SA–CME Information

Biliary tract emergencies: What the radiologist should know

Description

Acute biliary conditions are a common occurrence in the emergency department, but may be underappreciated on diagnostic imaging, particularly since these injuries may occur in complex patients or be a secondary injury in a patient presenting with a more obvious primary injury. The potential for delayed diagnosis could result in significant morbidity.

Since findings may be subtle, radiologists need to be comfortable with common presentations of acute biliary disease to maintain an adequate level of suspicion and detect early signs of injury. The radiologist should also be familiar with other imaging modalities that may be useful in confirming biliary injury and tailor effective follow up imaging to a patient's clinical situation.

Learning Objectives

After completing this activity, the participant will be able to:

- Explain why biliary obstruction detected on imaging can lead to a clinical emergency and what are the most common causes of biliary obstruction that present acutely;
- Identify biliary trauma on imaging and understand the most common causes of biliary trauma as well as the available imaging options for further evaluation;
- Distinguish the appearance of biliary injury after liver transplantation.

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Authors

Sarah D. Fenerty, MD; Sudhir Kunchala, MD; and Matthew A. Morgan, MD, are Radiologists with the University of Pennsylvania Hospital, Philadelphia, PA.

Target Audience

- Radiologists
- Radiologic Technologists
- Related Imaging Professionals

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Biliary tract emergencies: What the radiologist should know

Sarah D. Fenerty, MD; Sudhir Kunchala, MD; and Matthew A. Morgan, MD

The biliary tract is subject to a spectrum of pathologic conditions which require urgent clinical management. Some of these are due to biliary obstruction, such as jaundice and acute cholangitis. Others are traumatic and iatrogenic complications such as biliary leaks, hemobilia, and malfunctioning biliary drains/stents. Selection of the optimal imaging modality and accurate interpretation of imaging findings facilitates timely and accurate diagnosis and helps guide therapeutic interventions. The radiologist and interventional radiologist thus play a crucial role in the evaluation and management of these conditions. This article will focus on the pertinent imaging features of acute biliary tract disorders involving the intra- and extrahepatic bile ducts, excluding the gallbladder, as well as available radiologic interventions for the management of these conditions.

Dr. Fenerty, Dr. Kunchala, and Dr. Morgan are Radiologists with the University of Pennsylvania Hospital, Philadelphia, PA.

Biliary obstruction, stasis, and infection

Biliary obstruction and biliary dilatation has various etiologies, including choledocholithiasis, biliary strictures, malignancy, and parasitic disease. Evaluation for biliary obstruction is usually prompted by patient symptomatology and/or cholestatic liver enzyme abnormalities (elevation in serum direct bilirubin and disproportionate elevation in alkaline phosphatase relative to aspartate aminotransferase (AST) and alanine aminotransferase (ALT)).

Right upper quadrant transabdominal US can reliably detect biliary duct dilation and in most cases is an appropriate first line examination. [1] A common bile duct diameter greater than 7-8 mm is generally indicative of bile duct obstruction in patients without prior cholecystectomy, although some go as low as 6 mm.[2] Intrahepatic bile ducts should not exceed 2 mm diameter, or less than 40% of the caliber of the accompanying portal venous branch. [2,3,4] Visualization of a common bile duct (CBD) stone on US is the most reliable predictor of choledocholithiasis at subsequent endoscopic retrograde cholangiopancreatography (ERCP) or surgery. [5] However, although good for evaluating biliary dilatation, transabdominal US but has relatively poor sensitivity for detection of CBD stones, partly because of difficulty visualizing the CBD. [6]

CT is useful for evaluation of biliary ductal dilatation and the measurements used in CT are applicable, but it is only moderately sensitive for detection of choledocholithiasis (with reported sensitivities between 25-90%). Only 20% of stones are high attenuation and up to 24% are isoattenuating to the surrounding bile (Figure 1). [7,8] Narrow window settings and coronal reconstructions may help accentuate the stone from adjacent bile or soft tissue. [9]

Magnetic resonance cholangiopancreatography (MRCP) and abdominal MRI are highly accurate for imaging the biliary tree and is useful in multiple obstruction settings. For instance, it is useful for patients with obstructive jaundice in whom CT and ultrasound findings are inconclusive; when

