Complications from Cholelithiasis and its Management: Key Points for Diagnosis

Complicaciones secundarias a colelitiasis y su manejo: Puntos fundamentales para el diagnóstico

Luis Fernando Aleán Argueta[1]
Sandra Milena Ramírez Toncel[2]
Sebastián Francisco Cifuentes Sandoval[3]
Daniel Fernando Izquierdo Gracia[1]
Jorge Martín Vergara Gómez[4]

Key words (MeSH)

Cholelithiasis
Tomography, X-ray computed
Magnetic resonance imaging

Summary

Cholelithiasis is a highly prevalent disease in the world's population and it is important for surgeons and radiologists to make the early recognition of the complications in order to reduce mortality and morbidity secondary to the pathology and its surgical management, identifying entities that vary across the spectrum of disease from inflammatory and infectious conditions, to iatrogenic and vascular causes.

Palabras clave (DeCS)

Colelitiasis
Tomografía computarizada por rayos X
Imagen por resonancia magnética

Resumen

La colelitiasis es una condición patológica altamente frecuente en la población mundial, por lo que es de vital importancia, tanto para cirujanos como para radiólogos, reconocer de forma temprana las complicaciones; esto permitirá disminuir la morbimortalidad secundaria a la enfermedad y su manejo quirúrgico, identificando entidades que varían en un amplio espectro desde condiciones inflamatorias e infecciosas, hasta causas iatrogénicas y vasculares.

Introduction

The broad spectrum of pathological conditions of the gallbladder has been recognized since antiquity, especially those originated by calcifications, which were observed and described in autopsies of mummies of ancient civilizations, such as Egypt and China (1, 2). Vesalius, Fallopian, and Gray were dissectors who made important contributions in this area of medicine; Gray points out that he made an approach to the recognition of radiopaque gallstones by conventional radiology in studies of an Egyptian mummy at the University of Leiden in the Netherlands (1, 3).

The advent of new medical technologies, specifically diagnostic, offers tools for the early recognition of the pathology of the gallbladder, as well as the correct and timely detection of its complications, which has been demonstrated in the reduction of morbimortality rates.

This article describes the important points for the diagnosis of the main inflammatory, infectious, vascular, iatrogenic, obstructive and mechanical secondary to cholelithiasis.

Inflammatory complications and infections

Acute cholelcystitis

Cholecystitis is an entity characterized mainly by obstruction of the cystic duct, often by gallstones, which causes poor drainage of biliary mucus, increases gallbladder pressure and generates venous stasis, followed by arterial stasis, which subsequently causes vesicular wall ischemia and necrosis, with the risk of perforation (4-6). Its most common clinical presentation is diffuse abdominal pain, initially localized in the epigastrium, which, with increasing inflammation, is predominantly located in the upper right quadrant of the abdomen, associated with tachycardia, fever and positive Murphy's sign, in addition to leukocytosis in the laboratory exams, which speaks of its inflammatory origin.

[1]Radiology and diagnostic imaging, Hospital Universitario San Ignacio, Pontificia Universidad Javeriana. Bogotá, Colombia.

[2]Radiologist, emergency and trauma radiologist fellow. Universidad de Antioquia. Medellin, Colombia.

[3]Surgical doctor, Pontificia Universidad Javeriana. Bogotá, Colombia.

[4]Radiologist. SONOMAC. Clinica El Bosque. Bogotá, Colombia.

The preferred imaging method for the diagnosis of biliary pathology is ultrasound (US), with a sensitivity and specificity of 96% and 95% respectively (7). The following findings are critical for the diagnosis: thickening of the gallbladder wall (> 3 mm), overdistension of the gallbladder lumen (AP diameter> 4 cm and length> 10 cm), impacted gallstones in the neck of the vesicle or cystic duct, perivesicular fluid, positive ultrasound Murphy's sign, and hyperemic vesicle on color Doppler examination (Figure 1) (8, 9).

Scans, although less sensitive than ultrasound, especially in the early course of the disease, can also demonstrate uncomplicated cholecystitis findings, with a sensitivity and specificity of 45% and 80%, respectively (1, 10, 11). Among the radiological findings are: gallstones within the gallbladder (visualized in up to 80% of cases), increased wall enhancement, increased perivesicular fat density, perivesicular fluid, and changes due to hepatic hyperemia regional (Figure 2) (12-14).

Magnetic resonance imaging (MRI) has a high sensitivity in the diagnosis of cholecystitis (96%); T2-weighted sequences demonstrate overdistension of the gallbladder, low signal gallstones, increased signal of the vesicular wall and surrounding tissues by edema. Cholangiopancreatography evaluation in T2-weighted sequences facilitates the identification of gallstones (low signal) in the neck and in the extrahepatic biliary tract (7, 15-17).

Vesicular abscess

It is a complication of acute cholecystitis that occurs in 3 to 19% of cases. Intramural or perivesicular, unilocular or septate fluid collections are formed, with or without involvement of the adjacent liver parenchyma (11,13,14). The important findings for US diagnosis are a hypo, iso or echogenic mass in the vesicular bed, with no central flow during color Doppler examination, unilocular or multiseptate appearance, with posterior acoustic shadow of variable intensity according to the composition of the collection, and increase in the echogenicity of the perivesicular fat (18).

