

Imaging of gallbladder complications

Guilloïque M¹, Paisant A¹, Lebigot J¹, Bazeries P¹, Ronot M²,
Venara A¹, Nonent M³, Aubé C¹

¹University Hospital of Angers, France

²University Hospital of Beaujon, Clichy, France

³University Hospital of Brest, France

Learning objectives

- 1) To describe the common, rare and iatrogenic complications of gallbladder
- 2) To describe the imaging techniques to use for the diagnosis of the gallbladder complications
- 3) To identify the imaging appearances of the different gallbladder complications

Background

The gallbladder is the body's bile reservoir. Gallstones are the main cause of gallbladder complications in both emergency and chronic situations, but not only.

Moreover, the emergence of interventional radiology techniques are at the origin of new unknown complications. This requires radiologists to be familiar with the normal aspects of imaging and the specific complications of these new technologies.

Imaging of gallbladder complications

Emergency conditions

Acute cholecystitis

Perforated

Gangrenous

Emphysematous

Complications of acute cholecystitis

Erosion of the cystic artery

Other stone complication

Biliary ileus

Mirizzi syndrome

Post traumatic

Perforation

Hemobilia

Gallbladder volvulus

Anatomic variant

Chronic conditions

Xanthogranulomatous cholecystitis

Porcelain gallbladder

Hydrocholecyst on biliary duct

Iatrogenic complications due to interventional radiology

Post per-cutaneous complications

Perforation after liver thermoablation

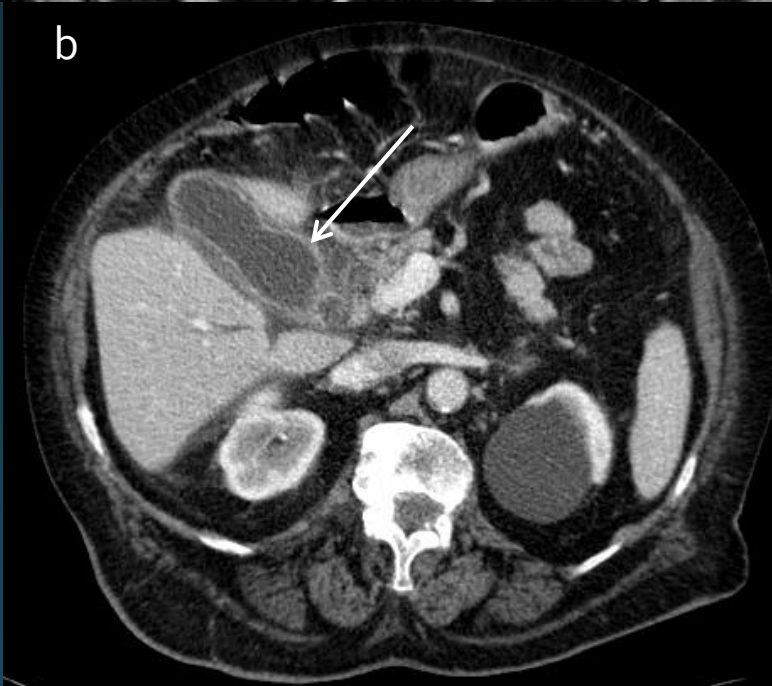
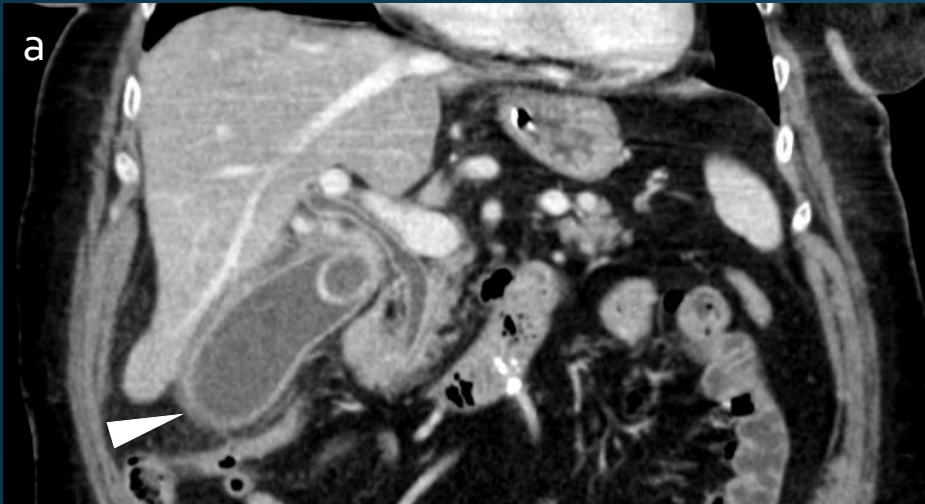
Post-embolization complications

Ischemic cholecystitis

Perforation

Emergency conditions

Acute cholecystitis



CT scan : acute cholecystitis with wall thickening, a) pericholecystic fat stranding (arrowhead), with b) increased enhancement of gallbladder wall (white arrow)

Epidemiology and physiopathology

Acute inflammation of the gallbladder

Etiology: mainly attributable to gallstones, but other factors are involved:

- ischemia
- motility disorders
- direct chemical injury
- infection with microorganisms

Radiologic findings

US:

- ❖ gallstones or sludge
- ❖ walls' oedema, thickened wall > 3 mm
- ❖ distended gallbladder > 4 cm
- ❖ pericholecystic fat stranding or fluid
- ❖ sonographic Murphy's sign

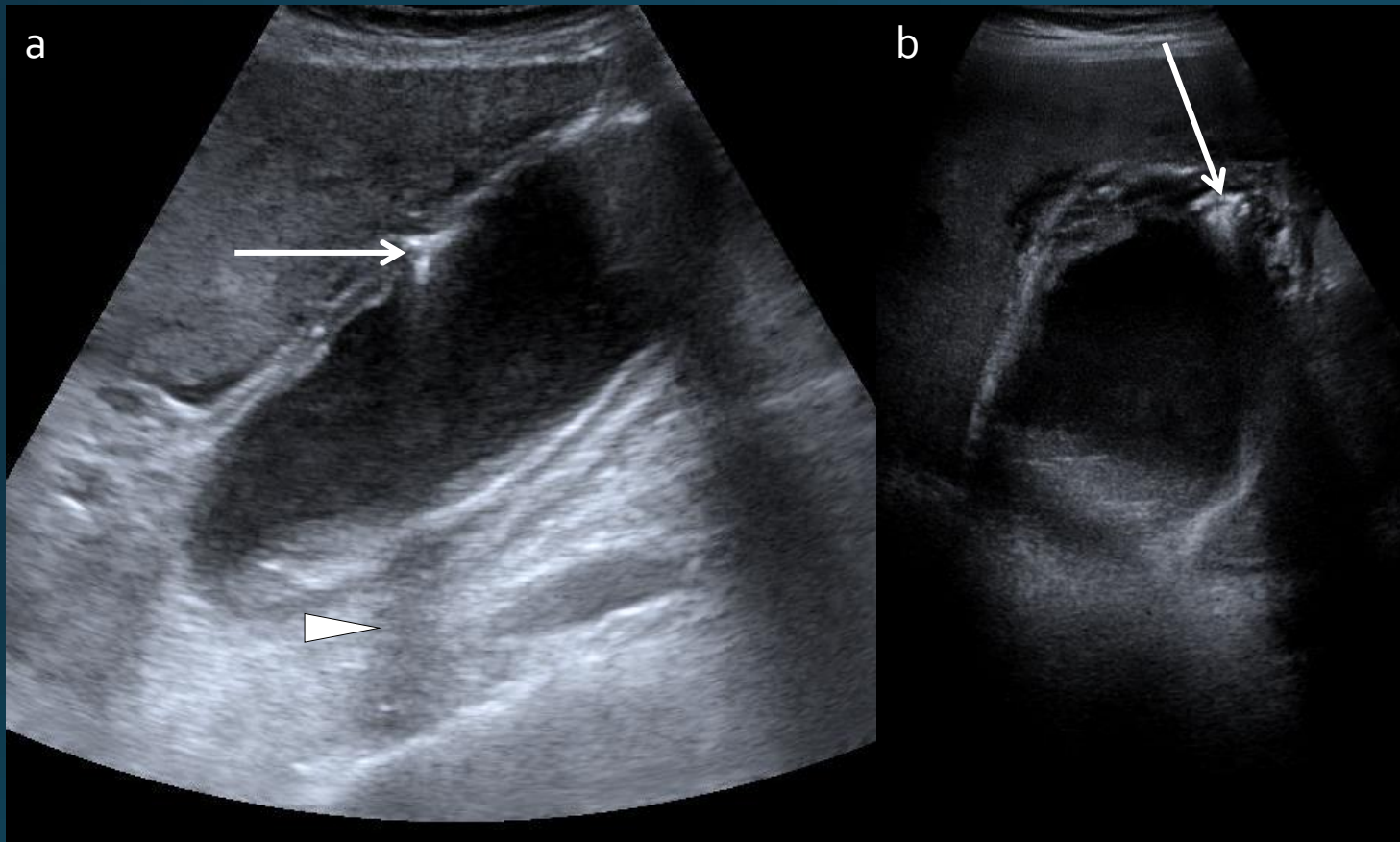
CT:

- ❖ gallstones or sludge content
- ❖ walls' oedema, thickened wall > 3 mm
- ❖ distended gallbladder > 4 cm
- ❖ pericholecystic fat stranding or fluid
- ❖ adjacent hepatic hyper-enhancement on the arterial phase
- ❖ increased wall enhancement