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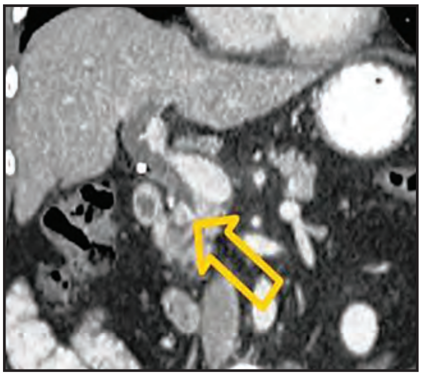
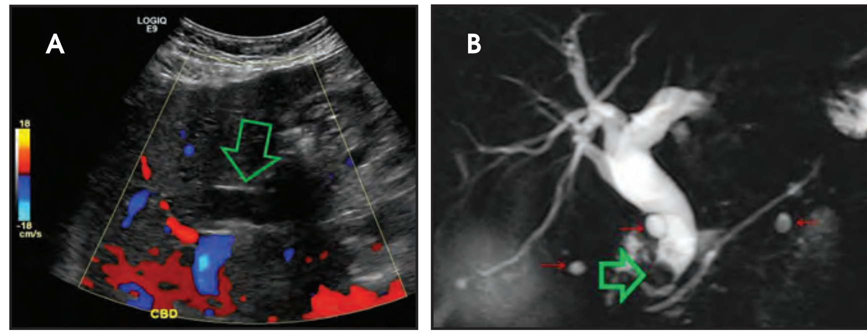


FIGURE 1. 61-year-old man presenting with right upper quadrant abdominal pain. A round structure in the distal common bile duct (yellow arrow) was later confirmed on MRCP to be a gallstone (not shown). The high-attenuation structure near the porta hepatis is a cholecystectomy clip. Choledocholithiasis can run a range of attenuation from calcium density to bile density.



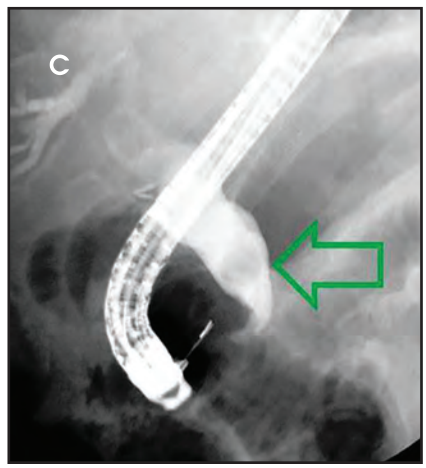


FIGURE 2. 55-year-old man with a history of a partial cholecystectomy, presenting with recurrent abdominal pain and mildly elevated alkaline phosphatase levels (214). On the initial abdominal ultrasound (A) the common bile duct was 1.6 cm (green arrow), more dilated than expected, even post-cholecystectomy. Note how the distal common bile duct is not well evaluated due to shadowing from overlying bowel gas. An MRCP was performed to confirm (B). A round filling defect appears in the distal common bile duct (green arrow), compatible with choledocholithiasis. The T2 hyperintense round lesions at the red arrows are pancreatic cysts. An ERCP was subsequently performed (C) and a round lucency in the distal common bile duct (green arrow) represents the stone that was then removed.

Table 1. American Society for Gastrointestinal Endoscopy predictors of choledocholithiasis[5]

Very strong	CBD stone on transabdominal ultrasound Clinical ascending cholangitis Bilirubin >4 mg/dl
Strong	Dilated CBD on transabdominal ultrasound (>6 mm with gallbladder in situ) Bilirubin level 1.8-4.0 mg/dl
Moderate	Abnormal liver biochemical test other than bilirubin Age >55 years old Clinical gallstone pancreatitis

underlying mass or biliary tract neoplasm is suspected; or for evaluation of suspected ascending cholangitis and associated complications (Figure 2).[3] Since it is noninvasive, MRCP avoids the potential complications of endoscopic retrograde cholangiopancreatography (ERCP) and is especially useful in patients with surgically altered biliary anatomy not amenable to ERCP (eg, those with biliary-enteric anastomosis).[10,11] ERCP is now largely reserved for therapeutic purposes.[3,12]

