2 Emergencies of the Biliary Tract

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Gallbladder is seen as an anechoic structure with wall thickness of less than 3 mm on ultrasound imaging. The normal common bile duct caliber is up to 5 mm in young adults, and it progressively increases with age, at the rate of 1 mm for each decade above 40 years. The intrahepatic ducts should not be more than 2 mm in diameter (not more than 40 % of the caliber of the accompanying portal vein branch).

Gallstones are seen in up to 10 % of the population, most commonly in middle-aged and elderly females. While majority of gallstones have cholesterol as the main component, a minority of stones are constituted by calcium bilirubinate and are called pigment stones. Ten to twenty percent of the gallstones contain enough calcium to be visible on plain radiograph (Fig. 2.1a). The stones are most commonly multiple and sometimes faceted. A triradiate collection of nitrogen gas within the fissures inside the gallstone produces Mercedes-Benz sign (Fig. 2.1b and c).

Typically, gallstones are seen as echogenic foci with clean distal acoustic shadowing (Fig. 2.1d). *Wall echo shadow sign* refers to the parallel echogenic lines produced by a combination of the gallbladder wall, echogenic stone, and associated distal acoustic shadowing (Fig. 2.1e). The hypoechoic line seen between the two echogenic lines represents interposed bile. This sign is seen in gallbladder filled with either a single large gallstone or multiple small gallstones. Ultrasound has higher sensitivity than CT in diagnosing gallstones and is therefore the screening modality of choice. Although ultrasound remains the exam of choice for suspected cholecystitis, there are ever more cases of acute cholecystitis being detected today with CT in the evaluation of abdominal pain than in the past.

Majority of the patients with gallstones are asymptomatic. Sometimes the gallstone can cause transient gallbladder outflow obstruction, leading to biliary colic. Biliary colic patients present with transient pain for 1–3 h with nausea and vomiting. The symptoms subside when the gallstone falls back into the gallbladder or passes distally into the biliary tree.

Acute Cholecystitis

Acute cholecystitis usually is caused by the gallstone obstruction of the cystic duct or the gallbladder neck (one-third of cases). Acute cholecystitis without stones (5–10 % of cases) can be seen in patients with adenomyomatosis, gallbladder polyp, and malignant neoplasm [1, 2]. The predisposing factors for acute acalculous cholecystitis include history of trauma, mechanical ventilation, hyperalimentation, postoperative/postpartum state, diabetes mellitus, vascular insufficiency, prolonged fasting, and burns [2].

The clinical presentation includes right upper quadrant pain for more than 6 h (vs. biliary colic), nausea, vomiting, and fever in a patient with history of gallstones. No clinical or lab finding provides high enough positive predictive value in making the diagnosis of acute cholecystitis.

Imaging

Ultrasound is the first-line imaging modality in diagnosing acute cholecystitis because of wide availability, ability to detect gallstones as well as biliary ducts, and accuracy in diagnosing acute cholecystitis. The ultrasound findings of acute cholecystitis include gallbladder wall thickening (>3 mm), gallbladder distension (>5 cm transverse dimension), and positive Murphy's sign (Fig. 2.2) [1, 3]. Sonographic Murphy's sign by itself does not have a high

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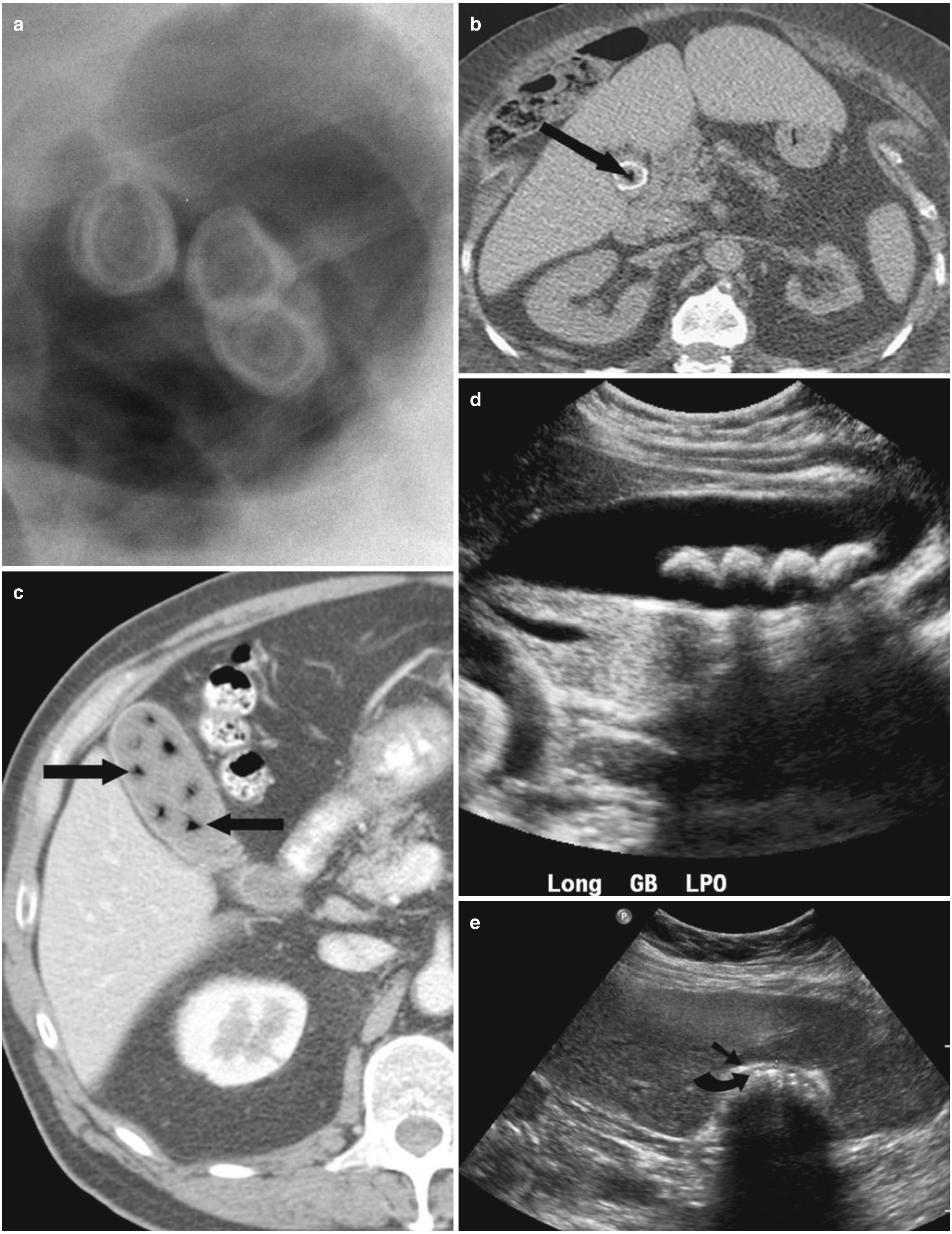
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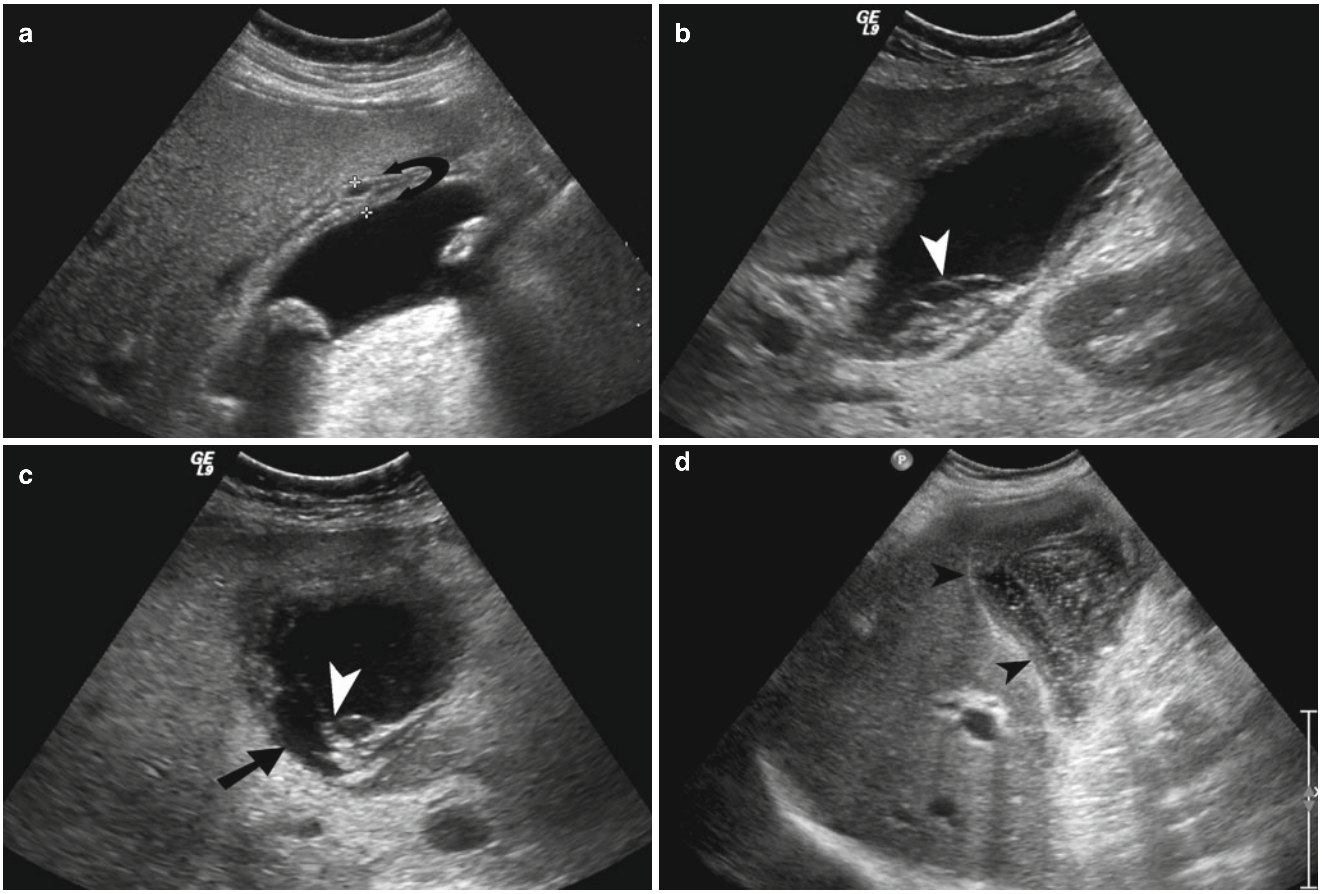