MRI:

- ❖ never used in emergency
- ❖ helpful to detect gallstones in the neck, in the cystic duct or in the common biliary

Emphysematous cholecystitis



US findings of emphysematous gallbladder with walls thickening and gas within the wall (white arrow) causing a shadow posteriorly (arrowhead)

Epidemiology and pathophysiology

Life-threatening condition
Surgery mandatory in emergency

Etiology :occurs in diabetic patients, linked to ischemic disease affecting small blood vessels. Due to gas-forming bacteria (clostridium perfringens) producing intramural and intraluminal gas

Radiologic findings

US:

- ❖ US findings of an acute cholecystitis
- ❖ gas in walls
- ❖ pneumobilia

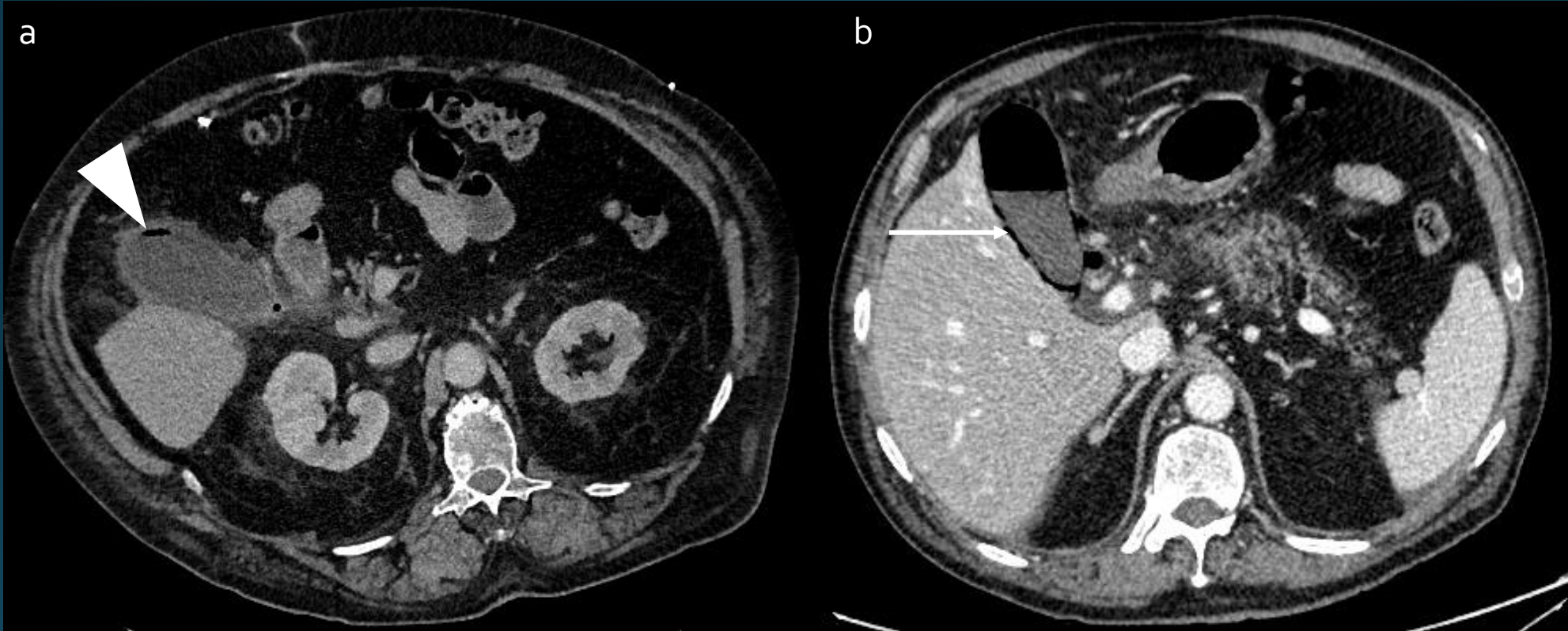
CT:

- ❖ CT findings of an acute cholecystitis
- ❖ gas in walls, lumen of the gallbladder or biliary ducts

MR:

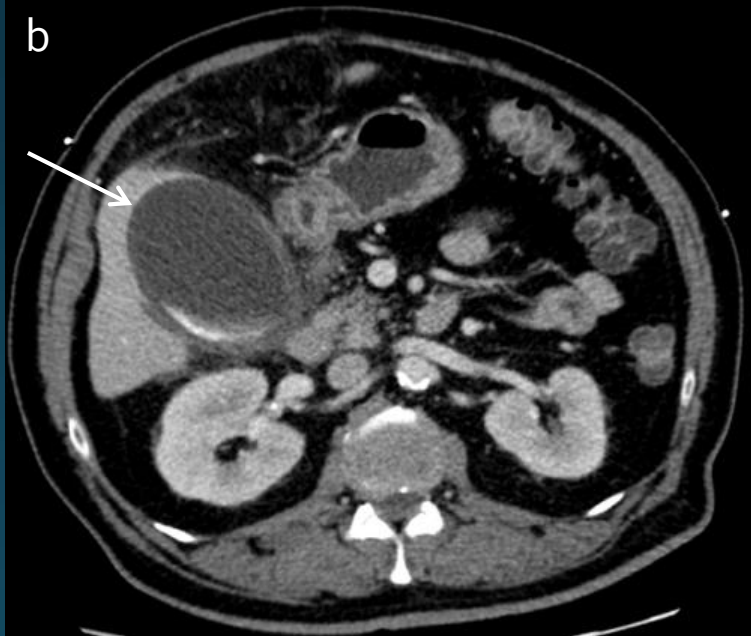
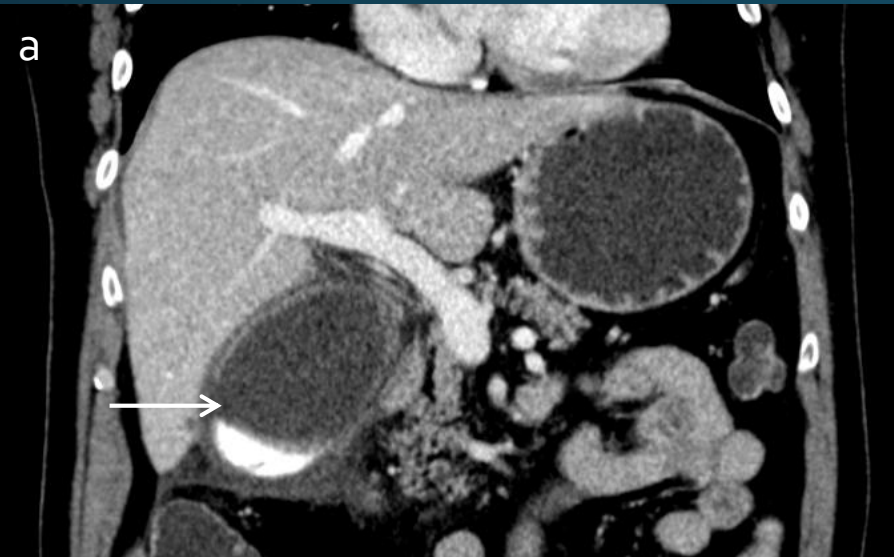
- ❖ never used in emergency
- ❖ air within the walls (detected as a signal vacuum on all sequences)

Emphysematous cholecystitis



Presence of gas within the lumen (arrowhead) and the wall of the gallbladder (arrow)

Gangrenous cholecystitis



Epidemiology and physiopathology

Cholecystitis with high morbidity and mortality rate

Etiology: severe inflammation of the gallbladder inducing wall edema, ischemia, necrosis and finally perforation

Radiologic findings

US:

- ❖ US findings of an acute cholecystitis
- ❖ intraluminal membranes
- ❖ CEUS: irregular wall enhancement with defect

CT:

- ❖ CT findings of an acute cholecystitis
- ❖ intraluminal membranes
- ❖ reduced mural enhancement

MRI:

- ❖ areas of wall necrosis in contrast-enhanced fat-suppressed sequences ("interrupted rim sign" with patchy enhancement of the gallbladder mucosa)

CT findings of gangrenous cholecystitis with pericholecystic fluid, lack of enhancement and focal mural defects (white arrow)

Perforated cholecystitis



US findings of perforated cholecystitis with wall thickening and focal defect in the gallbladder wall communicating with pericholecyst abscesses (white arrow)

Epidemiology and physiopathology

The most serious complication of acute cholecystitis occurring at advanced gangrenous cholecystitis with the higher morbidity-mortality rate

Etiology: severe inflammation of the gallbladder inducing wall edema, ischemia, necrosis and finally perforation

Radiologic findings

US:

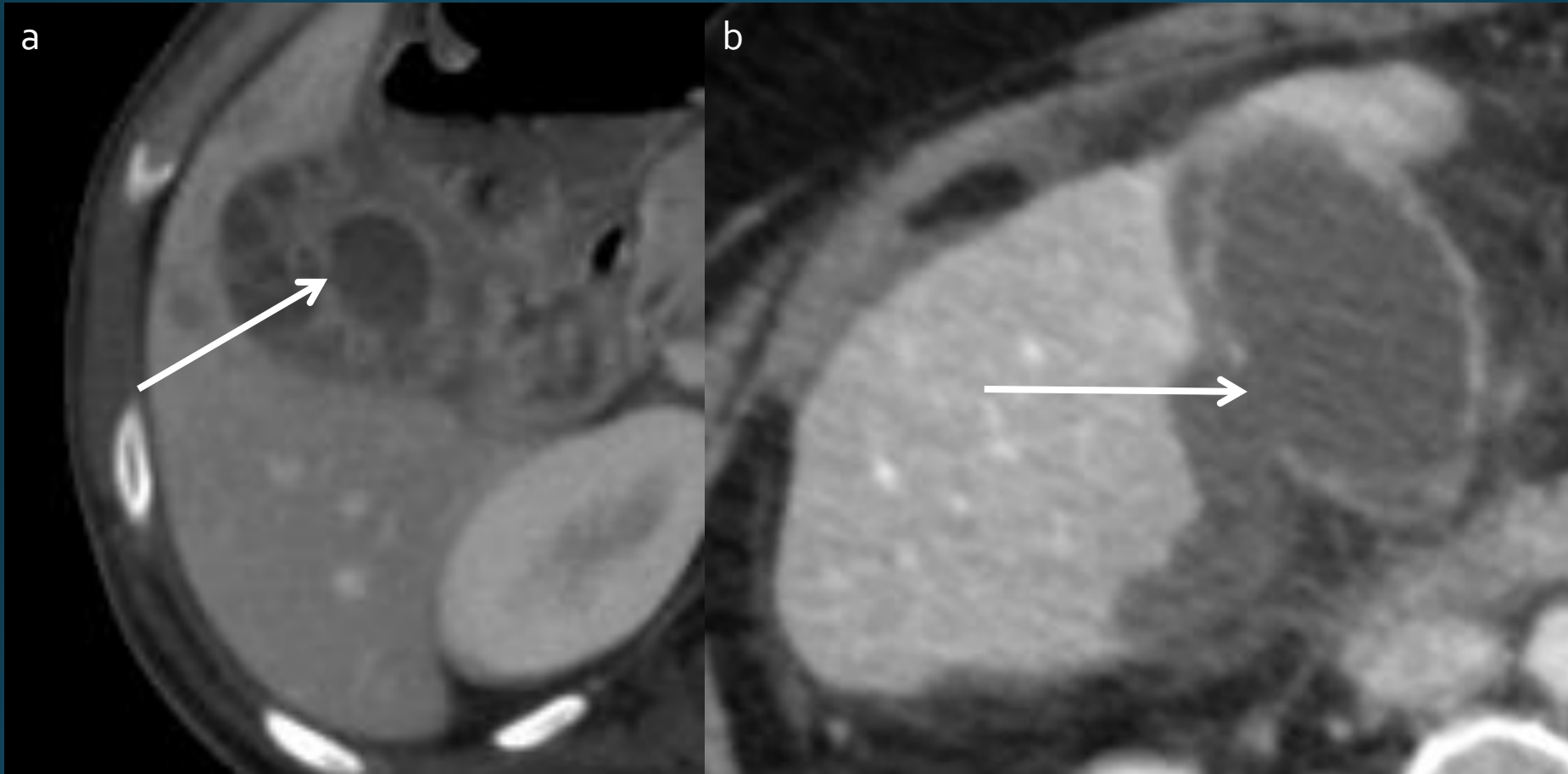
- ❖ US findings of an acute cholecystitis
- ❖ focal mural defect communicating with pericholecyst fluid or abscesses

CT:

- ❖ CT findings of an acute cholecystitis
- ❖ focal mural defect communicating with pericholecystic fluid or abscesses

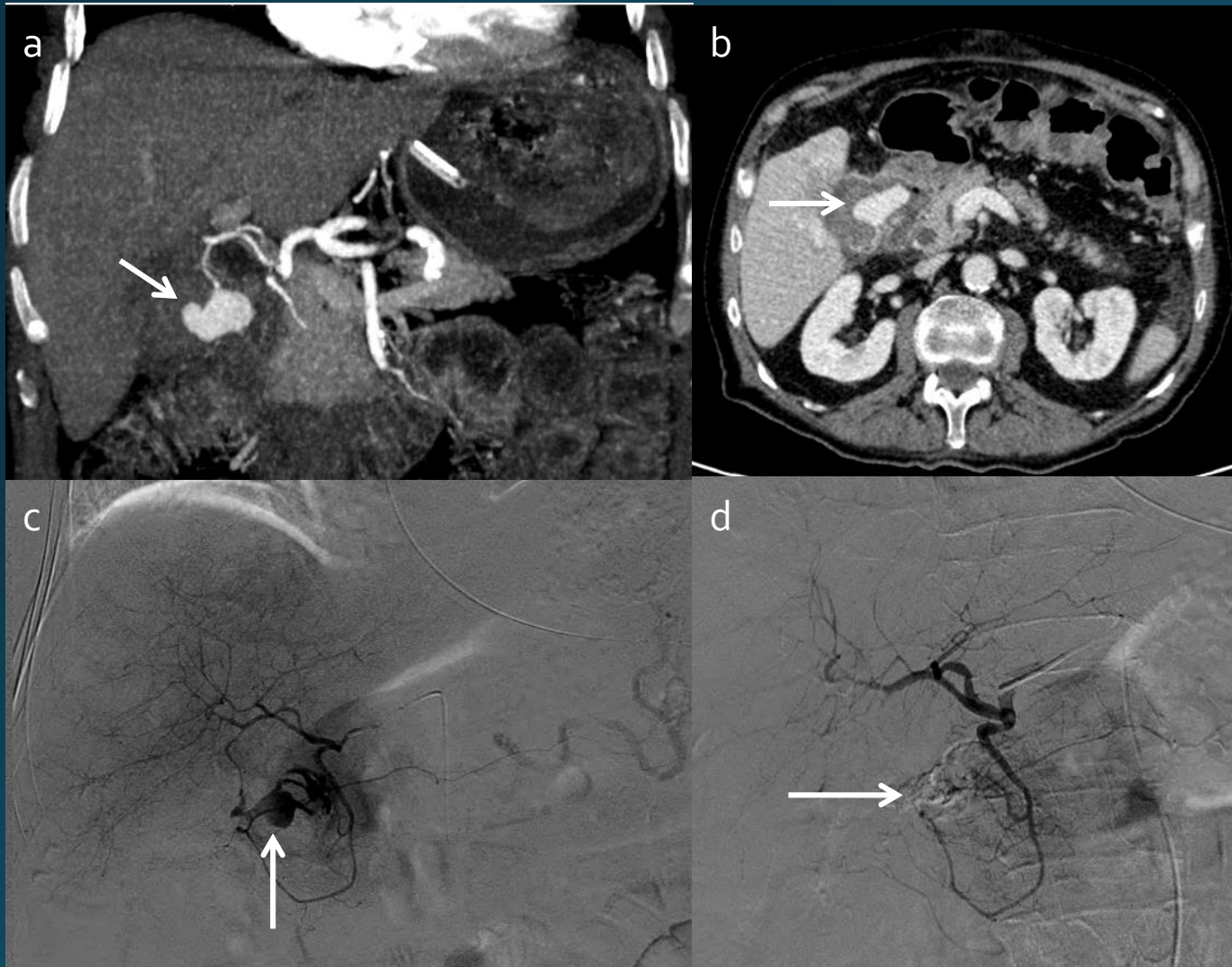
MRI:

- ❖ never used in emergency
- ❖ intramural microabscesses



a) gangrenous cholecystitis complicated by perforation (arrow: focal parietal enhancement defect) with intramural microabscesses; b) gangrenous cholecystitis with focal parietal defect (arrow) communicating with pericholecyst abscesses

Erosion of the cystic artery



Epidemiology and physiopathology

Rarity of this condition, despite the high rate of acute cholecystitis

Etiology: in rare cases, acute cholecystitis can cause pseudoaneurysm of the cystic artery due to local inflammation

Radiologic findings

US :

- ❖ US findings of an acute cholecystitis if imaging is performed early
- ❖ pulsatile wave pattern in the echogenic lesion of the gallbladder

CT :

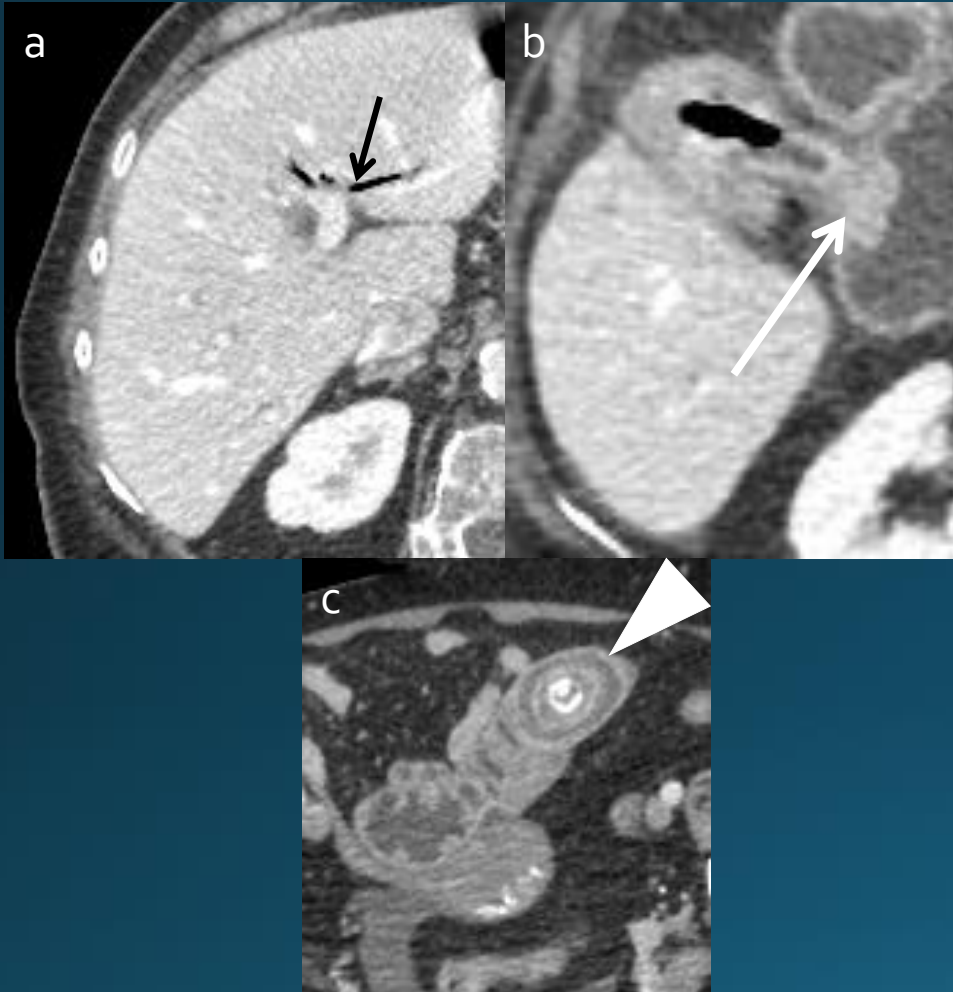
- ❖ CT findings of an acute cholecystitis if imaging is performed early
- ❖ pseudoaneurysm developed at the expense of the cystic artery in a distended gallbladder