The evaluation with images can identify multiple sites of low-density pus (0-10 UH), with peripheral enhancement after contrast medium administration, hydroareal levels and increased density of perivesicular fat with or without parenchyma extension hepatic, which may additionally present a low signal halo due to edema (10,19-21).

In MRI, the abscess presents a low signal center at T1 and a high signal at T2, with ring peripheral enhancement after administration of gadolinium, and shows restriction in the diffusion sequences (Figure 3) (22).

Emphyseous cholecystitis

It is a rapidly progressive and often fatal complication that develops in less than 1% of the cases of acute cholecystitis, with prevalence in men and with an increased risk of occurrence in diabetics or with splanchnic ischemia. It is characterized primarily by the presence of gas within the wall or the lumen of the gallbladder, which originates from the activity of bacteria such as Clostridium perfringens, Welchii, Escherichia coli and Klebsiella (23-26).

The findings for the diagnosis of this entity include, in conventional radiology, the visualization of a radiolucent image, rounded, with defined borders, located in the right hypochondrium (Figure 4). A very echogenic image in the vesicular bed associated with a reverberation artifact and gas bubbles in the non-gallbladder portion is identified by ultrasonography, which gives rise to the sign of "champagne bubbles" (26-28). Ultrasonography has a high specificity (93%), but low sensitivity in the diagnosis of emphysematous cholecystitis (28).

CT is the best modality for the assessment of intramural gas with sensitivity up to 100%. In addition, it is possible to evaluate the gas extension to the portal or the abdominal cavity (8, 29, 30). In the MRI, signal gaps secondary to gas bubbles are typically observed in the non-dependent areas of the vesicle, which helps to differentiate it from gallstones. It is also possible to identify artifacts without homogeneity or susceptibility in the different sequences (31,32).

Gangrenous cholecystitis

Complication occurs in 2-38% of cases of acute cholecystitis due to an increase in the pressure in the gallbladder light that produces wall ischemia and finally necrosis (4,5,20,33). Symptoms and signs in the patient are more generalized, and abdominal pain is more diffuse due to irritation of the parietal peritoneum by generalized peritonitis, probably secondary to perforation. Ultrasound and CT show defects of the vesicular wall (irregular or interrupted), membranes in the gallbladder, hydrocollects, lack of enhancement of the vesicular wall after administration of contrast medium and vesicular abscess (33-35).

Porcelain gallbladder

This is a rare disorder characterized by calcification of the wall of the gallbladder due to intermittent obstruction of the vesicular neck that generates a saturation of bile with the consequent precipitation and accumulation of calcium in the course of chronic cholecystitis. The porcelain vesicle presents with few symptoms, is more frequent in men, usually in the fifth decade of life and physical examination can sometimes find a palpable mass in the upper right quadrant.

Wall calcifications can be identified on plain radiography. In ultrasonography, the vesicle wall is identified as a linear or semilunar hyperechoic structure that generates acoustic shadows (Figure 5). It is also possible to visualize groups of irregular echoes, but without clear recognition of the posterior wall of the vesicle (36-38). In CT, calcifications are characterized more precisely. They may be thin, thick, or markedly irregular, and compromise the entire wall or segment (39).

Figure 1. A 58-year-old woman with pain in the right hypochondrium, fever, and leukocytosis. In the US, thickening of the walls of the gallbladder and impacted calculus in the neck are visualized. During the exploration is the positive ultrasound Murphy sign.

Figure 2. A 48-year-old woman with pain in the right flank and mesogastrium, fever and leukocytosis. Scanography shows thickening of the gallbladder walls, perivesicular fluid, and increased density of adjacent fat.