The American Society for Gastrointestinal Endoscopy has proposed a risk-stratified management algorithm to determine which patients with suspected choledocholithiasis would most benefit from further imaging based on clinical predictors at initial evaluation with transabdominal US.[5] The risk factors are divided into very strong, strong, and moderate (Table 1). Additional biliary imaging with MRCP or endoscopic ultrasound (EUS) may be most helpful in those at *intermediate* probability (10-50%) of choledocholithiasis – patients with only one “strong” predictor and/or at least one moderate predictor – to determine potential need for endoscopic stone extraction. Given the frequent need for therapeutic intervention in patients with *high* probability of choledocholithiasis – those with any “very strong” predictor or both “strong” predictors – preoperative ERCP or operative cholangiography is suggested instead.

Ascending cholangitis

The problem with biliary obstruction is that the decreased biliary flow allows ascent of bacteria from the duodenum. Biliary obstruction may also lead to hepatovenous reflux and subsequent bacteremia.[13,14] Ascending cholangitis is associated with high mortality and requires emergent biliary decompression. Imaging in suspected ascending cholangitis helps confirm the presence, level and cause of obstruction and to identify potential complications such as suppurative cholangitis, parenchymal abscess, portal vein thrombosis, and biliary peritonitis.[3]

MRI imaging characteristics of ascending cholangitis include central intrahepatic biliary dilation with smooth ductal wall thickening and enhancement. Associated parenchymal inflammatory changes include patchy or peribiliary parenchymal enhancement (most apparent

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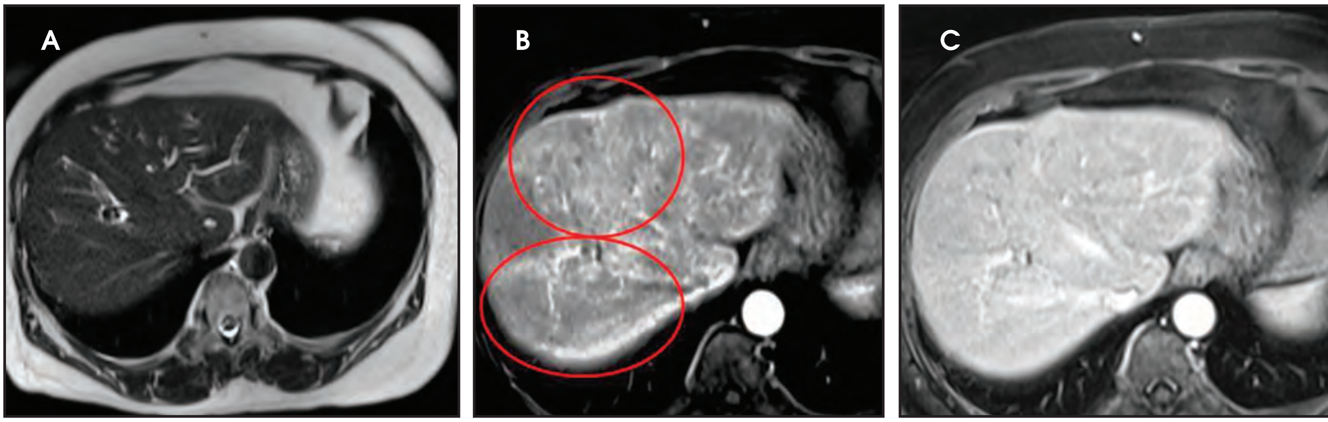

FIGURE 3. *64-year-old woman with polysubstance abuse and acute onset epigastric abdominal pain, nausea, vomiting, and diarrhea. MRI of the abdomen was performed for evaluation. On the T2 weighted axial images (A) there was very mild biliary ductal dilatation and no significant ductal dilatation, however, on the arterial phase images (subtractions shown, B) there was patchy geographic enhancement along the course of the mildly dilated ducts(red circles). This enhancement faded to background liver parenchymal enhancement by the time of the portal venous phase series (C). Cholangitis is best appreciated on the arterial phase images due to increased hepatic arterial flow.*

