

A Galling Problem: Imaging Review of the Complications of Acute Cholecystitis

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Learning Objectives

1. Understand that acute cholecystitis may potentially be complicated by conditions such as gangrene or perforation.
2. Recognize the imaging findings of complicated acute cholecystitis
3. Understand that gallbladder carcinoma can be a potential mimic of complicated acute cholecystitis

Background - Acute Cholecystitis

- Common surgical condition
- Inflammation of the gallbladder due to cystic duct obstruction from stones or sludge
- Gallstones affect 10-15% of the adult population in developed societies
- 1-4% of patients with gallstones become symptomatic each year
- 36% of symptomatic individuals present with acute cholecystitis
- Acute cholecystitis occurs in 1 % of patients with known gallstones per annum.

1. Stinton LM et al Epidemiology of gallbladder disease: cholelithiasis and cancer. *Gut Liver*. 2012;6(2):172-87.
2. Glasgow et al The spectrum and cost of complicated gallstone disease in California. *Arch Surg (Chicago, Ill: 1960)* 135(9):1021-1025
3. Sanders et al (2007) Gallstones. *BMJ (Clin Res ed)* 335(7614):295-299

Presentation

- Right upper quadrant pain that can radiate to the shoulder or back
- Fever, nausea, vomiting
- Positive Murphy's Sign
- Sepsis and peritonitis, depending on the severity
- Typically >25 years old
- Females for commonly affected (1:3)

Natural History and Prognosis

- Excellent prognosis for uncomplicated cases treated with prompt surgery
- Overall mortality from acute cholecystitis is 3-4% (< 1% in young patients and 10% in high-risk patients)
- Bedirli et al – 368 patients with acute cholecystitis. 83% were uncomplicated
- Acute cholecystitis can lead to potentially life-threatening complications such as empyema, gallbladder gangrene and gallbladder perforation.

Bedirli A, Sakrak O, Sözüer EM, Kerek M, Güler I. Factors effecting the complications in the natural history of acute cholecystitis. *Hepatogastroenterology*. 2001;48(41):1275-8.

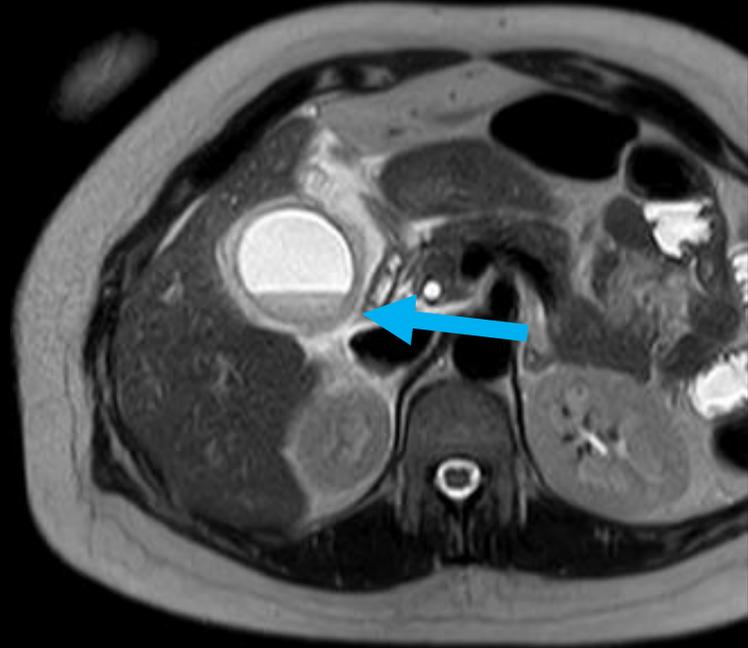
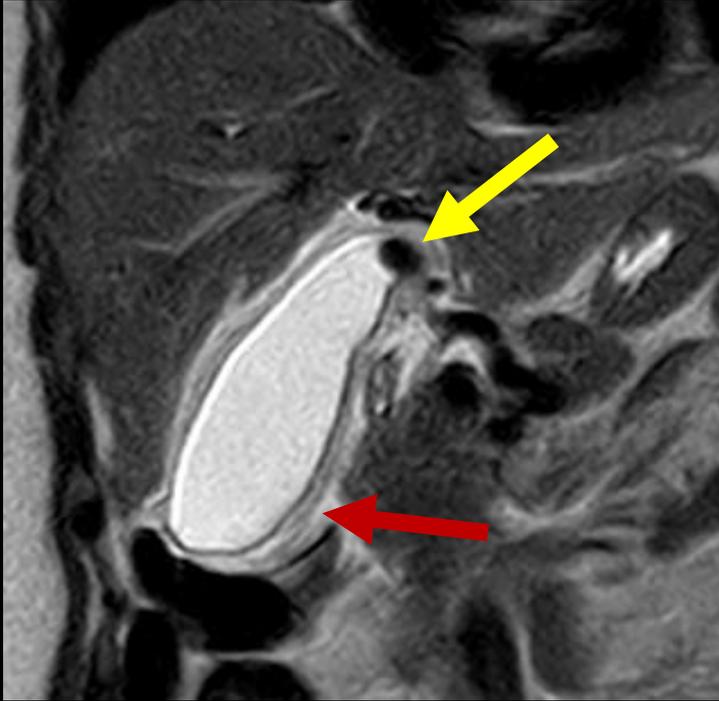
Acute Calculous Cholecystitis

- Obstruction of the cystic duct by a calculus (95%)
- Increases pressure within the gallbladder lumen
- Reduced perfusion from the cystic artery
- Cholesterol-supersaturated bile, triggers an acute inflammatory response
- Gallstones contribute to the inflammatory response by stimulating prostaglandins I₂ and E₂
- Ischaemic and inflammation
- Gallbladder wall thickening and pain
- Hyperdense calculus is seen 15% of the time

Kimura et al. Definitions, pathophysiology, and epidemiology of acute cholangitis and cholecystitis: Tokyo Guidelines. *J Hepatobiliary Pancreat Surg.* 2007;14:15–26.

SMJ 2015 Aug; 56(8): 438–444. Imaging of acute cholecystitis and cholecystitis-associated complications in the emergency setting

Acute Calculus Cholecystitis



Middle aged Chinese lady who presented with right upper quadrant pain. MRI was performed for this patient which showed a **calculus** in the neck of the gallbladder associated with **mural thickening** and **sludge**. The MRI findings are typical of acute calculus cholecystitis.

Complications of Acute Cholecystitis

- Bedirli et al – 368 patients with acute cholecystitis. 83% were uncomplicated
- Acute cholecystitis can lead to potentially life-threatening complications such as empyema, gallbladder gangrene and gallbladder perforation.

Gallbladder Empyema

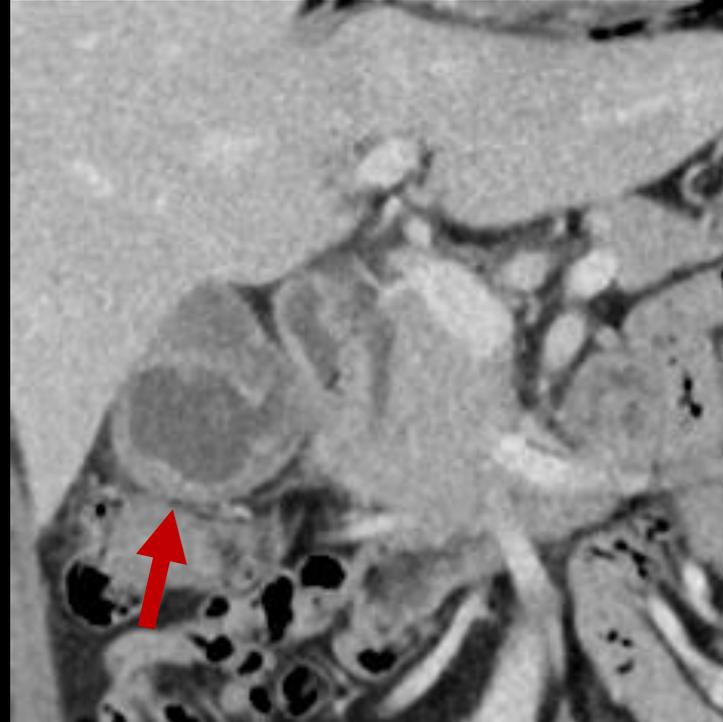
- Severe form of acute cholecystitis
- Stagnant bile in the gallbladder superinfected with microorganisms that leads to pus formation in an acutely inflamed gallbladder.
- Estimated to occur in 5 % to 15% of cases diagnosed to have acute cholecystitis
- Pus in the gallbladder increases the intraluminal pressure.
- Necrosis of the wall and perforation may occur if there is no prompt intervention.
- May result in generalized sepsis, gangrene of the gallbladder or perforation
- **Radiologically very similar to acute cholecystitis**

Ambe PC et al Surgical management of empyematous cholecystitis: a register study of over 12,000 cases from a regional quality control database in Germany. *Surg Endosc.* 2016 Dec;30(12):5319-5324.

Yukumi S et al Thoracic Empyema Caused by Percutaneous Transhepatic Gallbladder Drainage. *Intern. Med.* 2015;54(24):3189-91.

Kim et al Risk factors for conversion to conventional laparoscopic cholecystectomy in single incision laparoscopic cholecystectomy. *Ann Surg Treat Res.* 2016 Jun;90(6):303-8.

Gallbladder Empyema



Middle aged Malay gentleman who presented with right hypochondrial pain. His total white cell count (TW) was elevated at 15k/ml. CT scan which was performed showed a **calculus** lodged in the neck of the gallbladder. The **gallbladder wall was thickened** and also showed **irregular outpouchings**, possibly due to mucosal ulceration. During surgery, the lumen of the gallbladder was filled with pus.

On CT, acute cholecystitis is indistinguishable from gallbladder empyema.

