Gall bladder diseases on CT

Gall bladder (GB) diseases are common causes of upper abdominal pain in adult patients. It is difficult sometimes to differentiate GB disease from other causes of acute abdominal pain. The clinical features and symptoms of patients with GB disease can be non-specific and may cause significant morbidity and mortality without prompt diagnosis and management. Radiological imaging significantly helps in investigating patients with suspected GB pathologies.

Imaging modalities include plain radiography, ultrasonography, magnetic resonance cholangiopancreatography (MRCP), radionuclide imaging (99mTc-HIDA), CT cholangiogram (CTC) and endoscopic retrograde cholangiopancreatography (ERCP).

Ultrasound is usually the preferred first line investigation for acute cholecystitis with sensitivity of 80-100% and specificity of 60-100%. It is performed when wider differential diagnoses are being considered or for detecting complications of acute cholecystitis. 99mTc-HIDA scan provides functional and morphological information. ERCP can be used diagnostically and therapeutically to study both the biliary and pancreatic ducts and also to perform sphincterotomy, biopsy and stone extraction. MRCP and CTC are non-invasive alternatives to evaluate the biliary tree. However, due to the increasing use of CT as the primary imaging modality in the assessment of acute abdominal pain, recognition and evaluation of GB disease and its complications are increasingly performed as a routine by radiologists. In this article we illustrate the salient features of GB diseases on cross-sectional CT imaging.

Acute uncomplicated calculus cholecystitis (figure 1)
Acute inflammation of the GB occurs commonly in middle-aged obese females due to cystic duct obstruction (90-95%) by an impacted calculus. Contrast enhanced CT (CECT) can demonstrate distension of the GB, GB wall thickness >3mm, mural/mucosal enhancement, pericholecystic fluid, surrounding inflammatory fat stranding and cholelithiasis. Transient hepatic hyper-enhancement may also be seen adjacent to the GB fossa. GB wall thickening is a non-specific finding which occurs also in acute hepatitis, acute pancreatitis, acute pylonephritis, peritonitis, systemic diseases like hypo-albuminaemic states and congestive heart failure.

Acute gangrenous cholecystitis (figure 2)
This is a complication of acute cholecystitis (incidence 2-29% of all acute cholecystitis) which results from abnormal GB wall distention and ischaemic necrosis by vascular compromise. It is associated with significant morbidity and mortality. Prompt diagnosis and treatment is essential. Predisposing factors are diabetes and a high white blood cell count >15,000 cells/ml. CT has a high specificity (96%) and a low sensitivity (29%) for gangrenous cholecystitis. Specific CT features include gas within the GB wall/lumen, absence of GB enhancement, intraluminal membranes irregular or absent wall and peri-cholecystic abscesses. Other features are mural striation and adjacent hepatic hyperenhancement.

GB perforation (figure 3)
About 2-11% of acute cholecystitis will progress to perforation with a 60% mortality. Occlusion of the cystic duct by a calculus causes increased intraluminal pressure, abnormal GB wall distension, vascular compromise, transmural necrosis and ultimately perforation, which often occurs at the fundus. Niemeier described three types of perforation: Type I (acute) free perforation with peritonitis (33%); Type II (subacute) localised perforation with peri-cholecystic abscesses (48%); and Type III (chronic) with internal/external fistulisation (18%). CT (sensitivity of 88%) may show extraluminal gallstone, pneumomedia, crumpled wall of collapsed GB and peri-cholecystic abscesses.

Emphysematous cholecystitis (figure 4)
This is an uncommon life-threatening condition caused by infection and vascular compromise of the GB by gas-forming organisms like clostridium species, escherichia coli, klebsiella and anaerobic streptococci. Elderly men with diabetes are at particular risk. There is increased risk of gangrene and perforation in emphysematous cholecystitis with a mortality of 15%. Plain radiographs of the abdomen may show curvilinear lucencies within the GB wall or air-fluid levels within its lumen. CT is the most sensitive modality for detection of intraluminal or intramural gas. Other features, like peri-cholecystic collection or perforation, are also seen.

GB empyema and haemorrhagic cholecystitis (figure 5)
These are complications of acute cholecystitis that occur when the GB gets distended with purulent material or blood. CT shows high attenuation material within the GB which are often indistinguishable from sludge. It may progress to GB perforation or haemoperitoneum.

Acute acalculous cholecystitis
This commonly occurs in critically ill patients (post-trauma and post-operative) and also patients on total parenteral nutrition. Increase in bile viscosity causing functional cystic duct obstruction is thought to be the etiology. CT features include abnormal distension of the GB, GB wall thickening (>3-5mm), peri-cholecystic fluid, sludge (with absence of gallstones), peri-cholecystic inflammatory fat stranding, suberosal oedema and transient adjacent hepatic hyperaemia. It is reasonable to perform CT for initial diagnosis of critically ill patients because it helps to identify occult abscesses and visualise biliary pathology, which is often difficult using ultrasound in presence of bowel distension.

Chronic cholecystitis
This is a common form of GB inflammation that is almost always associated with gallstones. CT shows contracted or distended GB, GB wall thickening, gallstones and absence of peri-cholecystic inflammatory stranding/fluid. Complications include recurrent attacks of acute cholecystitis, biliary-enteric fistula and GB carcinoma.