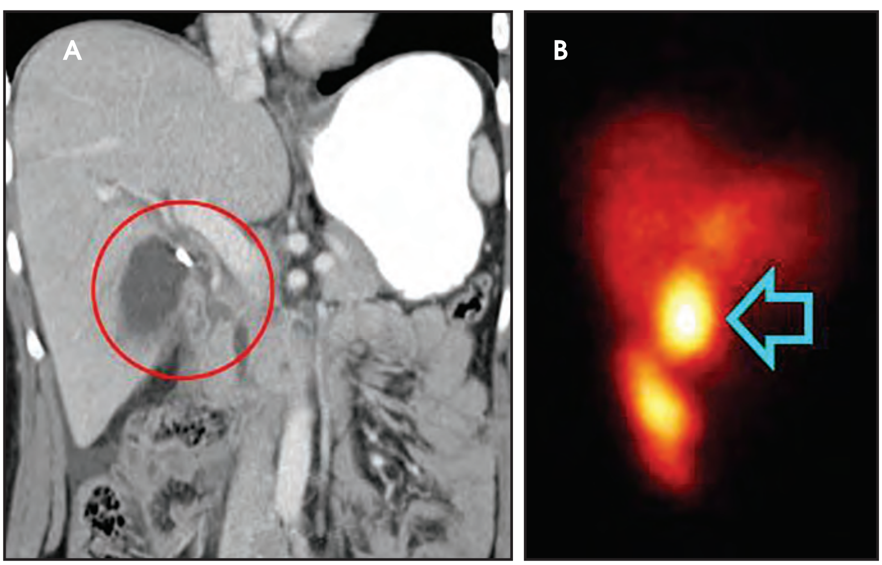

FIGURE 4. *31-year-old man with abdominal pain after a recent cholecystectomy (1 week previous). On the initial CT (A) there is a hypoenhancing collection in the gallbladder fossa which almost looks like a gallbladder; cholecystectomy clips can be seen in the porta hepatis. A follow-up hepatobiliary scintigraphy study with Tc-99m mebrofenin (B) demonstrated a large amount of activity within the collection (blue arrow) and additional tracer extending down the right paracolic gutter.*

on arterial phase postcontrast imaging) and geographic, wedge-shape T2-hyperintense segments of inflamed tissue around the involved bile ducts (Figure 3). In acute suppurative cholangitis, dilated bile ducts filled with echogenic purulent material are observed on ultrasound; dense biliary contents are seen on CT.[10] Biliary contents will appear low signal relative to liver on T2-weighted MRI and intermediate signal on T1-weighted MRI.[15] A uni- or multiloculated collection with capsular or rim enhancement is characteristic for abscess formation on CT and MRI; coalescence of adjacent abscesses may result in a cluster sign.[16]

Biliary injuries: Bile leaks and hemobilia

Biliary complications can result from either traumatic or iatrogenic bile duct injury and encompass a spectrum of often coexisting entities, including retained stones, hemorrhage, hemobilia, bile leaks, bile duct ligation and strictures.

Traumatic bile leaks

Biliary tract injury is a rare complication of abdominal trauma, with a reported prevalence of 2.8–7.4% in patients sustaining blunt hepatic injury.[17,18] Injuries to the extrahepatic bile ducts usually result from acute deceleration and tend to occur at sites of anatomic fixation, such as the intrapancreatic portion of the CBD. Injuries to the intrahepatic bile ducts may be seen in the setting of parenchymal liver injury.

Traumatic complications such as biloma or biliary peritonitis, can manifest days to weeks after initial trauma.[19] Because bile is sterile and absorbed by the peritoneum, symptoms may not arise until the bile becomes superinfected. Patients frequently exhibit nonspecific progressive symptoms such as abdominal pain, nausea, vomiting, and, rarely, acute abdomen with peritoneal signs. Serum biochemical tests may reveal rising or persistently elevated serum bilirubin levels, sometimes accompanied by jaundice.