Acute Cholecystitis with Perforation

- Increased intraluminal pressure within the gallbladder lumen
- Resulting ischaemia of the gallbladder wall renders it susceptible to perforation
- Perforation occurs in 2-11% of acute cholecystitis patients
- Commonest location in the fundus
- 3 types according to Neimeier's classification
 - Type 1: Acute free perforation into the peritoneal cavity
 - Type 2: Subacute perforation with pericholecystic abscess (most common)
 - Type 3: Chronic perforation with cholecystoenteric fistula

1. Niemeier OW (1934) Acute free perforation of the gallbladder. *Ann Surg* 99:922–924

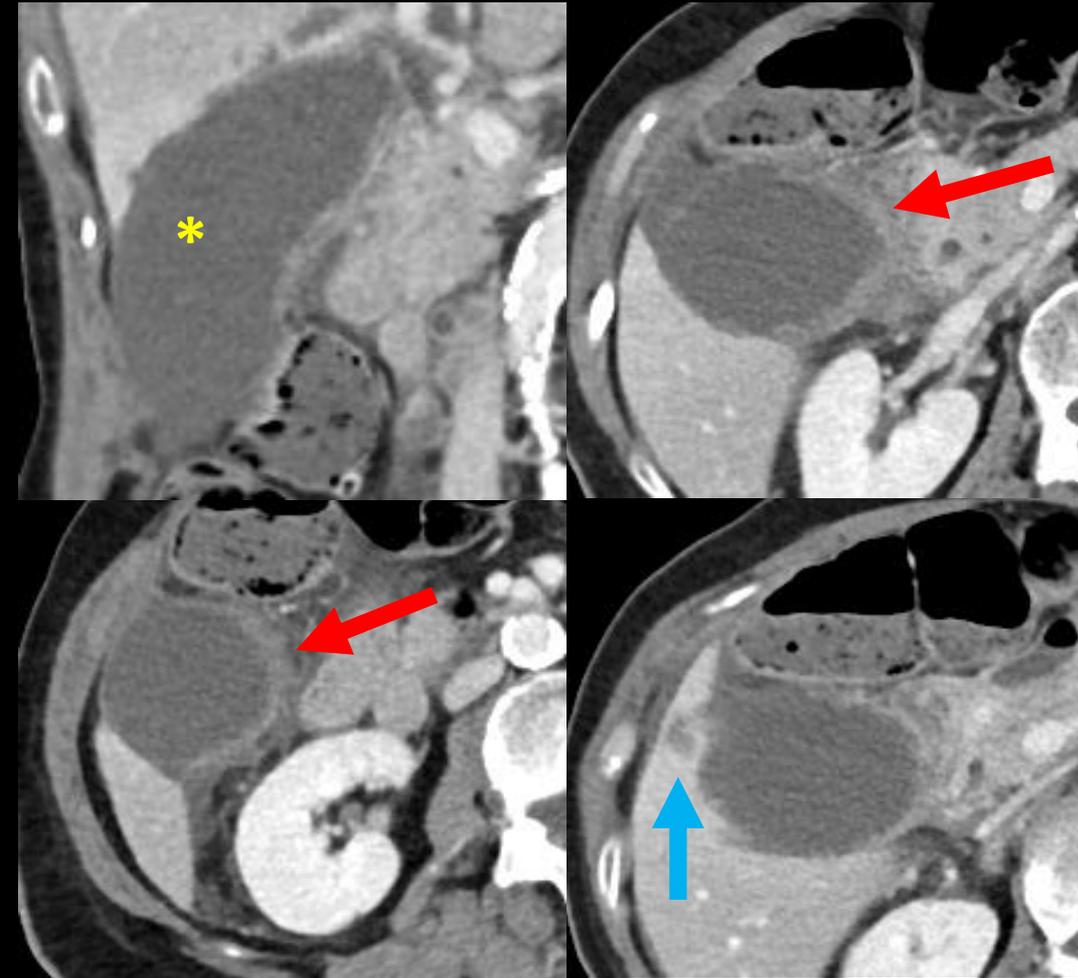
2. Derici H, Kara C, Bozdogan AD, Nazli O, Tansug T, Akca E. Diagnosis and treatment of gallbladder perforation. *World J Gastroenterol*. 2006;12(48):7832-6.

3. Ravindra et al Gallbladder perforation: Case series and systematic review

4. Gallbladder perforation: morbidity, mortality and preoperative risk prediction, *Surgical Endoscopy* April 2015 Vol 29

5. Date RS, et al Gallbladder perforation: case series and systematic review. *Int J Surg*. 2012;10(2):63-8.

Acute Cholecystitis with Type 1 & 2 Perforation

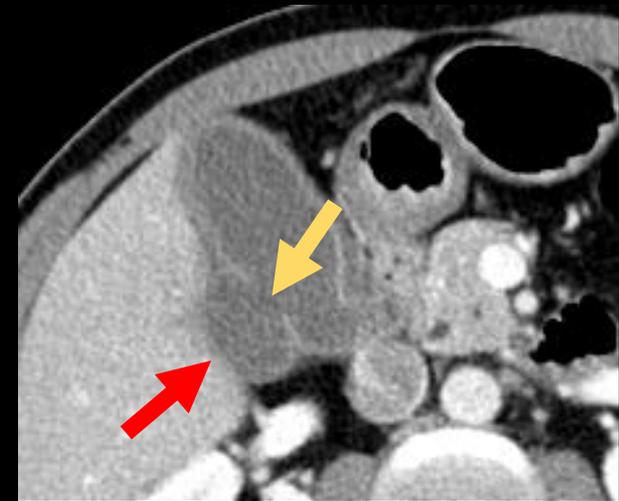
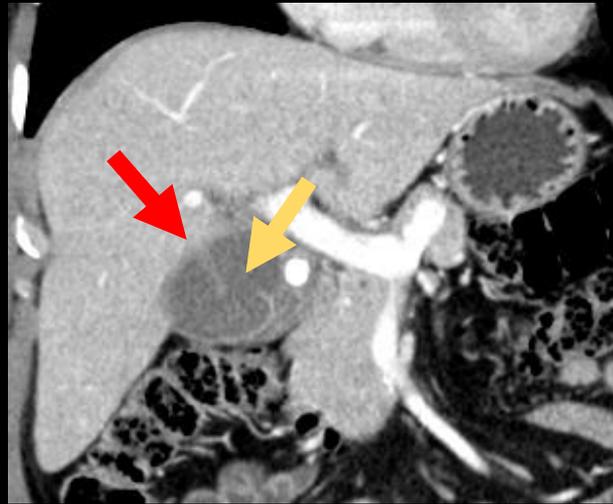
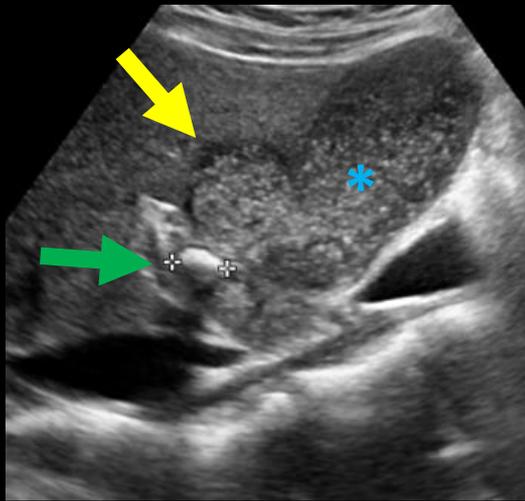


Elderly patient undergoing rehabilitation in the subacute ward after internal fixation of a femoral neck fracture. He complained of right hypochondrial pain associated with a fever. TW was 25k/ml.

CT showed that the **gallbladder was distended** with **mural thickening in the neck and proximal body of the gallbladder**. A small **perihepatic abscess** is also seen in segment 5/6, indicating the presence of perforation (**Type 2 perforation**).

Intra-operatively, free bile was also seen in the hepatorenal fossa due to perforation (**Type 1 perforation**).

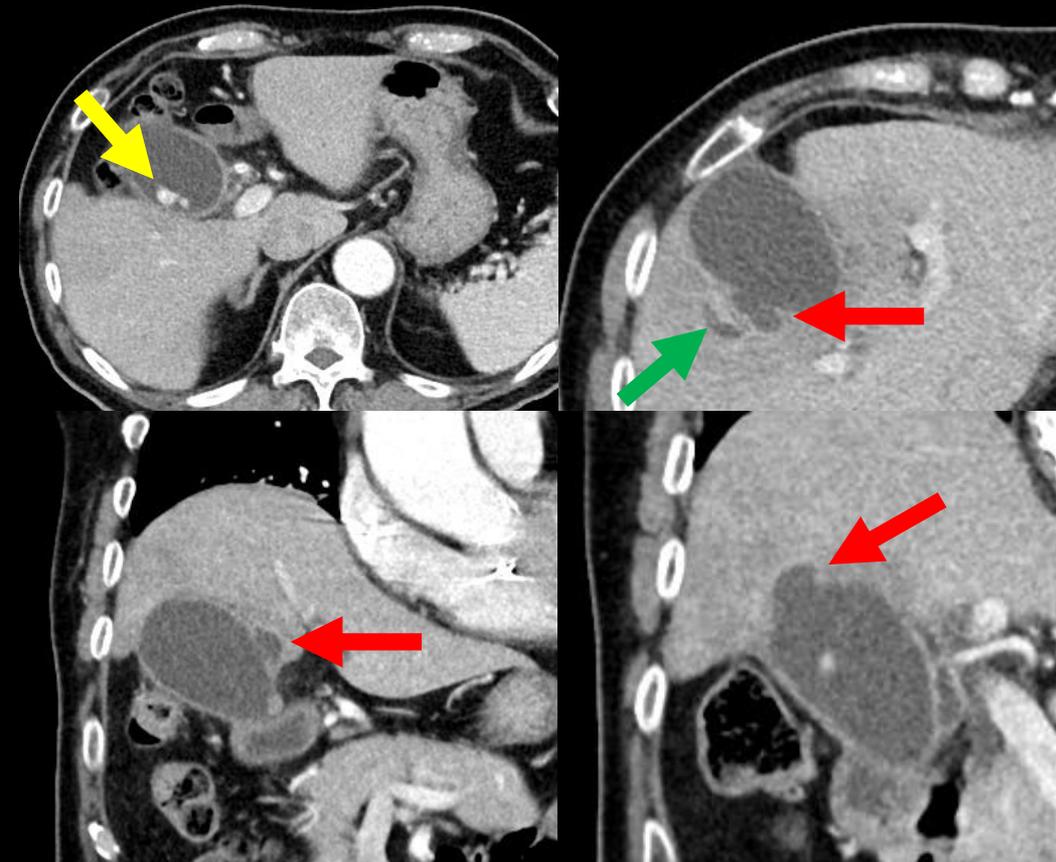
Acute Cholecystitis with Type 2 Perforation



Patient who presented with right upper quadrant pain for 5 days. TW was elevated at 13k/ml. An ultrasound was performed which showed the gallbladder to be filled with **sludge** and a **calculus lodged in the neck of the gallbladder**. **An outpouching is also seen along the wall of the gallbladder**.

CT confirmed the presence of an outpouching/fluid collection along the wall of the gallbladder, in keeping with a focal region of **perforation**. A definite **mural defect** can also be seen in association with this collection. Surgery confirmed the multicystic appearance of the gallbladder with deep outpouchings and cavities, likely due to infection and perforation.