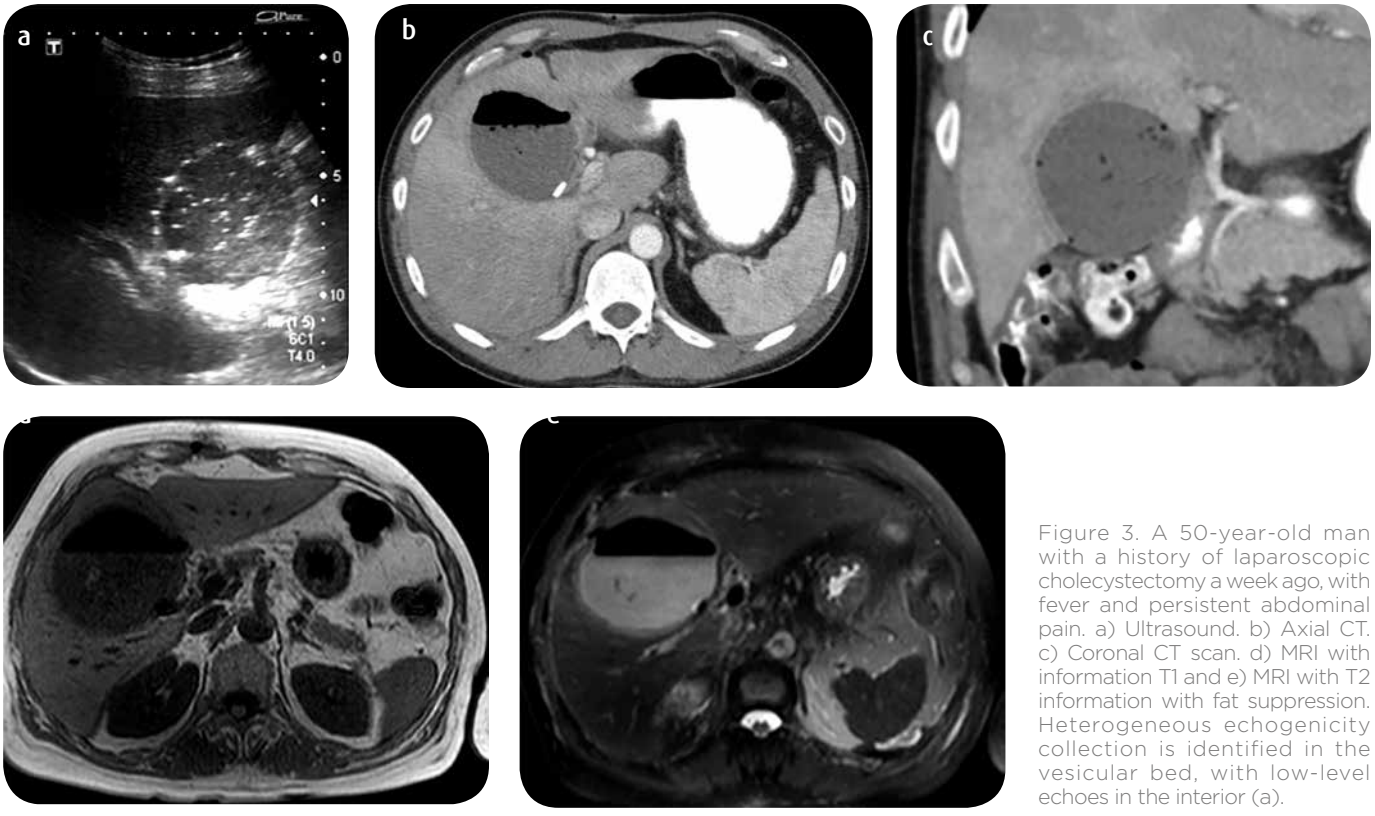


Figure 3. A 50-year-old man with a history of laparoscopic cholecystectomy a week ago, with fever and persistent abdominal pain. a) Ultrasound. b) Axial CT. c) Coronal CT scan. d) MRI with information T1 and e) MRI with T2 information with fat suppression. Heterogeneous echogenicity collection is identified in the vesicular bed, with low-level echoes in the interior (a).

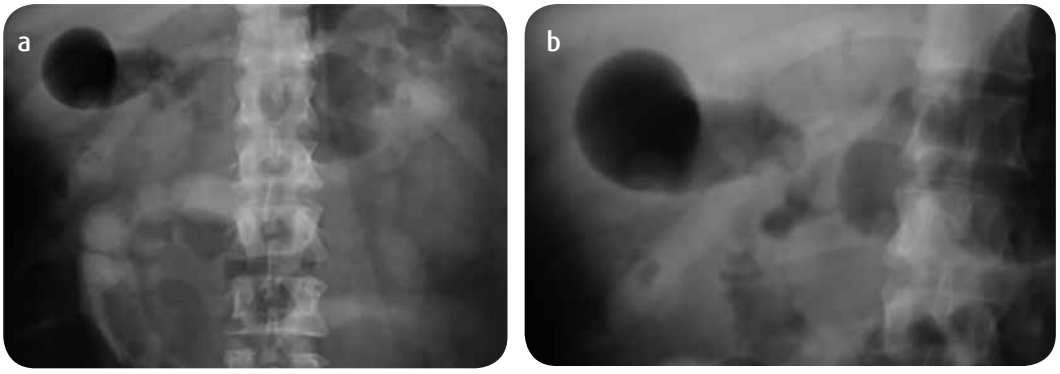


Figure 4. a and b) 58-year-old man with abdominal pain in the flank and right hypochondrium, and fever. In the simple abdominal x-ray image radiolucent in the right hypochondrium, corresponding to the gallbladder with air inside, with small radiopaques images in its light that are gallstones .

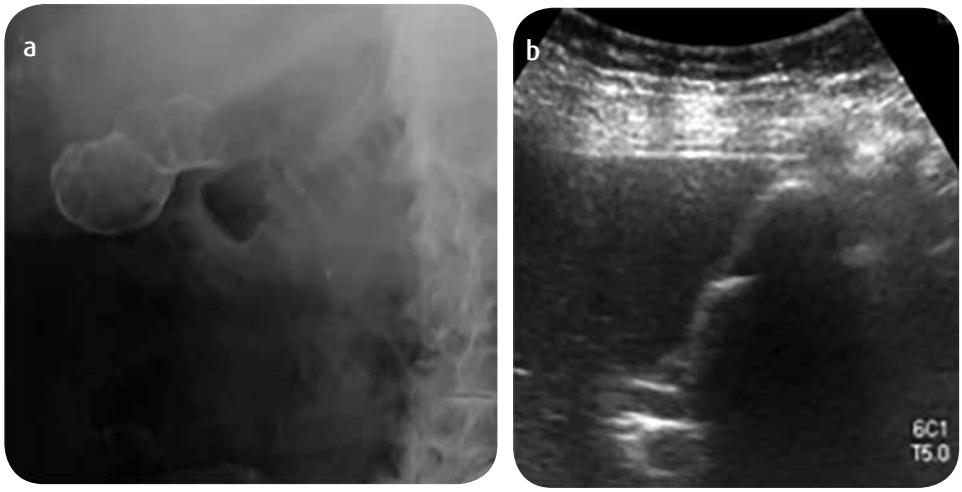


Figure 5. A 70-year-old woman with diffuse abdominal pain. a) In the simple x-ray of the abdomen, a calcified wall vesicle is observed. b) On ultrasound, the wall is echogenic and generates extensive posterior acoustic shade that limits the intraluminal assessment.