CT is often the first-line imaging modality in the setting of trauma. Findings of bile duct injury are relatively nonspecific, and diagnosis often requires a high level of suspicion on the part of the radiologist. Secondary findings such as liver lacerations, focal peri- or intrahepatic fluid collections, ascites, and associated solid organ injuries may be the only indicators of bile

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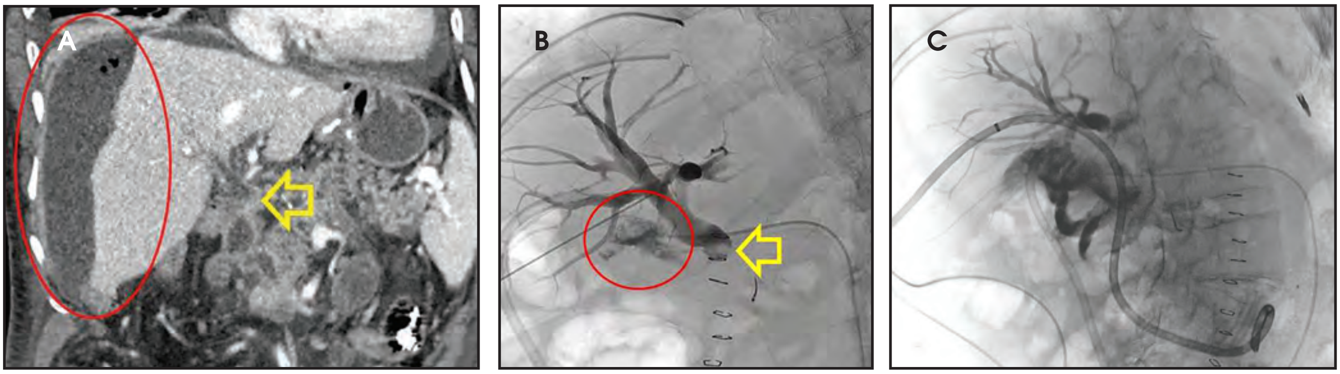

FIGURE 5. *76-year-old man with fevers and leukocytosis postoperative day 4; a Whipple procedure for obstructive pancreatic cyst. An initial CT of the abdomen and pelvis (A) shows a sub-diaphragmatic fluid collection along the right hepatic lobe with two foci of gas (red oval). The choledochojejunostomy can be seen (yellow arrow), but there is no definite injury. A drain was placed into the collection, which revealed bilious fluid. A percutaneous transhepatic cholangiogram was performed (B), which showed a leak (red circle) arising from the biliary-enteric anastomosis (yellow arrow). A 12F internal/external transhepatic biliary drain was then placed across the anastomosis (C) to divert the bile flow and aid healing.*