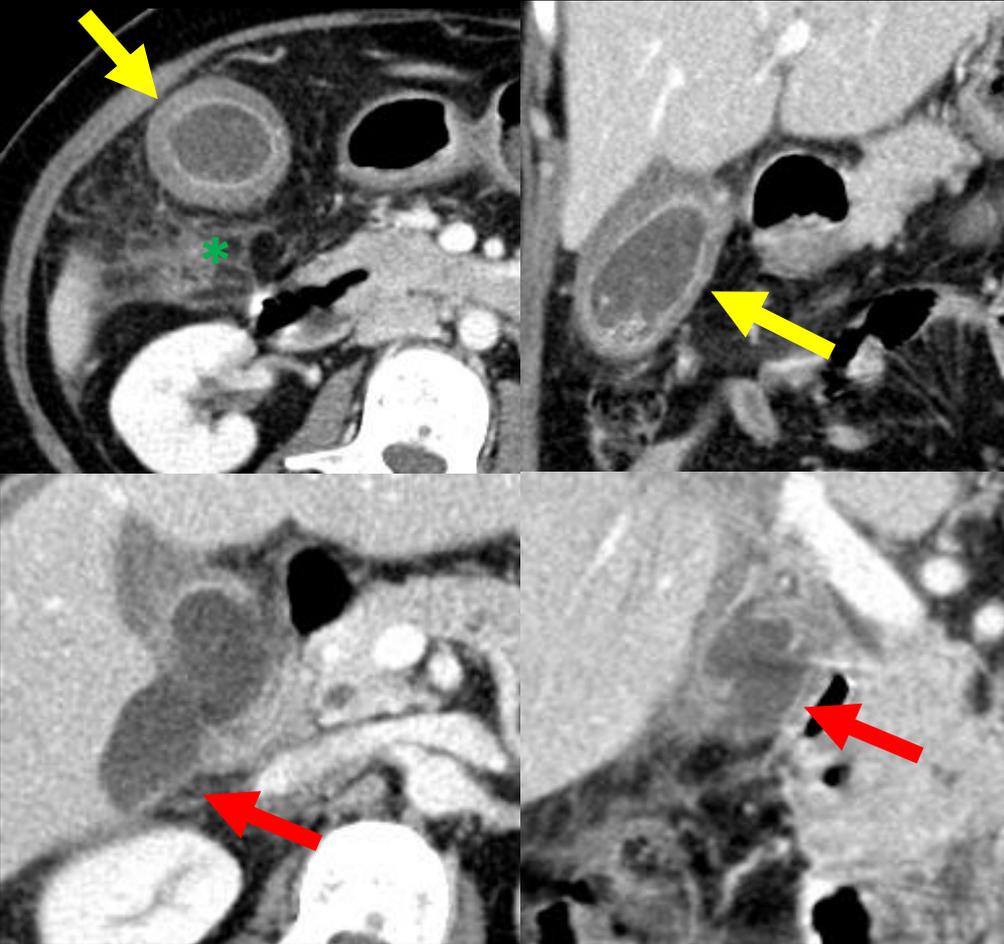
Acute Cholecystitis with Type 2 Perforation



Elderly Chinese gentleman who presented with fever and lethargy for several days. TW was elevated at 14k/ml and the patient had raised inflammatory markers.

CT was performed which showed small **gallbladder calculi**, focal outpouchings and mural defects along the wall of the gallbladder, in keeping with sites of **perforation**. A small **hepatic abscess** is also seen in segment VIII of the liver, adjacent to a focal perforation. Perforation along the posterior wall of the gallbladder was confirmed on surgery.

Acute Cholecystitis with Type 2 Perforation



Elderly Chinese lady who presented with fever and right hypochondrial pain. TW was elevated at 14k/ml.

CT was performed which showed the typical changes of acute cholecystitis with **mural thickening** and pericholecystic **inflammatory fat stranding**.

Furthermore, a focal collection and mural defect is seen along the posterior wall of the gallbladder, in keeping with a site of **perforation**.

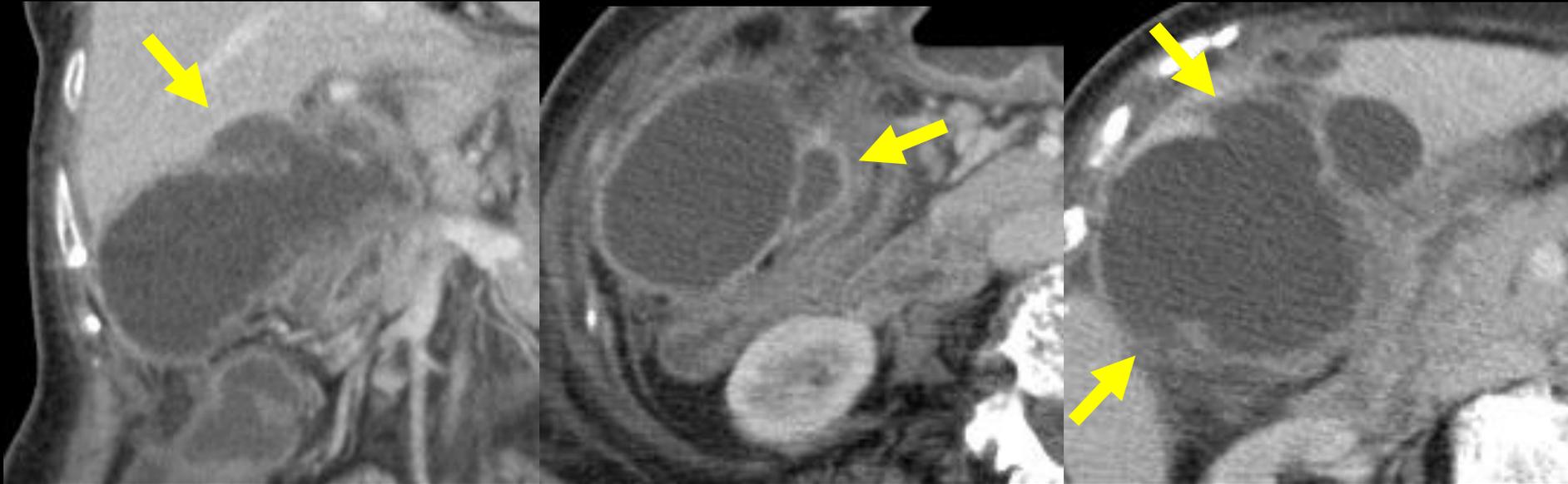
Acute Cholecystitis with Type 2 Perforation



An MRI was also performed for the patient which revealed **multiple calculi** within the gallbladder. The aforementioned **fluid collection and mural defect** is again demonstrated along the posterior wall of the gallbladder which contains a layer of sludge. Surgery confirmed the finding of gallbladder perforation and perihepatic abscess. A subtotal cholecystectomy was performed for was patient.

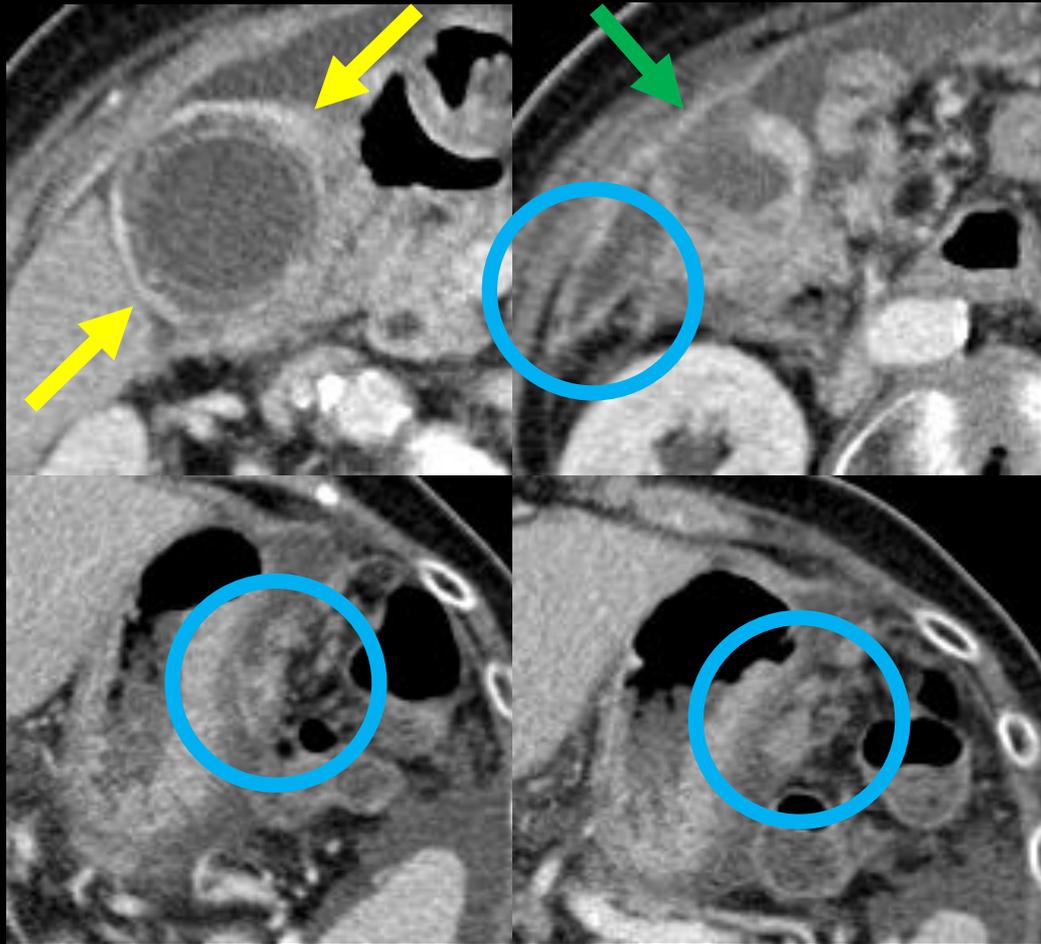
This case highlights the importance of recognising the presence of a perforation due to the fact that a subtotal cholecystectomy was performed. ***If the area of perforation was not included with the resected gallbladder, the patient would have suffered from a persistent bile leak.***

Acute Cholecystitis with Type 2 Perforation



95 year old Chinese lady who had persistent fever after a bipolar hemiarthroplasty for a neck of femur fracture. Her total white cell count was 28k/ml. CT revealed the gallbladder to be distended with **multiple mural defects and peri-cholecystic fluid collections, in keeping with perforation.** This patient was treated with a percutaneous cholecystostomy rather than surgery in view of her co-morbidities.