Fig. 2.2 Ultrasound imaging of acute cholecystitis. (**a**) Ultrasound in a patient with acute cholecystitis demonstrates multiple gallstones and striated thickening of the gallbladder wall (*arrow*). (**b** and **c**) Ultrasound in a patient with gangrenous cholecystitis demonstrates striated thickening of the gallbladder wall, intraluminal sludge, and sloughed mucosa (*arrowhead*). Focal thinning of the necrotic gallbladder is indicated by the *straight arrow* and appears to represent the donor site for the sloughed-off mucosa. (**d**) Ultrasound in a patient with acute cholecystitis shows gallbladder wall thickening (*arrowheads*) and complex fluid, which represented pus during cholecystostomy tube placement

positive predictive value and can be falsely negative in patients who have received analgesic medication. Another imaging finding of acute cholecystitis is the presence of a pericholecystic fluid collection, sometimes extending to the perihepatic space [2, 4].

Gallbladder wall thickening is a finding of acute cholecystitis which can also be seen in other conditions such as hypoproteinemia, ascites, pancreatitis, right heart failure, renal failure, liver failure, and hepatitis. Striated gallbladder wall thickening is no more specific for acute cholecystitis than the observation of gallbladder wall thickening from other causes. In the clinical setting of acute cholecystitis, the presence of striated gallbladder wall thickening suggests gangrenous cholecystitis.

Cholescintigraphy (HIDA scan) is considered second-line imaging modality which can be used after equivocal ultrasound study. Cholescintigraphy has a sensitivity and specificity which is superior to ultrasound. Although it may take more than 2 h to complete the study, the use of morphine (0.04 mg/kg) allows cholescintigraphy to be completed in 1.5 h. The classic findings on cholescintigraphy include nonvisualization of the gallbladder 30 min after morphine injection and presence of a curvilinear area of increased

Fig. 2.1 Imaging appearance of gallstones on plain radiograph and ultrasound. (**a**) Plain radiograph demonstrates laminated radiopaque gallstones in the *right upper quadrant*. Up to a fifth of the gallstones can be seen on plain radiograph of the abdomen. (**b** and **c**) Noncontrast CT of the gallbladder shows gallstones with Mercedes-Benz sign (*arrows*). Mercedes-Benz sign is due to nitrogen collection in triradiate configuration, within fissures of a gallstone. (**d**) Ultrasound shows multiple echogenic gallstones with distal acoustic shadowing, within the gallbladder lumen. (**e**) Ultrasound shows wall echo shadow sign in a patient with multiple gallstones and chronic cholecystitis. The outer echogenic line (*straight arrow*) represents the gallbladder wall, while the inner echogenic line (*curved arrow*) represents the outer edge of gallstones

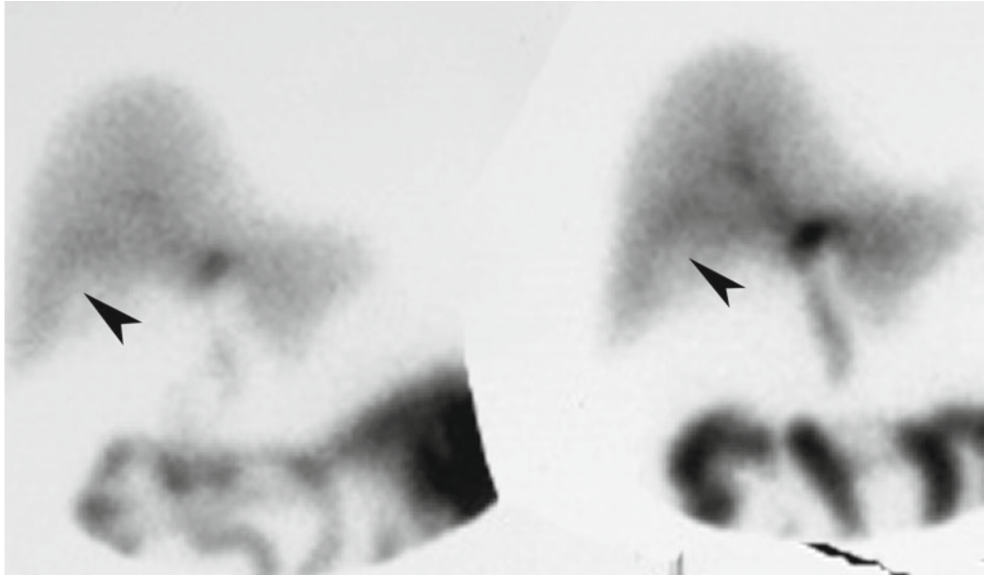

Fig. 2.3 Gangrenous cholecystitis on cholescintigraphy. Cholescintigraphy study (HIDA scan) demonstrates nonvisualization of the gallbladder and a curvilinear area of increased radiotracer activity (*rim sign*) in the pericholecystitic liver parenchyma (*arrowheads*)

radiotracer activity (rim sign) in the liver adjacent to the gallbladder (Fig. 2.3). Rim sign is most commonly seen in patients with gangrenous cholecystitis and is due to extension of inflammation beyond the gallbladder.

If ultrasound and/or cholescintigraphy show no evidence of acute cholecystitis or any other cause for the right upper quadrant pain, a contrast-enhanced CT is considered the next most appropriate imaging modality. The CT findings include gallstones, gallbladder wall thickening, gallbladder wall enhancement, increased bile attenuation (possibly indicative to empyema), distended gallbladder, and pericholecystic fluid collection (Table 2.1; Fig. 2.4) [5]. CT has lower sensitivity than US in detecting gallstones and can miss noncalcified gallstones.

Table 2.1 CT findings of acute cholecystitis

Thickening of the gallbladder wall (normal wall thickness is up to 3–4 mm)
Gallstones
Gallbladder distention (>5 cm in transverse dimension)
Pericholecystic fluid
Indistinct interface between the gallbladder wall and the liver
Pericholecystic inflammatory changes
Transient focal attenuation difference
Increased density bile

MR imaging is not a frontline imaging modality for acute cholecystitis and can be used after equivocal US study. The advantage of MR over CT is its ability to reliably study

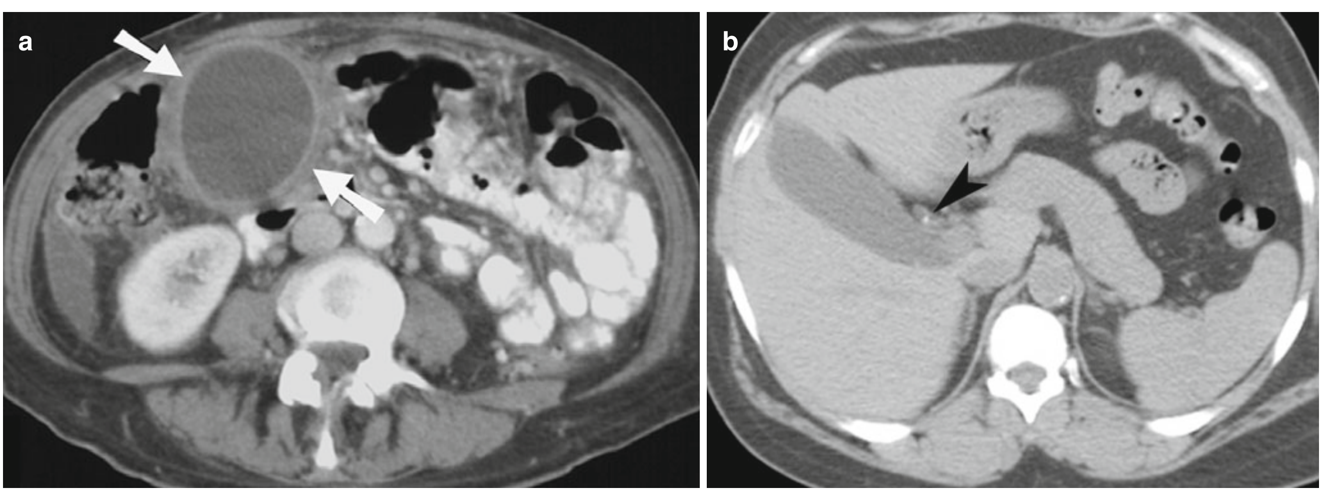

Fig. 2.4 CT findings of acute cholecystitis. (**a**) Contrast-enhanced CT shows distended gallbladder with wall thickening (*arrows*) and pericholecystic inflammatory changes. (**b**) Contrast-enhanced CT shows small calculus (*arrowhead*) causing cystic duct obstruction

common bile duct and the lack of ionizing radiation which is especially important in pregnant population. Although, gadolinium is useful in making the diagnosis of acute cholecystitis, it should not be used in pregnant population. The important findings of cholecystitis on MR imaging are described in Table 2.2 (Fig. 2.5).