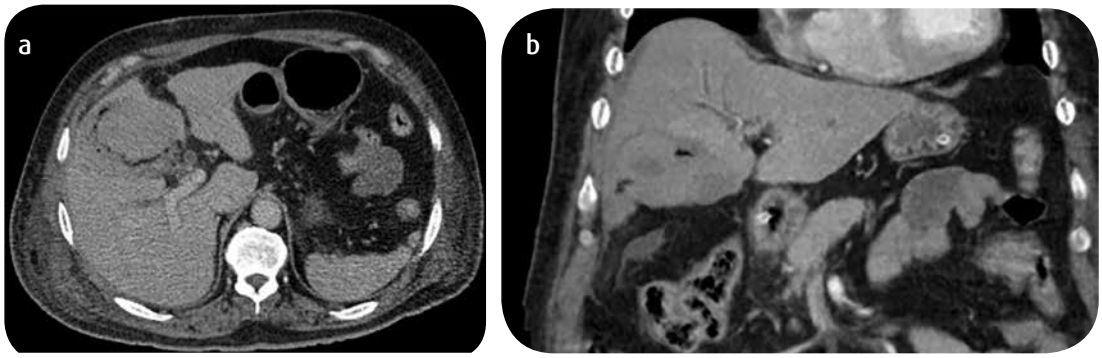


Figure 6. a and b) Patient on fifth postoperative day by laparoscopic cholecystectomy. Consultation for pain in right hypochondrium. The CT scan shows a well-defined, high density collection, located in the vascular bed, with gas inside.

Vascular complications

Pseudoaneurysms

A rare complication secondary to procedures in the biliary tract, including laparoscopic cholecystectomy. The exact mechanism by which it occurs is not known, but it has been proposed that erosion of the gallbladder wall and the consequent extension of inflammation to the adventitious layer of the blood vessels adjacent to the vesicular bed facilitate the formation of pseudoaneurysms. The cystic artery is the most frequently involved, and in rare cases, the common hepatic artery and the portal vein (40, 41). Likewise, erosion produced by the placement of the vascular clips, direct injury of the vascular wall and the electric current diffused by the clips are also suggested as triggers.

The diagnosis of this complication is difficult, so it is important to suspect it clinically when the patient presents abdominal pain, anemia, hemobilia and elevated liver function tests. Ultrasound evaluation reveals a rounded hypoechoic or anechoic structure, compatible with the aneurysm, where slow flow or signs of partial thrombosis can be detected. On color Doppler examination, the yingyang sign is found and it is sometimes possible to detect an associated arteriovenous fistula. The spectral analysis shows a flow in and out. During the arterial phase of the CT scan, pseudoaneurysm enhancement is noted, and the integrity of the wall should be assessed and the contrast medium extravasated (33, 42).

It is a rare complication of acute cholecystitis that can occur in the presence or not of gallstones. Initially, there is ulceration and necrosis of the mucosa, with subsequent intraluminal hemorrhage. This entity classically presents with biliary colic, jaundice and manes. Ultrasound identifies irregularities of the vesicular wall, echogenic content in the lumen of this organ, and in most cases, overlap of findings of gangrenous cholecystitis. Contrast studies demonstrate active extravasation of the medium and complications secondary to vesicular perforation, such as hemoperitoneum (42).

Superinfectious post-operative hematoma

A rare (<1%) hemorrhagic vascular complication, not exclusive to laparoscopic cholecystectomy, since it can occur due to other procedures performed in the biliary tract, which is classified in the variable presentation range; can range from a small hematoma to significant bleeding that would compromise the general condition of the patient. Postoperative hematoma may originate from multiple sources of bleeding: dependent on the vesicular bed after gallbladder removal, trocar insertion sites, major or minor vascular injury, falciform ligament or ruptured hepatic capsule.

This bleeding can compromise the general state of the patient with increased pain, vomiting and fever. In addition, hematomas

are not free from infection and require follow-up studies and even reintervention to control bleeding if they do not respond to conservative measures (42, 43). For its diagnosis it is fundamental to visualize on ultrasound a collection of heterogeneous echogenicity, which over time becomes more hyperechoic, which may confuse it with an abscess in many occasions. Additionally, a high-density collection in the vesicular bed is found in CT, which does not enhance after administration of contrast medium (Figure 6). This collection may have signs of active bleeding or not, which determines the need for endovascular management as the first option (43).