Biliary-enteric fistula and gallstone ileus (figure 6)
This is an uncommon complication and may result from cholelithiasis, acute/chronic cholecystitis, biliary tract carcinoma, peptic ulcer disease, trauma and congenital anomalies. Communication commonly develops with duodenum (70%), colon (26%) and stomach (4%). The fistulation causes passage of gallstones into bowel, leading to small bowel obstruction. The typical site of obstruction is in the terminal ileum. Gallstone ileus is diagnosed by Rigler’s radiographic triple test (pneumomedia, ectopic gall stone, small bowel obstruction). Gallstone ileus is associated with a high mortality (20-40%).

Xanthogranulomatous cholecystitis
(Ceroid granulomas of GB)
This is an uncommon (0.7%-13.2%) inflammatory disease of GB often seen in elderly people and is characterised by abnormal intramural nodules. The rupture of Rokitansky-Aschoff sinuses results in intramural extravasation of bile.
causing inflammatory reaction attracting histiocytes which phagocytose insoluble cholesterol. Preoperative imaging diagnosis of xanthogranulomatous cholecystitis is often difficult. CT may shows hypo-attenuating intramural nodules, hypo-attenuating outer band, cholelithiasis, GB wall thickening (diffuse or focal) and peri-cholecystic fat stranding. These CT appearances can mimic GB cancer. There is some overlap between the two diseases and it remains debatable whether they are mutually exclusive diagnoses.

**Mirizzi syndrome** (figures 7a, 7b,7c)
This syndrome occurs when an impacted gallstone within the cystic duct causes extrinsic compression of common hepatic duct and resultant obstruction of intra-hepatic biliary tree. CT shows impacted cystic duct stone, dilated common hepatic duct and a normal calibre bile duct. The GB wall can be thickened with associated peri-cholecystic fluid.\(^\text{16}\)

**GB volvulus**
This is a rare condition occurring in elderly women, with significant weight loss resulting in loss of peri-cholecystic fat. Associated variation in mesenteric anatomy causes the GB to twist on itself.\(^\text{17}\) GB torsion causes obstruction of venous drainage and ischemia. CT shows abnormal orientation and distension of the GB, abrupt tapering of cystic duct and peri-cholecystic fluid.\(^\text{22}\) Complications include gangrene and perforation.

**Porcelain GB** (figure 8)
This is an uncommon condition where there is calcium carbonate incrustation of the GB wall. Its incidence is about 0.6-0.8% with a male-to-female ratio of 1:5. 90% are associated with gallstones. CT shows curvilinear calcification within the wall with intra-luminal gallstones. There is an increased risk of GB cancer (10-20%).\(^\text{23}\) A non-functioning GB can be seen on oral cholecystogram.

**GB carcinoma** (figure 9)
This is the most common biliary cancer and the sixth most common gastrointestinal malignancy, predominantly affecting elderly females. Risk factors include cholelithiasis, porcelain GB, chronic cholecystitis, primary sclerosing cholangitis, congenital biliary cysts, inflammatory bowel disease and familial polyposis coli. 60% of GB cancers occur within fundus, 30% in body and 10% in the neck. CT shows either a heterogeneous mass replacing the GB, focal or diffuse wall thickening or a discrete intraluminal mass. The extra-gall bladder changes like pericholecystic infiltration, hepatic involvement, biliary obstruction and lymphadenopathy suggest an aggressive disease of the GB. CT has a sensitivity of 93% for staging of GB cancer. More recently, PET/CT has been reported as a useful test in the diagnosis and staging of GB cancer as well as detecting residual tumours, recurrence and distant metastases.\(^\text{24}\)

**Conclusion**
Although often not the initial study of choice in GB disease, CT can be used in diagnostic challenges or to further characterise complications of GB disease to allow appropriate subsequent monitoring, management and intervention.

**References**

FIGURE 1
Acute cholecystitis. Axial CT image shows a mildly distended GB with wall thickening and mural enhancement (arrow).

FIGURE 2
Gangrenous cholecystitis. Axial CT Image shows loculated fluid (arrow) adjacent to the gall bladder consistent with peri-cholecystic abscess.

FIGURE 3
GB perforation. Axial CT image shows discontinuity of GB wall (arrow) with peritonitis.

FIGURE 4
Emphysematous cholecystitis. Axial CT image shows gas (arrow) within the wall of GB and extensive peri-cholecystic fat stranding.

FIGURE 5
GB empyema. Sagittal CT image of a septic patient showing a very distended and tense GB filled with high attenuation material.

FIGURE 6
Gallstone ileus. Axial CT image shows a single gallstone in the distal small bowel with associated small bowel ileus.
**FIGURES 7a-c**
(A and B) Mirizzi. Axial and coronal CT images show a large gallstone within the GB causing intra-hepatic biliary dilatation. (C) MRCP MIP image shows the large gallstone causing compression to the common hepatic duct and proximal common bile duct.

**FIGURE 8**
Porcelain GB. Axial CT image shows curvilinear calcification (arrow) of the gall bladder wall.

**FIGURE 9**
GB carcinoma. Axial CT image shows ill-defined GB wall and heterogeneous mass replacing the GB (arrow) with associated biliary obstruction.