The complications of acute cholecystitis include gallbladder empyema, gangrenous cholecystitis, emphysematous cholecystitis, gallbladder perforation, Mirizzi syndrome, and gallstone ileus.

Mirizzi Syndrome

The obstruction of the common bile duct or common hepatic duct by calculus impacted in the Hartmann's pouch or cystic duct constitutes Mirizzi syndrome (Fig. 2.6). Mirizzi syndrome or choledocholithiases should be suspected whenever there is elevated bilirubin level along with clinical symptoms of acute cholecystitis.

Table 2.2 MR findings of acute cholecystitis

Gallbladder empyema	Low-signal intensity on T2 and high-signal intensity on T1 WI
Gallstones	Signal void on MRCP and low signal on T1–T2 WI
Gallbladder wall thickening	Enhancing wall and high signal on T1 and low to high on T2 WI
Gas within the gallbladder wall	Signal void in the wall
Pericholecystic inflammation	High intensity on T1 and T2 WI
Hemorrhage	High intensity on T1 and T2 WI
Fluid collection	High intensity on T1 and T2 WI

Empyema

It is also called suppurative cholecystitis and occurs typically in diabetic patients, when the bile becomes infected and pus fills the distended gallbladder [1]. On imaging, gallbladder empyema is manifested as gallbladder distension, wall thickening, pericholecystic fluid accumulation, intraluminal sludge/pus, and intraluminal air (Fig. 2.7).

Gangrenous Cholecystitis

It is an advanced form of acute cholecystitis, most frequently seen in elderly men. It is characterized by increased intraluminal pressure, gallbladder distension, gallbladder wall necrosis, intramural hemorrhage, and abscess formation (Fig. 2.8) [1, 2]. There is an increased association of gangrenous cholecystitis with cardiovascular disease and leukocytosis of more than 17,000 WBC/mL. Although CT is highly specific (>90 %) in identifying patients with acute gangrenous cholecystitis, it is not very sensitive (Table 2.3).

Once gangrenous cholecystitis is suspected, the patients require emergency cholecystectomy or cholecystostomy to avoid life-threatening complications. These patients frequently require an open surgical procedure rather than laparoscopic cholecystectomy.

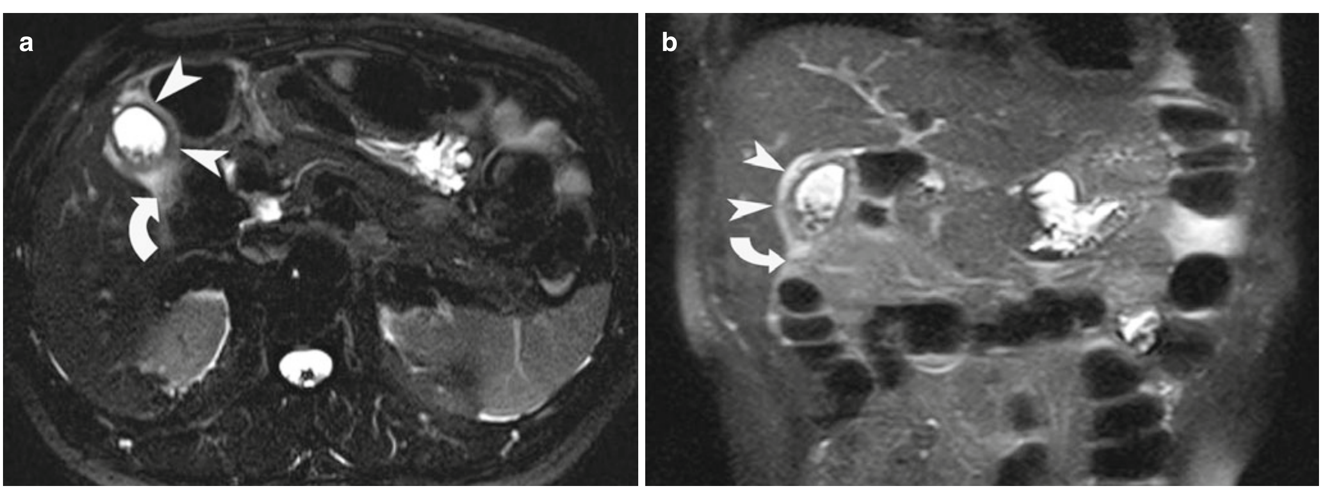

Fig. 2.5 MR findings of acute cholecystitis. (**a** and **b**) HASTE sequence shows gallbladder wall thickening (*arrowheads*), increased signal intensity (*curved arrows*), and multiple small gallstones. HASTE is a high-speed, heavily T2-weighted sequence with partial Fourier technique which has high sensitivity for fluid and a fast acquisition time (<1 s/slice)

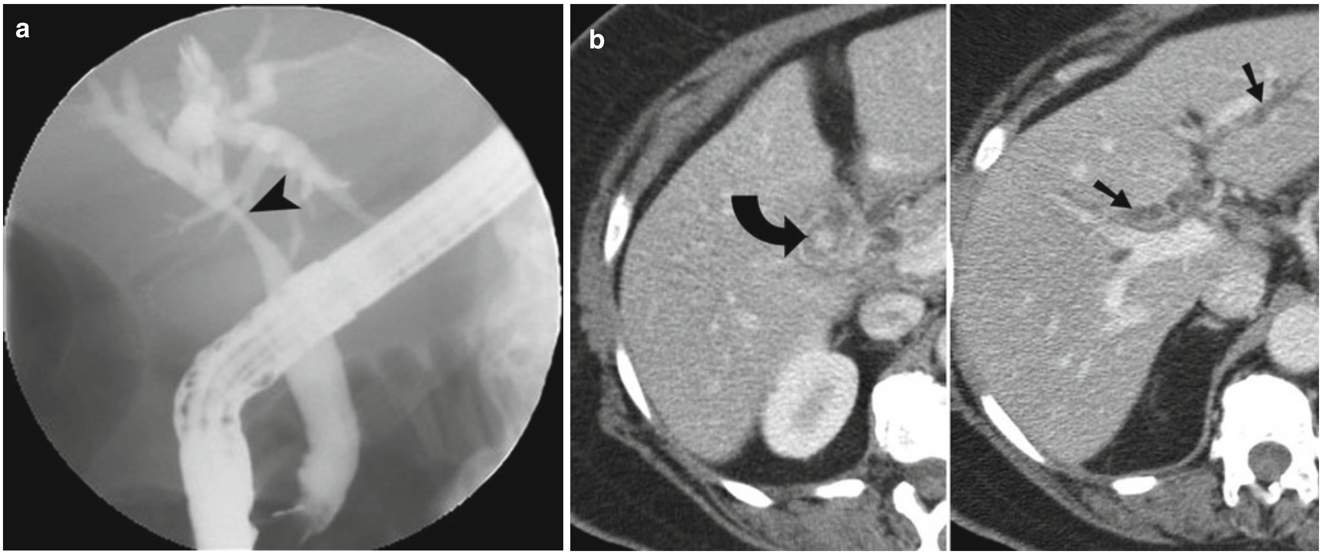

Fig. 2.6 Mirizzi syndrome. (**a**) ERCP demonstrates narrowing of the proximal CBD (*arrowhead*) due to extrinsic impression produced by calculus in the gallbladder neck. (**b**) Contrast-enhanced CT shows the calculus (*curved arrow*) in the gallbladder neck with secondary inflammation causing intrahepatic biliary ductal dilatation (*arrows*)

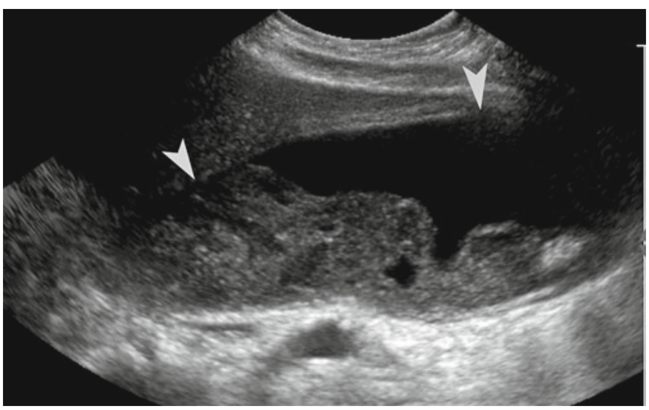

Fig. 2.7 Gallbladder empyema. Ultrasound shows marked distention (*arrowheads*) of the gallbladder lumen and intraluminal debris in a patient with gallbladder empyema

Table 2.3 CT findings of gangrenous cholecystitis

Gas in the gallbladder wall or lumen
Intraluminal membranes
Irregularity of wall
Pericholecystic abscess
Lack of mural enhancement
Greater degree of gallbladder distention and wall thickening

Emphysematous Cholecystitis

This is a rare life-threatening complication of acute cholecystitis and is characterized by gas within the gallbladder wall and/or lumen due to gas-forming bacteria. It has high mortality, especially when the diagnosis is missed. On ultrasound, gas can be recognized by the presence of dirty distal