Iaotrogenic complications

Fallen gallstones

This entity occurs during a laparoscopic cholecystectomy, in which control of bile and gallstones can be a challenge, and inadequate management leads to its onset in up to 2% of all cases surgical procedure (21). Although many times the stones are asymptomatic, they can also produce wound infections, abscesses, a cutaneous sinus, and fistulas from the gallstones to the gastrointestinal tract, the thoracic cavity, or the skin. Additionally, they may cause mechanical intestinal complications, such as an ileus (44).

Fallen gallstones are frequently diagnosed by CT as high / low signal images, with defined borders, which represent the gallstones with collections around them (abscesses) and peripheral enhancement after the administration of the contrast medium; can be located from the subphrenic and subhepatic space to the parietal-colonic drip, compromising the walls of the ascending colon and less frequently those of the transverse colon (36, 40, 44). In ultrasound the findings are more subtle; the fallen gallstones are visualized as echogenic images with posterior acoustic shadow on the surface adjacent to the liver, and abscesses as small hypoechoic collections in the hepatic periphery (Figure 7).

Obstructive and mechanical complications

Choledocholithiasis

Choledochal gallstones may manifest clinically with jaundice, elevation of bilirubin at the expense of its direct fraction, and pain in the upper right quadrant. This complication occurs in 15% of patients with symptomatic cholelithiasis. Ultrasound, CT and MRI demonstrate dilation of the extrahepatic biliary tract and usually also intrahepatic biliary tract. Ultrasound, although with a variable sensitivity estimated between 22 and 75%, can identify the calculation in the common bile duct as an echogenic image that generates posterior acoustic shadow in 90% of the cases, although there is a 10% that due to its small size or its composition it does not present this artifact (10,41,45,46).

In CT, the identification of the gallstone depends on its composition. If the gallstones are mixed with cholesterol and calcium bilirubin, they appear with the sign of "ox eye" or "target", which has a sensitivity up to 80% and refers to a low signal bile halo around of the high density calculation (Figure 8a) (46). Gallstones of pure cholesterol are rare and are not visualized in the simple CT scan because they have densities similar to those of bile. Cholangiorresonance has a sensitivity of 100% and specificity of 85 to 100% for the detection of gallstones in the bile duct. In T2-weighted sequences, calculations are identified as low-intensity, rounded or meniscal signal defects in the biliary tract, which should not be confused with motion artifacts (Figure 8b) (46).

Vesicular perforation

This entity presents secondary to occlusion of the cystic duct, with the consequent accumulation of intraluminal secretions and increased pressure in its lumen, which leads to alteration of lymphatic drainage, venous and arterial irrigation, which causes necrosis of the wall of the gallbladder. It occurs in up to 10% of patients with acute cholecystitis, and its early identification helps reduce morbidity and associated mortality, which may otherwise reach up to 24% in some series (47).

Three stages are described: acute (10%), subacute (60%, more frequent) and chronic (30%); the acute stage is the one with the worst prognosis, due to the fact that it presents with generalized peritonitis and the formation of perivesicular abscesses. In the images, we can find extra illumination of gallstones, which is the most specific finding of vesicular perforation associated with a focal defect in the vesicular wall (Figure 9). Other secondary signs are pneumoperitoneum, perivesicular or hepatic abscesses, and, less frequently, small bowel obstructions (48,49).

Mirizzi Syndrome

Described in 1948 by Pablo Luis Mirizzi in his publication entitled "Syndrome of the hepatic duct" (48). It is, in essence, a mechanical obstruction, since among its presentations can occur as acute cholelithiasis secondary to gallstones impacted in the neck of the gallbladder or in the cystic duct; according to anatomical relationships there is mechanical compression of the common hepatic duct resulting in obstruction of the biliary tree and cholestasis, which leads to the known obstructive jaundice, which may or may not be associated with pain in the right hypochondrium, fever and leukocytosis. At this point, its diagnostic imaging is of special value because of its wide differential diagnosis, which would allow differentiating the causes of obstructive jaundice and better guiding medical and surgical management in each case (8,23).

The preoperative diagnosis of Mirizzi syndrome is difficult; nevertheless, among the modalities of useful images for its diagnosis are the ultrasound and the CAT in which one can observe impacted gallstones in the neck of the gallbladder or in the cystic duct; as well as secondary dilatation of the intrahepatic biliary tract and the common hepatic duct proximal to the obstruction. Pericolectic and peri-inflammatory inflammatory changes, including pericolecular plaiting, thickening of the wall and abnormal distension of the gallbladder, are also part of the echographic and scannographic findings. Another current and more useful diagnostic modality is

cholangiopancreatography MRI, since it allows the identification of anatomical variants that may predispose to this syndrome, including a low insertion of the cystic duct or the increase of its length with a parallel arrangement with the common bile duct. It may be possible to better visualize the dilatation of the proximal common hepatic duct and the same of normal caliber distal to the obstruction, as well as those previously mentioned in the other diagnostic modalities. It is also possible to find concomitant acute cholecystitis in up to 80% of cases (8,48,49).

