Acute Cholecystitis: Ultrasonography and CT indications in the emergency department

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Learning objectives

To evaluate the accuracy of Ultrasonography (US) in the diagnosis of acute cholecystitis (AC) and the indications for the multidetector CT (MDCT) study in the emergency department (ED)
Background

AC is defined as an acute inflammation of the gallbladder wall and represents 3%-10% of cases of acute abdominal pain that require hospitalization and surgery in the ED. Its main cause (90-95% of cases) is the lithiasic obstruction due to an impacted stone in the cystic duct or gallbladder neck leading to increased intraluminal pressure, distention of the gallbladder and irritation of the gallbladder mucosa with the release of several inflammatory mediators and progressive gallbladder wall inflammation. Approximately 10-15% of adult population have cholelithiasis but less than 15% of these patients have an history of biliary symptoms and less than 5% develop AC. In the remaining 5-10% of cases, this condition occurs in the absence of gallstones and is known as acalculous AC, which is usually seen in severely ill patients and is associated with higher morbidity and mortality rates.

Traditionally, the diagnosis has been based on the clinical triad of Murphy sign, elevated body temperature and elevated white blood cell count. However this triad is present in only 8% of patients so imaging findings have assumed an important role to ensure the final diagnosis and to detect complications of this disease.

The Tokyo guidelines introduced diagnostic and severity criteria to standardize the diagnosis and severity assessment of acute cholecystitis. The diagnostic criteria are one local sign of inflammation (Murphy sign or right upper quadrant pain, mass or tenderness), one systemic sign of inflammation (fever, elevated C-reactive protein level, increased white blood cell count), and confirmatory imaging findings.

Characteristic imaging findings in a patient clinically suspected to have AC include:

- thickened gallbladder wall or enlarged gallbladder on US, MDCT or magnetic resonance (MR) imaging
- tendereness provoked by pressing the exact area of the gallbladder with US probe (sonographic Murphy sign)
- pericholecystic fluid collection on US and MDCT imaging or pericholecystic high signal intensity at MR imaging.

The severity of AC is classified into three grades, as mild, moderate, or severe:

- Grade I (mild AC) is defined as cholecystitis in a patient who has mild inflammatory changes adjacent to the gallbladder without organ dysfunction.
- Grade II (moderate AC) is characterized by elevated white blood cell count, a palpable tender mass in the right upper quadrant, disease duration of longer than 72 hours and marked local inflammation.
- Grade III (severe AC) is defined as cholecystitis with organ dysfunction.

Treatment management is based on symptom severity and the patient’s surgical risk. Laparoscopic cholecystectomy is the preferred treatment in low-risk patients and
should be performed within 96 hours after the start of the complaint. Laparotomic cholecystectomy and antibiotic therapy are the initial treatments in patients with severe inflammation or surrounding infiltration at imaging; percutaneous drainage of the inflamed gallbladder with delayed cholecystectomy can be another safe option.
Findings and procedure details

In the ED, US is the first level technique performed for acute right upper quadrant pain suggestive of biliary pathology and is considered the most appropriate imaging modality for the diagnosis of AC showing a sensitivity of 88% and a specificity of 80%.

Sonographic features of uncomplicated AC include: presence of gallstones (fig.1) or sludge (fig.2), thickened gallbladder wall more than 4mm (fig.3), enlarged gallbladder more than 8cm in long axis or more than 4cm in short axis (fig.4), pericholecystis fluid collection (fig.5), enlargement of biliary tree (fig.6), hyperemic wall upon evaluation with Color Doppler (fig.7) and positive sonographic Murphy sign. Specially some US findings are more strongly associated with AC: a positive sonographic Murphy sign with a sensitivity of 92% and thickened gallbladder wall in the presence of stones with a positive predictive value of 95%.

Although US is the most useful imaging modality for initial evaluation of AC, MDCT is helpful when US findings are equivocal or clinical symptoms are nonspecific. The most sensitive CT findings in uncomplicated AC are inflammation and significant thickening of the gallbladder wall with mucosal hyperenhancement in the setting of a distended gallbladder (fig.8-9). Transient focal areas of increased enhancement in the hepatic parenchyma can be seen adjacent to the inflamed gallbladder, findings probably caused by reactive hepatic arterial hyperemia. Other findings include haziness of the pericholecystic fat, pericholecystic fluid, gallstones and increased attenuation of the bile (fig.8-9). In patients with acute abdominal pain, a combination of some or all of these CT findings is highly specific for AC, showing a good diagnostic accuracy with a sensitivity of 92% and a specificity of 99% comparable to those of US.

MDCT can also be used to demonstrate complications of AC which may urge a surgical treatment, such as emphysematous and gangrenous cholecystitis, gallbladder perforation and gallstone ileus.