MRI :

- ❖ MRI has no indication

a) MIP reconstruction at arterial time disclose pseudoaneurysm of the cystic artery (white arrow) in the lumen of the gallbladder;; b) CT scan of the same patient in the axial plan; selective transcatheter arterial embolization before c) and d) after treatment

Gallstone ileus



Epidemiology and pathophysiology

Rare complication of cholelithiasis (<1%) due to chronic recurrent cholelithiasis

Associated complication: cause of mechanical bowel obstruction

Etiology: a biliodigestive fistula, a perforated duodenal ulcer into the biliary tree or a neoplastic infiltration cause the passage of one or more gallstones from biliary tree to the intestinal lumen with mechanical bowel obstruction

Radiologic findings

US:

- ❖ gallbladder with thickened walls
- ❖ gallbladder collapsed by the biliodigestive fistula

CT:

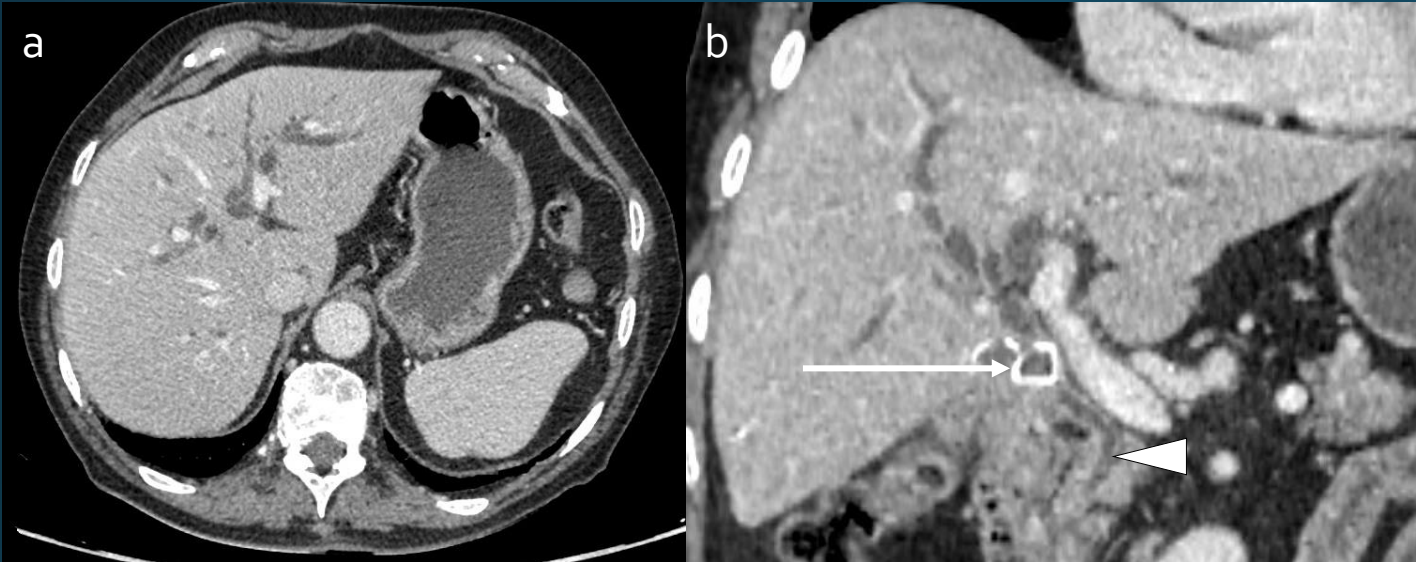
- ❖ pneumobilia
- ❖ small bowel obstruction
- ❖ ectopic gallstone at point of the obstruction
- ❖ contracted gallbladder with luminal gas
- ❖ loop of bowel inseparable from the gallbladder wall with a biliodigestive fistula sometimes visible

MRI:

- ❖ MRI is not recommended in this indication

Gallstone ileus with Rigler's triad on CT scan a) pneumobilia (black arrow), b) contracted gallbladder with luminal gas and a loop of bowel inseparable from the gallbladder (white arrow), c) small bowel obstruction and ectopic gallstone impacted at point of obstruction (arrowhead)

Mirizzi syndrome



Mirizzi syndrome with a) dilated biliary ducts b) mechanical extrinsic compression of the common hepatic duct by a gallstone (arrow) impacted in the cystic duct with thin choledoch downstream (arrowhead)

Epidemiology and physiopathology

A rare cause of obstructive jaundice

Associated complication: cause of mechanical biliary tree obstruction

Etiology : mechanical extrinsic compression of the common hepatic duct by a gallstone impacted in the cystic duct or neck of the gallbladder or by the concomitant inflammation

Radiologic findings

US:

- ❖ US findings of acute cholecystitis
- ❖ gallstone impacted in the cystic duct or in the neck of the gallbladder
- ❖ dilated intrahepatic biliary ducts

CT:

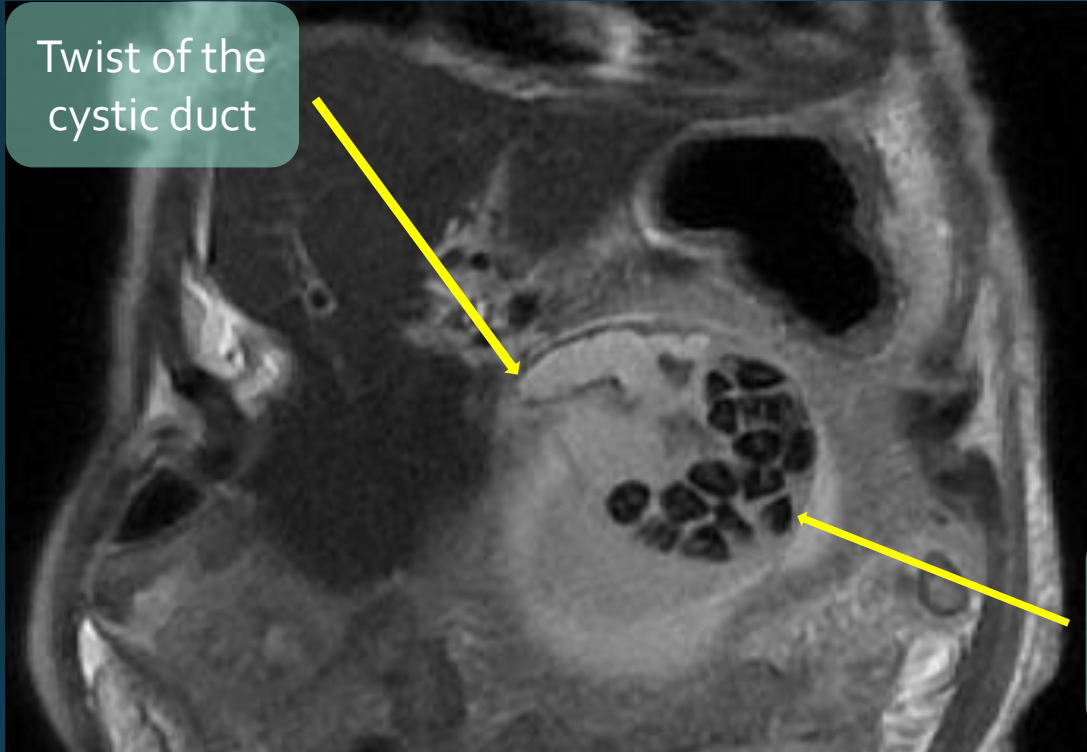
- ❖ CT findings of acute cholecystitis
- ❖ gallstone impacted in the cystic duct or in the neck of the gallbladder
- ❖ dilated intrahepatic biliary ducts

MRI:

- ❖ MR cholangiopancreatography (MRCP) reveals the exact level of the impacted gallstone in the cystic duct and common hepatic duct

Gallbladder volvulus

Twist of the
cystic duct



Distended
gallbladder with
gallstones
contents

MRI coronal T2 SSFSE : rotation of the gallbladder along the axis of the cystic duct and artery, ectopic position of the gallbladder abnormally low