Torsion or vesicular volvulus

This pathology is an unusual cause of acute abdomen and does not yet have a well-established etiology; however, it represents a diagnostic challenge because of its non-specific manifestations can be attributed to other entities, but it requires a quick action since its definitive therapeutic behavior is surgical and seeks to release the torsion to avoid catastrophic consequences in the patient with abdominal pain, such as necrosis and gangrene. Since its description by the surgeon Wendel in 1898, it has been seen that there are predisposing anatomic causes related to the mesentery, of which it is known that it may only be supporting the cystic duct; this allows the vesicle to hang freely thus giving the classic appearance known as "floating vesicle" or simply being a lax mesentery prone to torsion. This is a more open slope of the gallbladder that, in association with factors of the affected patients, such as cholelithiasis, in 20 to 30% of cases, weight loss, loss of visceral fat and elasticity, hepatic atrophy, deformities of the vertebral column, such as kyphoscoliosis, congenital anomalies of development, atherosclerosis and tortuosity of the cystic duct, make up the group of trigger factors that give the possibility of the organ

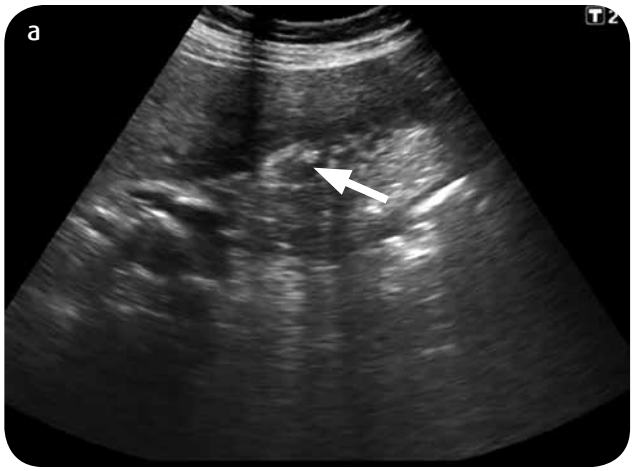
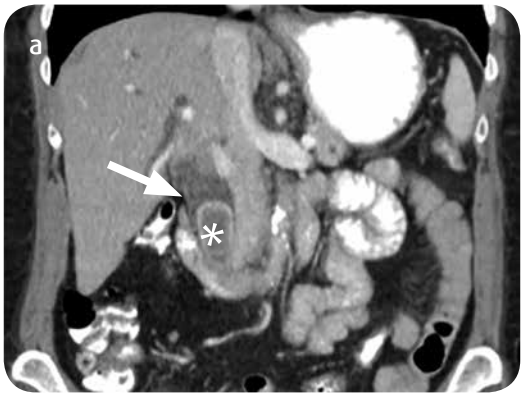


Figure 7. a and b) A 54-year-old woman with a history of cholecystectomy, with abdominal pain, fever, and leukocytosis. In the ultrasound, multiple echogenic images of perihepatic location are visualized, which generate posterior acoustic shadow (arrows).



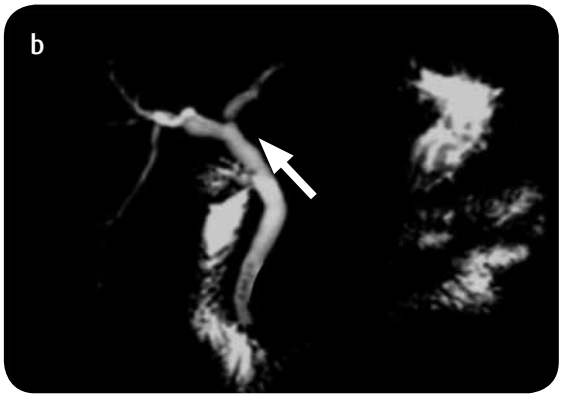


Figure 8. a) CT coronal reconstruction of a patient with icteric syndrome: dilatation of the extrahepatic biliary tract (arrow) is observed with a gallstone in the distal common bile duct (asterisk). b) Cholangiorresonance, 3D reconstruction of another patient with multiple gallstones in the distal bile duct (arrow).

Figure 9. Male patient with abdominal pain in the right hypochondrium of 4 days of evolution, fever and leukocytosis. US: Distended gallbladder with multiple gallstones and biliary mud, with loss of definition of the wall and perivesicular laminar fluid (arrow).

turning on its axis. In this review of the literature we find that these conditions are widely discussed by the authors and are not exclusive, but they can probably be seen in combination in older adult women, the population most affected, specifically between the sixth and eighth decades of life.

Classically, the torsion has been classified as complete when there is a rotation of more than 180° which differs from the incomplete one of less than 180° of rotation, due to its involvement of both vascular and biliary ducts, leading to necrosis. Imaging findings for the diagnosis include ultrasound, such as hidrocolecyst, signs of acute cholecystitis with a continuous hypoechoic line, which indicates edema and explains the thickening of the wall; a mobile vesicle in the vesicular bed is described as floating, with or without gallstones in it, and is more specific outside its normal fossa, in a position inferior to the liver or in a transverse orientation, with an echogenic conical structure representing twisting of your pedicle. CT findings are less specific, in which the pathology is suspected if the enlarged gallbladder is found with unusual shape and contours. MRI may be an option in preoperative diagnosis. It shows images with high signal intensity within the vesicular wall in T1-weighted studies, suggesting complications such as necrosis and hemorrhage that, together with the patient's clinical condition, indicate the diagnosis of complete vesicular torsion (50-53).

