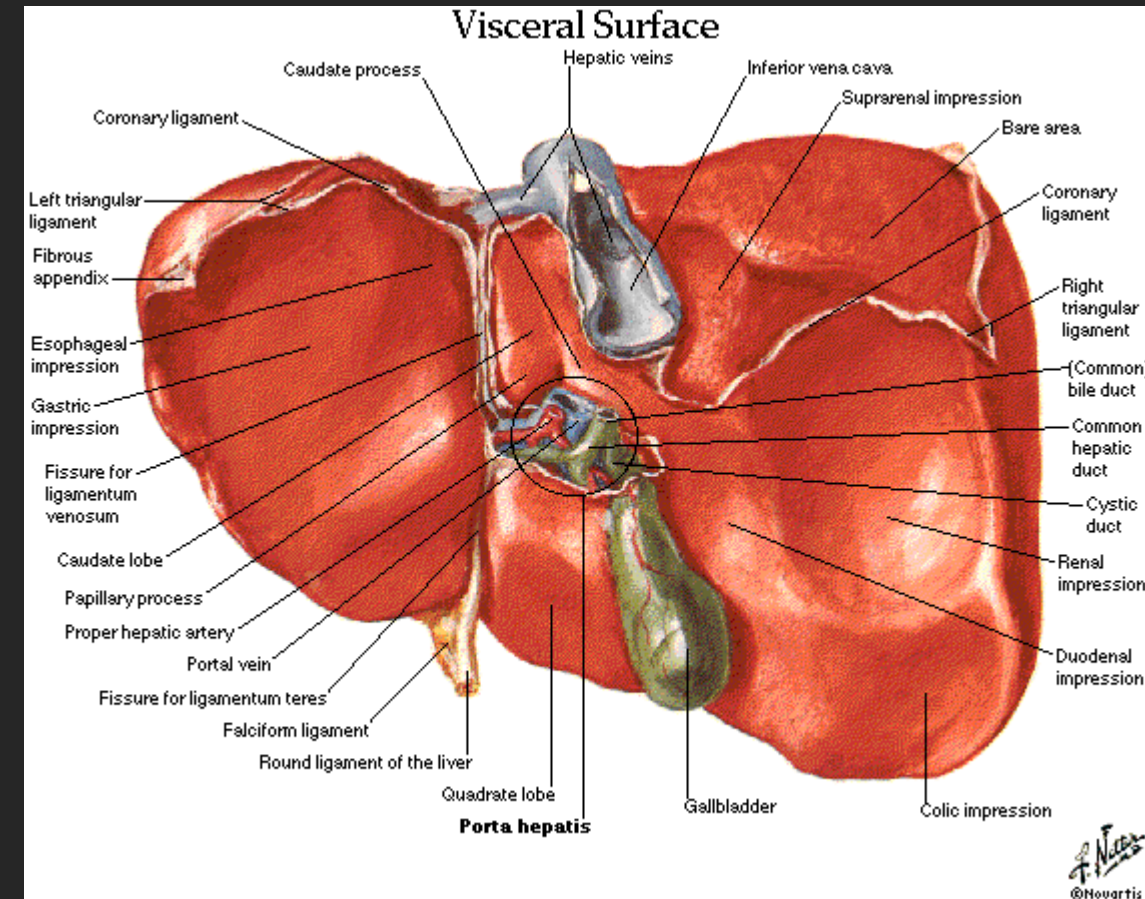


Fig. 1 Normal gallbladder location and anatomical relations (adapted from *Atlas Of Human Anatomy*; Netter, F.)

Background

Normal anatomy of the gallbladder

- Divided in three parts:
 - Fundus
 - Body
 - Neck
- Normal size: 7-10 cm length, 3cm width
- Normal wall thickness 3mm

Sonographically (when contracted):

- Echogenic mucosa
- Hypoechoic muscularis

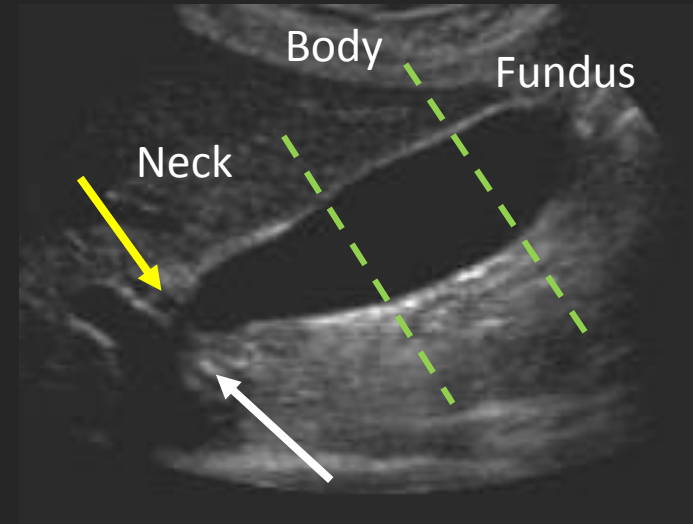


Fig. 2 Normal gallbladder at US in a longitudinal view. Cystic duct (yellow arrow) and common hepatic duct (white arrow) also partially visualized

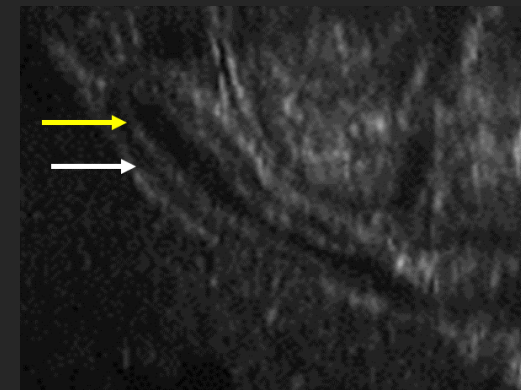


Fig. 3 Contracted gallbladder. Hyperechoic mucosa (yellow arrow) and the hypoechoic muscularis.

Background

Technique

- 3-5Mz transducer
- The patient should be the supine position
- Subcostal (with deep inspiration) and intercostal approaches
- Mobilization is paramount to document intraluminal structure mobility
- Especial care is to be taken with the visualization of the gallbladder neck -> often insufficiently visualized!

Patients should fast for a minimum of 4 hours :



Adequate gallbladder distention

Reduced bowel gas

Gallbladder Variants

- Variants are common
- Most with little clinical significance
- Examples:
 - ✓ Folds (common)
 - ✓ Septations
 - ✓ “Phrygian cap” – gallbladder folds unto itself
 - ✓ Congenital variations (rare):
 - ✓ Intrahepatic gallbladder (most common)
 - ✓ Duplication (complete or partial)
 - ✓ Agnesia

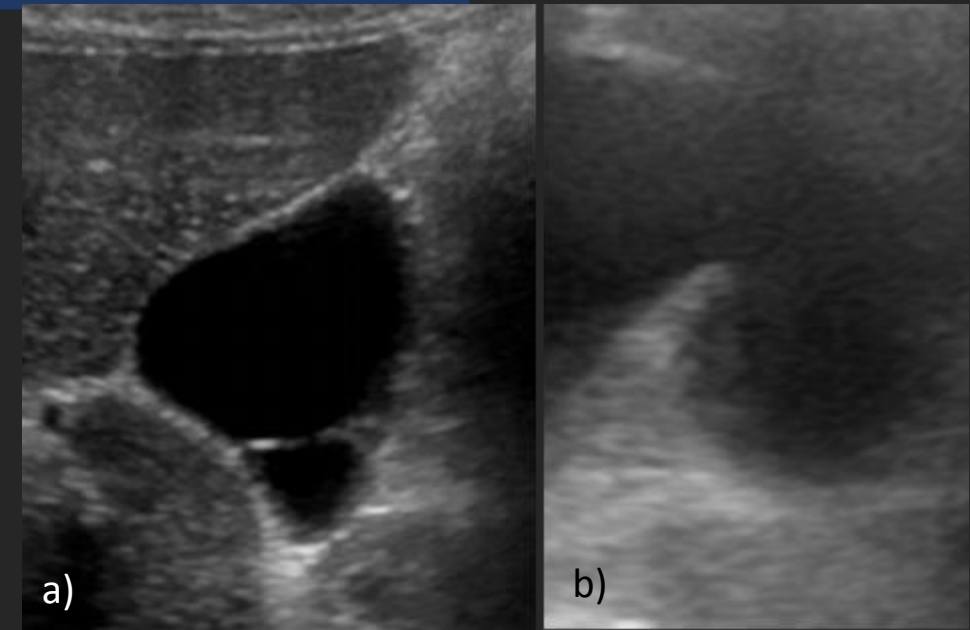


Fig. 4 Gallbladder sept (a) and fold (b).
Septations are rarer and usually thinner than folds. They separate the gallbladder and may sometimes communicate through a small pore, as shown in image b).