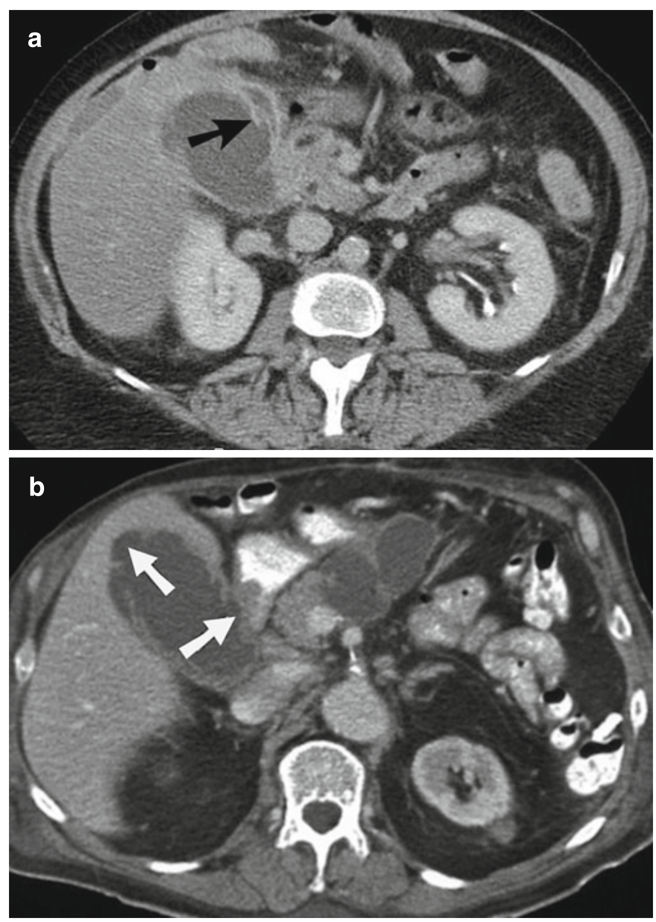

Fig. 2.8 Gangrenous cholecystitis. (**a** and **b**) Contrast-enhanced CT scan in two patients with gangrenous cholecystitis shows irregularity (*arrows*) of the gallbladder wall, gallbladder wall thickening, and pericholecystic inflammation

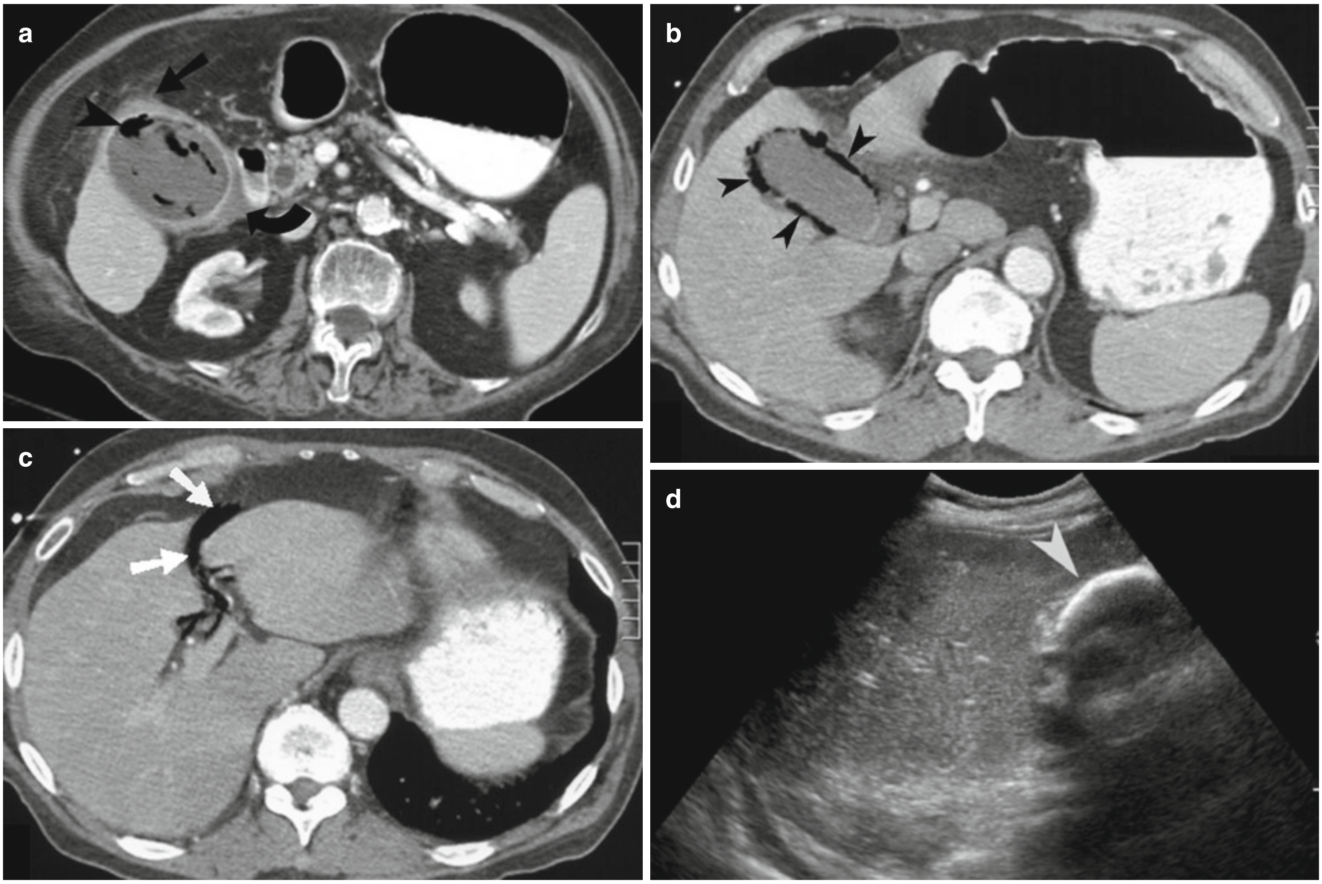

Fig. 2.9 Emphysematous cholecystitis. (**a**) Contrast-enhanced CT scan shows pericholecystic inflammation (*straight arrow*), pericholecystic fluid (*curved arrow*), and air within the gallbladder lumen (*arrowhead*). There was no air seen in the gallbladder on a previous CT study. (**b** and **c**) Contrast-enhanced CT shows air (*arrowheads*) in the wall of the gallbladder. Air is also seen to track along the ligamentum teres (*straight arrows*), indicating the presence of concomitant perforation. (**d**) Ultrasound demonstrates echogenic air (*arrowhead*) with dirty distal acoustic shadowing in the gallbladder lumen

acoustic shadowing. CT reliably allows distinction of gallbladder wall gas from porcelain gallbladder (Fig. 2.9).

Perforation

This is usually a complication of acute gangrenous cholecystitis and is associated with a high mortality of 19–24 % [1, 2]. It can be associated with generalized peritonitis, pericholecystic abscess, and cholecystoenteric fistula (chronic perforation).

The most common site of the gallbladder perforation is the fundus. These patients can develop pericholecystic or intrahepatic abscesses, cholecystoenteric fistulas, or biliary peritonitis. The CT findings of gallbladder perforation include gallbladder wall defect/bulge, streaky densities in the omentum or mesentery, pericholecystic fluid collection, and striated appearance of the gallbladder wall (Fig. 2.10).

The definitive treatment for gallbladder perforation is cholecystectomy (surgical or laparoscopic).

Gallbladder Torsion

It is characterized by acalculous cholecystitis and is most commonly seen in elderly women. A long or absent mesentery leading to abnormal mobility of the gallbladder predisposes to rotation of the gallbladder along its axis. If the torsion of gallbladder is partial (<180°), it leads to cystic duct obstruction. If the gallbladder torsion is complete (>180°), it leads to interruption of blood flow, leading to ischemia and gangrene.

On US, there is enlargement of the gallbladder which is abnormally oriented, with thickened wall and intramural or intraluminal gas due to gangrene [2].

Biliary Ductal Obstruction

Jaundice secondary to biliary obstruction is associated with pain, nausea, and vomiting. CT is the first-line imaging modality whenever malignancy is suspected as the cause of