Perforated Gallbladder Carcinoma as a Pitfall



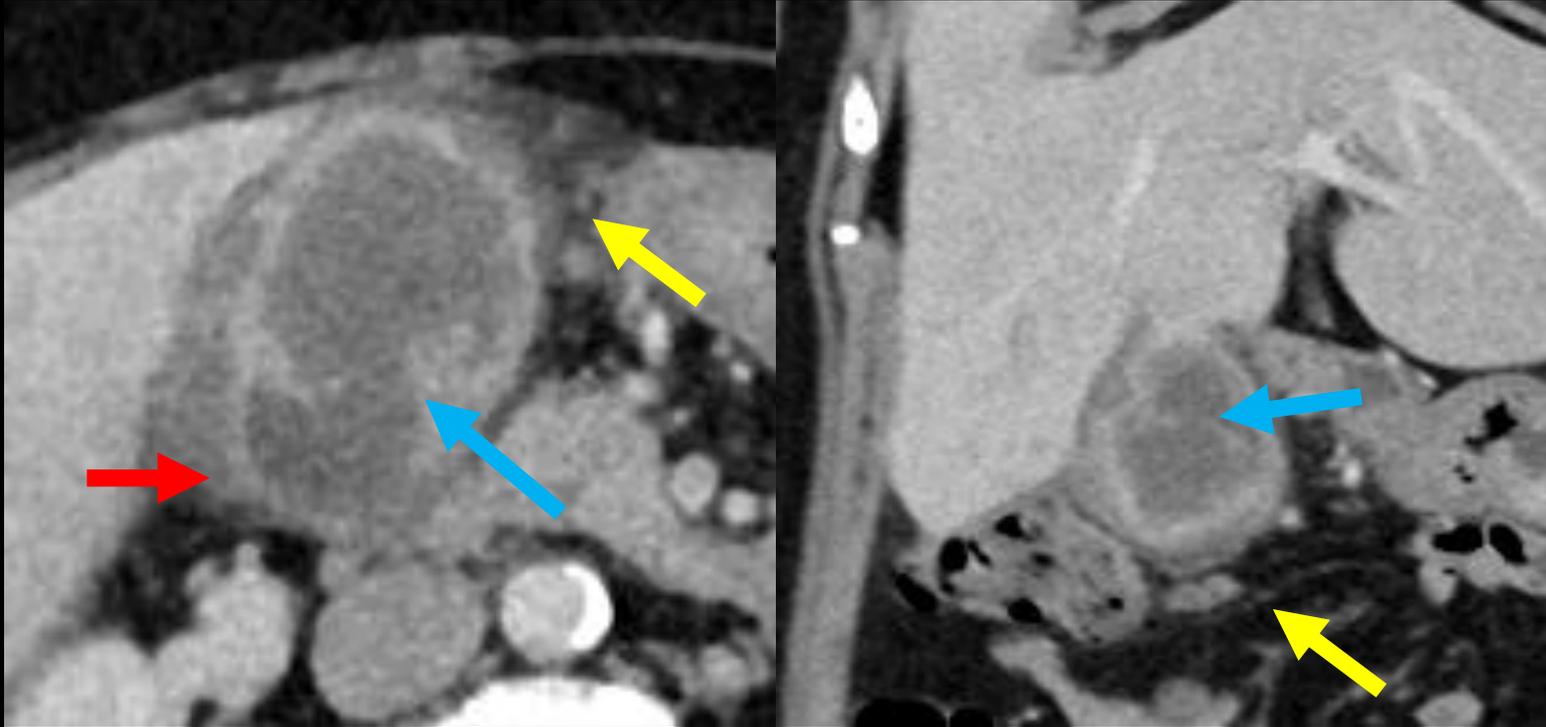
Elderly Chinese lady presented with 6 month history of lower abdominal pain associated with lethargy and loss of weight.

The **gallbladder wall is thickened and enhancing**. A **mural defect** is seen in the fundus which could be mistaken for perforated cholecystitis.

However, closer examination showed that the peritoneum is **thickened and enhancing**. **Multiple peritoneal deposits could also be seen along the gastrosplenic ligament**. This raised the suspicion of metastatic gallbladder carcinoma.

Aspiration of the fluid revealed atypical cells. However, the patient passed away before definitive histological diagnosis could be established.

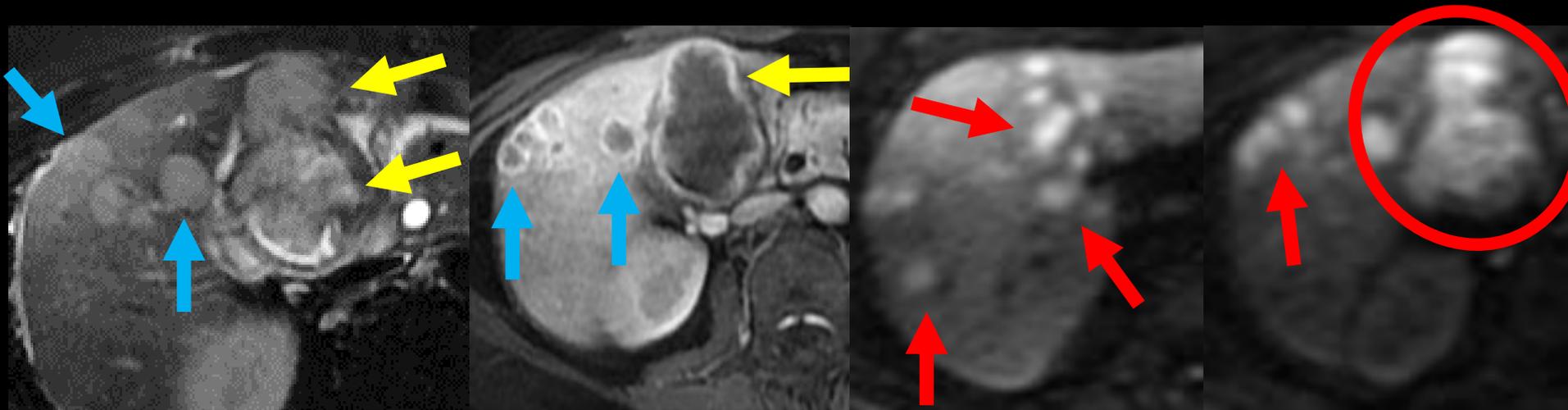
Gallbladder Carcinoma as a Pitfall



Middle aged patient presented with right upper quadrant pain with elevated TW at 15k/ml.

The **gallbladder wall is thickened** with **adjacent inflammatory fat stranding**. There appears to be a **mural defect** at the fundus associated with contour abnormality which was suggestive of perforated cholecystitis.

Gallbladder Carcinoma as a Pitfall

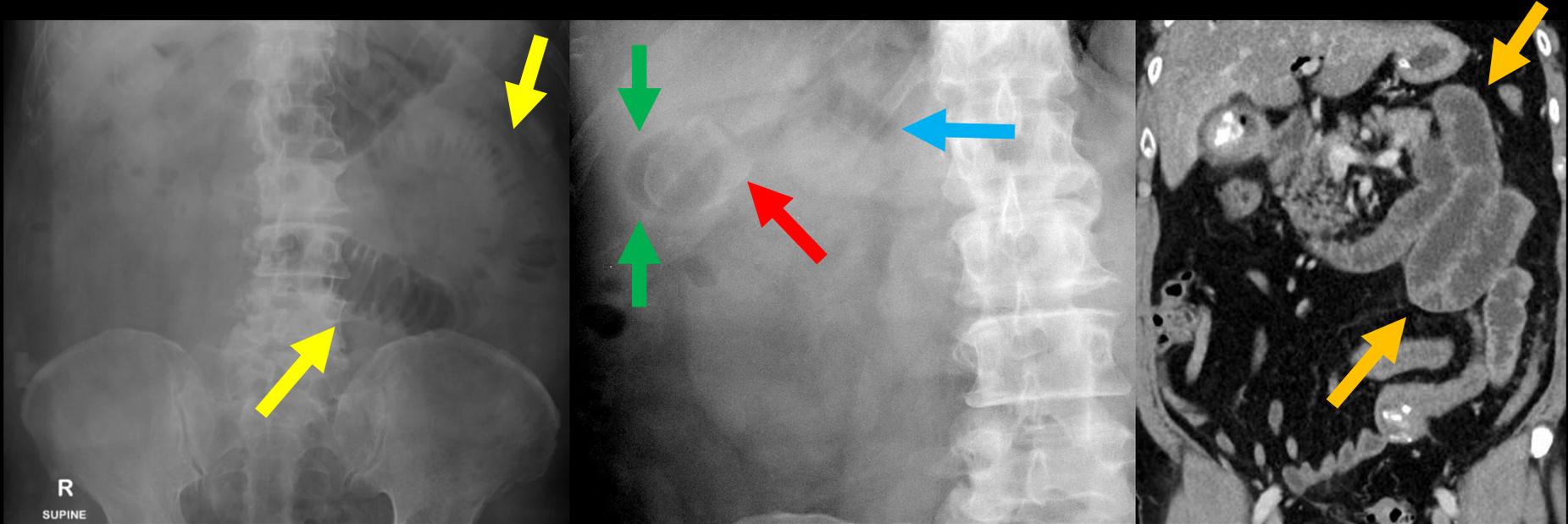


However, an MRI performed 2 weeks later showed that the gallbladder was filled with a **T2 hyperintense solid mass which showed rim-enhancement**.

Multiple T2 hyperintense solid nodules which showed rim enhancement was also seen in both lobes of the liver. The **liver nodules and the gallbladder mass (circled) demonstrated restricted diffusion**.

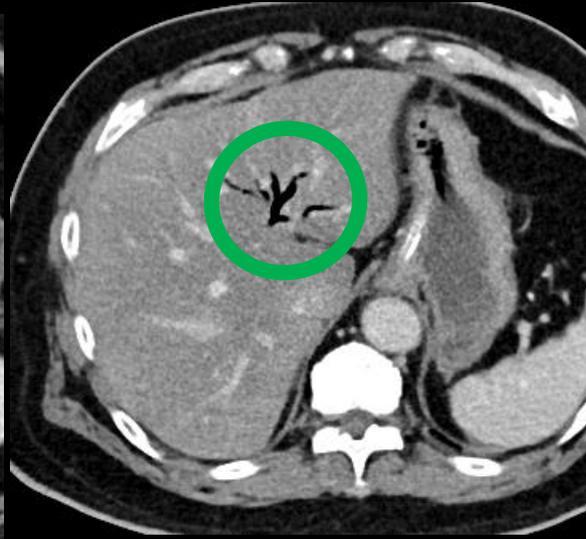
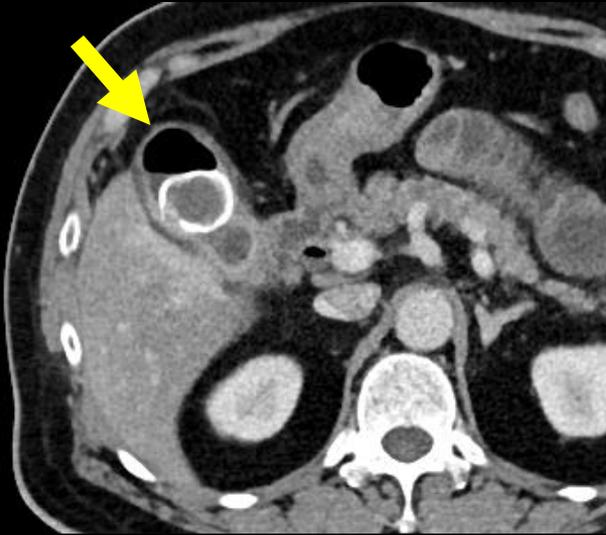
Cholecystectomy was performed for this patient which confirmed the diagnosis of gallbladder carcinoma. *This case was challenging for the radiologist and the clinical team as the presenting complaint and the rapid disease progression mimicked that of an infective/inflammatory process rather than malignancy.*

Acute Cholecystitis with Type 3 Perforation



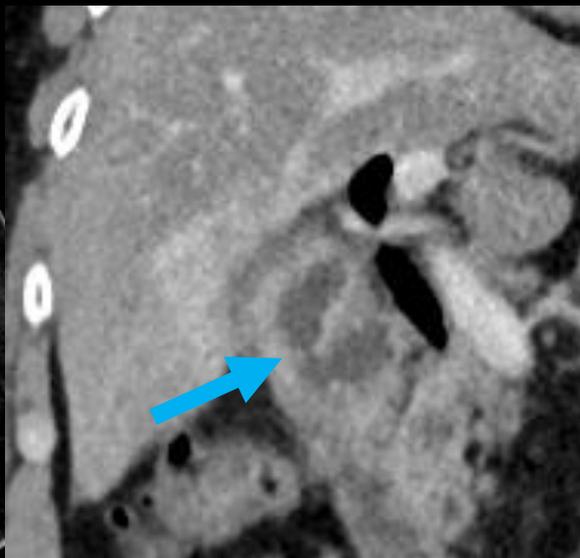
This patient presented with symptoms of intestinal obstruction. Supine abdominal radiograph showed **dilated small bowel loops**. Closer examination of the right upper quadrant showed **aerobilia**, **gas within the gallbladder** and a **calcified gallstone**. TW was also elevated at 17k/ml and a contrast-enhanced CT was performed which confirmed the findings of **small bowel intestinal obstruction**. Overall, the radiographic picture was in keeping with gallstone ileus.