Gallbladder Variants

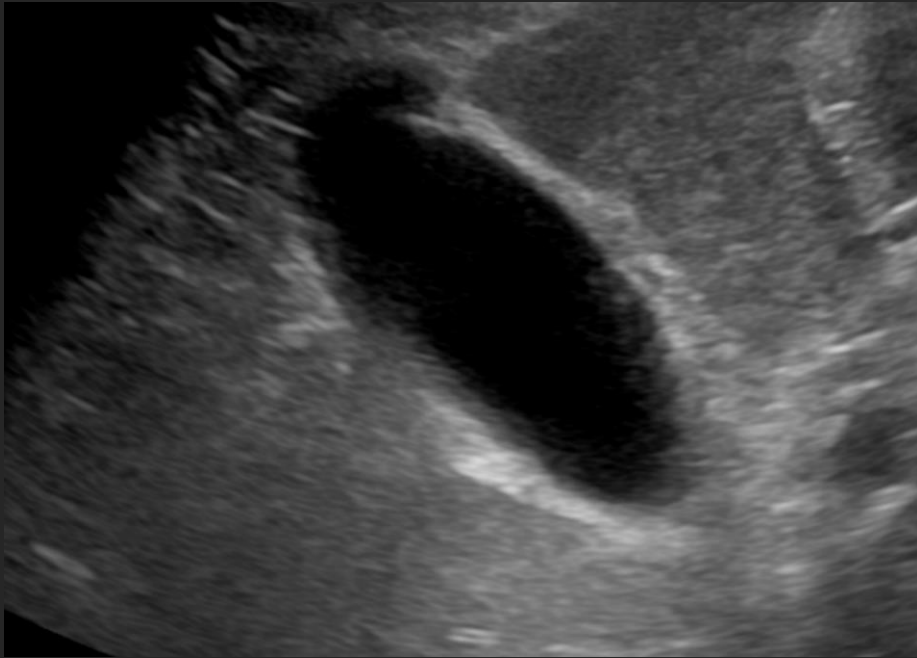


Fig. 5 Phrygian cap



Fig. 6 Multiple gallbladder septa

Gallstones

- Very common (10% of European and American population)
- Risk factors:
 - ✓ Age
 - ✓ Female gender
 - ✓ Obesity
 - ✓ Diabetes pregnancy
- Mainly composed of cholesterol and pigment
- Most are asymptomatic
- Most common manifestation is biliary colic that lasts up to 6 hours and ends when the stone clears the gallbladder neck or passes through the cystic duct

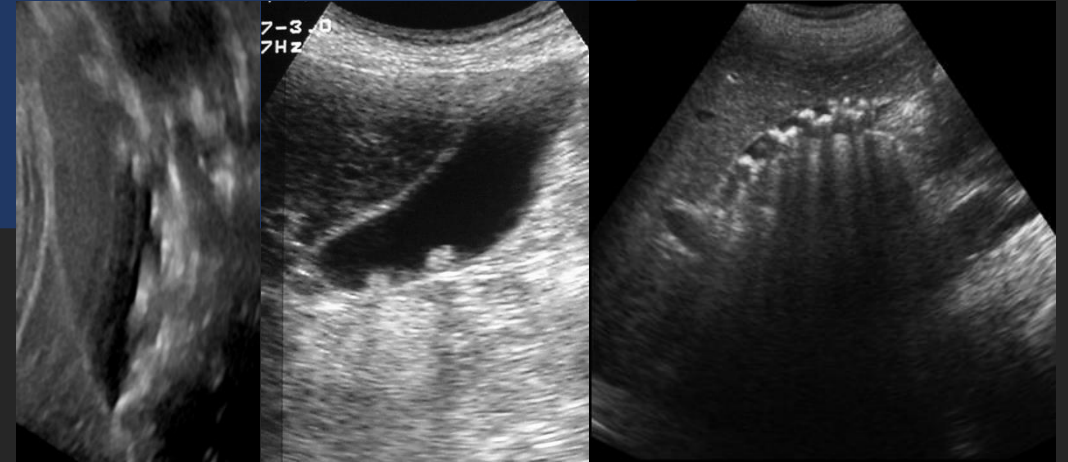


Fig. 7 Gallstones in different patients

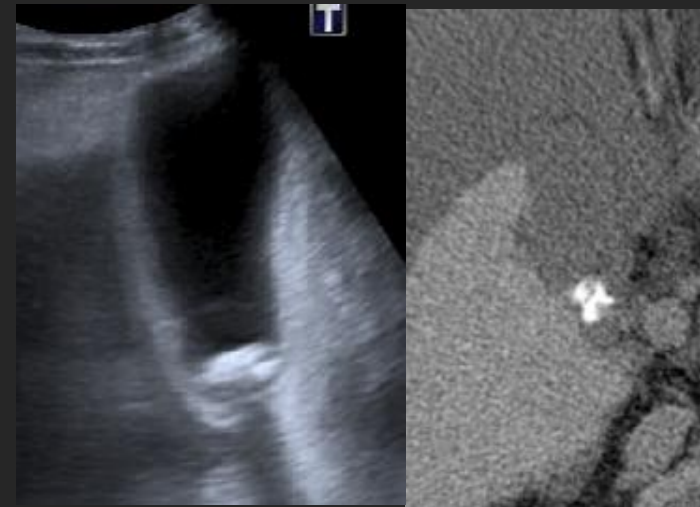


Fig. 8 A Jack stone, a rare shape of stone that can sometimes be predicted in sonography. CT correlational the right.

Gallstones

- Sonography is **highly sensitive**

Sonographic features:

- ✓ Generally round or oval
- ✓ Mobile
- ✓ Echogenic
- ✓ Shadow producing

- **Stones smaller than 3mm may not cast shadow.**
- Non-shadowing stones can emit shadow at higher frequencies
- **Mobility** is an important feature of stones (differentiation from polyps or other entities)
- Multiple, small non-shadow producing stones can made to converge together and form a single shadow.