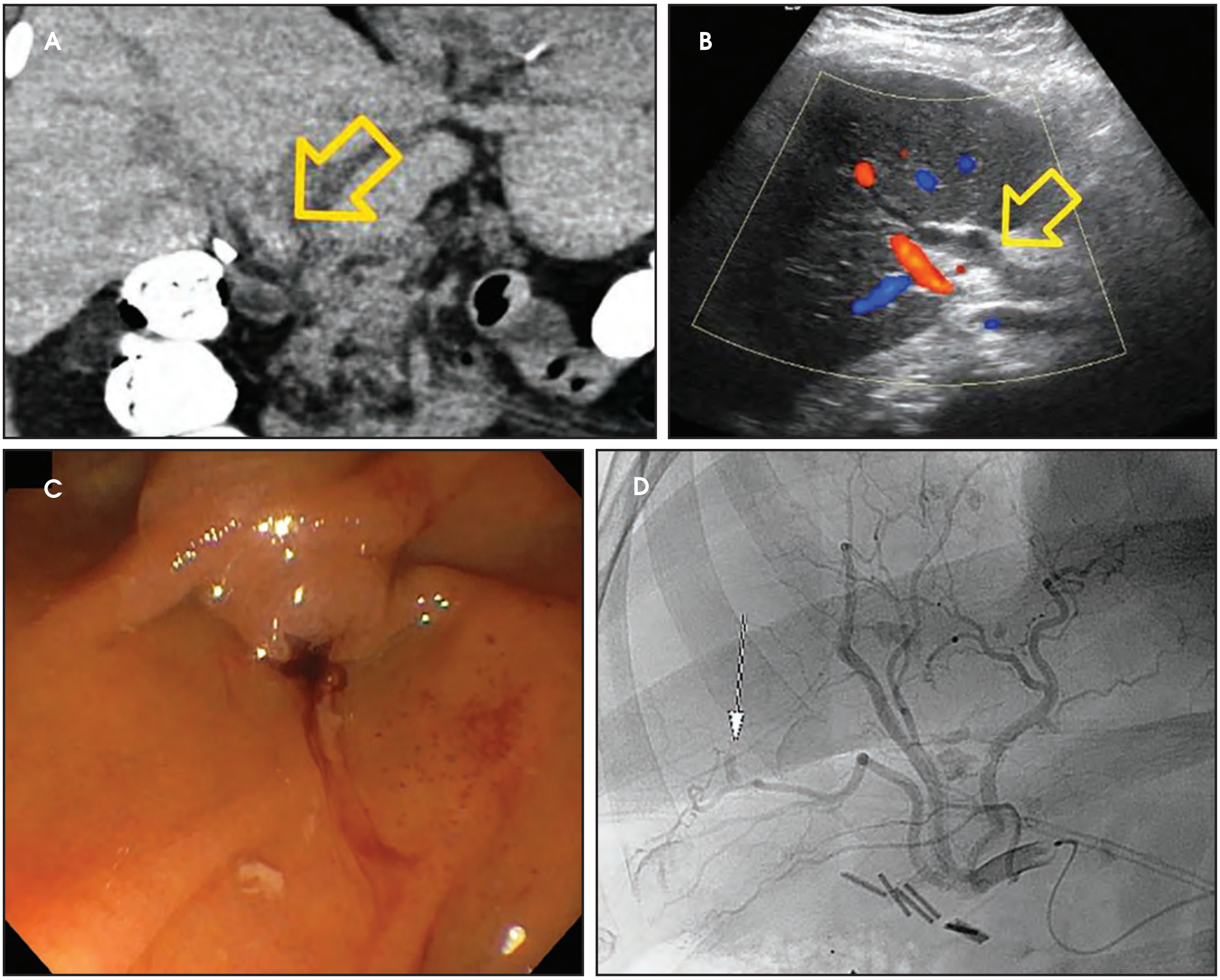

FIGURE 6. *72-year-old woman present with abdominal pain after a liver core biopsy. An initial noncontrast CT (A) shows subtle high attenuation in the common bile duct (yellow arrow), but no other abnormality. A follow up right upper quadrant ultrasound (B) shows debris in the common bile duct (yellow arrow). Given the suspicion for hemobilia, an upper endoscopy was performed (C) and bright red blood was found oozing from the ampulla. An angiogram was then performed (D) and a small blush of contrast was found originating from a hepatic artery branch along the track of the biopsy (white arrow). This bleeding artery was then coil embolized and the patient recovered uneventfully.*

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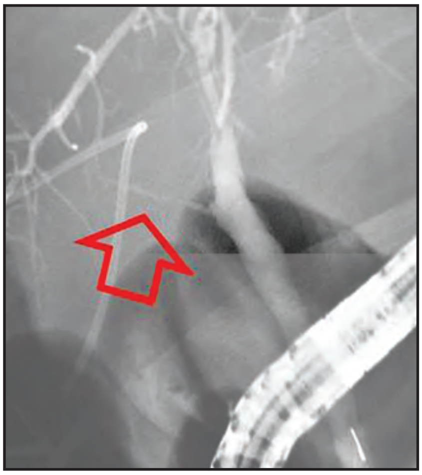

FIGURE 7. 36-year-old man with a history of primary sclerosing cholangitis and orthotopic liver transplantation. His T tube had been removed the prior day. On follow-up ERCP, a thin track of contrast extends out from the biliary anastomosis along the track of the tube (red arrow), compatible with a leak.

duct injury at initial imaging. Follow-up imaging is often helpful; progressive growth of a well-circumscribed, low-attenuation perihepatic or intraparenchymal fluid collection suggests a biloma; persistent or increasing low-attenuation intraperitoneal fluid raises concern for bile leakage; peritoneal thickening and hyperenhancement may indicate biliary peritonitis [20]

Ultrasound is primarily utilized for follow-up of findings such as bilomas, but can be used to screen for the presence or absence of perihepatic and intrahepatic fluid collections, and ascites.[19,21]

Dynamic hepatobiliary scintigraphy can detect the presence and severity of an active bile leak. Progressive intra-abdominal accumulation of radiotracer that does not conform to the morphologic appearance of the bowel is characteristic (Figure 4).[22] Its main limitation is poor spatial resolution, which can be partly overcome with use of SPECT/CT.[19.23]