Acute Cholecystitis with Type 3 Perforation



CT also confirmed the presence of **gas and calculi** within the gallbladder. **Aerobilia** was also observed.

A **calculus was detected in the ileum** which was causing intestinal obstruction. Closer evaluation of the gallbladder showed a small **cholecystoduodenal fistula**.



Surgery was performed for this patient. The calculus in the ileum was removed through an enterotomy. A subtotal cholecystectomy and closure of the cholecystoduodenal fistula was also performed.

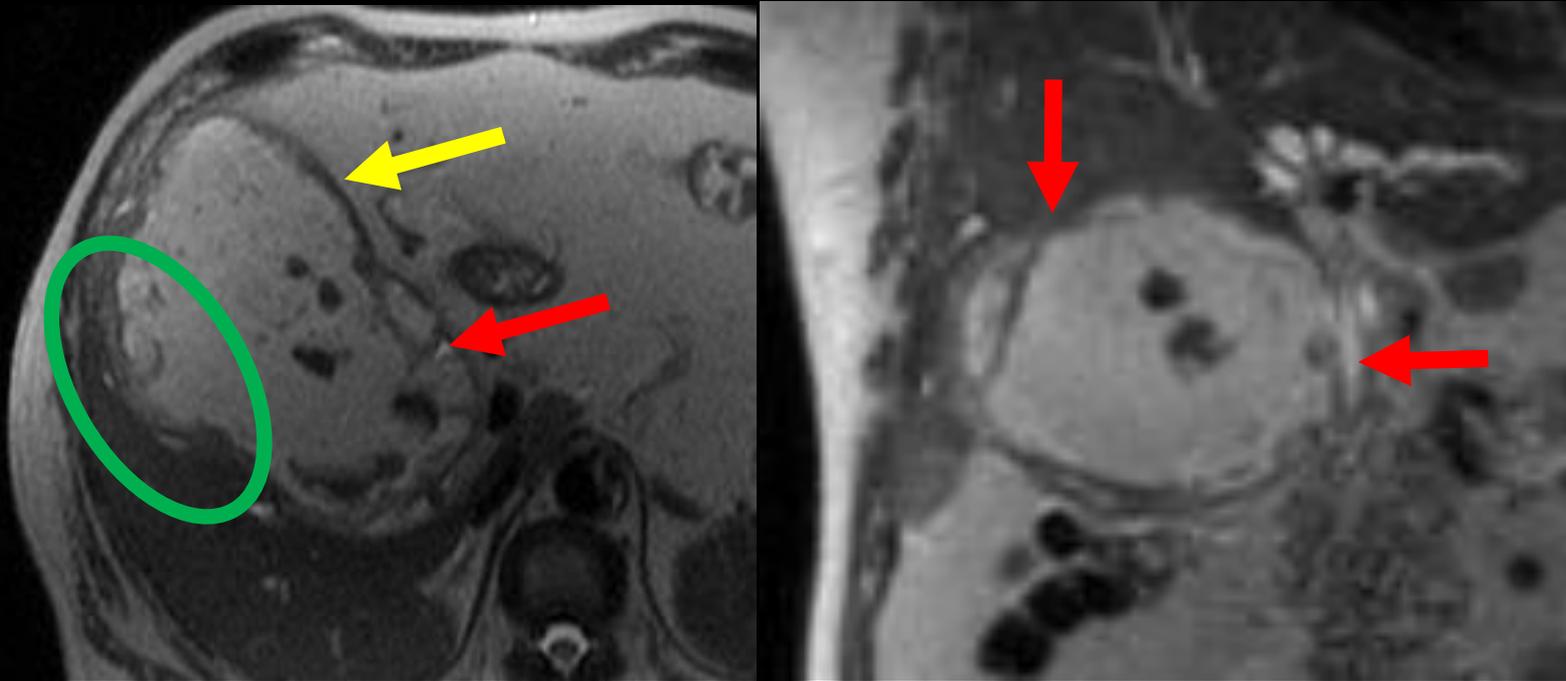
Contributed by Dr Kenneth Kwan

Acute Gangrenous Cholecystitis

- Reflects worsening ischaemia leading to necrosis of the gallbladder
- Associated with a poor prognosis
- Occurs in 39% of patients with acute calculous cholecystitis
- Elderly patients, and patients with a history of diabetes mellitus and white blood cell count > 15,000 cells/mL are at an increased risk of having gangrenous changes at presentation
- Classically described features include non-enhancing gallbladder wall, focal thinning of the gallbladder wall and intraluminal membranes.

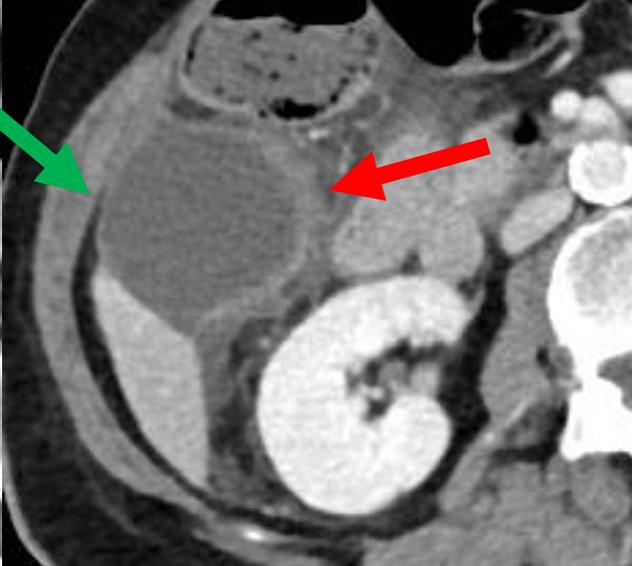
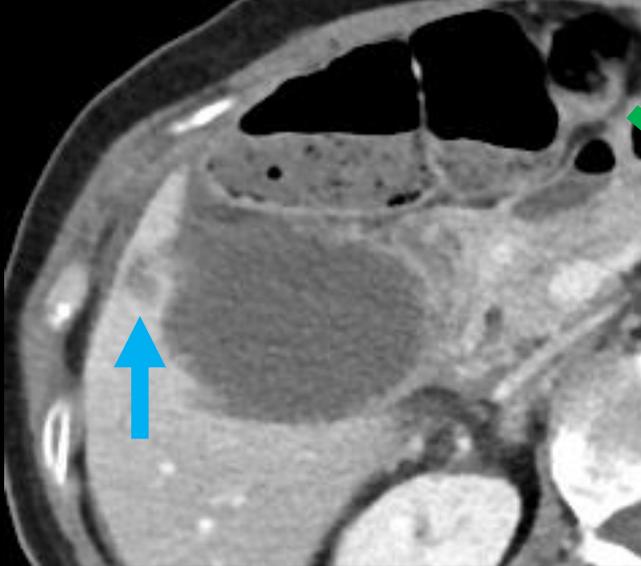
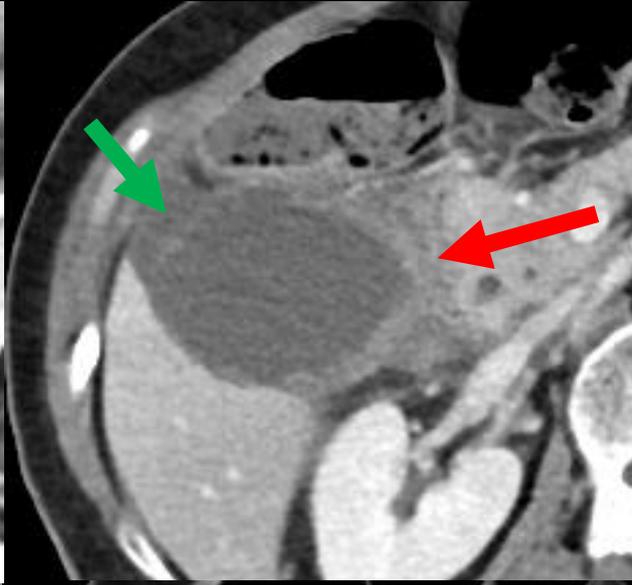
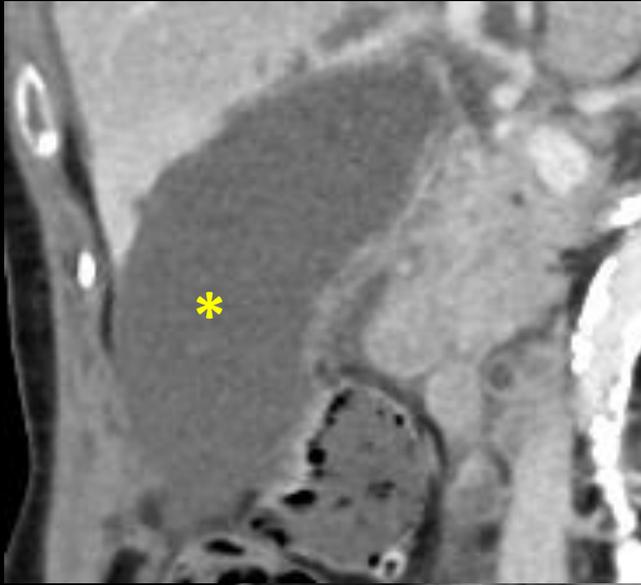
Chawla et al, SMJ 2015 Aug; 56(8): 438–444. Imaging of acute cholecystitis and cholecystitis-associated complications in the emergency setting

Acute Gangrenous Cholecystitis



Middle aged Chinese gentleman was in a subacute inpatient ward for rehabilitation after a motor-vehicle accident. He developed fever and abdominal pain associated with raised total white cell count of 19k/ml. MRI showed the gallbladder to be markedly distended. **Multiple linear filling defects are seen along the wall of the gallbladder which are suggestive of intraluminal membranes.** Note that the gallbladder wall is also **thinned**. The contour of the gallbladder is distorted with an outpouching seen posteriorly, worrisome for an **area of perforation**. During surgery, the gallbladder was gangrenous with an area of perforation. The area of perforation was walled off by omentum and the lumen of the gallbladder contained pus.

