My patient has got abdominal pain: identifying biliary problems

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Abstract

Right upper quadrant and epigastric abdominal pain are common presenting complaints in the emergency department. With increasing access to point-of-care ultrasound, emergency physicians now have an added tool to help identify biliary problems as a cause of a patient's right upper quadrant pain. Point-of-care ultrasound has a sensitivity of 89.8% (95% CI 86.4–92.5%) and specificity of 88.0% (83.7–91.4%) for cholelithiasis, very similar to radiology-performed ultrasonography. In addition to assessment for cholelithiasis and cholecystitis, point-of-care ultrasound can help emergency physicians to determine whether the biliary system is the source of infection in patients with suspected sepsis. Use of point-of-care ultrasound for the assessment of the biliary system has resulted in more rapid diagnosis, decreasing costs, and shorter emergency department length of stay.

Keywords: Point-of-care ultrasound, PoCUS, gallbladder, cholelithiasis, cholecystitis, emergency medicine

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Clinical questions

In a patient who presents to the emergency department (ED) with right upper quadrant (RUQ) pain, how can one use point-of-care ultrasound (PoCUS) to identify whether cholelithiasis or cholecystitis is the source of his/her pain? In an ill patient with signs and symptoms suggestive of sepsis, how can one use PoCUS to identify whether the biliary system is a potential source of infection?

Introduction

Approximately 5–9% of men and 14–27% of women in the United States have either cholelithiasis or a history of cholecystectomy secondary to cholelithiasis.¹ The prevalence of gallbladder disease worldwide is highly variable and depends on factors such as ethnicity and country of origin.² Between 2.5% and 12% of emergency hospital visits in the United States and United Kingdom are related to cholelithiasis.^{3–5}

Despite their high prevalence, diagnosing cholelithiasis and cholecystitis can be challenging, and it often relies on radiology-performed ultrasonography.^{6,7} The lack of immediate, 24-hour access to these radiology-performed ultrasound scans for ED patients may potentially delay diagnosis and management.

Case 1

A 40-year-old woman presents to the ED on the weekend, complaining of a five-day history of RUQ pain after eating. She admits to having several alcoholic beverages over the weekend. Despite taking an anti-inflammatory medication, she continues to have RUQ pain. She is afebrile and all vital signs are normal. On physical examination, she is tender in the epigastrium and RUQ. Her blood tests are normal.

Case 2

A 70-year-old man presents to the ED in the evening with signs and symptoms suggestive of sepsis. There is no obvious source of infection other than his complaint of vague abdominal pain. On examination, his abdomen is slightly tender in the RUQ with no peritoneal signs. His blood tests show a leukocytosis and elevated lactate.

Rationale

Assessment of the biliary system with PoCUS has become more common in the ED for several reasons: limited access to radiology-performed ultrasound scans, increasing availability of bedside ultrasound machines, and the increasing comfort and experience of emergency physicians (EPs) with ultrasound. PoCUS has a reported sensitivity of 89.8% (95%

CI 86.4%–92.5%) and specificity of 88.0% (83.7%–91.4%) for the detection of cholelithiasis in symptomatic ED patients.⁸ This compares favorably with radiology-performed ultrasound scans that, when adjusted for verification bias, have a reported sensitivity of 88% (74%–100%) and specificity of 80% (62%–98%) for the detection of cholelithiasis.^{9,10} PoCUS of the biliary system can be reliably performed by EPs who have been trained^{11,12} and has been shown to decrease costs¹³ as well as ED length of stay¹⁴ in patients presenting with symptomatic cholelithiasis.

It is important to note that the presence of gallstones may be an incidental finding in patients with RUQ pain. Only 20% of those patients with cholelithiasis will develop cholecystitis;¹⁵ however, approximately 90–95% of patients with the acute cholecystitis have gallstones.^{16,17} As such, PoCUS should not be used alone in making a diagnosis of gallbladder disease, but rather in conjunction with clinical pre-test probability to maximize its benefits and minimize the chances of error.

Technique

Image generation

A low-frequency (2–5 MHz) curvilinear transducer should be used to allow for maximum penetration. An abdominal preset should be used with the depth maximized, gain optimized, and tissue harmonics on.

With the patient supine, the transducer is placed in the sagittal plane (probe marker pointed towards the head) at the level of the xiphoid. The transducer is then moved from medial to lateral towards the patient's right following the costal margin. The liver should be visualized first, followed by the gallbladder. The patient will often be required to hold his/her breath in order for the gallbladder to be displaced below the costal margin to improve visualization. The gallbladder should be viewed in both the longitudinal and transverse planes (Figure 1).