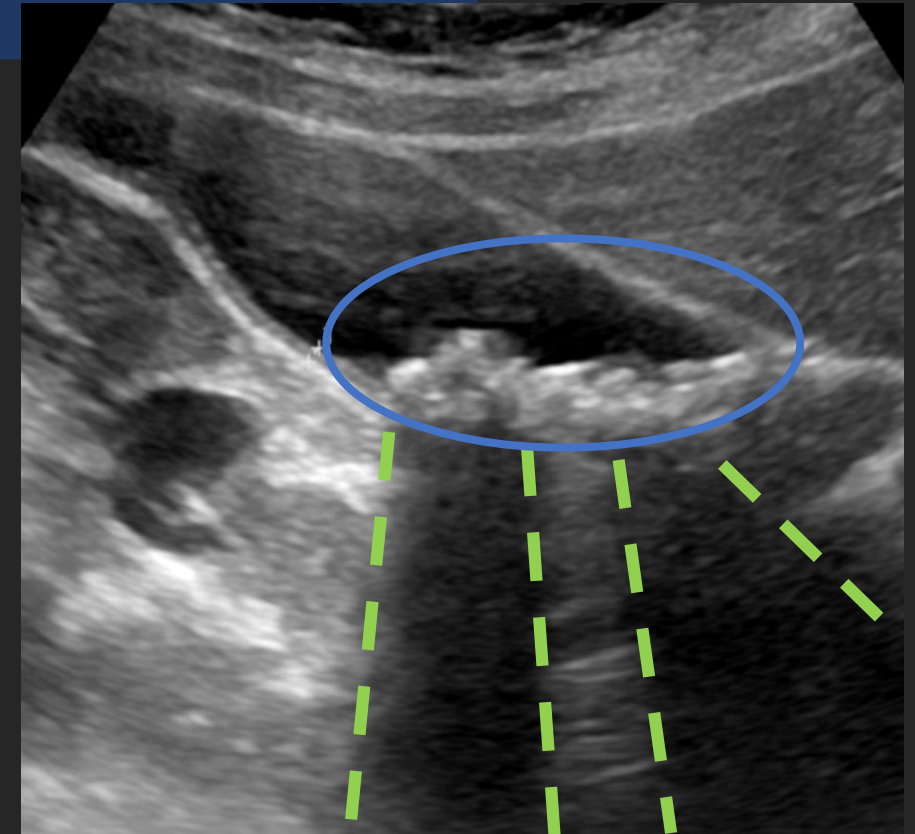
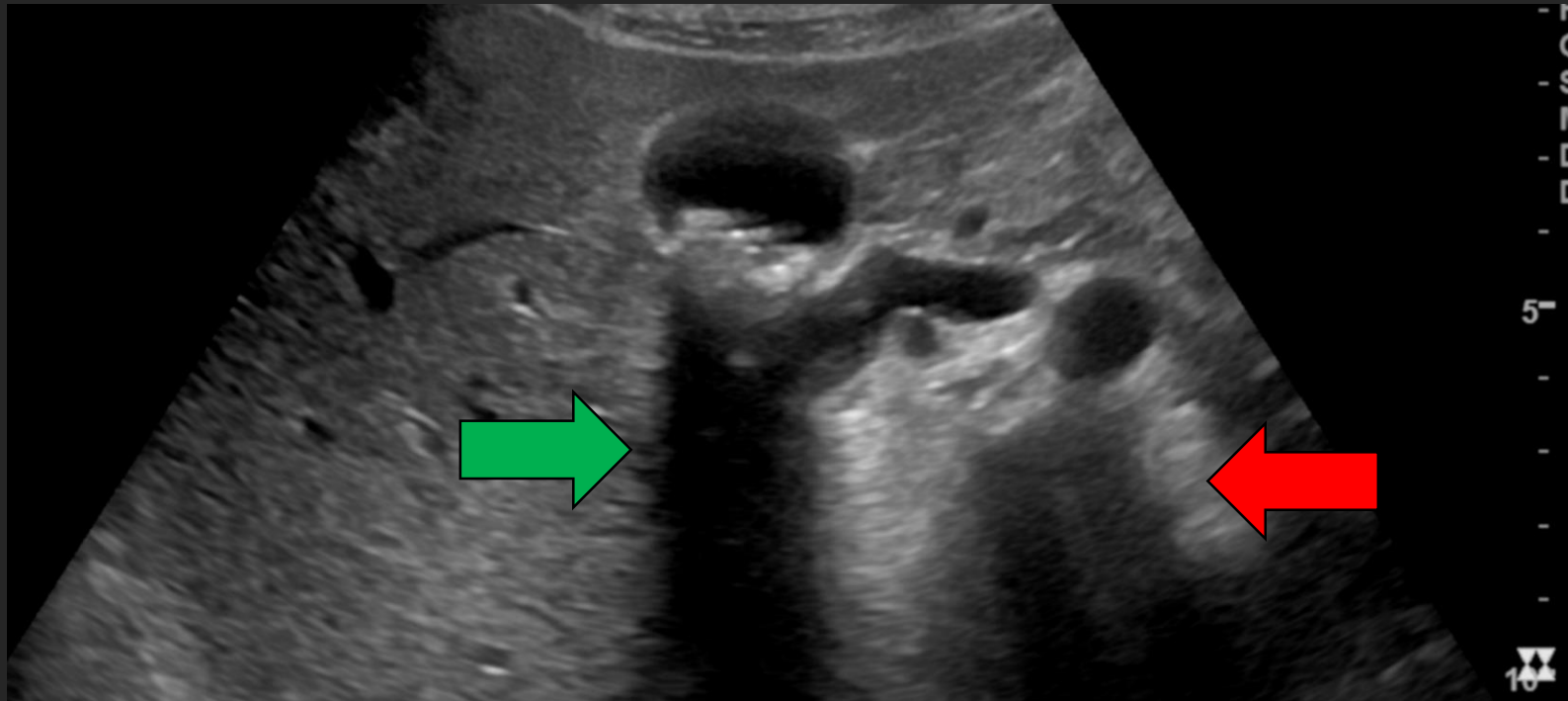


Fig.9 Gallstones. Echogenic, mobile structures in the dependent portion of gallbladder. Notice the acoustic shadow (green lines).

Gallstones

Stones cast “clean shadow” (green arrow)

Gas casts a “dirty shadow” (red arrow)



Acoustic shadowing type may be useful in distinguishing between a gallbladder filled with stones from a gas-filled loop.

Gallstones

- The Wall-Echo-Shadow (WES complex) can also help to differentiate between a intestinal loop from a stone-filled gallbladder.
- Three arched lines followed by a shadow:
 - First line - Echogenic - Peri-cholestatic fat
(*White arrow*)
 - Second line - Hypoechogenic – Muscle
(*Yellow arrow*)
 - Third line - Echogenic – Stones
(*Blue arrow*)

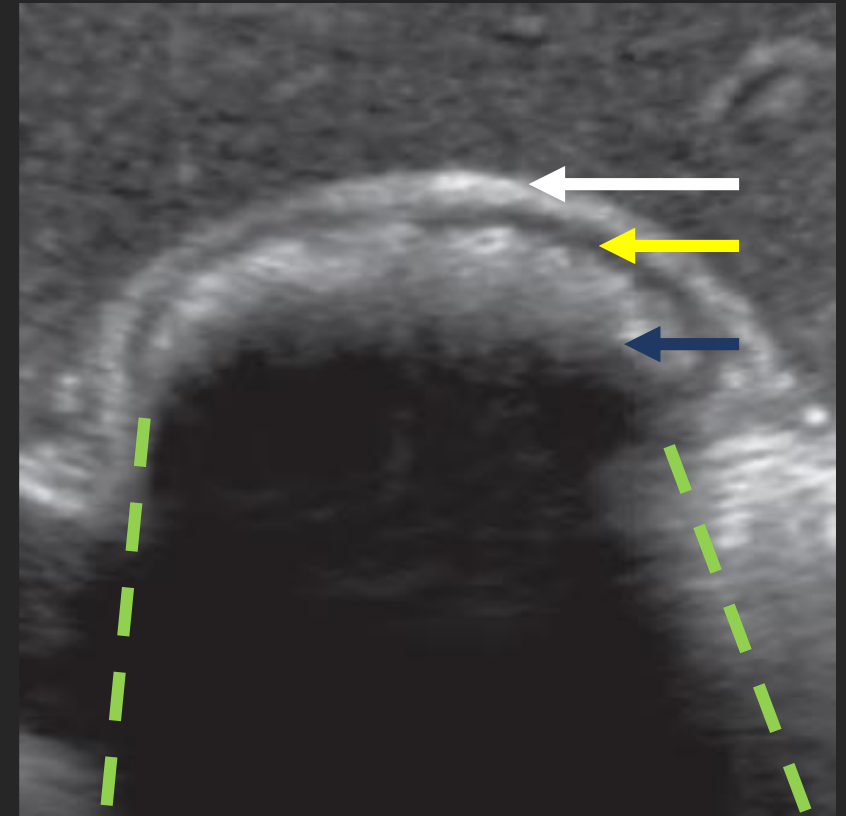


Fig. 10 Gallbladder filled with stones displaying a WES complex.

Mirizzi syndrome

- Rare complication
- Impacted gallstone in cystic duct or neck of gallbladder



External compression of common bile duct

- Symptoms :
 - ✓ Recurrent bouts of cholecystitis
 - ✓ Cholangitis
 - ✓ Pancreatitis
- Sonographic findings:
 - ✓ Dilated ducts
 - ✓ Mass effect from shadowing stone
 - ✓ Edema at level of obstruction
 - ✓ Cholecystic-choledochal fistula