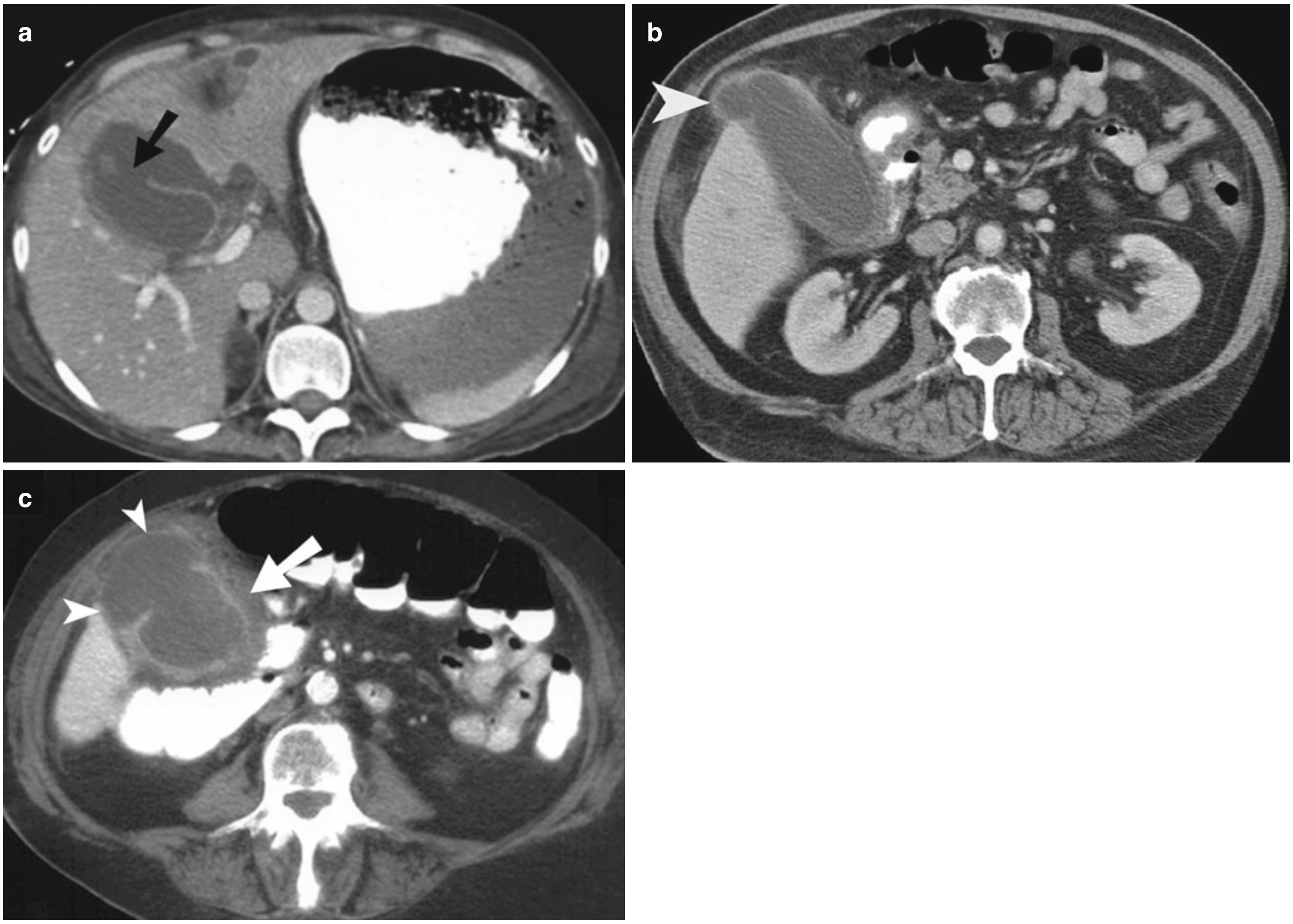

Fig. 2.10 Gallbladder perforation. (**a**) Axial contrast-enhanced CT image shows discontinuity of the gallbladder wall (*arrow*) and pericholecystic fluid. (**b**) Contrast-enhanced CT performed 3 months after cholecystostomy for acalculous cholecystitis shows CT findings of acute cholecystitis with focal perforation at the fundus (*arrowhead*). The fundal perforation was present at the site of entry of a previously placed cholecystostomy tube. (**c**) Contrast-enhanced CT demonstrates gallbladder wall perforation with intense pericholecystic inflammatory changes (*arrow*) and gallbladder wall edema. A contained perforation with bile collection (*arrowheads*) is seen anterior to the gallbladder

biliary obstruction. The most sensitive noninvasive imaging test in diagnosing choledocholithiasis is MRCP (Fig. 2.11). Therefore, it is the first-line imaging modality whenever choledocholithiasis is suspected to be the cause of biliary obstruction. Ultrasound is less effective than CT or ERCP in determining the site or cause of biliary obstruction.

Although ERCP is more expensive than other modalities, it is the first-line procedure for symptomatic choledocholithiases. The complication as well as diagnostic success rate of ERCP is lower than PTC. In patients with suspected malignant biliary obstruction and negative CT, ERCP with endoscopic ultrasound can provide cytologic diagnosis. Since ERCP has a 3 % complication rate and 0.4 % mortality rate, the use of MRCP can decrease the use of indiscriminate ERCP. ERCP is preferred when there is high likelihood of finding choledocholithiases, which requires therapeutic interventions. Percutaneous transhepatic cholangiography is useful when the obstruction is present proximally in the biliary tree. In clinical practice, PTC is most commonly performed after failed ERCP.

Percutaneous biliary decompression by catheter provides the decompression of the bile duct enlargement in patients with unresectable pancreatic head neoplasm, multifocal biliary strictures, and diffuse ductal strictures [6].

Cholangitis

Bacterial cholangitis is secondary to bile stasis, biliary ductal obstruction, and increased biliary pressure, followed by colonization by bacteria. Besides choledocholithiases, other causes of cholangitis include malignancy, sclerosing cholangitis, and biliary instrumentation.

The causes of cholangitis include bacteria, parasites, and viruses (AIDS patients). AIDS cholangiopathy is an acquired sclerosing cholangitis and is seen in patients

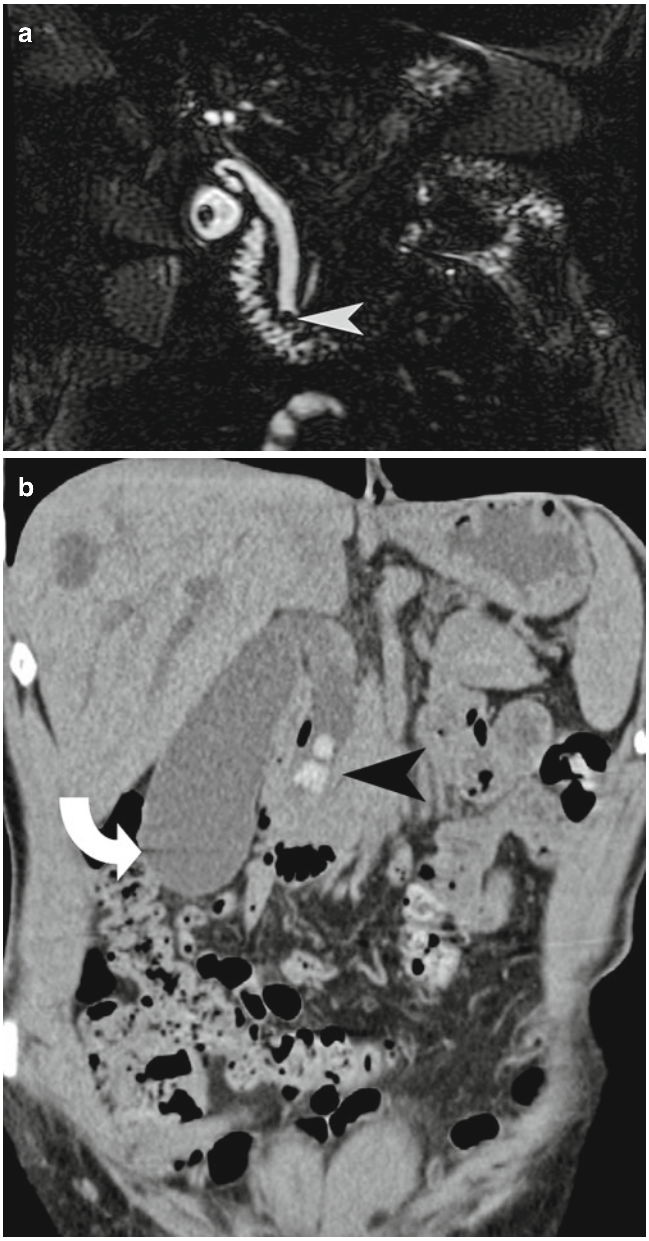

Fig. 2.11 Choledocholithiases. (**a**) MRCP shows dilatation of the CBD with choledocholithiases (*arrowhead*) at its lower end. (**b**) Coronal CT reformation shows two calculi (*arrowhead*) causing biliary obstruction at the lower end of the CBD. The gallbladder (*curved arrow*) is distended secondary to the biliary obstruction

where CD4 count is less than 100/mm^3. In posttransplant patients, bacteria (Mycobacterium avium complex), viruses (adenovirus, Cytomegalovirus, and Cryptosporidium parvum), and fungi (Candida, Microsporidium) may be the cause of cholangitis [7, 8].

The classic clinical presentation (Charcot's triad) includes fever, pain, and jaundice. In immunocompromised patients the symptoms are less typical than in immunocompetent patients.

Ultrasound is the first-line imaging tool in patients with suspected cholangitis and demonstrates biliary duct

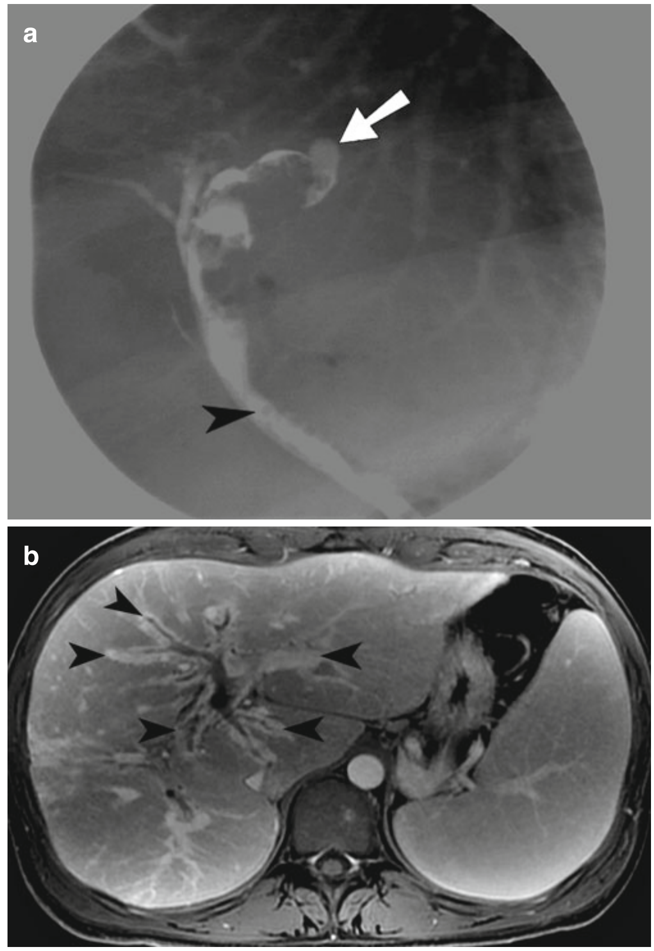

Fig. 2.12 Pyogenic cholangitis (**a**) ERCP shows irregularity of the biliary ducts, choledocholithiases (*arrowhead*), intraductal debris, and intrahepatic abscess (*arrow*). (**b**) T1-weighted gadolinium-enhanced MR shows biliary ductal dilatation and intense enhancement (*arrowheads*) of the biliary ductal wall

enlargement, biliary duct wall thickening, fluid collection, and abscess. The MR findings include increased T2 signal intensity in a wedge-shaped configuration or in the parenchyma surrounding the infected biliary ducts. Wedge-shaped, peribiliary, or patchy contrast enhancement is seen most often in the arterial phase. Patchy hepatic enhancement and bulging as well as enhancing papilla are most often associated with pyogenic cholangitis. Biliary ductal wall enhancement is a common finding and best seen on delayed postgadolinium T1-weighted images (Fig. 2.12).