Conclusions

There are multiple modalities of diagnostic images that are fundamental for the assessment of patients with biliary pathology in which there is clinical uncertainty in their initial or postoperative presentation. Ultrasound is usually the tool used in the initial approach of a patient with abdominal pain in the upper right quadrant when lithiasis of the bile duct is presumed to be a major cause or, in certain cases, in search of complications potential of their surgical approaches or interventional radiology. CT and MRI better characterize findings and complications in cases where ultrasound diagnosis is limited. Due to the above, the timely and accurate diagnosis of cholelithiasis and its potential or already established complications is paramount, since adequate and definitive therapy may be significant in the clinical outcome of the patient and in the reduction of morbidity and mortality rates.

References

1. Bennet GL, Balthazar EJ. Ultrasound and CT evaluation of emergent Bennet GL, Balthazar EJ. Ultrasound and CT evaluation of emergent gallbladder pathology. Radiol Clin North Am. 2003;41(6):1203-16.
2. Hanbidge AE, Buckler PM, O'Malley ME, Wilson SR. From the RSNA refresher courses: imaging evaluation for acute pain in the right upper quadrant. Radiographics. 2004;24(4):1117-35.
3. Rubens DJ. Hepatobiliary imaging and its pitfalls. Radiol Clin North Am. 2004;42(2):257-78.
4. Shaffer EA. Gallstone disease: epidemiology of gallbladder stone disease. Best Pract Res Clin Gastroenterol. 2006;20(6):981-96.
5. Anderson SW, Lucey BC, Varghese JC, Soto JA. Accuracy of MDCT in the diagnosis of choledocholithiasis. AJR Am J Roengenol. 2006;187(1):174-80.
6. Sonmez G, Ozturk E, Mutlu H, Sildiroglu O, Basekim C, Kizilkaya E. Education and imaging. Hepatobiliary and pancreatic: emphysematous cholecystitis. J Gastroenterol Hepatol. 2007;22(11):2035.
7. Ash-Miles J, Roach H, Virjee J, Callaway M. More than just stones: a pictorial review of common and less common gallbladder pathologies. Curr Probl Diagn Radiol. 2008;37(5):189-202.
8. Smith EA, Dillman JR, Elsayes KM, Menias CO, Bude RO. Cross-sectional imaging of acute and chronic gallbladder inflammatory disease. AJR Am J Roentgenol. 2009;192(1):188-96.
9. Stinton LM, Myers RP, Shaffer EA. Epidemiology of gallstones. Gastroenterol Clin North Am. 2010;39(2):157-69.
10. Gore RM, Thakrar KH, Newmark GM, Mehta UK, Berlin JW. Gallbladder Imaging. Gastroenterol Clin N Am. 2010;39(2):265-87.
11. Shakespear JS, Shaaban AM, Rezvani M. CT Findings of acute cholecystitis and its complications. AJR Am J Roentgenol. 2010;194(6):1523-9.
12. O'Connor OJ, Maher MM. Imaging of cholecystitis. AJR Am J Roentgenol. 2011;196(4):W367-74.
13. Charalel RA, Jeffrey RB, Shin LK. Complicated cholecystitis: the complementary roles of sonography and computed tomography. Ultrasound Q. 2011;27(3):161-70.
14. Pinto A, Reginelli A, Cagini L, Coppolino F, Stabile Ianora AA, Bracale R, Giganti M, Romano L. Accuracy of ultrasonography in the diagnosis of acute calculous cholecystitis: review of the literature. Crit Ultrasound J. 2013;5(Suppl 1):S11.
15. Sutijono D, Declerck M. Point-of-care ultrasound diagnosis of a post-cholecystectomy abscess. J Emerg Med. 2013;44(5):e359-60.
16. Gallagher TK, Parks RW. Gallstones. Surgery. 2014;32(12):635-42.
17. Caffaso DE, Smith RR. Symptomatic cholelithiasis and functional disorders of the biliary tract. Surg Clin North Am. 2014;94(2):233-56.
18. Luu MB, Deziel DJ. Unusual complications of gallstones. Surg Clin North Am. 2014;94(2):377-94.
19. Knab LM, Boller AM, Mahvi DM. Cholecystitis. Surg Clin North Am. 2014;94(2):455-70.
20. Noble F, Johnson C. Gallstones. Medicine. 2015;43(11):689-93.
21. Bennet GL. Evaluating patients with right upper quadrant pain. RadiolClin North Am. 2015; 53(6): 1093-130.
22. Mirizzi PL. Síndrome del conducto hepático. J Int Chir. 1948;8:731-77.
23. Zaliekas J, Munson JL. Complications of gallstones: The Mirizzi syndrome, gallstone ileus, gallstone pancreatitis, complications of "lost" gallstones. SurgClin North Am. 2008;88:1345-68.
24. Seyal AR, Parekh K, Gonzalez-Guindalini FD, Nikolaidis P, Miller FH, Yaghmai V. Cross-sectional imaging of perforated gallbladder. Abdom Imaging. 2014;39(4):853-74.
25. Thurley PD, Dhingsa R. Laparoscopic cholecystectomy: postoperative imaging. AJR Am J Roentgenol. 2008;191:794-801.
26. Gill KS, Chapman AH, Weston MJ. The changing face of emphysematous cholecystitis. Br J Radiol. 1997;70:986-91.
27. Abou-Saif A, Al-Kawas FH. Complications of gallstone disease: Mirizzi syndrome, cholecystocholedochal fistula, and gallstone ileus. Am J Gastroenterol. 2002;97(2):249-54.
28. Lohan D, Walsh S, McLoughlin R, Murphy J. Imaging of the complications of laparoscopic cholecystectomy. Eur Radiol. 2005;15(5):904-12.
29. Choi JY, Kim MJ, Park MS, Kim JH, Lim JS, Oh YT, Kim KW. Imaging findings of biliary and nonbiliary complications following laparoscopic surgery. Eur Radiol. 2006;16(9):1906-14.
30. Watanabe Y, Nagayama M, Okumura A, Amoh Y, Katsube T, Suga T, Koyama S, Nakatani K, Dodo Y. MR imaging of acute biliary disorders. Radiographics. 2007;27(2):477-95.
31. Greenfield NP, Azziz AS, Jung AJ, Yeh BM, Aslam R, Coakley FV. Imaging late complications of cholecystectomy. Clin Imaging. 2012;36(6):763-7.
32. Ramamurthy NK, Rudralingam V, Martin DF, Galloway SW, Sukumar SA. Out of sight but kept in mind: complications and imitations of dropped gallstones. AJR Am J Roentgenol. 2013;200(6):1244-53.
33. Patel NB, Oto A, Thomas S. Multidetector CT of emergent biliary pathologic conditions. Radiographics. 2013;33(7):1867-88.
34. Wigham A, Alexander Grant L. Radiologic assessment of hepatobiliary surgical complications. Semin Ultrasound CT MR. 2013;34(1):18-31.
35. Desai NS, Khandelwal A, Virmani V, Kwatra NS, Ricci JA, Saboo SS. Imaging in laparoscopic cholecystectomy: what a radiologist needs to know. Eur J Radiol. 2014;83(6):867-79.
36. Smereczyński A, Starzyńska T, Kołaczyk K, Kładny J. Role of sonography in assessing complications after laparoscopic cholecystectomy. J Ultrason. 2014;14(57):152-62.
37. Chawla A, Bosco JI, Lim TC, Srinivasan S, Teh H, Shenoy JN. Imaging of acute cholecystitis and cholecystitis-associated complications in the emergency setting. Singapore Med J. 2015;56(8):438-43.
38. Revzin MV, Scoutt L, Smitaman E, Israel GM. The gallbladder: uncommon gallbladder conditions and unusual presentations of the common gallbladder pathological processes. Abdom Imaging. 2015;40(2):385-99.
39. Weltman DI, Zeman RK. Acute diseases of the gall- bladder and biliary ducts. Radiol Clin North Am. 1994;32:933-50.
40. Paulson EK. Acute cholecystitis: CT findings. Semin Ultrasound CT MR. 2000;21:56-63.