Fig.11 Mirizzi syndrome

Mirizzi syndrome

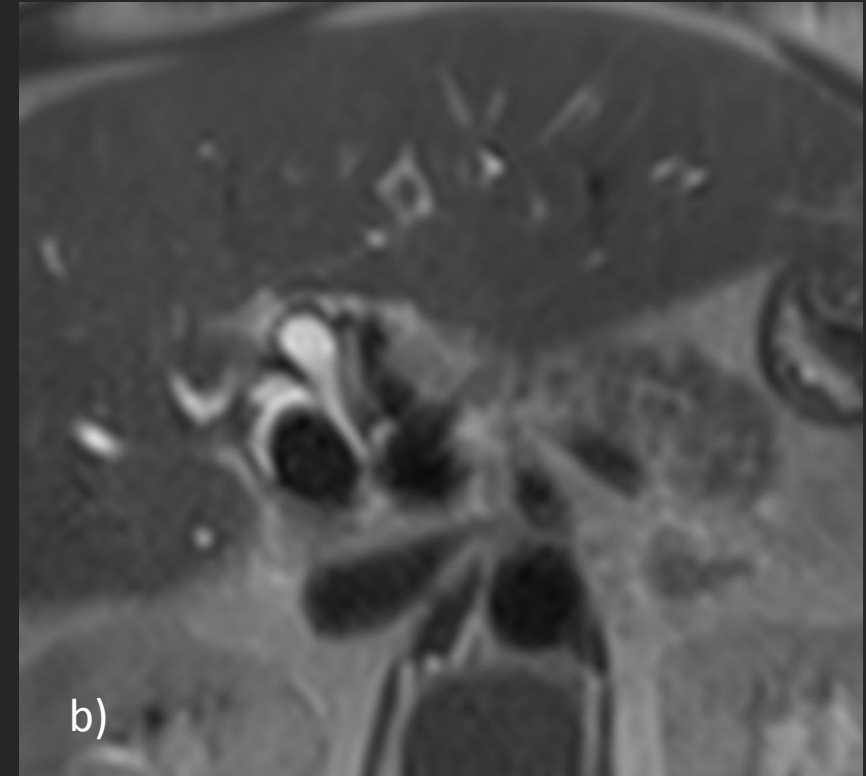
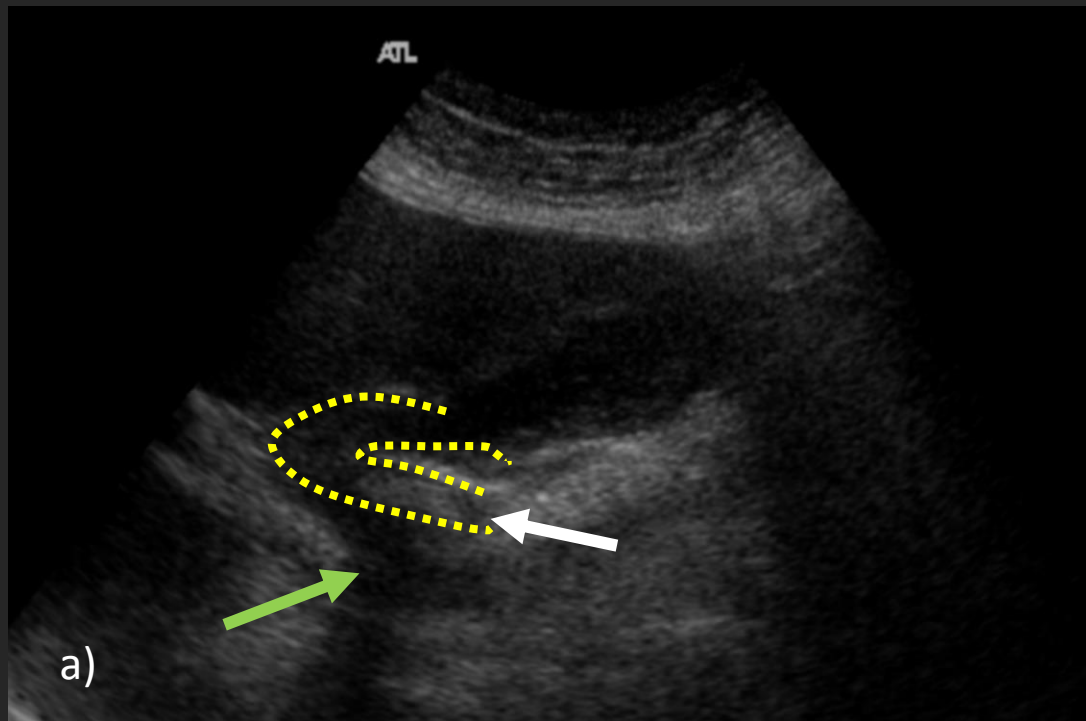


Fig. 12 a) Longitudinal US shows dilated common bile duct (green arrow) obstructed by a large stone (white arrow) impacted in the distal cystic duct (yellow line). Image b) shows MR correlation.

Sludge

- Mixture of calcium bilirubinate granules and cholesterol crystals that form a thick viscous bile
- Risk factors include: pregnancy, weight loss, critically illness, total parenteral nutrition and ceftriaxone use.

Sonographic features:

- ✓ Non-shadowing
- ✓ Mobile
- ✓ Lack of internal vascularity
- ✓ May form sludge level (on dependant portion)
- ✓ May fill the entire lumen
- ✓ May form mass like aggregates (“sludge balls”)
- ✓ May present “Twinkle artifacts”

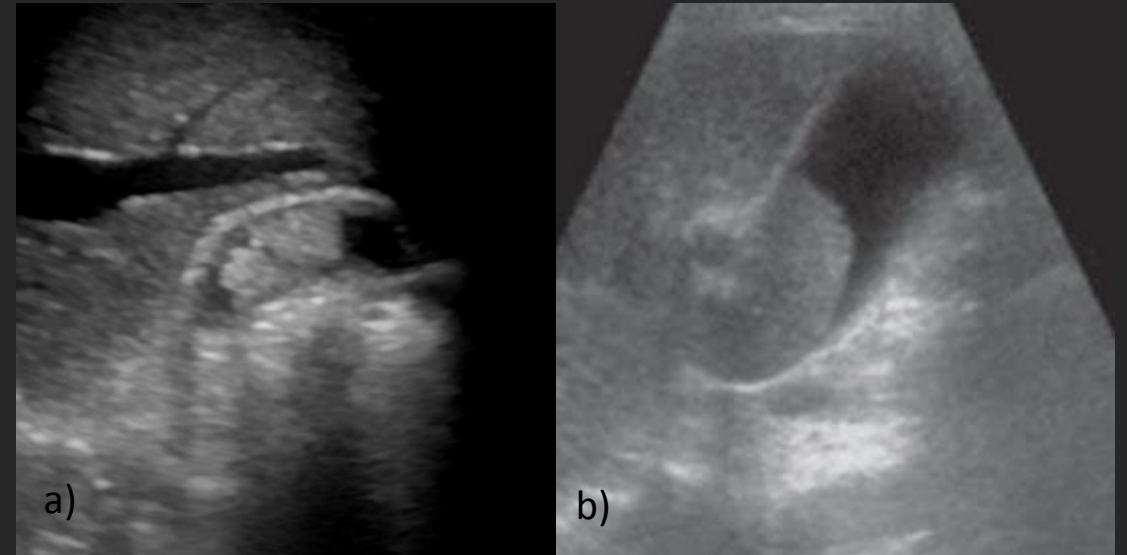


Fig. 12 Sludge. a) Sludge Balls in poorly distended gallbladder
b) Sludge in dependent portion of gallbladder.

Polypoid Masses

Common Polypoid Masses:

- ✓ Cholesterol polyps (50%-60%)
- ✓ Inflammatory polyps (5%-10%)
- ✓ Adenoma(<5%)
- ✓ Focal adenomyomatosis
- ✓ Gallbladder adenocarcinoma
- ✓ Metastases (esp. melanoma)

(Adapted from "Diagnostic Ultrasound, Rumack, C.")

General considerations:

< 5 mm: no follow up required

5-10 mm: surveillance

> 10 mm and solitary: excision may be advised

Multiple polyps are usually benign

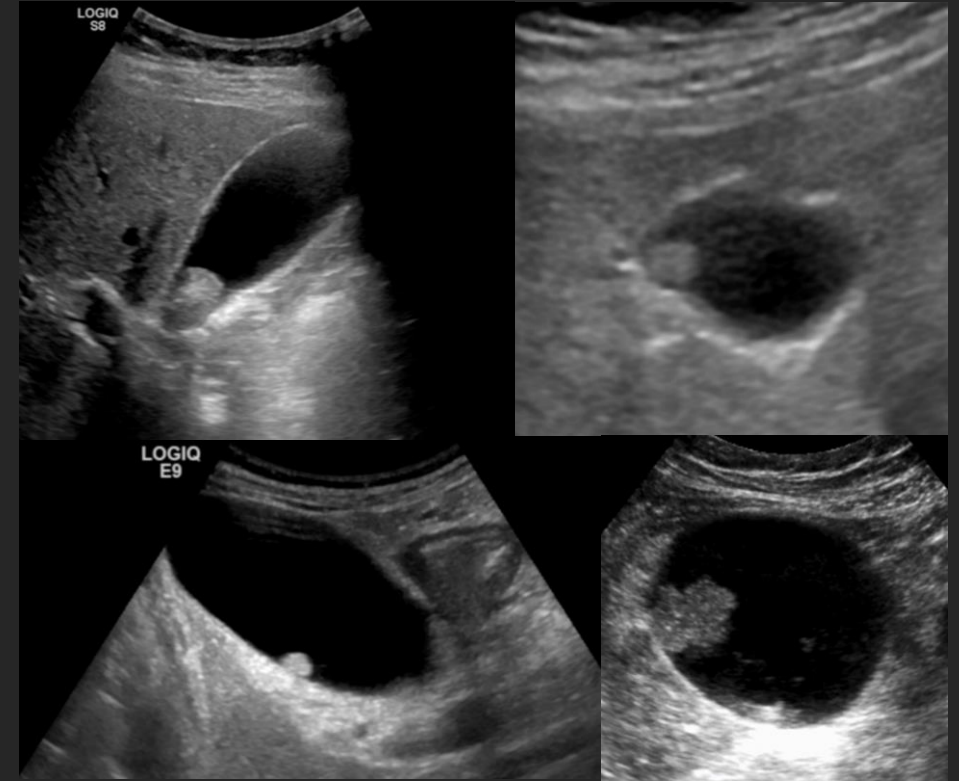


Fig. 13 Polyps in different patients

Polyps in melanoma and lung cancer patients should be closely monitored!