Emphysematous cholecystitis occurs with secondary infection of the gallbladder wall by gas-forming organisms such as Clostridium perfringens. CT is the most sensitive and specific imaging modality for identification of gas in the gallbladder lumen or wall, highly suggestive of emphysematous cholecystitis (fig.10); infact the US appearance of gas may mimic a porcelain gallbladder or multiple stones in a contracted gallbladder.

Perforation occurs in 2% to 11% of AC and is one of the most severe complications with high morbidity and mortality. Although emphysematous, gangrenous, and hemorrhagic cholecystitis may progress to gallbladder perforation, the most common mechanism involves cystic duct obstruction leading to gallbladder distention, vascular compromise, ischemia, necrosis and ultimately perforation. Because of its poor blood supply, the
fundus of the gallbladder is the most frequent site of perforation. Gallbladder perforation is classified into three types: type I includes patients with free perforation into the peritoneal cavity and generalized peritonitis, type II describes patients with localized perforation and pericholecystic abscess formation (fig.11) and type III patients with cholecysto-enteric fistulas (fig.11). Less frequent forms include cholecysto-biliary fistula or intrahepatic perforation of the gallbladder with liver abscess (fig.12). CT imaging represents the most sensitive tool to diagnose and localize gallbladder perforation. An extraluminal gallstone is a finding specific for gallbladder perforation. Although it was originally described for US, the "hole sign," which refers to a focal gallbladder defect, is more commonly seen at CT and is a reliable sign of gallbladder perforation. Others findings include free intraperitoneal air bile leak, pericholecystic or intrahepatic abscess formation and small bowel obstruction.

Gallstone ileus is a rare complication of AC and an infrequent cause of mechanical bowel obstruction, accounting for up to 3% of cases. Severe cases of cholecystitis can result in secondary inflammation of duodenal tissue adjacent to the inflamed gallbladder wall. If this process is long-standing and severe, a gallstone may erode through the gallbladder wall and into the duodenum. CT findings include pneumobilia, small bowel obstruction, ectopic gallstone, cholecysto-duodenal fistula and thickened duodenal wall (fig.13).
Fig. 1: US scan shows enlarged gallbladder with multiple gallstones in a patient with acute cholecystitis.

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**Fig. 2:** Trasverse US scan shows distended gallbladder with layering sludge in a patient with acute cholecystitis.

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**Fig. 3:** US scan shows a mild (a) and a severe thickening of the gallbladder wall with microabscesses and sludge in two patients with acute cholecystitis.

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**Fig. 4:** US scan shows gallbladder hydrops.

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Fig. 5: US scan shows pericholecystic fluid, impacted gallstone and distended gallbladder in a patient with acute cholecystitis.

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Fig. 6: US scan shows enlargement of the common bile duct in a patient with acute cholecystitis.

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Fig. 7: US scan shows hyperemic gallbladder wall upon evaluation with Color Doppler in a patient with acute cholecystitis.

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Fig. 8: Axial contrast enhanced CT images show a diffuse thickening and hyperenhancing of the gallbladder wall with layering gallstones (a), enlarged gallbladder with a stone in the cystic duct and pericholecystic fat stranding (b) in two patients with acute cholecystitis.
Fig. 9: Axial contrast enhanced CT images show distended gallbladder with layering sludge and gallstones (a), marked enlargement of intrahepatic biliary ducts (b), pericholecystic fluid (c) and enlargement of the common bile duct with an impacted stone in its terminal tract (c-d).
Fig. 10: Contrast enhanced CT images show gas collections within the gallbladder wall diagnostic of emphysematous cholecystitis. Axial CT images show the gallbladder distended with sludge and gallstones, pericholecystic fat stranding (a) and mild aerobilia (b). In addition, coronal CT image shows infiltration of the surrounding fat and reactive mural thickening of adjacent duodenum and hepatic flexure of colon(c).

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Fig. 11: Contrast enhanced CT images show a thickening of the gallbladder wall with aereobilia and a fistula to the duodenum (a), pericholecystic fat stranding (b) and two pericholecystic abscesses result from perforation of the gallbladder (c-d).

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Fig. 12: Contrast enhanced CT images show the presence of a liver abscess, appearing as localized fluid collections with rim enhancement, with direct continuity into the gallbladder suggesting by cholecystitis complicated with intrahepatic perforation.

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Fig. 13: Contrast enhanced CT images show a diffuse thickening of the gallbladder wall with large gallstones and a fistula to the duodenum, a stone at the distal ileum (b) and dilated fluid-filled loops of small bowel proximal to the obstruction (c); findings that are diagnostic for gallstone ileus.
Conclusion

US should be considered the first imaging technique for patients clinically suspected of having AC and the modality of choice for the detection of stones and the evaluation of inflammation. MDCT is indicated to exclude alternative diagnosis in patients with aspecific clinical or US findings and for evaluating the main complications such as emphysematous cholecystitis, gallbladder perforation and gallstone ileus. Radiologic findings have an important influence also on planning the optimal surgical approach patients with AC.
References