Epidemiology and physiopathology

Rare event that often occurs in the elderly

Associated complication: risk of necrosis / perforation

Etiology: anatomic factors such as congenital anomaly (absence of gallbladder mesentery) / atrophy of the liver / loss of visceral fat

Radiologic findings

US:

- ❖ distended / gallstones or sludge;
- ❖ ectopic position (abnormally low);
- ❖ pericholecystic fluid, laminated appearance of gallbladder walls

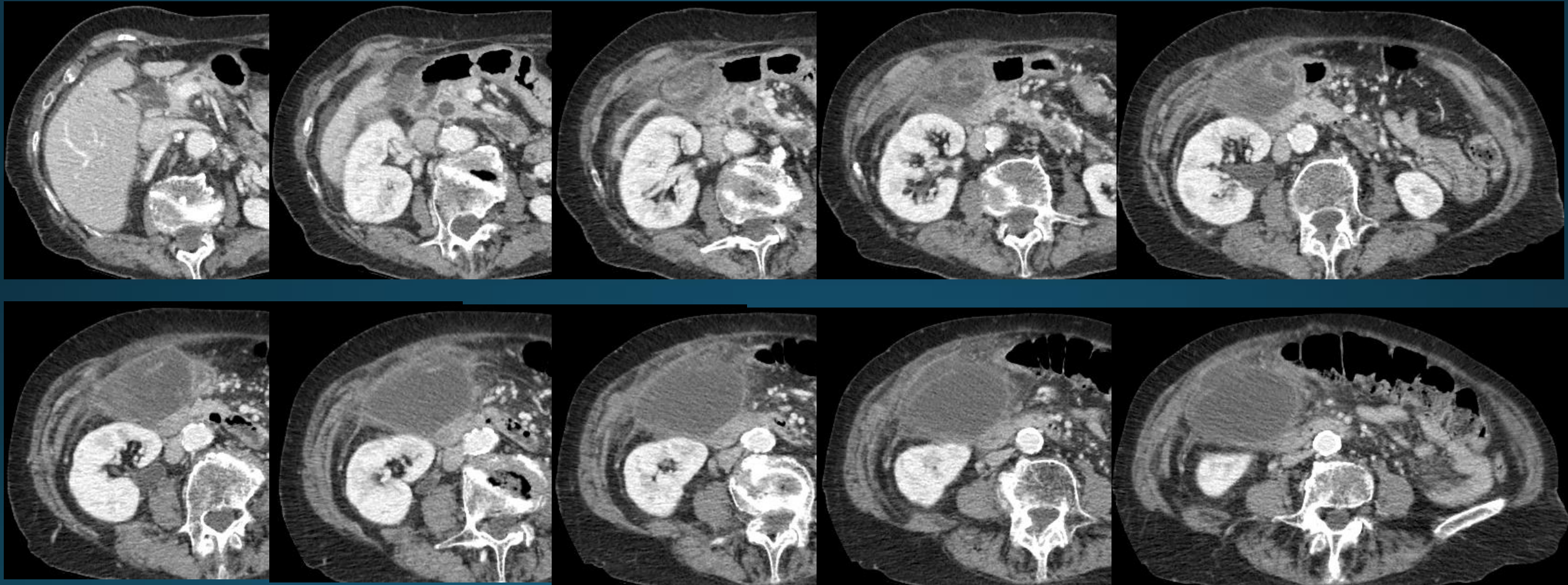
CT:

- ❖ distended / gallstones or sludge
- ❖ ectopic position (abnormally low)
- ❖ pericholecystic fluid, thickening of the gallbladder walls
- ❖ twist of the cystic duct and artery (complete twist : 360° or incomplete 180°)

MRI:

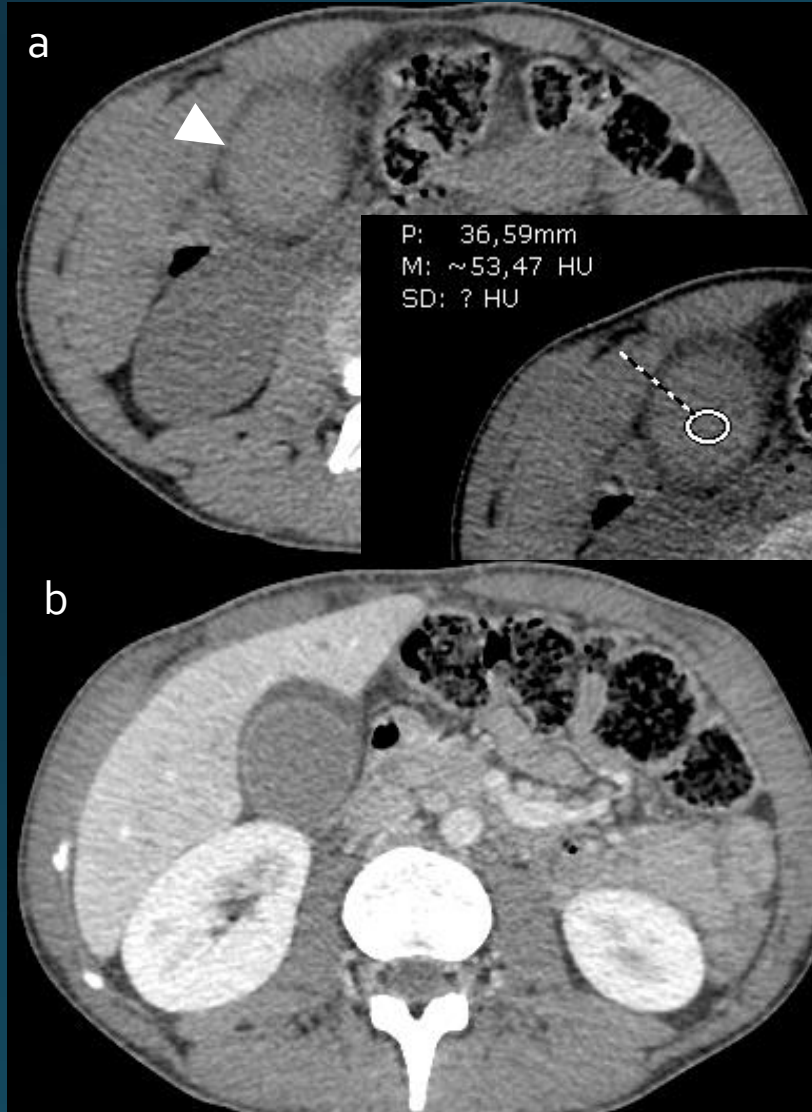
- ❖ distended / gallstones or sludge
- ❖ ectopic position (abnormally low)
- ❖ pericholecystic fluid, laminated appearance of gallbladder walls
- ❖ common bile duct next to the neck of the gallbladder which suggests a twist along the axis of the cystic duct

Gallbladder volvulus



Axial CT: distended gallbladder in ectopic position (abnormally low) with the « whirl sign » of the cystic duct

Post traumatic injuries of the gallbladder



Epidemiology and physiopathology

Gallbladder injury secondary to trauma have a low incidence reported to be between 1.9% and 2.1% of all abdominal traumas

Etiology: blunt trauma include road traffic accidents; trauma to the gallbladder is often associated with liver, duodenum and spleen trauma

Radiologic findings

US:

- ❖ echogenic fluid within the lumen
- ❖ defect in the wall of the gallbladder in case of perforation associated with pericholecystic fluid
- ❖ +/- intraperitoneal effusion

CT:

- ❖ simple hematoma within the lumen/the wall
- ❖ irregular contour of the gallbladder with pericholecystic fluid in case of perforation
- ❖ +/- intraperitoneal effusion

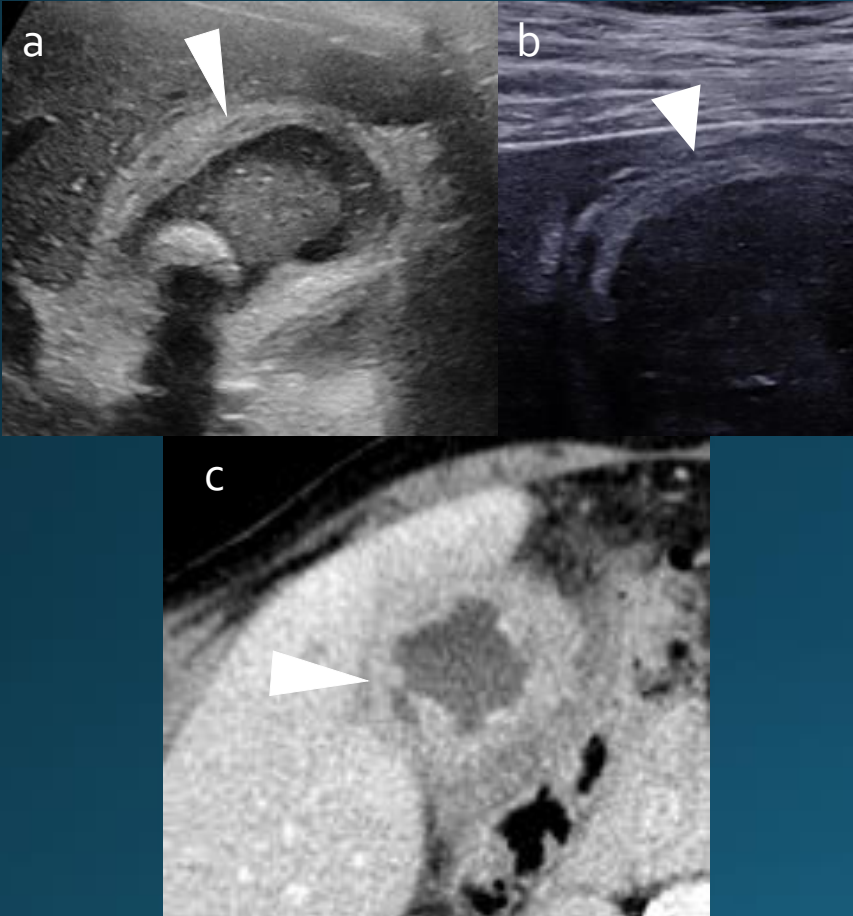
MRI:

- ❖ MR imaging is not used in emergency but can be used in cases of biliary tract injury associated

Haemobilia after a traffic road accident, a) intraluminal hematoma (arrowhead) with 53 UH in spontaneous contrast, b) CT after injection of contrast agent: persistence of spontaneous hyperdensity without enhancement in favour of tissue damage

Chronic conditions

Chronic cholecystitis



US findings of chronic cholecystitis with a) thickened walls (arrowheads), abnormal content with gallstones and sludge, b) ultrasonography with linear probe; c) CT findings of chronic cholecystitis with wall thickening and contracted gallbladder

Epidemiology and physiopathology

Represents 32.7% of patient with acute right upper quadrant

Histology: parietal thickening affecting all layers with hypertrophy of the muscularis and fibrosis of the serosa

Etiology: secondary to acute iterative flare-ups cholecystitis

Radiologic findings

US:

- ❖ thickened wall > 3 mm
- ❖ gallstones content
- ❖ absence of pericholecyst inflammation

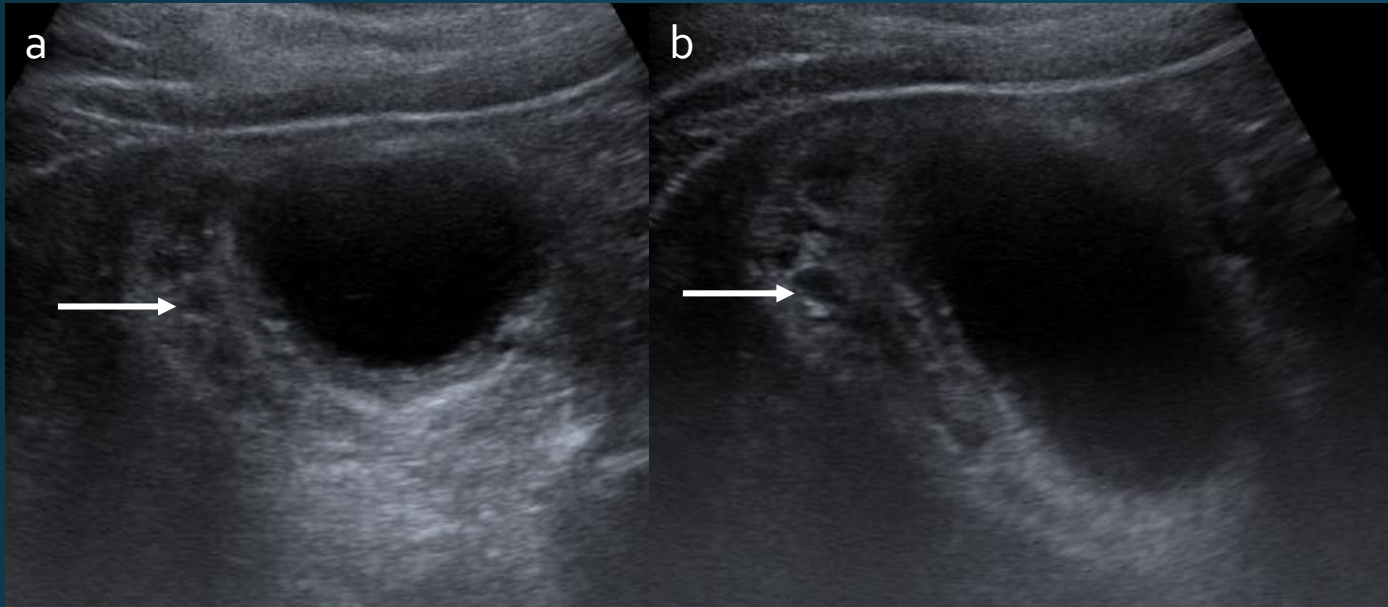
CT:

- ❖ thickened wall > 3 mm
- ❖ gallstones content
- ❖ absence of pericholecyst inflammation

MRI:

- ❖ useful to make difference between chronic cholecystitis and gallbladder carcinoma
- ❖ gallbladder wall enhancement in chronic cholecystitis usually smooth, slow, and prolonged, unlike in gallbladder carcinoma which is usually irregular, early and prolonged

Xanthogranulomatous cholecystitis



US findings of xanthogranulomatous cholecystitis with irregular wall thickening with intramural nodules (white arrow)

Epidemiology and physiopathology

Rare and characterized by a focal or diffuse destructive inflammatory process of the gallbladder

Etiology: chronic inflammatory process as a granulomatous reaction followed by the extravasation of bile into the gallbladder wall probably due to rupture of the Rokitansky-Aschoff sinuses

Radiologic findings

US:

- ❖ diffuse or focal wall thickening
- ❖ intramural nodules or bands in the wall

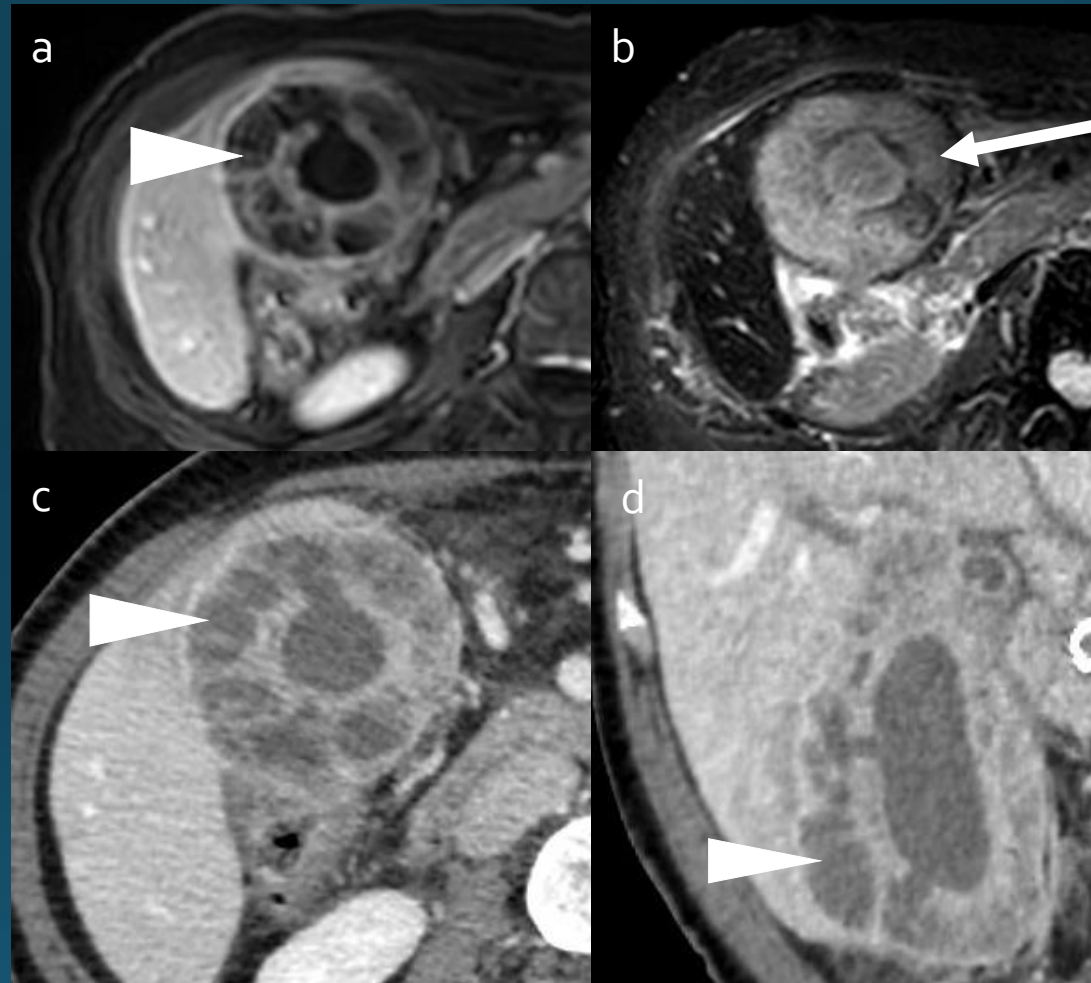
CT:

- ❖ diffuse or focal wall thickening
- ❖ heterogeneous wall enhancement
- ❖ hypoattenuating intramural nodules

MRI:

- ❖ intramural lesions with significantly elevated T2 signal intensity
- ❖ preservation of linear mucosal enhancement at MR imaging is suggestive of XGC rather than carcinoma

Xanthogranulomatous cholecystitis



intramural
lesions with
significantly
elevated T2
signal intensity

Xanthogranulomatous cholecystitis with a,b,c) heterogeneous wall enhancement, hypoattenuating intramural nodules (arrowhead), and continuous linear enhancement of the mucosa

Porcelain gallbladder (risk of adenocarcinoma)

Radiologic findings

US:

- ❖ hyperechoic semilunar structure or irregular clumps of echoes depending on the extent and nature of calcification with posterior acoustic shadowing
- ❖ hyperechoic devoid of any posterior acoustic shadowing, often associated with hepatic lesions in case of transformation into carcinoma

CT:

- ❖ characteristic calcification of the gallbladder wall
- ❖ calcified irregularly thickened wall often associated with hepatic lesion, abdominal lymph adenopathy, and tumor infiltration into the adjacent viscera in case of transformation into carcinoma

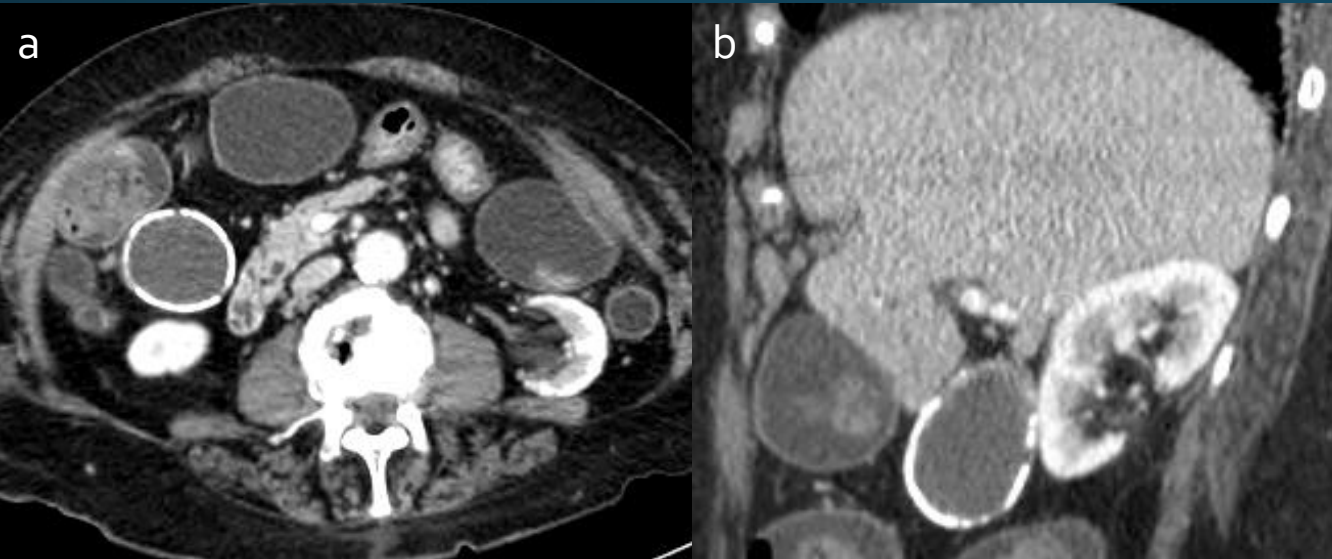
MRI:

- ❖ useful for the adenocarcinoma staging, with heterogeneous hyperintense T2-weighted images, iso- or hypointense T1-weighted images with enhancement after gadolinium
- ❖ stage T1 and T2 are difficult to differentiate from benign parietal thickening.

Epidemiology and physiopathology

Chronic inflammation associated with gallbladder cancer

Etiology: uncommon finding of chronic cholecystitis with extensive calcification in the wall of the gallbladder caused by calcium carbonate deposition



CT findings of porcelain gallbladder with extensive calcification in the wall of the gallbladder

Gallbladder hydrops

Epidemiology and physiopathology

Etiology: acute distension of the gallbladder due to chronic mechanical obstruction of the gallbladder neck or the cystic duct (gallstone, clot or cancer)

Radiologic findings

US:

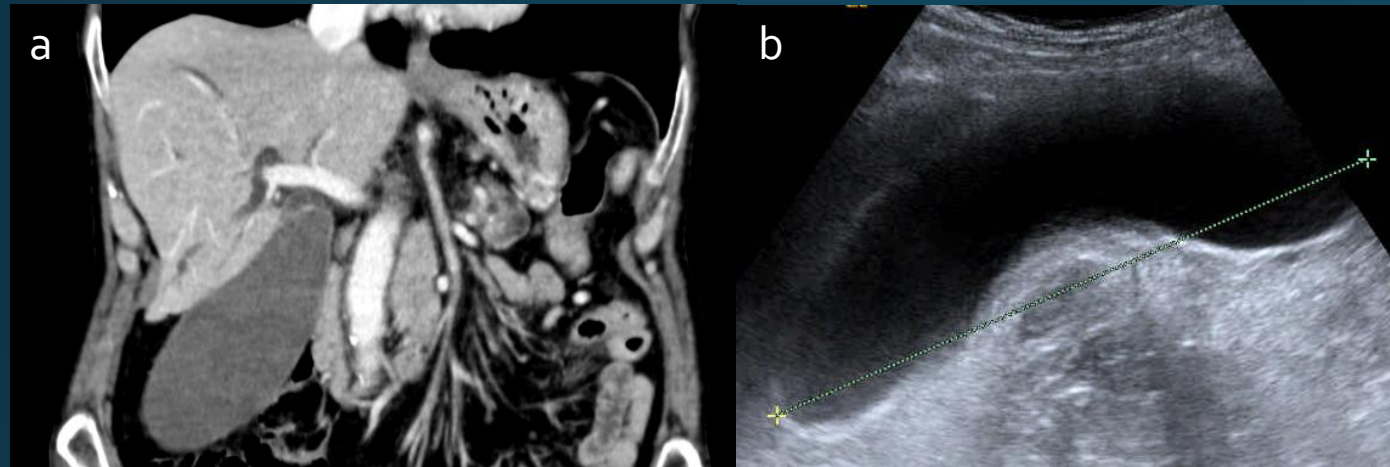
- ❖ distended gallbladder > 4 cm
- ❖ no gallstones
- ❖ no thickening of the walls
- ❖ no pericholecystic fat stranding or fluid

CT:

- ❖ distended gallbladder > 4 cm
- ❖ no gallstones
- ❖ no thickening of the walls
- ❖ no pericholecystic fat stranding or fluid

MRI:

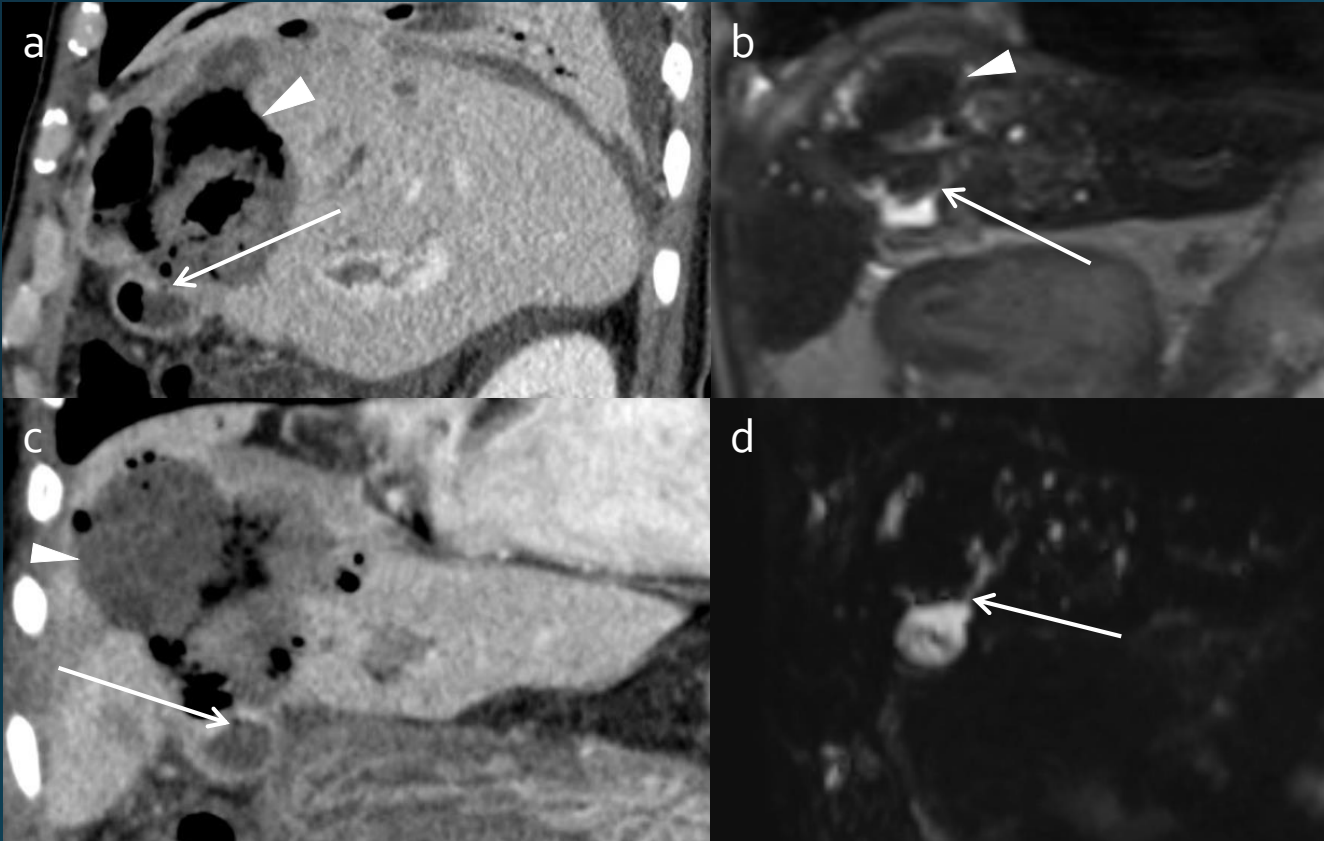
- ❖ helpful for the etiology diagnostic



Gallbladder hydrops upstream of pancreatic cancer a) CT findings with distended gallbladder without pericholecystic inflammation and b) US findings with distended gallbladder with thin walls

iatrogenic complications due to
interventional radiology

Post per-cutaneous treatment complications



Post-RF imaging of perforation of gallbladder revealed by bilioma a) sagittal CT, b) coronal MRI T2 haste sequences, c) coronal CT, d) MRCP with bilioma located in the right liver (arrowhead) and focal mural defect (white arrow)