Polypoid Masses

Cholesterolosis

- Approximately 50% of all polyps
- Accumulation and enlargement of lipid filled macrophages (not true neoplasms).
- Deposition may be
 - Planar -> rarely visible on ultrasound
 - Polypoid -> attached to the wall by a slender stalk.

Sonographic features:

- ✓ Intraluminal ovoid lesions, attached to the gallbladder wall
- ✓ Usually 2 to 10 mm
- ✓ May be multiple
- ✓ Ball-on-the-wall sign (stalk is rarely seen)
- ✓ Non-shadowing and non-mobile

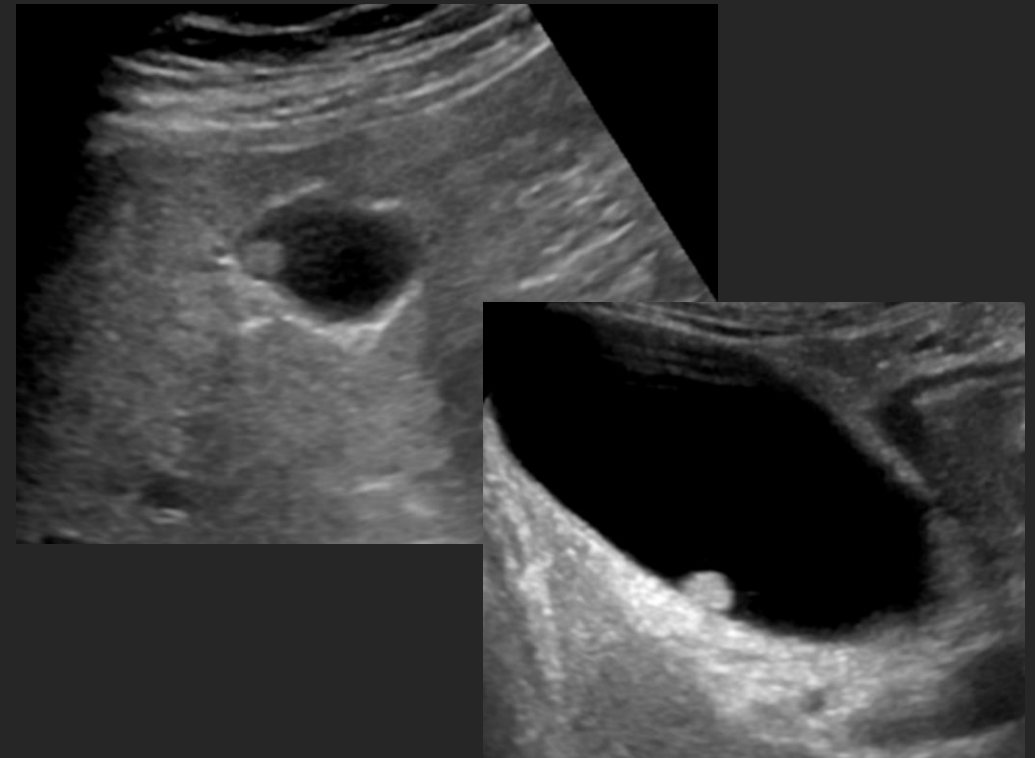


Fig. 14 Cholesterolosis.
Small, non-shadowing polyps with “ball-on-the-wall sign”

Adenomyomatosis

- Benign condition due to by exaggeration of the normal epithelial invaginations (Rokitansky-Aschoff sinuses) and subsequent cholesterol crystal deposition.
- Not associated with lithiasis.
- Adenomyomatosis may be **focal or diffuse**.
- Sonographic features:
 - ✓ “Comet tail” artifacts – tiny, reflective foci in wall
 - ✓ “Twinkling artifact”
 - ✓ Hypoechoic/cystic spaces on the wall
 - ✓ Annular thickening
 - ✓ Localized mass (adenomyoma)
 - ✓ Diffuse wall thickening
- Higher frequency should be used

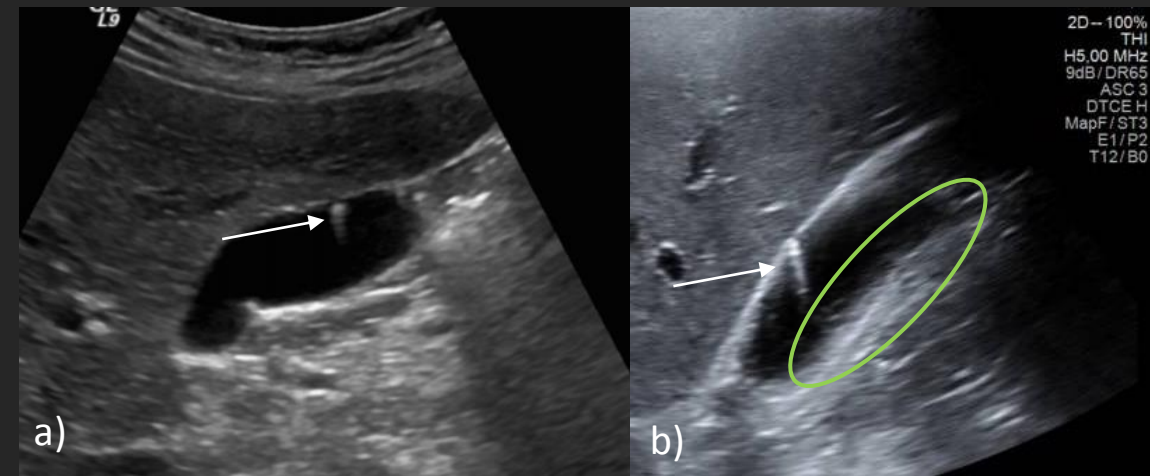


Fig. 15 Adenomyomatosis. Typical examples showing comet tail artifact (arrows). In image b) focal thickening can also be seen (green circle).

Adenomyomatosis

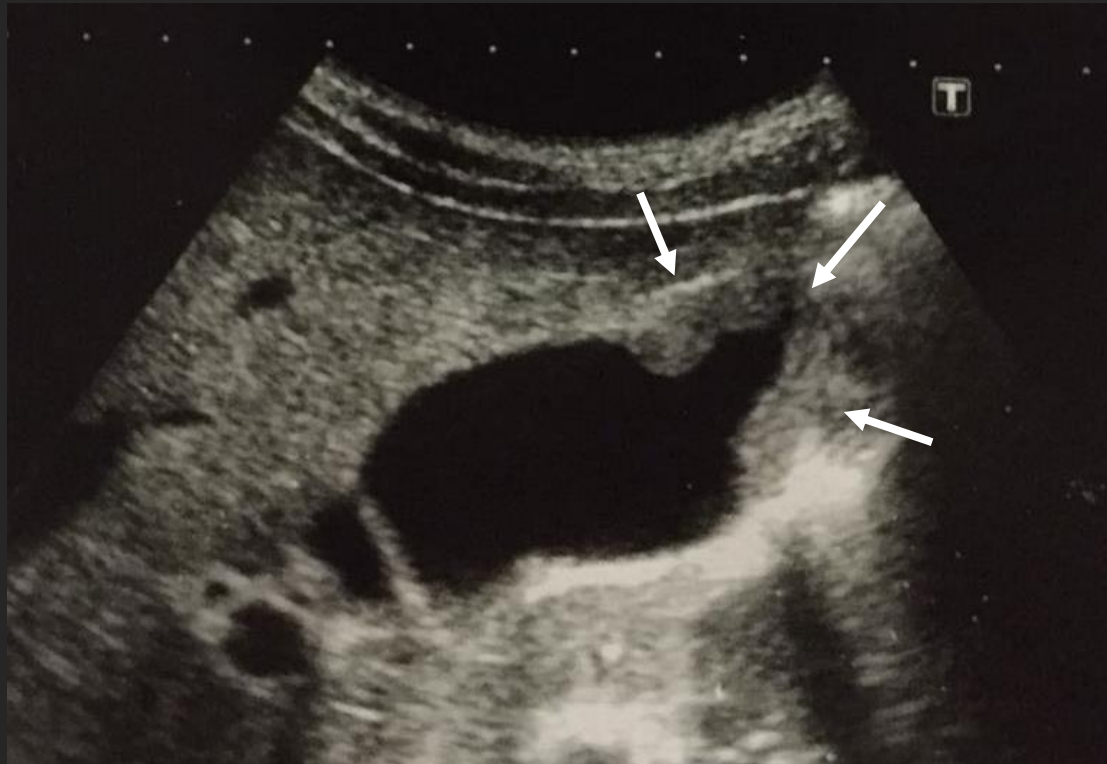


Fig. 16. Focal Thickening of the gallbladder wall near the gallbladder fundus (arrows). Thought suspicious, pathology revealed it was actually adenomyomatosis