The imaging findings in HIV patients are often similar to sclerosing cholangitis (Fig. 2.13). The imaging findings include intra- and extrahepatic biliary dilatation, saccular dilatations, biliary strictures, pruning, irregular thickening of the extrahepatic biliary tree wall, papillary stenosis, and cholecystitis [7].

The complications of bacterial cholangitis include sepsis, hepatic abscesses, portal vein thrombosis, biliary peritonitis,

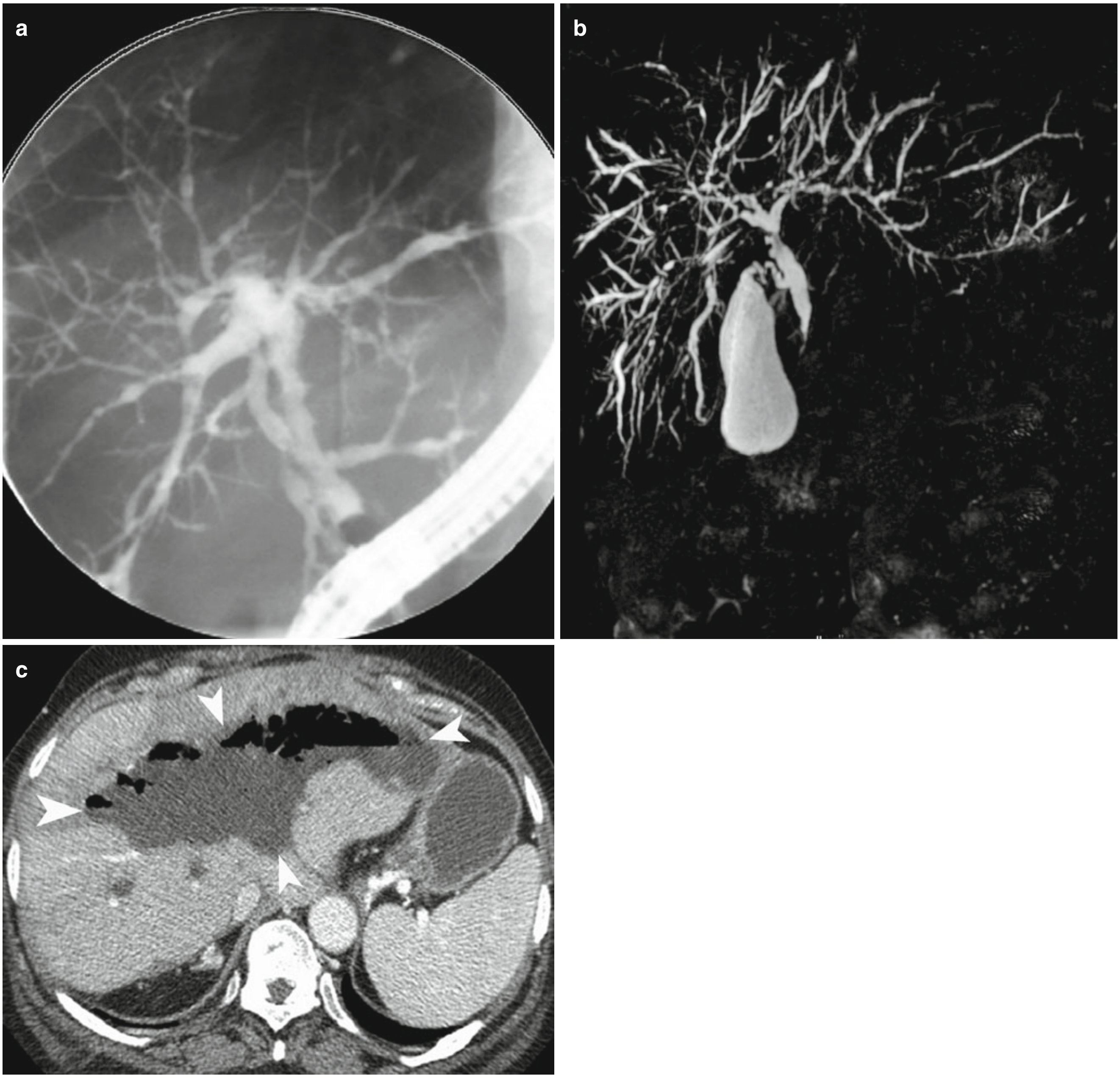

Fig. 2.13 Other biliary pathologies, including sclerosing cholangitis and biliary necrosis. (**a**) Sclerosing cholangitis. ERCP shows multiple areas of biliary dilatation, strictures, and pruning in the right as well as the left hepatic ducts. (**b**) Sclerosing cholangitis. MRCP demonstrates multiple intrahepatic biliary ductal narrowing and dilatation. (**c**) Contrast-enhanced CT in a patient with hepatic artery occlusion after liver transplant demonstrates biliary necrosis. The biliary ducts (*arrowheads*) are dilated secondary to sloughed-off ductal walls

recurrent pyogenic cholangitis, sclerosing cholangitis, and suppurative cholangitis.

Hemobilia

Hemobilia is characterized by upper gastrointestinal bleeding which originates in the biliary tree. Clinically, the classic presentation is known as Quincke's triad and is characterized by right upper quadrant pain, upper gastrointestinal bleeding, and jaundice.

The most common cause of hemobilia is blunt and penetrating abdominal trauma. The other causes include malignancy, rupture of an aneurysm, hemorrhagic cholecystitis, and blood dyscrasias (Fig. 2.14).

The imaging findings indicative of hemobilia include blood clots, appearing as filling defects in the gallbladder lumen and hemorrhagic bile, seen as altered density/signal

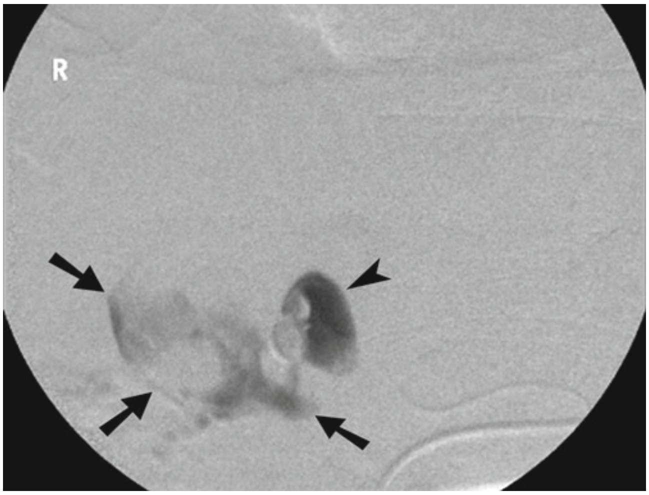

Fig. 2.14 Hemobilia. Conventional angiogram demonstrates a post-traumatic pseudoaneurysm (*arrowhead*) with active extravasation (*arrow*) of contrast. The pseudoaneurysm was subsequently embolized using endovascular coils

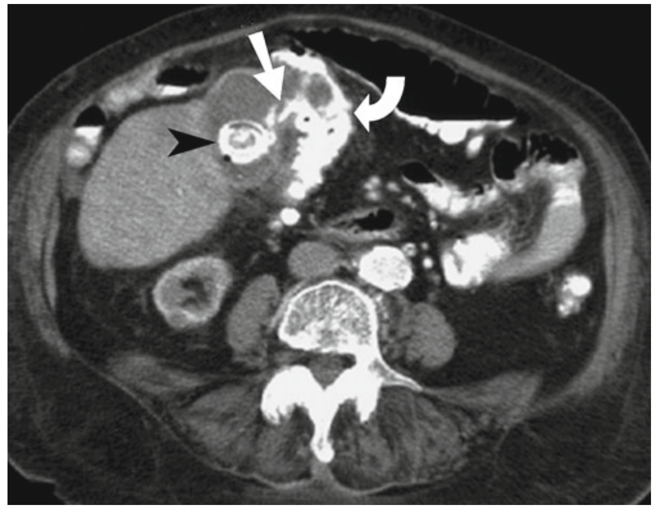

Fig. 2.15 Cholecystocolonic fistula. Axial contrast-enhanced CT image shows reflux of contrast (*straight arrow*) from the transverse colon (*curved arrow*) into the gallbladder lumen through the cholecystocolonic fistula. The gallbladder contains a gallstone (*arrowhead*) which is abutting the colonic contrast

intensity on unenhanced CT or MR imaging (increased signal on T1-weighted and decreased signal on T2-weighted images). The other findings include fluid-fluid level within the gallbladder, pseudoaneurysm, and extravasation of contrast on contrast-enhanced CT. The diagnosis can be confirmed on endoscopy or conventional angiography.