Acute Gangrenous Cholecystitis

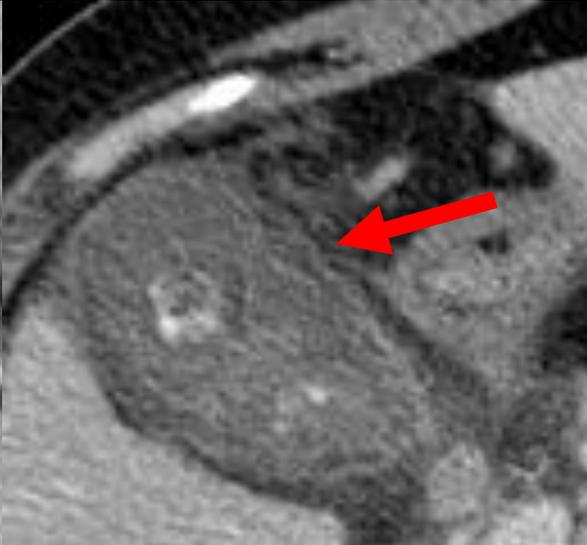
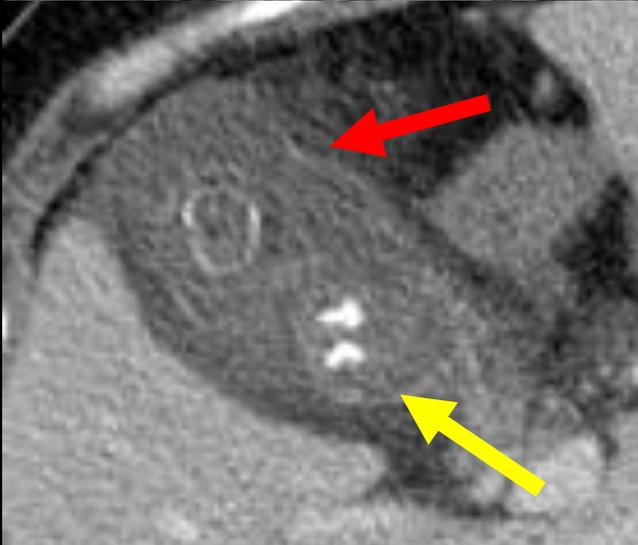


Elderly patient undergoing rehabilitation in the subacute ward after internal fixation of a femoral neck fracture. He complained of right hypochondrial pain associated with a fever. TW was 25k/ml.

CT examination showed that the **gallbladder was distended** with **mural thickening in the neck and proximal body of the gallbladder**. However, in the **distal segment of the gallbladder, the wall was noted to be thinned, which was worrisome for gangrene**. A small **perihepatic abscess** is also seen in segment 5/6, indicating the presence of perforation.

Intraoperatively, 80% of the gallbladder was gangrenous. Free bile was also seen in the hepatorenal fossa due to perforation.

Acute Gangrenous Cholecystitis



Middle aged Chinese lady who presented with abdominal pain and septic shock. Her TW was 15k/ml.

CT examination showed that the gallbladder contained **multiple calculi**. The walls of the gallbladder were **irregular, thin and poor enhancing**. This raised the possibility of underlying gangrene.

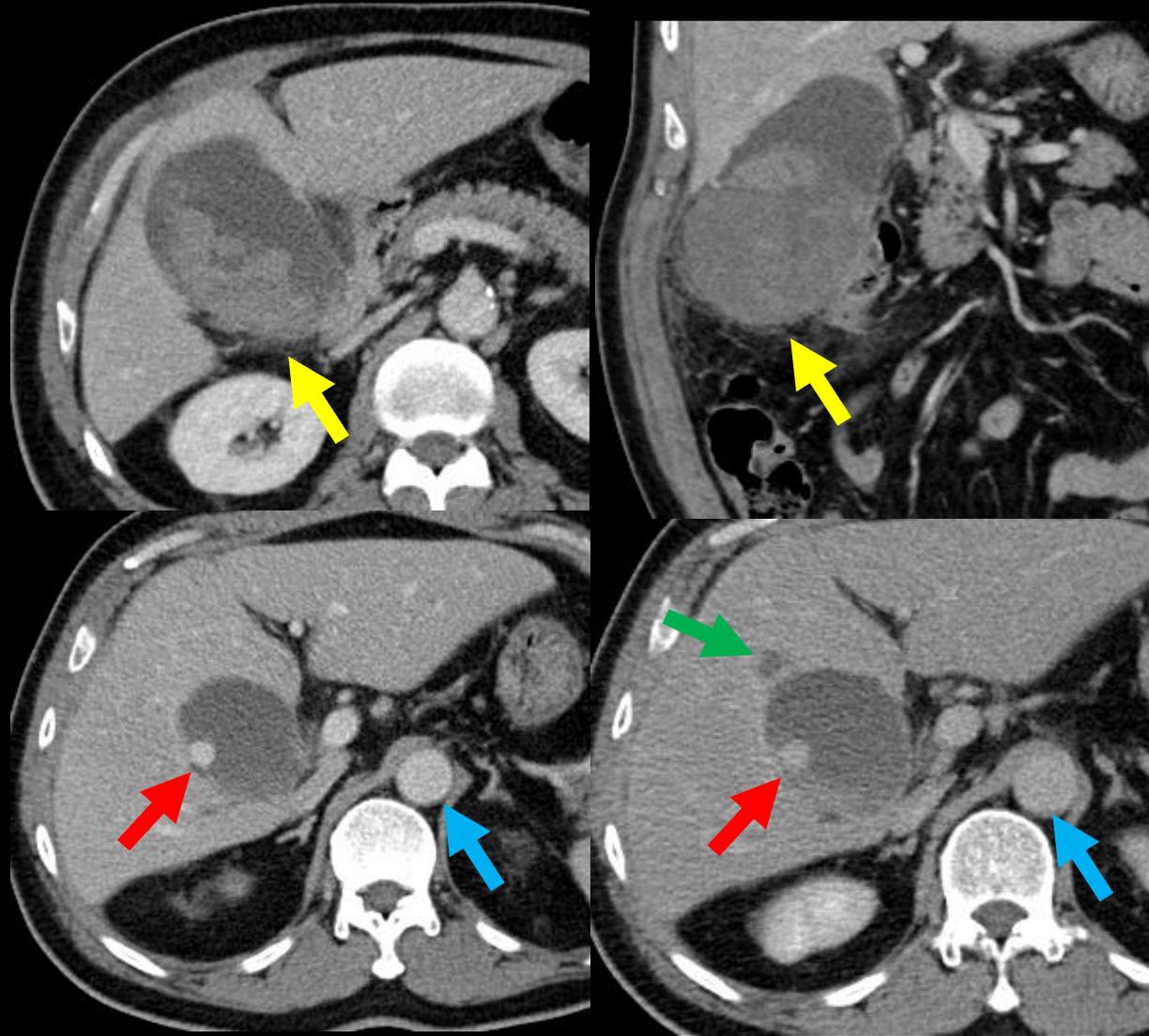
Intraoperatively, the gallbladder showed patchy areas of gangrene.

Cystic Artery Pseudoaneurysm

- Rare vascular complication of acute cholecystitis
- 30 cases reported worldwide
- more than half were spontaneously associated with cholecystitis or cholelithiasis
- one-half of the patients were men aged 60–80 years
- More than three-fourths presented with haemobilia resulting from rupture of the aneurysm.
- Principal cause of the aneurysm to be inflammation of the gallbladder

Unruptured pseudoaneurysm of the cystic artery with acute calculous cholecystitis incidentally detected by computed tomography. *Radiat Med.* 2008 Jul;26(6):384-7

Cystic Artery Pseudoaneurysm

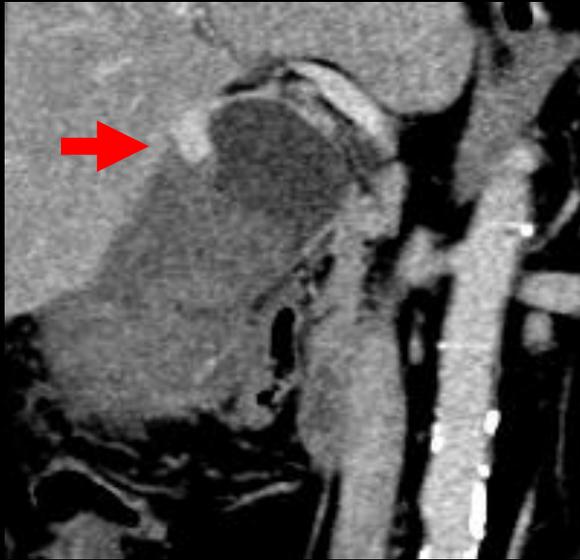


Middle aged Chinese lady who presented with right upper quadrant pain.

CT showed that the gallbladder was distended and contained **hyperdense blood products**.

A **hyperdense lesion** was also noted along the wall of the gallbladder which became more hypodense during the delayed scan. Note that the **attenuation of this lesion is similar to the attenuation of the aorta on both the portal venous and delayed phase**. This raised the possibility that this lesion could be an aneurysm. Note also the **focal area of perforation**

Cystic Artery Pseudoaneurysm



Coronal contrast CT images of the same patient showing the wide-neck pseudoaneurysm (red arrow) arising from the cystic artery. As the patient was fairly ill, after discussion with the surgeon, decision was made to embolise the pseudoaneurysm endovascularly as a bridging procedure prior to cholecystectomy.