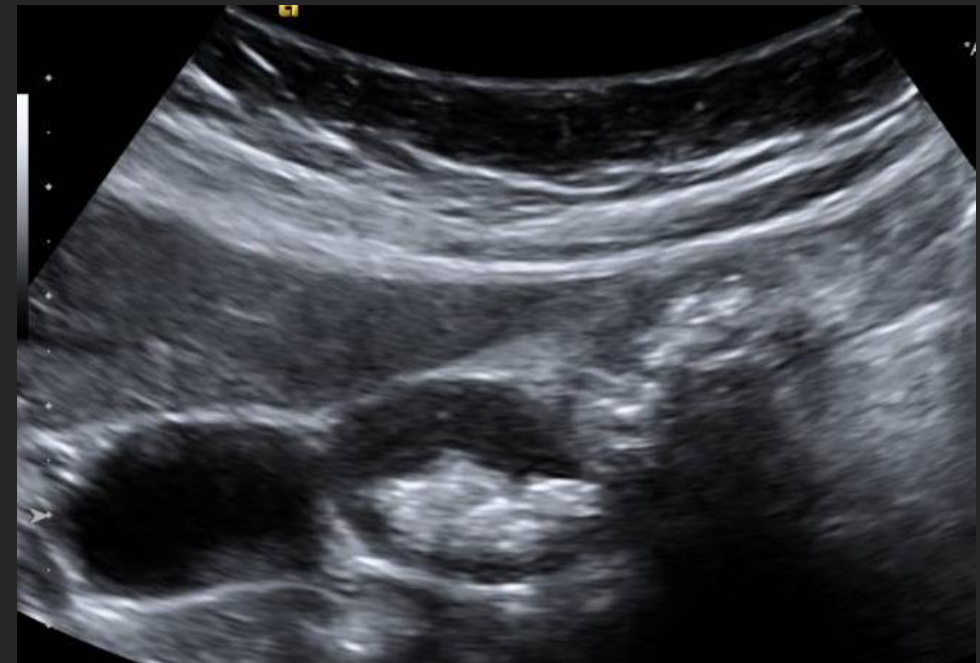


Fig. 17 Longitudinal view of a gallbladder with adenomyomatosis on body and neck, (without typical comet-tail artifacts) with sept-like focal thickening. Extensive lithiasis is also observed on the fundus.
(Courtesy of Dr. Carolina Carneiro)

Acute Cholecystitis

- Very common (9% of hospital admissions)
- Most cases – impacted gallstone on cystic duct of gallbladder neck (95%)
- Surgery is the treatment of choice (48 to 72 hours)
- May perforate if left untreated
- 5% are acalculous, more often in critically ill patients -> worse prognosis
- Diagnosis is often based on a combination of sonographic and clinical signs



Fig. 18 Acute acalculous cholecystitis. Wall thickening, distended lumen and sludge level are apparent. Pericholecystic fluid indicates perforation and a more severe stage of the disease.

Acute Cholecystitis

Sonographic features:

- ✓ Gallstones
- ✓ Wall thickening (>3mm)
- ✓ Distention of gallbladder lumen (>4 cm transverse diameter)
- ✓ Impacted stone
- ✓ Sonographic Murphy sign
- ✓ Thin rim of fluid
- ✓ Hyperemic gallbladder wall on Doppler
- ✓ Biliary sludge (bacterial growth due to stasis)

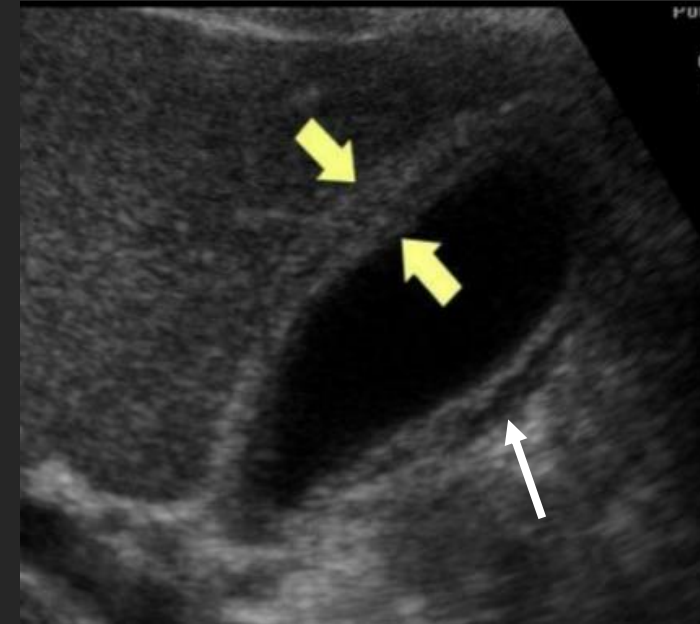


Fig. 19 Acute acalculous cholecystitis. Notice the wall thickening (yellow arrows), the distended lumen and a thin fluid rim (white arrow).

Acute Gangrenous Cholecystitis

- If acute cholecystitis is prolonged, the gallbladder may undergo necrosis.
- Murphy's sign is absent in 66% of patients (nerve damage from necrosis)
- Perforation is also a sign of necrosis (5% to 10% of acute cholecystitis)

Sonographic features

- ✓ Pericholecystic fluid
- ✓ Sloughed mucosal membranes
- ✓ Wall disruption
- ✓ Wall ulceration
- ✓ Focal wall bulge

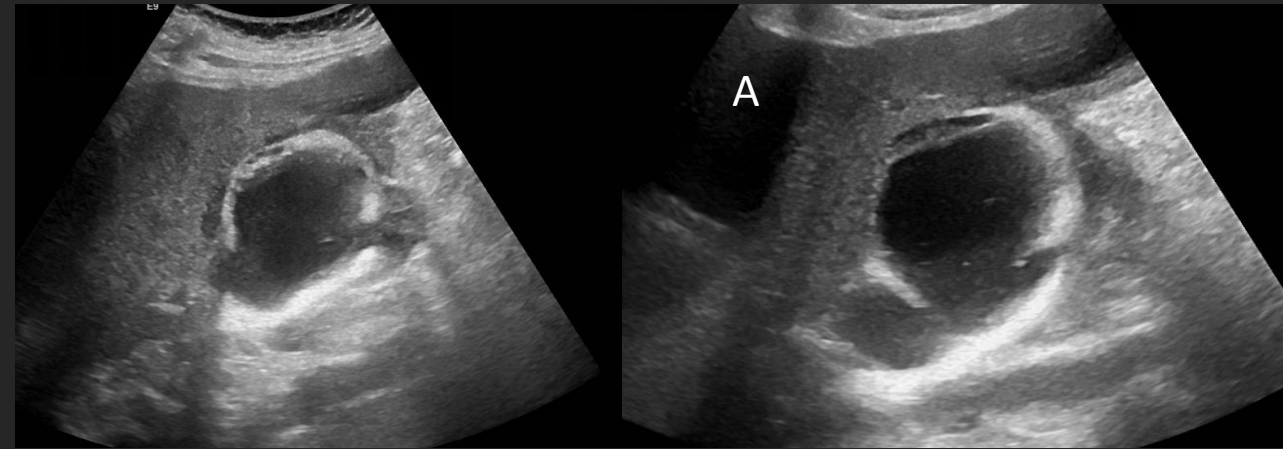


Fig. 20 Gangrenous cholecystitis.

Areas of focal ulceration are apparent in a thick gallbladder wall, surrounded by echogenic inflamed fat. The mucosa is irregular, and slightly sloughed. Pericholecystic fluid collections can also be seen as well as an abscess(A).

Acute Emphysematous Cholecystitis

Gas in the wall and lumen of gallbladder, usually produced bacteria after ischemic event.