Imaging the common bile duct (CBD) is a challenging examination requiring significant operator experience. Initially, follow the gallbladder in the longitudinal plane along the main lobar fissure to the portal vein. With the portal vein centered on the screen, the transducer can be

carefully rotated until the CBD is visualized in the longitudinal axis (Figure 2). Color Doppler can be applied to demonstrate flow in the portal vein and the hepatic artery. Bile is extremely slow moving in the CBD, and therefore, no color Doppler signal will be seen.

Troubleshooting

A lateral approach using the liver as an acoustic window can be used when the gallbladder does not fall below the costal margin. The transducer is placed between the anterior and mid-axillary lines. Sweep the transducer slowly while the patient is holding his/her breath until the gallbladder is visualized within the liver.

If the gallbladder continues to be difficult to visualize, the patient can be turned onto his/her side in the left lateral decubitus position. This position allows the bowel gas to move and the gallbladder to drop below the costal margin where it is more easily visualized with ultrasonography. And asking the patient to hold his/her breath will further enhance visualization of the gallbladder in this position. Finally, asking the patient to push his/her abdomen out may also shift bowel gas that might be obstructing the view of the gallbladder.

To assist with visualization of very small stones, consider turning off compounding/multi-beam functions to improve visualization of acoustic shadows and also increase the frequency as high as possible.

Image interpretation

Normal

The normal non-contracted gallbladder will appear as a cystic structure. Cystic structures appear as anechoic fluid with hyper-echoic walls and acoustic enhancement posteriorly. The anterior wall is usually measured in the transverse plane and should be less than 4 mm. The normal CBD measured from inner wall to inner wall is less than

Figure 1 Normal gallbladder in longitudinal plane. Asterisk indicates portal vein. Arrow indicates gallbladder

Figure 2 Normal common bile duct (CBD). Calipers indicate a diameter of 0.31 cm. Arrow indicates hepatic artery. PV: portal vein

7 mm in diameter just at the crossing of the hepatic artery in the longitudinal plane. It can enlarge by as much as 1–2 mm as it approaches the pancreas. Controversy exists whether the CBD can dilate in older patients or in patient's post-cholecystectomy.¹⁶

Cholelithiasis (gallstones/sludge)

Gallstones produce an echogenic rim and posterior acoustic shadow (Figure 3). Gallstones less than 5 mm may not produce an acoustic shadow but should still be echogenic. Sludge, the precursor material to gallstones, is echogenic but with no acoustic shadow and appears in the most dependent areas of the gallbladder. With patient movement, the sludge will settle with gravity (Figure 4).

Once a gallstone is visualized, it is important to see mobility of the gallstone by repositioning the patient in a decubitus or standing position and repeating the PoCUS examination. Non-mobile or impacted gallstones at the neck are more likely to cause acute cholecystitis.

Figure 3 Gallbladder with multiple gallstones. Arrows indicate stones with associated posterior acoustic shadowing

Figure 4 Gallbladder with sludge. Arrow indicates sludge in most dependent area

Cholecystitis

There are many sonographic signs indicating acute cholecystitis, although none of them is pathognomonic. The presence of gallstones is significant because it is the primary criterion in diagnosing acute cholecystitis. Approximately 90–95% of patients with acute cholecystitis have gallstones in combination with a sonographic Murphy's sign, which is defined as maximal tenderness elicited with the transducer compressing the gallbladder directly.^{17–19}

Secondary sonographic signs include gallbladder wall thickening (>3 mm), a distended gallbladder (diameter >4 cm and length greater than that of the adjacent kidney), and peri-cholecystic fluid (Figure 5).¹⁶ Gallbladder wall thickening may be caused by several other conditions and hence, this alone should not be considered to make the diagnosis of cholecystitis. Some etiologies of gallbladder wall thickening include oedematous states (e.g. congestive heart failure and hypo-proteinaemia), inflammatory conditions (e.g. hepatitis and colitis), gallbladder cancer, and adenomyomatosis.²⁰

If untreated, acute cholecystitis can progress, perforate, and develop into an abscess (Figure 6).

Figure 5 Acute cholecystitis. Arrow indicates peri-cholecystic fluid. Asterisk indicates thickened gallbladder wall

Figure 6 Hepatic abscess secondary to gallbladder perforation. Arrow indicates the abscess. Color Doppler highlights the portal vein and flow around the abscess

Cholelithiasis

CBD dilatation, defined as a measurement of greater than 7 mm, could be a reflection of either intrinsic (e.g. stone, stricture) or extrinsic (e.g. mass) compression resulting in obstruction (Figure 7).¹⁵ The clinical setting will help determine the specific cause of CBD dilatation, including whether slight dilatation is a variation of normal. Stones less than 5 mm and in the distal portion of the duct may be difficult to visualize.