The management of hemobilia can be conservative (most common), intra-arterial embolization or surgery.

Gallstone Ileus

Gallstone ileus is the result of recurrent gallstone cholecystitis leading to a cholecystoenteric fistula formation. Gallstone ileus is most often seen in elderly females (70–75 years old; M:F 1:5) with history of gallstones [8, 9]. Although gallstone ileus overall accounts for less than 1 % of small bowel obstructions, in elderly population it may account for up to 20 % of the cases of small bowel obstruction [9, 10].

Since gallbladder is in anatomical contact with the duodenum and transverse colon, gallbladder perforation may create fistulous communication with these structures. The cholecystoduodenal fistula is the most common gallbladder fistula and allows passage of gallstone into the bowel. Although most stones will pass through the bowel without causing obstruction (85 %), the larger stones may cause small bowel obstruction (15 %) (Fig. 2.15). The most frequent site of small bowel obstruction is in the ileum because it represents the narrowest segment of the small bowel (Table 2.4). Gastric outlet or duodenal obstruction by a gallstone is rare and constitutes the Bouveret's syndrome [11].

The plain radiograph of patients with gallstone ileus may show pneumobilia (one-third of cases) and multiple air-fluid levels in small bowel loops (Fig. 2.16a). The presence of gas within the gallbladder is not always recognized on plain radiograph, and this contributes to the delay in diagnosis [12]. On ultrasound, it may be difficult to identify the gallbladder, because of the presence of air and gallbladder contraction (chronic inflammation). Ultrasound may also show bowel dilatation and rarely find the site of the bowel obstruction. However, CT better demonstrates all findings necessary to make the diagnosis. Contrast-enhanced CT in patients with gallstone ileus can show the Rigler's triad of distended small bowel loops, pneumobilia, and ectopic calcified gallstone (Fig. 2.16b–d).

Table 2.4 Sites of bowel obstruction in patients with gallstone ileus

1. Terminal ileum (60 %)
2. Proximal ileum (30 %)
3. Distal jejunum (5–10 %)
4. Colon or rectum (2–4 %)
5. Duodenum (1–3 %)

Bouveret's syndrome (duodenal or pylorus obstruction) is an uncommon type of gallstone ileus most commonly seen in elderly women where the gallstone is lodged in the duodenum or stomach (Fig. 2.16e) [13]. Pneumobilia may be present in about 30–50 % of patients with intestinal obstruction from gallstones [14]. The diagnosis of Bouveret's syndrome can be made by endoscopy (60 %), upper GI series (45 %), or abdominal radiograph (23 %). The mortality rate is approximately 12 % in recent years [13].

Intestinal obstruction in gallstone ileus typically occurs when stones larger than 2.5 cm migrate through the bowel [15]. It is recommended to obtain an early abdominal CT scan for the investigation of bowel obstruction in the elderly,

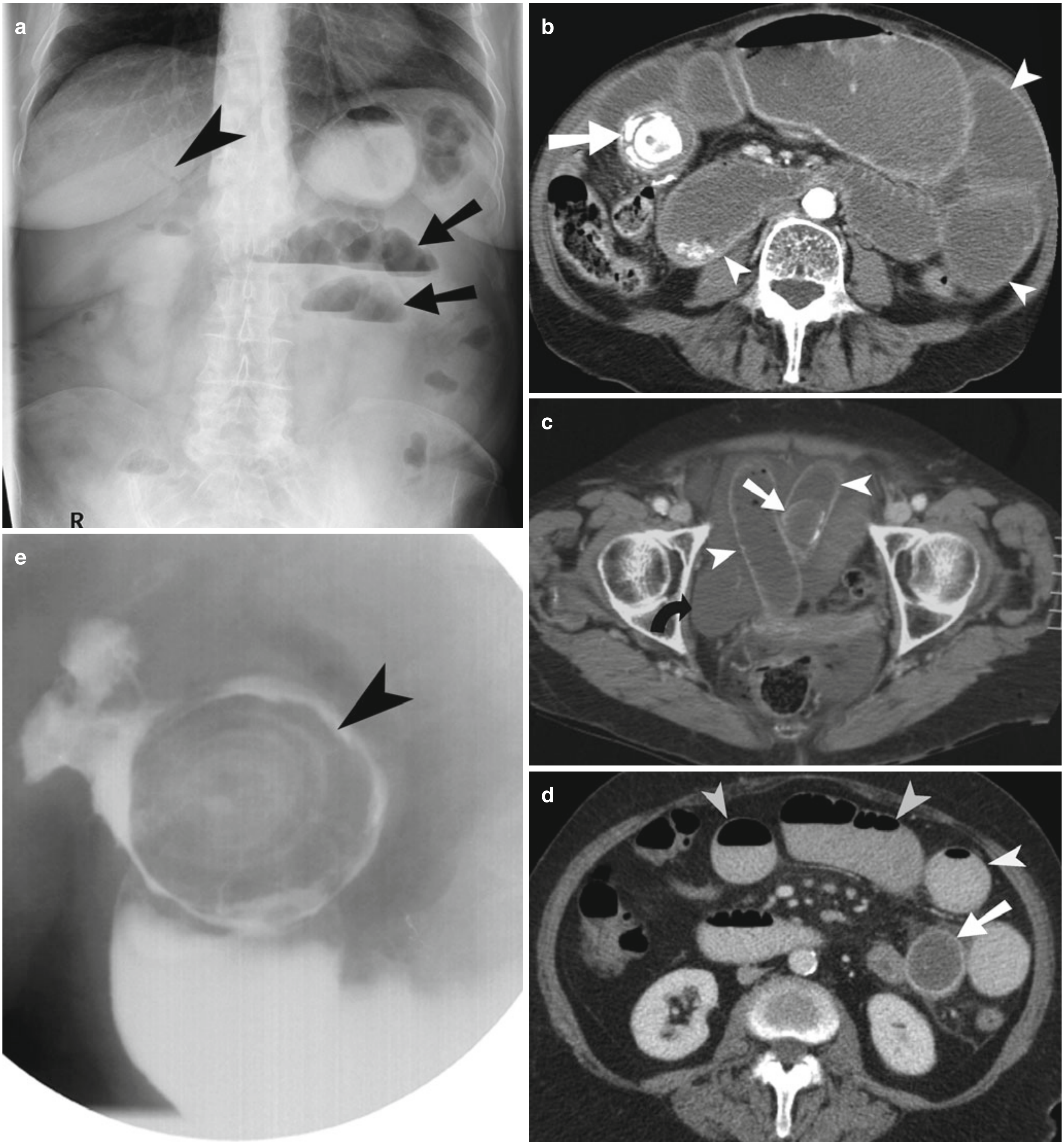

Fig. 2.16 Gallstone ileus. (**a**) Plain radiograph of a patient with gallstone ileus demonstrates pneumobilia (*arrowhead*) and multiple air-fluid levels in dilated small bowel loops (*arrows*). (**b–d**) Contrast-enhanced CT scan in three different patients with gallstone ileus demonstrates the obstructing gallstone (*arrows*) causing dilatation of small bowel loops (*arrowheads*). Free fluid (*curved arrow*) in the pelvis is identified in one of the patients. (**e**) Upper GI study in a patient with Bouveret's syndrome demonstrates a 6.8 cm gallstone (*arrowhead*) in the duodenal bulb with gastric outlet obstruction

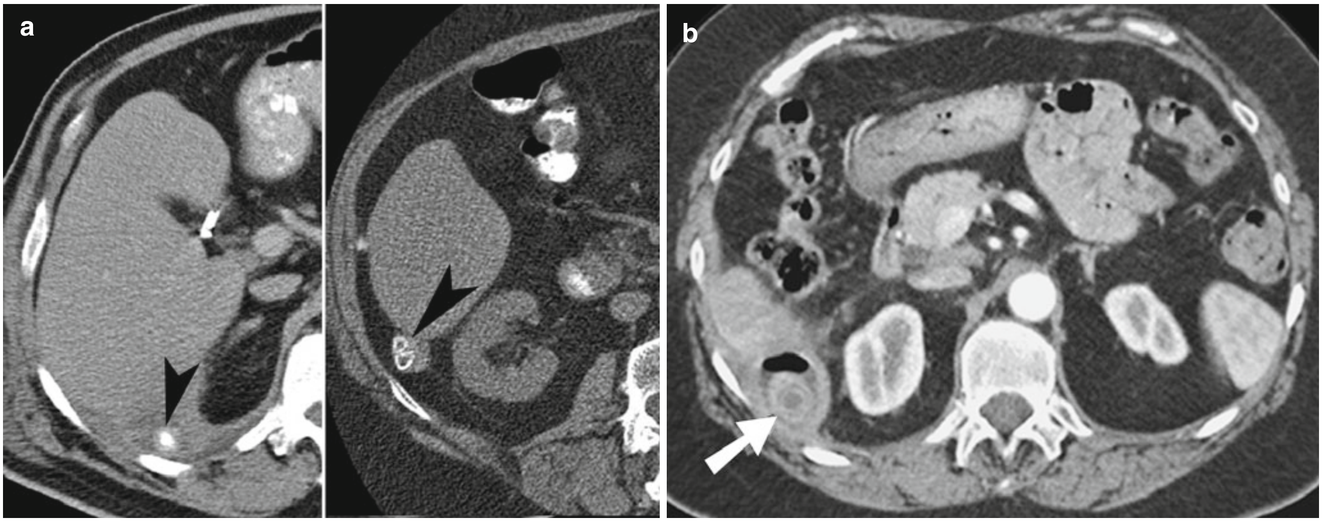

Fig. 2.17 Dropped gallstones. (**a**) Contrast-enhanced CT demonstrates dropped gallstones (*arrowheads*) incidentally detected adjacent to the caudal edge of the liver in two patients with remote history of cholecystectomy. (**b**) Contrast-enhanced CT demonstrates an abscess developing around a dropped gallstone (*arrow*) in the Morrison's pouch, in a patient where the gallstone was lost during laparoscopic cholecystectomy

as gallstone ileus is a disproportionately more common cause than in younger population [16].