Characteristics:

- Rare (< 1% of cholecystitis)
- 3-7x more common in men (especially elders)
- 33-50% acalculous
- Associated with diabetes
- Higher risk of perforation (5x)
- Fatal in approximately 15% of patients due to fast progression

Urgent cholecystectomy is recommended in all patients

Sonographic appearance:

- ✓ Echogenic lines in nondependent wall
- ✓ “Dirty” acoustic shadow (gas)
- ✓ Reverberation artifact (“Ring-down” artifact)
- ✓ Pneumobilia may be observed

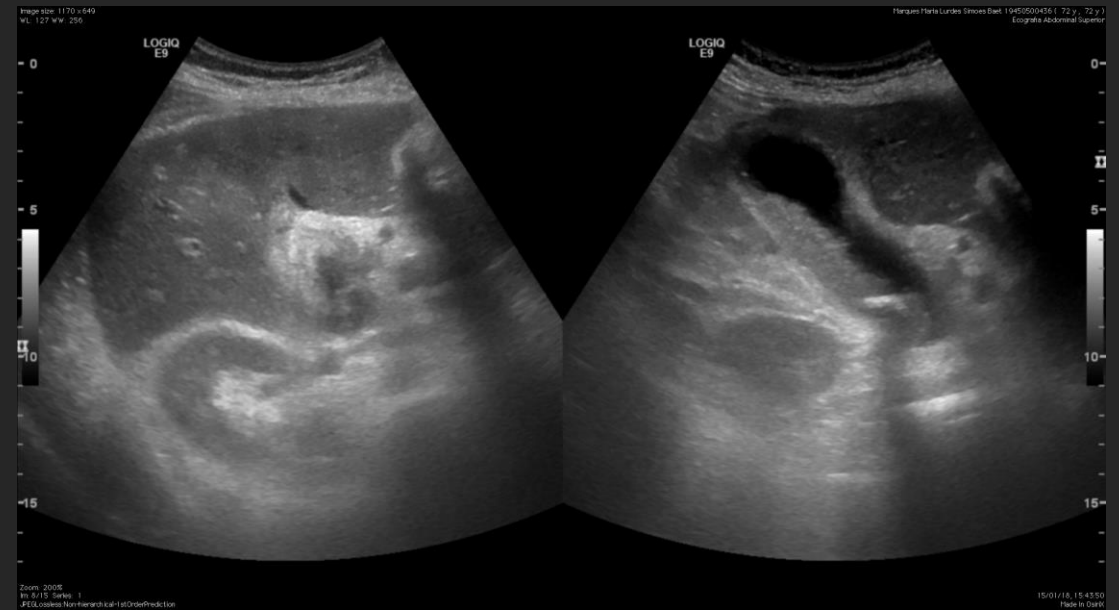


Fig. 21 Emphysematous cholecystitis.

Hyperechogenic areas in nondependent gallbladder wall, with “dirty” acoustic shadow, that represent intraluminal gas. Gallstone and sludge are also visible.

Acute Emphysematous Cholecystitis

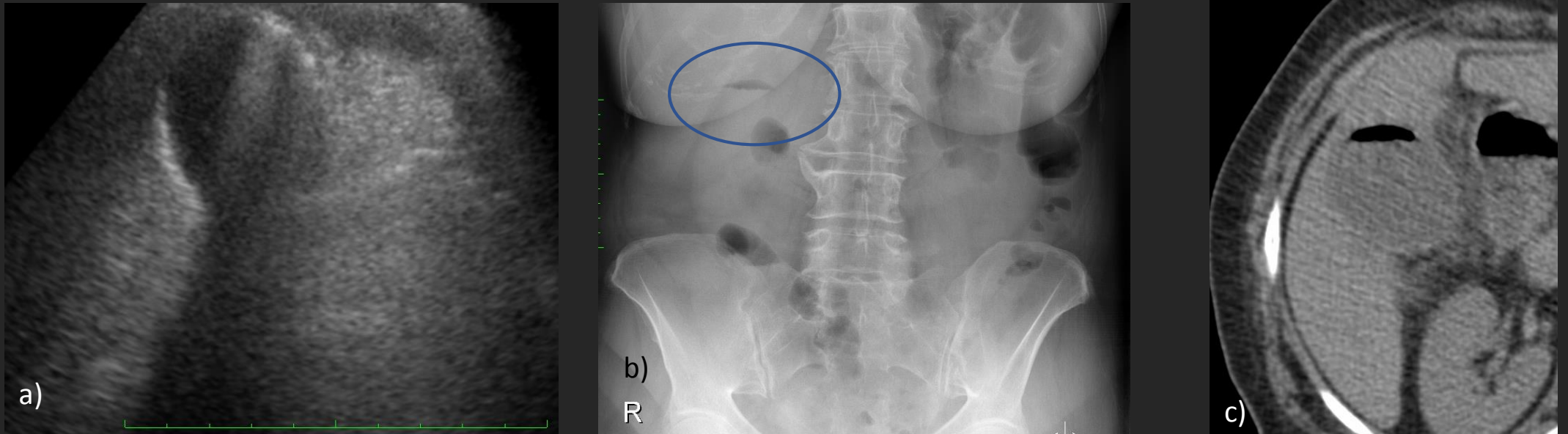


Fig. 22 Emphysematous cholecystitis on different imaging modalities.

- a) Longitudinal sonogram shows a bright curvilinear reflection from the nondependent wall of the gallbladder with a “dirty shadow”
- b) Abdominal radiograph shows subdiaphragmatic free gas (circle).
- c) CT scan confirms presence of gas in the gallbladder lumen.

Chronic Cholecystitis

- Prolonged inflammation of the gallbladder
- Usually associated with cholelithiasis due to intermittent obstruction
- Can lead to fibrosis (advanced cases)
- May present as recurrent acute cholecystitis or biliary colic
- Some are asymptomatic
- Possible complications: acute cholecystitis, gallbladder carcinoma and biliary-enteric fistula (rare)

Sonographic features

- ✓ Gallstones
- ✓ Wall thickening
- ✓ Contracted or distended gallbladder



Fig. 21 Chronic Cholecystitis. Diffuse wall thickening and gallstones, non-specific features.

Chronic Xanthogranulomatous Cholecystitis

- Rare variant of chronic cholecystitis
- Female patients (60-80 years old)
- Collections of lipid-laden macrophages in gallbladder wall
- Clinical presentation similar to acute cholecystitis
- May severely affect neighboring structures (liver, bowel and stomach -> dense adhesions, perforation, abscess formation, fistulas)

Sonographic features:

- ✓ Gallbladder wall thickening (diffuse or focal)
- ✓ Intramural hypoechoic nodules or bands
- ✓ Gallstones often present
- ✓ Loss of the intervening fat plane, with focal hypoechogenicity of hepatic parenchyma (if hepatic infiltration by inflammatory process)

Often hard to distinguish from gallbladder carcinoma.