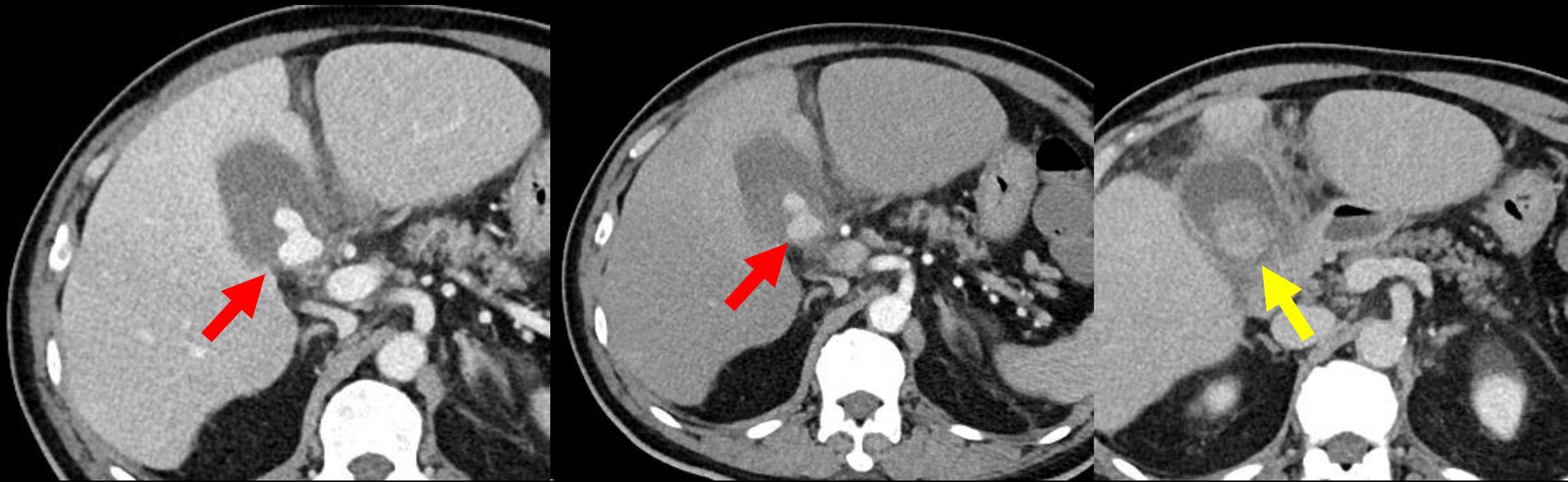


Via a right femoral arterial approach, the celiac trunk was cannulated with a 5F Cobra catheter and the cystic artery was selectively cannulated with a 2.8F Microcatheter (black arrow).



The pseudoaneurysm sac and the cystic artery was then successfully embolised using a mixture of lipiodol and glue in a (6:1) ratio with satisfactory glue cast seen filling of the pseudoaneurysm sac (black arrow). The patient ultimately went to have an open cholecystectomy without any further complications.

Cystic Artery Pseudoaneurysm

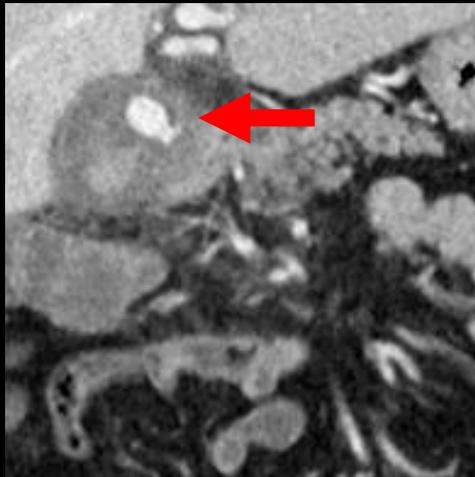


Different patient who presented with right upper quadrant pain.

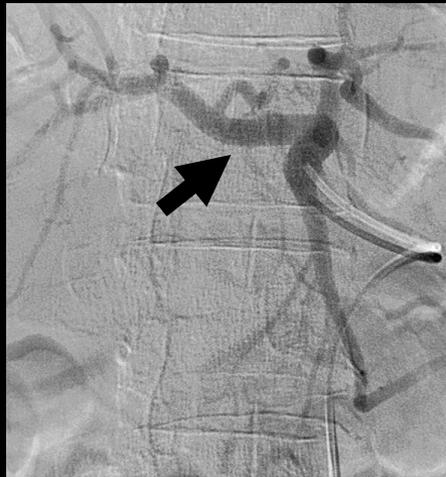
Again, a lobulated **hyperdense lesion** is seen along the wall of the gallbladder which became more hypodense during the delayed scan.

Blood products were also seen inferiorly within the gallbladder fundus.

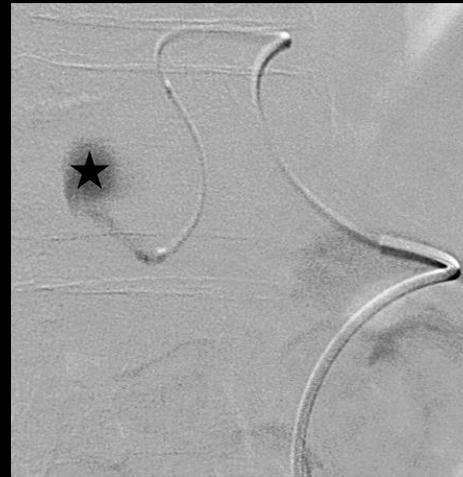
Cystic Artery Pseudoaneurysm



Corresponding coronal contrast CT images of the same patient showing the pseudoaneurysm (red arrow) arising from the cystic artery.



Via a right femoral arterial approach, the celiac trunk was cannulated with a 5F Cobra catheter. Gentle contrast injection shows the origin of the cystic artery faintly opacified (black arrow).

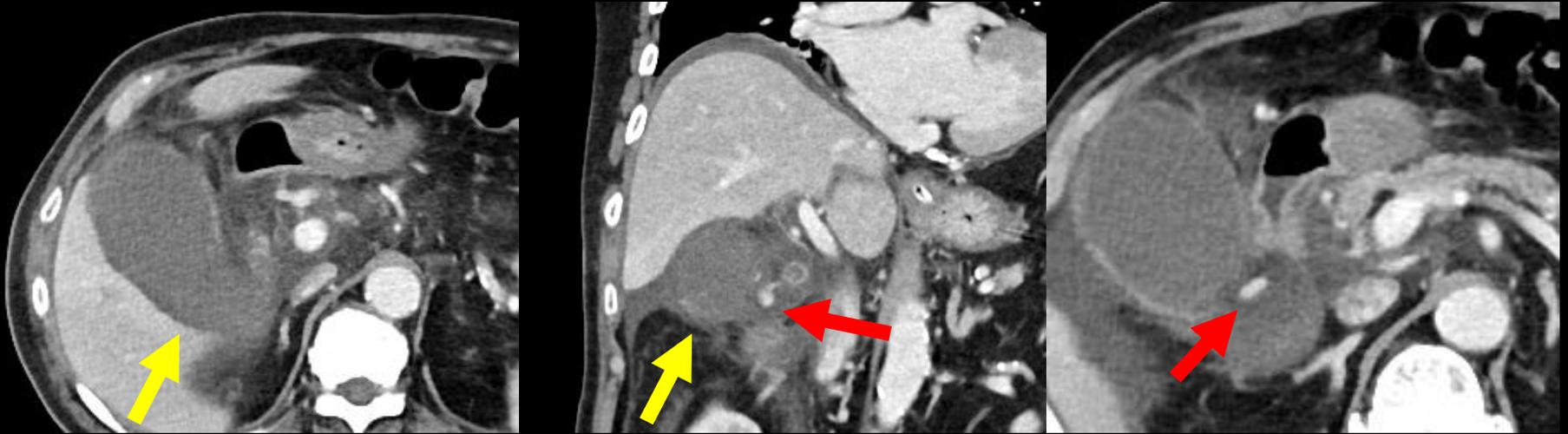


This was selectively cannulated with a 2.3F microcatheter confirming the presence of the pseudoaneurysm (black star) arising from the cystic artery.



This was successfully embolised using a mixture of fibred 2 mm and 3 mm embolization coils. Note 1 of the coils (black arrow) mal-deployed within the pseudoaneurysm sac. Final angiogram shows complete occlusion of the cystic artery with no further filling seen. Patient subsequently went on to have a laparoscopic cholecystectomy safely.

Cystic Artery Pseudoaneurysm



Elderly Chinese gentleman who presented with acute right upper quadrant pain.

The gallbladder is distended. Note that the **posterior and inferior aspects of the gallbladder wall is thinned and does not enhance**. Extensive inflammatory changes are also seen around the gallbladder. These findings are in keeping with gangrenous cholecystitis.

A focal **hyperdense lesion** is seen external to the wall of the gallbladder and also appears to connect with an adjacent vessel. This was diagnosed as a cystic artery aneurysm. This patient declined surgery or treatment for the aneurysm.

Cystic artery pseudoaneurysm treatment

- Cystic artery pseudoaneurysm is a rare entity and as such there is no consensus on the clinical management of this condition.
- A variety of treatment strategies have been reported in the literature including radiological selective embolization and coiling, open cholecystectomy with ligation of the aneurysm, or a two-step approach involving radiological management of the pseudoaneurysm followed by an elective cholecystectomy.
- In high risk patients or unstable patients, angiographic embolization has been performed successfully ^[2]. The definitive management of these patients is cholecystectomy and ligation of the pseudoaneurysm. Therefore, embolization can be seen as a 'bridge' to surgery in an attempt to stabilise the patient and avoid an emergency laparotomy.

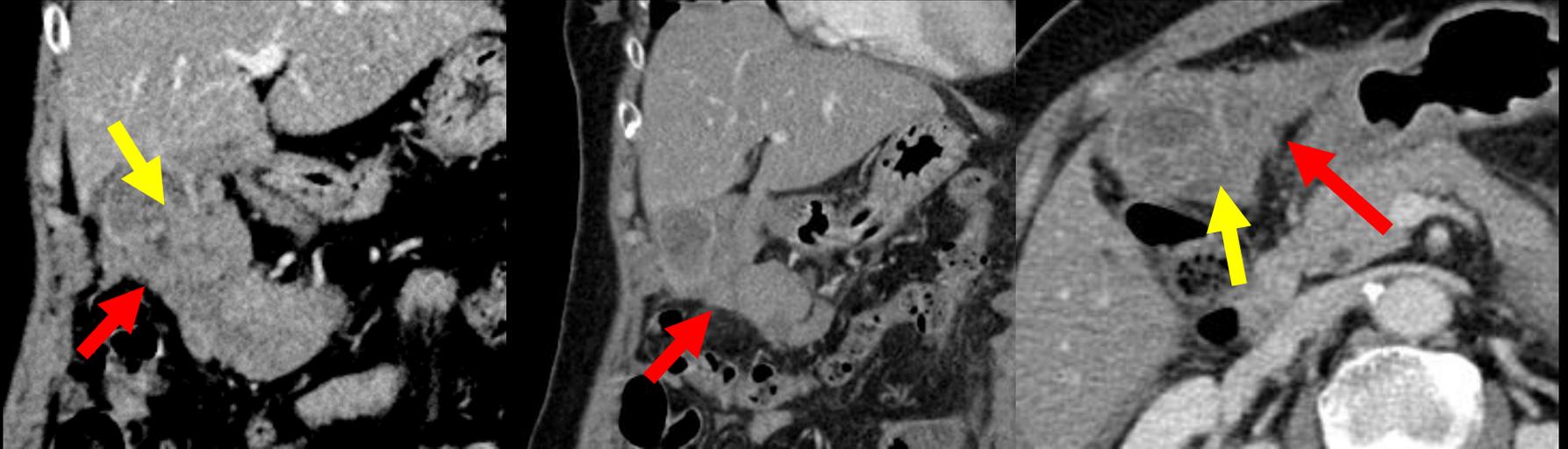
[2] Mullen R., Suttie S.A., Bhat R., Evgenikos N., Yalamarathi S., McBride K.D. Microcoil embolization of mycotic cystic artery pseudoaneurysm: a viable option in high-risk patients. *Cardiovasc. Interv. Radiol.* 2009;32(November (6)):1275–1279.