Intrahepatic duct dilatation may be visualized with more proximal obstructions (e.g. cholangiocarcinoma, liver metastases, and cholangitis). This is defined as greater than 2 mm or more than 40% of the size of the adjacent portal vein. The use of color Doppler can help differentiate between hepatic ducts and blood vessels, as color will not appear in the slow flow hepatic ducts but will appear in blood vessels (Figure 8).

Figure 7 Dilated common bile duct (CBD). Arrow indicates dilated CBD just distal to hepatic artery indicated with color Doppler

Figure 8 Dilated intrahepatic ducts. Color Doppler highlights the portal vein. Arrows indicate the dilated intrahepatic ducts

Pitfalls

As demonstrated by the reported sensitivity and specificity of biliary ultrasonography, false-negative and false-positive scans occur frequently. Many of these pitfalls can be avoided by careful repeated scanning in more than one plane and from more than one window. Complete scanning of the gallbladder from one side all the way through to the other must be performed with particular attention at gallbladder neck.

Contracted gallbladder

Given that most patients presenting to the ED are not fasting, the gallbladder can often appear contracted (Figure 9). This makes it more difficult to identify and can give the appearance of bowel gas. Additionally, the gallbladder wall will be thickened, making this sonographic finding much less specific for cholecystitis. In a contracted state, a thickened gallbladder wall should not be used alone to diagnose cholecystitis.

Gallbladder polyps

Gallbladder polyps can also make the gallbladder appear thickened and can be mistaken for gallstones (Figure 10). Polyps can be differentiated from gallstones, as they are not dependent on patient positioning and are fixed to the gallbladder wall. Cholesterol polyps and adenomyomas are types of gallbladder polyps that often have comet-tail artifact originating from the polyp itself that produces no acoustic shadow.

Wall-echo-shadow

The wall-echo-shadow (WES) complex is a sonographic sign that makes it difficult to identify the gallbladder and in some instances can lead the operator into mistaking the gallbladder for the duodenum or missing the gallbladder altogether (Figure 11). It is important to visualize the area of interest in multiple planes and to change the patient

Figure 9 Contracted gallbladder. Arrow indicates the thickened contracted gallbladder wall

Figure 10 Gallbladder polyp. Arrow indicates polyp suspended from non-dependent area of the gallbladder wall. Asterisk indicates shadow created by edge artifact

Figure 11 Gallbladder in transverse demonstrating wall–echo–shadow (WES)

position to better delineate the gallbladder wall from the lumen and gallstones.

Acalculous cholecystitis

The absence of gallstones makes the diagnosis of cholecystitis very difficult. The EP should be aware of acalculous cholecystitis as a potential diagnosis in critically ill patients, especially in those with signs and symptoms suggestive of sepsis. A high index of suspicion is also required in patients with burns, severe multisystem trauma, or total parenteral nutrition, as these groups have a higher incidence of acalculous cholecystitis.²¹

Emphysematous cholecystitis and pneumobilia

The clinical sonographer should be aware of emphysematous cholecystitis, in which air appears in the gallbladder wall, as well as pneumobilia, in which air appears in the biliary tree. Pneumobilia is a recognized finding in patients following recent sphincterotomy. Air within the portal venous system is an ominous finding in the unwell infant

(suggestive of necrotizing enterocolitis) or the unwell elderly patient (suggestive of mesenteric infarction).

Bowel gas

Bowel gas can also mimic the appearance of the gallbladder and multiple views of the area of interest should be obtained to minimize this interpretation error. Side lobe artifact can cause bright air in adjacent duodenum to “appear in the gallbladder” and can look similar to a stone.

Edge artifact

Shadows due to edge artifact from gallbladder itself can be misinterpreted as being due to stones. This is especially a problem at the neck of the gallbladder (Figure 10).

Conclusion

PoCUS provides clinical information that can be used in conjunction with the patient’s history, physical examination, and laboratory findings to diagnose biliary disease. In the patient presenting with RUQ or epigastric pain, where there is a clinical suspicion of biliary disease, PoCUS is an important aid in the diagnosis of cholelithiasis and cholecystitis and can help to identify a biliary source of infection in patients with possible sepsis. PoCUS biliary scans should be followed by a radiology-performed ultrasound scan, especially if the findings do not fit with clinical suspicions.

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