41. Bortoff GA, Chen MY, Ott DJ, Wolfman NT, Routh WD. Gallbladder stones: imaging and intervention. Radiographics. 2000;20(3):751-66.
42. Kalloo AN, Kantsevoy SV. Gallstones and biliary disease. Prim Care. 2001;28(3):591-606.
43. Ahmad M, Cheung RC, Keeffe EB, Ahmed A. Differential diagnosis of gallstone-induced complications. South Med J. 2000;93(3):261-4.
44. Ahmed A, Cheung RC, Keeffe EB. Management of gallstones and their complications. Am Fam Physician. 2000;61(6):1673-80, 1687-8.
45. Lee JY, Keane MG, Pereira S. Diagnosis and treatment of gallstone disease. Practitioner. 2015;259(1783):15-9, 2.
46. Costi R, Gnocchi A, Di Mario F, Sarli L. Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy. World J Gastroenterol. 2014;20(37):13382-401.
47. Gore RM, Yaghmai V, Newmark GM, Berlin JW, Miller FH. Imaging benign and malignant disease of the gallbladder. Radiol Clin North Am. 2002;40(6):1307-23.
48. Privette TW Jr, Carlisle MC, Palma JK. Emergencies of the liver, gallbladder, and pancreas. Emerg Med Clin North Am. 2011;29(2):293-317.
49. Morris BS, Balpande PR, Morani AC, Chaudhary RK, Maheshwari M, Raut AA. The CT appearances of gallbladder perforation. Br J Radiol. 2007;80(959):898-901.
50. Schirmer BD, Winters KL, Edlich RF. Cholelithiasis and cholecystitis. J Long Term Eff Med Implants. 2005;15(3):329-38.
51. Shaikh AA, Charles A, Domingo S, Schaub G. Gallbladder volvulus: report of two original cases and review of the literature. Am Surg. 2005;71(1):87-9.
52. Nakao A, et al. Gallbladder torsion: case report and review of 245 cases reported in the Japanese literature. J Hepatobiliary Páncreas Surg. 1999;6(4):418-21.
53. Tarhan OR, Barut I, Dinelek H. Gallblader Volvulus: review of the literature and report of a case. Turk J Gastroenterol. 2006;17(3):2009-11.

Correspondence

Luis Fernando Aleán Argueta
Hospital Universitario San Ignacio
Carrera 7 # 40-62
Bogotá, Colombia
luis899@gmail.com

Received for evaluation: April 1, 2017
Accepted for publication: May 18,2017