Presence of hypoattenuating nodule favours xanthogranulomatous cholecystitis

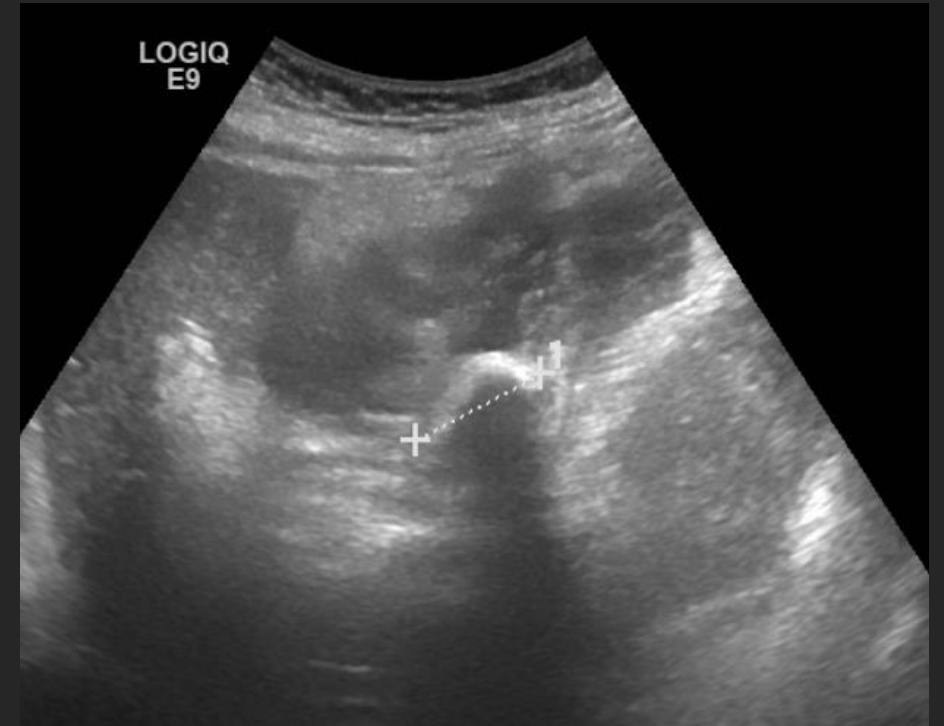


Fig. 24 Xanthogranulomatous Cholecystitis

Chronic Xanthogranulomatous Cholecystitis

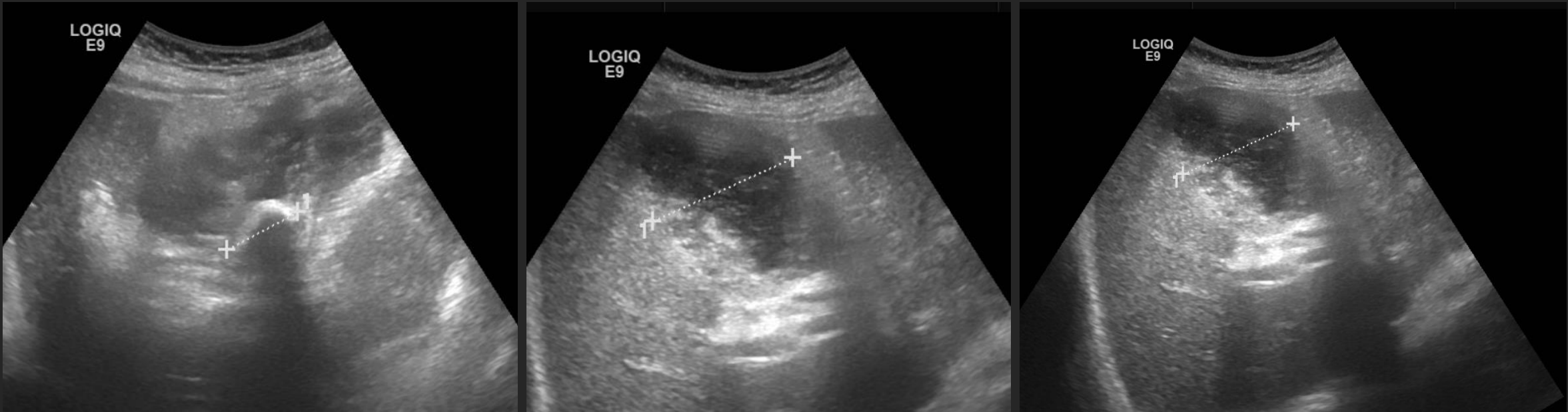


Fig. 25 Initially thought to be carcinoma, biopsy revealed xanthogranulomatous cholecystitis. In these images disruption of mucosal line is apparent, associated with loss of the intervening fat plane, and hypoechoic nodules that correspond to lipid-filled macrophages. A large gallstone can also be observed.

Porcelain Gallbladder

- Rare form of chronic cholecystitis
- Calcification of the gallbladder wall
- Associated with gallstones

Sonographic features:

- ✓ If extensive calcification -> hyperechoic semilunar line with dense posterior shadowing
- ✓ If mild calcification -> variable degree of shadowing, luminal contents visible

WES complex NOT PRESENT!



The calcifications occur in wall, not on the lumen!



Fig. 26 Porcelain gallbladder.
(Adapted from "Diagnostic Ultrasound, Rumack, C.")

Neoplasm

- Gallbladder cancer is the fifth most common gastrointestinal malignancy
- Correlation with chronic irritation by stones (x10 higher risk if gallstone >3cm)
- More common in women
- Poor prognosis -> 2% 5 year survival rate

Sonographic features

- ✓ Soft-tissue mass that obliterates lumen (more commonly)
- ✓ Focal or diffuse Wall thickening
- ✓ Less common as a polypoid mass (usually sessile and > 10 mm)

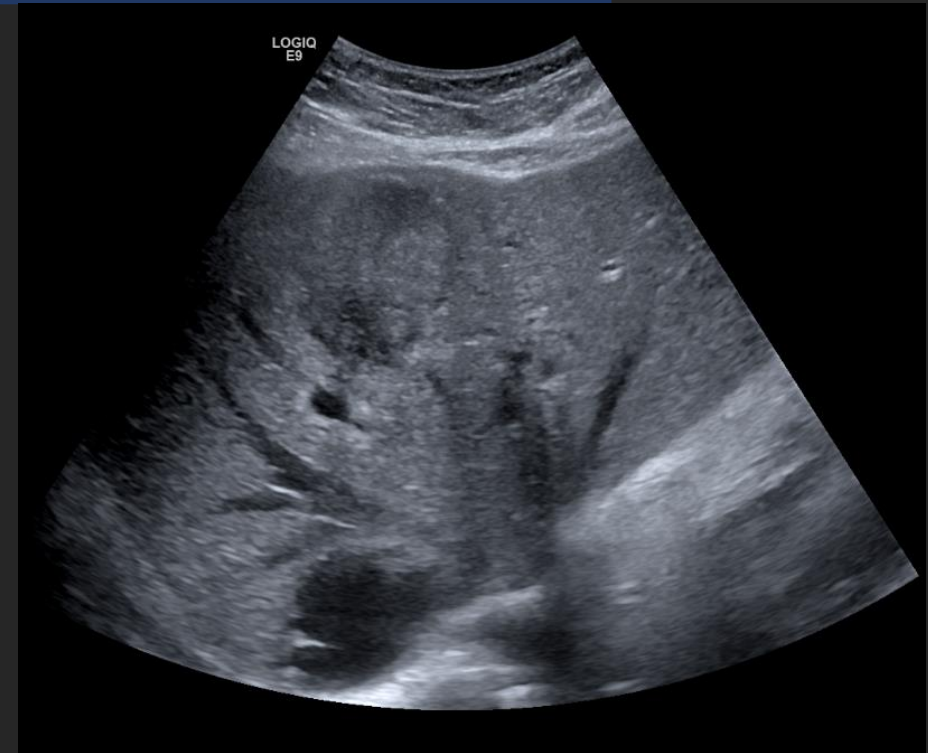


Fig. 27 Adenocarcinoma of the gallbladder
Homogenous mass extending from the gallbladder fossa, and invading the adjacent liver. Intra-hepatic biliary ducts dilatation is visible.

Neoplasm

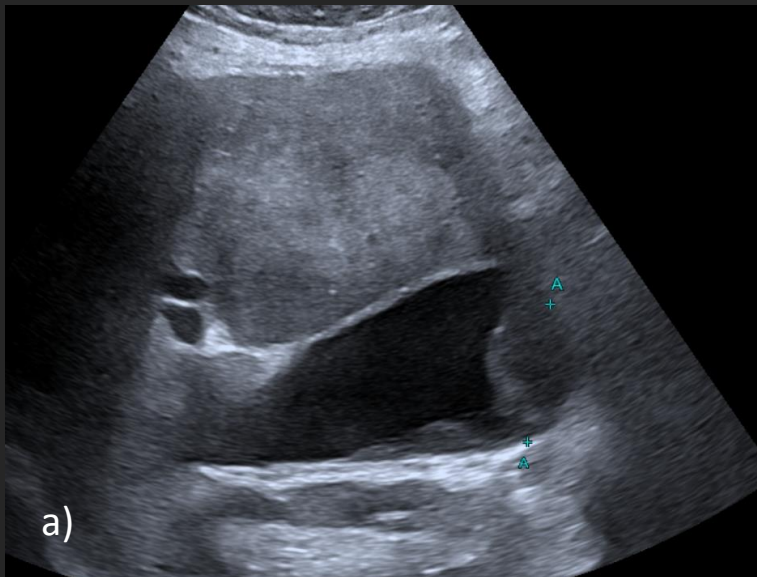


Fig. 28 Gallbladder cancer in two patients

- a) Longitudinal sonogram shows lobulated sessile polypoid mass, arising from the gallbladder wall. Extensive hepatic metastazition is also visible.
- b) Homogeneous hypoechoic mass that obliterates the gallbladder lumen and engulfs two gallstones. CT correlation on the right.

Metastasis

- Metastasis disease is a rare form of polypoid lesions
- Most commonly from melanoma (50 to 60%)
- Lung cancer can also metastize to gallbladder

Benign-looking polyps in patients with history of melanoma should ALWAYS be monitored



Fig. 29 Metastatic Melanoma
Longitudinal view of the gallbladder showing a large polypoid mass in the neck.

Parasitosis

- Rare in gallbladder
- more common in women
- Most common parasite *Ascaris lumbricoides*
- Complications include: pancreatitis, acute cholecystitis and liver abscess.

Sonographic features:

- ✓ Hypoechoic tubular structure with well-defined echogenic walls
- ✓ Curling movements in real-time evaluation



Fig. 29 Gallbladder Parasitosis
(Courtesy of Dr. Raquel Madaleno, Centro Hospitalar e Universitário de Coimbra)

Conclusion

- Ultrasonography remains the first-line imaging modality for the diagnosis of both inflammatory and non-inflammatory pathology of the gallbladder.
- It is a safe and cost-effective technique, allowing radiologists to provide an accurate differential diagnosis, therefore preventing further imaging or contrarily identifying cases where additional examinations may be needed.