Haemorrhagic Acute Cholecystitis

- Rare complication of acute cholecystitis
- Few isolated case reports of haemorrhagic cholecystitis in patients on anticoagulation, or associated with conditions which affect coagulation such as Haemophilia.
- Bleeding caused by cholecystitis is extremely rare - inflammation is thought to cause vascular thrombosis
- Bleeding may also occur due to wall inflammation leading to mucosal ulceration and necrosis
- Patients may also present with additional symptoms of bleeding from the upper gastrointestinal tract
- CT plays a crucial role in detecting a haematoma in the gallbladder fossa and also to evaluate for active bleed.

Murad et al Acute cholecystitis presenting with massive intra-abdominal haemorrhage, Journal of Surgical Case Reports
Kinnear et al Haemorrhagic cholecystitis in a newly anticoagulated patient BMJ Case Rep. 2017 Apr 12;2017

Haemorrhagic Acute Cholecystitis



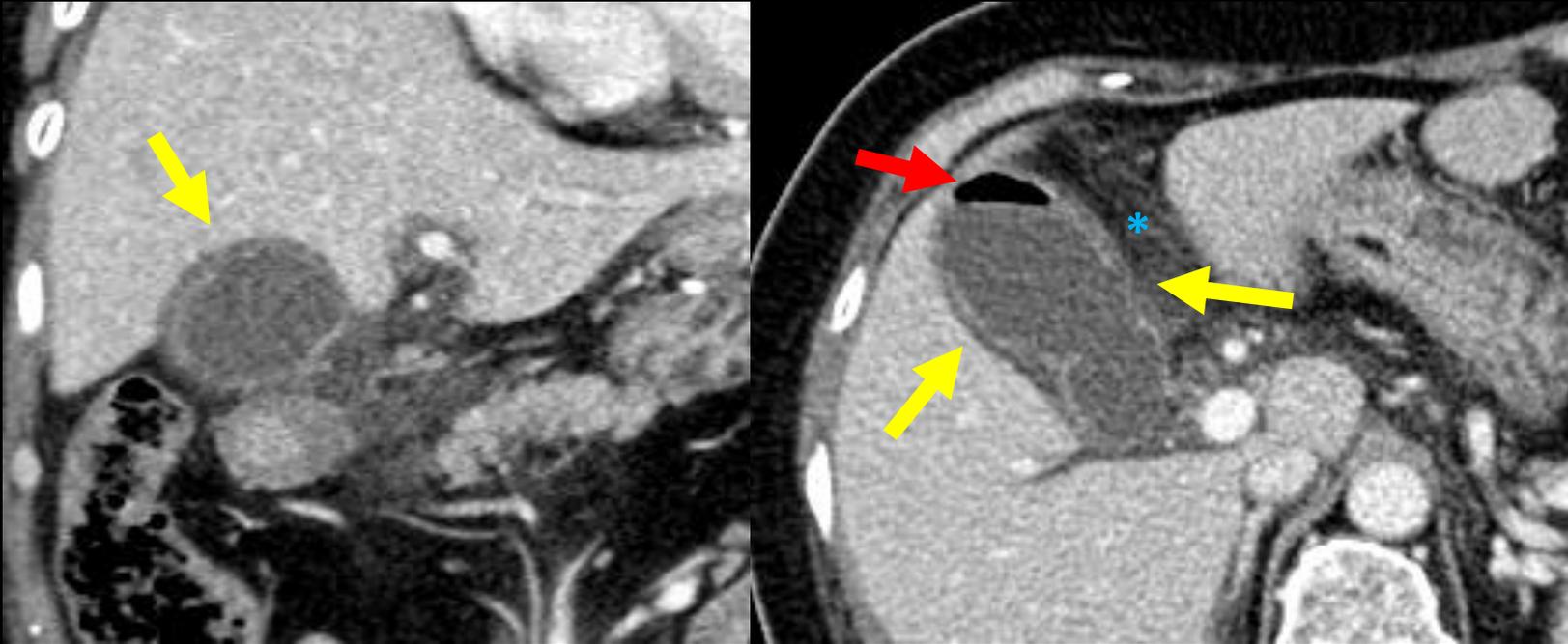
Patient presented with right upper quadrant pain and anaemia. CT showed **hyperdense fluid surrounding the gallbladder and also within the gallbladder lumen, likely to be blood**. Mural thickening was not appreciable due to the hyperdense material within the gallbladder. A **mural defect was also seen along the medial aspect of the gallbladder body**. The diagnosis of haemorrhagic cholecystitis with perforation was confirmed on surgery and histopathology.

Emphysematous Cholecystitis

- Thrombosis or occlusion of the cystic artery
- Ischemic necrosis of the gallbladder wall and secondary infection by gas-forming organisms such as *Clostridium welchii*
- Pathogenesis is thought to be partially secondary to vascular compromise of cystic artery
- More frequent in patients with acalculous cholecystitis
- More common in patients with diabetes (more prone to clostridial infection and atherosclerotic disease)
- Atherosclerosis with decreased flow in cystic artery may be a contributing factor
- 3 stages: gas in the gallbladder lumen, gallbladder wall and pericholecystic tissues.
- **Mortality rate in emphysematous cholecystitis as high as 15% compared with 4% in acute cholecystitis**

Chen et al, Emphysematous cholecystitis presenting as gas-forming liver abscess and pneumoperitoneum in a dialysis patient: a case report and review of the literature, BMC Nephrology 2016

Emphysematous Cholecystitis



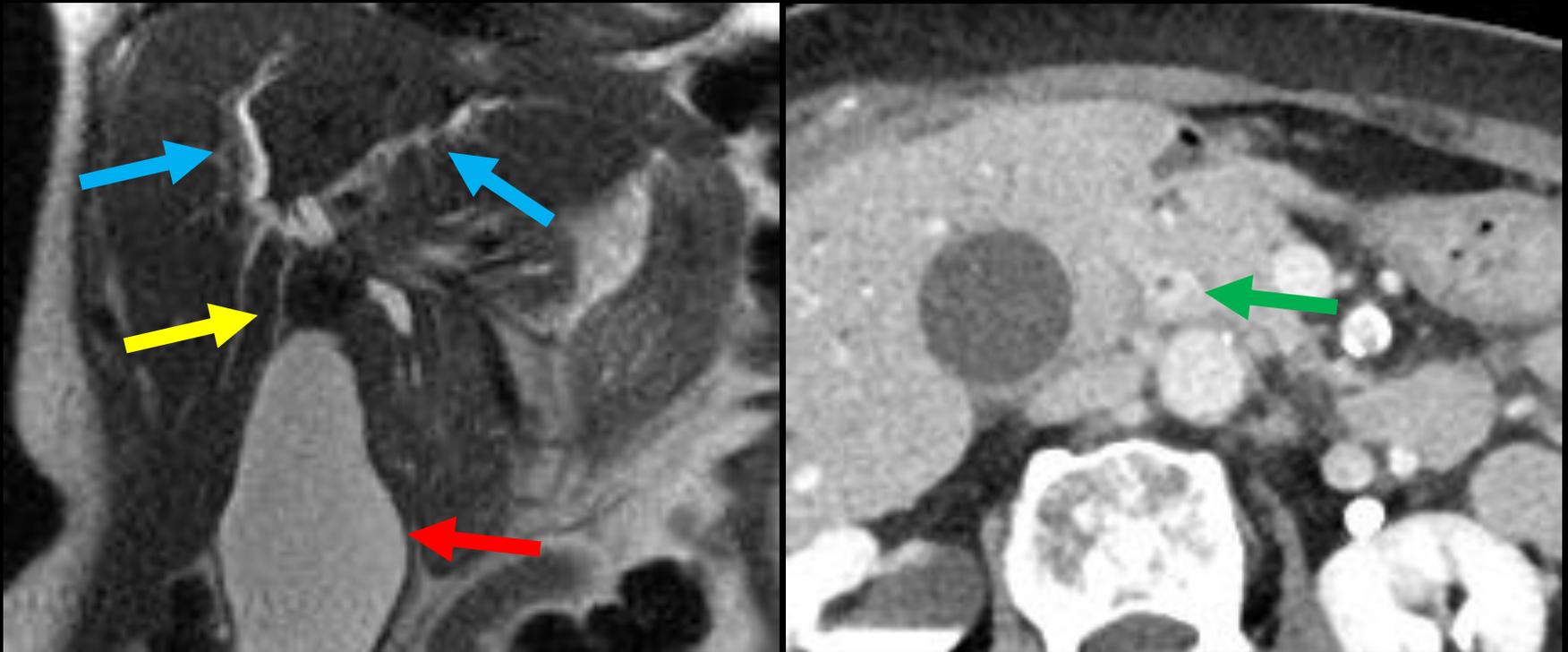
Patient presented with right upper quadrant pain. TW was 17k/ml.

CT showed **mural thickening with areas of ulceration** and **surrounding inflammatory fat stranding**. **Gas is seen within the lumen of the gallbladder**. As this patient did not have any prior history of biliary surgery or ERCP, the possibility of emphysematous cholecystitis was raised. Surgery confirmed the presence of cholecystitis. Histology showed mucosal ulceration, purulent inflammation and gangrenous gallbladder wall.

Mirizzi's Syndrome

- Compression of the extrahepatic biliary tree due to a stone lodged in Hartmann's pouch of the gallbladder
- Obstruction may be due to direct mass effect or due to stricture formation in the common duct due to repeated inflammation
- Cholecystocholedochal fistula may develop due to chronic inflammation/pressure necrosis, with gallstones eroding from cystic duct into bile duct
- Predisposing factors: Long cystic duct running parallel to CHD or low insertion of cystic duct into common bile duct

Mirizzi's Syndrome



Patient who presented with right upper quadrant pain and jaundice. A **calculus is lodged in Hartmann's pouch of the gallbladder**. This resulted in **distension of the gallbladder** and also **obstruction of the intrahepatic biliary tree**, accounting for the jaundice. Incidentally, this patient also has an **enhancing area of circumferential mural thickening in the distal common bile duct**. Brushings from the stricture revealed adenocarcinoma.

Conclusion

- Acute cholecystitis is a common surgical problem
- Complications such as perforation or gangrene can occur in a small percentage of patients who present with acute cholecystitis.
- Important for the radiologist to be able to recognise the imaging features of these complications
- This would assist the surgeon in either planning his surgery or in guiding further management.