Complications After Biliary Surgery

Each year, approximately 1.5 million of patients undergo cholecystectomy, and 80,000 patients undergo biliary tract surgery for various causes (obstructive jaundice or pancreaticobiliary disorders) in the USA. The complication rate of these surgeries is 14.3 % and mortality rate is 0.52 % [17].

Intraperitoneal gallstone loss is not uncommon and can occur in up to 40 % of cholecystectomies. Dropped gallstones can lead to abscess (perihepatic, pelvic, or abdominal wall) and biliary-enteric fistula formation (Fig. 2.17) [18].

On CT and ultrasonography, bilomas are invariably well demarcated, but most do not have an identifiable capsule (Fig. 2.18). Communication with ducts of Luschka (ducts that drain a portion of the right lobe of the liver) or cystic duct stump can lead to accumulation of bile in the subhepatic area after cholecystectomy (Fig. 2.19). Ducts of Luschka or subvesical ducts are small biliary ducts which originate from the right hepatic lobe and course along the gallbladder fossa bed. Injuries to the ducts of Luschka are the second most frequent cause of postcholecystectomy bile leaks.

Postcholecystectomy bilomas are usually well drained by image-guided percutaneous catheter placement. ERCP, PTC, and CT are the usual modalities in making the diagnosis of biliary leak. ERCP allows diagnosis as well as treatment (stenting and nasobiliary drainage) of patients with postcholecystectomy bile leak.

The other complications after cholecystectomy include biliary perforation, biliary stricture, retained surgical sponge, biliary peritonitis, and hemorrhage (Fig. 2.20).

Teaching Points

- The first-line imaging modality for the diagnosis of acute cholecystitis is ultrasound and cholescintigraphy.
- Ultrasound is preferred over cholescintigraphy because of wider availability, shorter duration of the investigation, and ability to diagnose gallstones as well as choledocholithiases.
- Although the sensitivities of ultrasound and cholescintigraphy are both high, ultrasound has relatively lower sensitivity and specificity compared to cholescintigraphy.
- CT and MR are second-line imaging modalities, most appropriately used when ultrasound results are equivocal.
- CT is especially useful in diagnosing complications of acute cholecystitis and extrabiliary disorders.

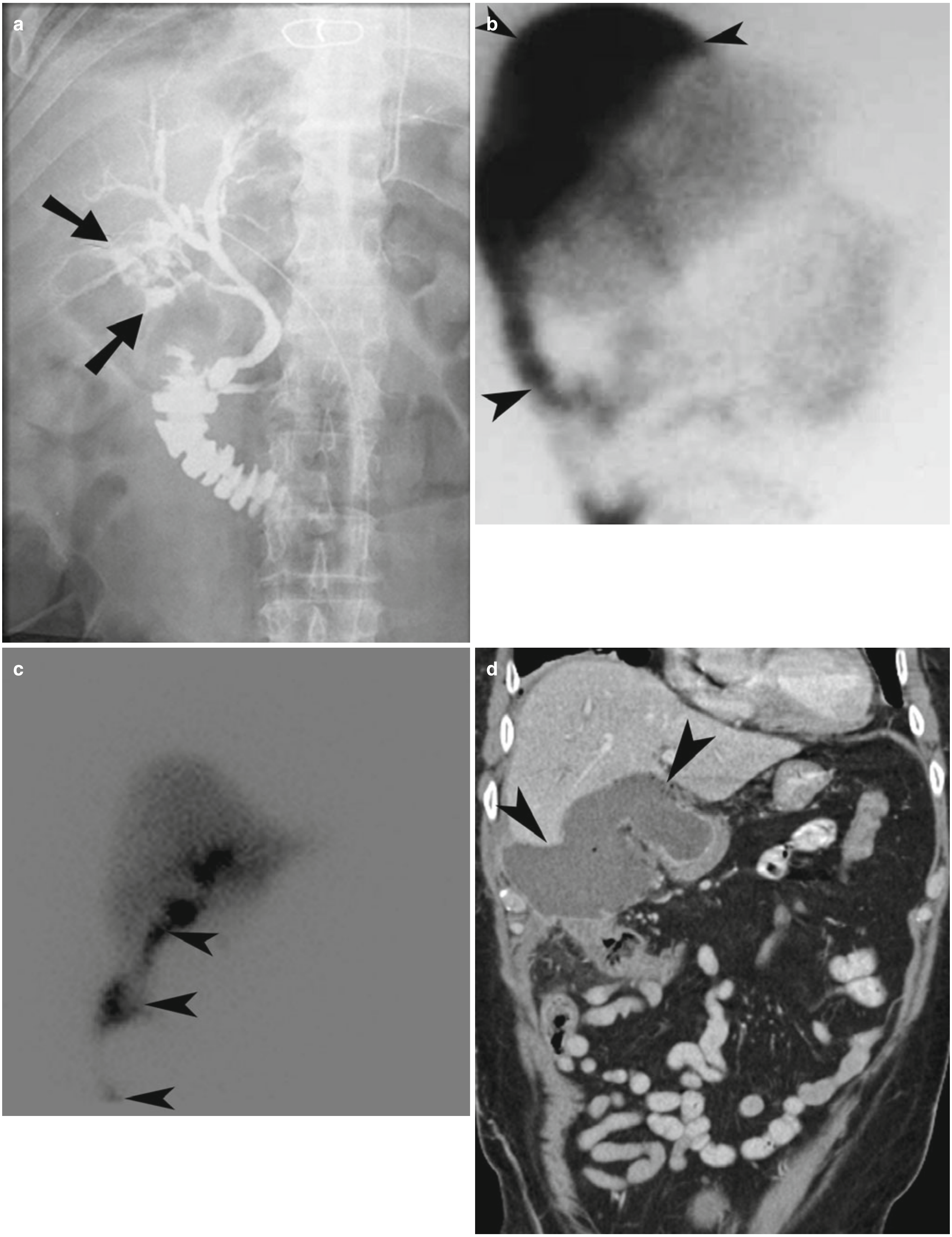

Fig. 2.18 Postcholecystectomy bile leaks. (**a**) Percutaneous transhepatic cholangiogram demonstrates leakage of contrast from the cystic duct stump in a patient with recent cholecystectomy and dehiscence of cystic duct stump. (**b** and **c**) Cholescintigraphy demonstrates accumulation of radiotracer outside the biliary system, into the peritoneal cavity (*arrowheads*). (**d**) Coronal CT reformation demonstrates biloma (*arrowheads*) in the right subhepatic location

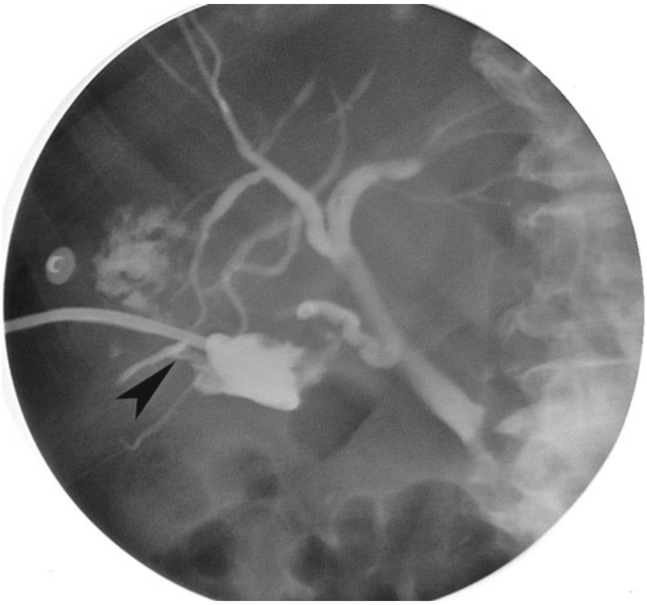

Fig. 2.19 Postcholecystectomy biloma communicating with ducts of Luschka. Pigtail catheter injection after image-guided pigtail catheter drainage of a biloma demonstrates communication of the biloma with ducts of Luschka (*arrowhead*)

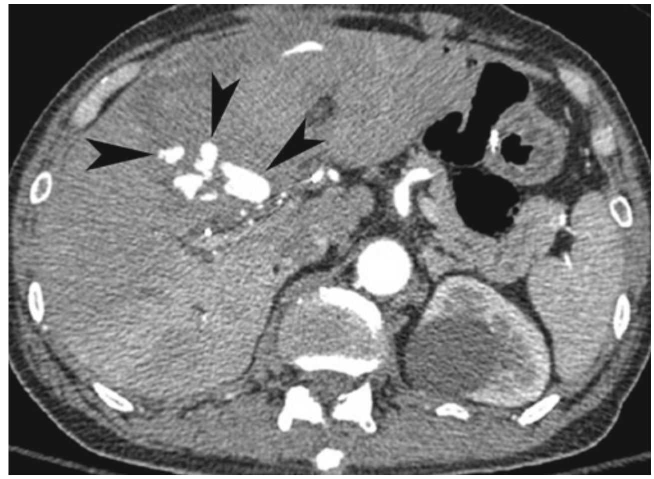

Fig. 2.20 Postcholecystectomy hemorrhage. Postcholecystectomy CT angiogram of the abdomen demonstrates active extravasation of contrast (*arrowheads*) into the gallbladder fossa

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