Epidemiology and physiopathology

Prevalence of 4.0% per completed treatment with RF ablation and 1.9% per individual treatment session

Etiology : gallbladder risks thermal damage after liver radiofrequency (RF) depending on the treated tumor size and location (within 1 cm to the gallbladder), leading to perforation and/or acute cholecystitis

NB: bile aspiration with or without additional hydrodissection are described to protect the gallbladder from thermal injuries

Radiologic findings

US :

- ❖ US findings of acute cholecystitis
- ❖ hemocholecyst (clot-filled gallbladder) with clumps of echogenic material within the lumen of the gallbladder

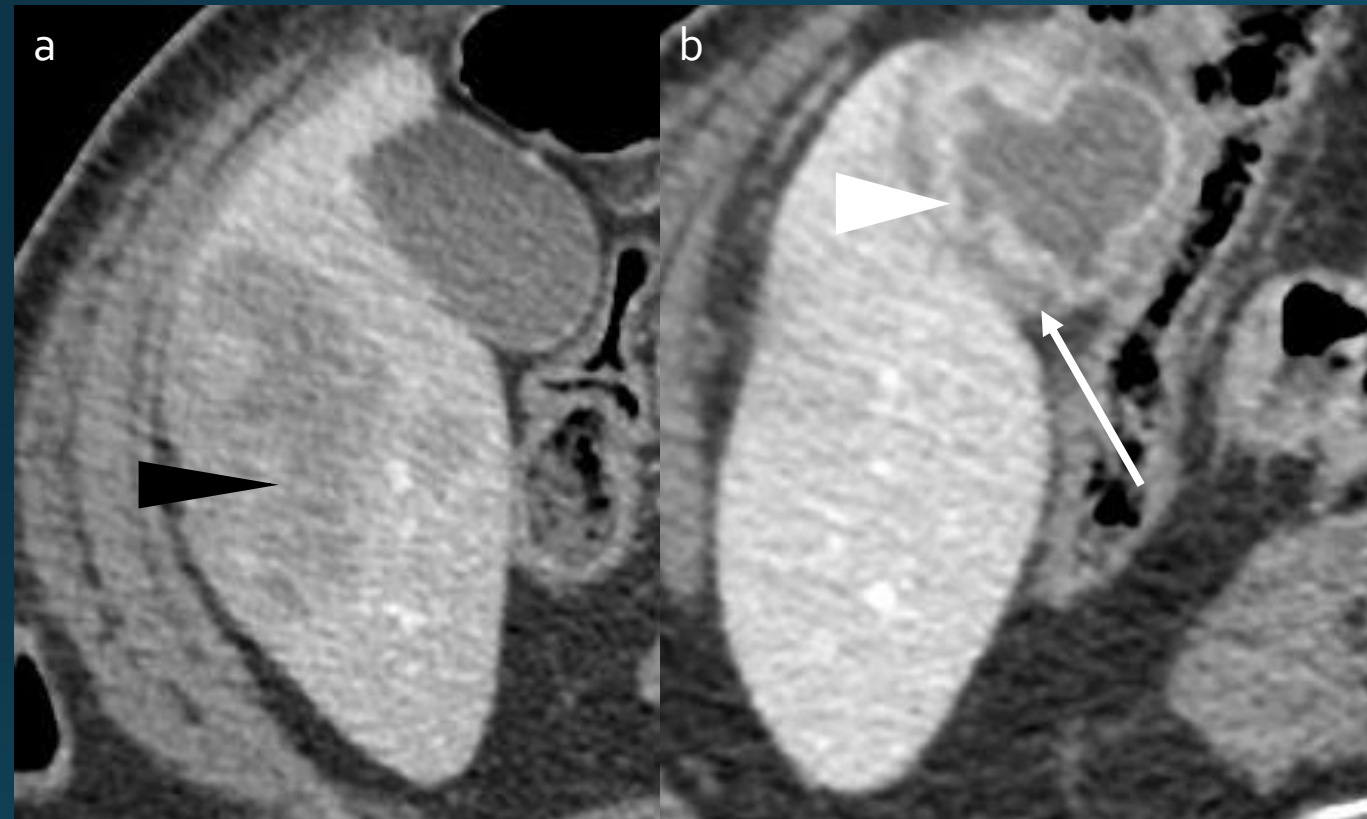
CT :

- ❖ CT findings of acute cholecystitis
- ❖ focal mural defect of the walls
- ❖ bilioma
- ❖ gas within the lumen

MRI :

- ❖ helpful in case of associated bile ducts injuries to determine the origin of bilioma

Post-embolization complications



Post-embolization complication a) before TACE with hepatic tumor of segments V and VI (black arrowhead); b) after TACE with wall thickening (white arrowhead) and pericholecystic fluid (arrow)

Epidemiology and physiopathology

During transarterial chemoembolization (TACE) inadvertent embolization of the cystic artery occurred in 53%

Etiology: TACE for palliative treatment for hepatic tumors can lead to embolization of the cystic artery, leading to acute ischemic cholecystitis and/or perforation

Radiologic findings

US:

- ❖ US findings of an acute cholecystitis
- ❖ intraluminal membranes
- ❖ CEUS: irregular wall enhancement with defect

CT:

- ❖ CT findings of an acute cholecystitis
- ❖ intraluminal membranes
- ❖ reduced mural enhancement

MRI:

- ❖ not used in emergency but can show associated ischemic cholangitis

Conclusion

- Complications of the gallbladder present some typical imaging features to recognize.
- Rare complications due to chronic conditions should be known for an early diagnosis and treatment.
- Uncommon complications due to new therapeutic interventions should be known in order to try to avoid them or to recognize them early
- Complications of the gallbladder do not necessarily imply wall thickening
- MRI have no indication in emergency but can be useful in chronic conditions to distinguish between inflammatory and malignant diseases

Bibliography

1. Catalano OA, Sahani DV, Kalva SP, Cushing MS, Hahn PF, Brown JJ, Edelman RR. MR imaging of the gallbladder: a pictorial essay. Radiographics. 2008 Jan-Feb;28(1):135-55
2. Schirmer BD, Winters KL, Edlich RF. Cholelithiasis and Cholecystitis - Journal of Long-Term Effects of Medical Implants, 2005;15(3):329-38.
3. Contini S, Uccelli M, Sassatelli R, Pinna F, Corradi D. Gallbladder ulcer eroding the cystic artery: a rare cause of hemobilia. Am J Surg. août 2009;198(2):e17-19.
4. Gasparrini M, Liverani A, Catracchia V, Conte S, Leonardo G, Marino G, et al. Gallstone ileus: a case report and review of the literature. Chir Ital. oct 2008;60(5):755-9.
5. Bower TC, Nagorney DM. Mirizzi Syndrome. HPB Surg. 1988;1(1):67-76.
6. Blunt abdominal trauma resulting in gallbladder injury: a review with emphasis on pediatrics. - PubMed - NCBI [Internet]. [cité 27 nov 2018]. Disponible sur: <https://www.ncbi.nlm.nih.gov/pubmed/21610404>
7. Kaura SH, Haghighi M, Matza BW, Hajdu CH, Rosenkrantz AB. Comparison of CT and MRI findings in the differentiation of acute from chronic cholecystitis. Clin Imaging. 1 juill 2013;37(4):687-91.
8. Smith EA, Dillman JR, Elsayes KM, Menias CO, Bude RO. Cross-Sectional Imaging of Acute and Chronic Gallbladder Inflammatory Disease. Am J Roentgenol. 1 janv 2009;192(1):188-96.
9. Han S-H, Chen Y-L. Diagnosis and Treatment of Xanthogranulomatous Cholecystitis: A Report of 39 Cases. Cell Biochem Biophys. 1 nov 2012;64(2):131-5.
10. Yun EJ, Yoon DY, Choi CS, Bae SH, Seo YL, Chang SK, et al. Calcified Carcinoma of the Gallbladder with Calcified Nodal Metastasis Presenting as a Porcelain Gallbladder: A Case Report. Cancer Res Treat Off J Korean Cancer Assoc. mars 2011;43(1):71-4.
11. Herek O null, Yildiran N. Gallbladder hydrops caused by intraluminal clot in hemobilia: an unusual complication of hepatic trauma in childhood. J Pediatr Gastroenterol Nutr. juill 2001;33(1):92-3.
12. Akahane M, Koga H, Kato N, Yamada H, Uozumi K, Tateishi R, et al. Complications of percutaneous radiofrequency ablation for hepatocellular carcinoma: imaging spectrum and management. Radiogr Rev Publ Radiol Soc N Am Inc. oct 2005;25 Suppl 1:S57-68.
13. Takayasu K, Moriyama N, Muramatsu Y, Shima Y, Ushio K, Yamada T, et al. Gallbladder infarction after hepatic artery embolization. Am J Roentgenol. 1 janv 1985;144(1):135-8.