Despite the dual therapeutic and diagnostic capabilities of ERCP, the invasive nature and inability to help detect extrabiliary abnormalities limit its diagnostic application as a first-line modality for bile leak detection.[24]

MRCP with hepatobiliary contrast agents such as gadoxetate disodium (Eovist; Bayer Healthcare Pharmaceuticals, Berlin, Germany) can provide useful functional and anatomic information and in many cases may supersede both scintigraphy (through superior anatomic detail and spatial resolution) and ERCP (by demonstrating peripheral sites of leakage that do not opacify by retrograde injection) in the dynamic evaluation of biliary injury. Delayed hepatocyte phase T1-weighted MR imaging may allow improved characterization of biliary anatomy by providing a higher signal-to-noise ratio in the bile duct than can be achieved with conventional T2-weighted MR imaging.[25] Extravasation of contrast material in the liver, perihepatic space, peritoneum, or pleural cavity is indicative of bile leak. Pooling of contrast material within an intrahepatic or perihepatic fluid collection implies direct communication with the biliary tree.[26]

Iatrogenic bile leaks

Bile leaks have been associated with various surgical procedures, including open and laparoscopic cholecystectomy, hepatic resection, liver biopsy, liver transplantations, ERCP, percutaneous transhepatic cholangiography (PTC), and ablation of hepatic tumors. [27,28] Significant postoperative bile leaks have been reported in up to 1% of patients following laparoscopic cholecystectomy, 0.5% of patients after open cholecystectomy and in 2%–25% of patients after orthotopic liver transplantation or hepatic resection.[24,29,30] Postoperative bile leaks can go unrecognized due to nonspecific imaging findings and even less specific clinical features, which may be attributed to other more common postoperative complications. Intraperitoneal bile collections may also be difficult to distinguish from other postoperative fluid collections.

Bile leaks typically manifest within one week of surgery, but may not become apparent for up to one month. CT and US may demonstrate free or loculated fluid but cannot reliably distinguish between bile leaks and other postoperative collections. As in the post-traumatic setting, hepatobiliary scintigraphy can provide functional information and demonstrate the presence of free or contained bile leakage. Delayed MRI imaging with hepatobiliary contrast agents may indicate the site of bile leak and help distinguish between fluid collections of biliary and nonbiliary origin by demonstrating contrast accumulation and communication with the biliary tree. MRI/MRCP may also delineate other postoperative complications, such as biliary strictures or retained stones.

Leakage of bile can lead to biloma formation, and these may become encapsulated from inflammation and fibrosis. Although occasionally intraparenchymal, postoperative bilomas tend to form in the gallbladder fossa or porta hepatis and appear as discrete, rounded, hypoechoic (US) or hypoattenuating (CT) fluid collections when uncomplicated (Figure 4). [22] On MRI, bilomas appear hypointense on T1W MRI and TW MRI; high T1 and low T2 signal may reflect concentrated layering bile. Identification of a thick enhancing rim or internal complexity should raise suspicion for superinfection or abscess. In the setting of biliary leaks, interventional procedures can facilitate upstream biliary drainage and help stabilize the patient (Figure 5). [31-33] They also can provide biliary anatomy proximal to the site of ductal injury for possible surgical intervention. Percutaneous aspiration is also often helpful to confirm a suspected biliary collection.

Hemobilia

Hemobilia is a rare cause of upper gastrointestinal bleeding which results from a fistulous connection between the hepatic vasculature and biliary ductal system. Most cases develop as a complication of diagnostic or therapeutic hepatobiliary interventions (percutaneous transhepatic biliary drain (PTBD) placement, percutaneous and transjugular liver biopsy, transjugular intrahepatic portosystemic shunt, ERCP, and

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hepatobiliary surgery).[34] Hepatobiliary neoplasms account for the majority of noniatrogenic hemobilia.[35] Other etiologies include liver trauma, vascular malformations, inflammatory conditions, calculus disease, hemorrhagic cholecystitis and underlying blood dyscrasias. These patients generally receive an upper gastrointestinal bleeding workup with endoscopy. Visualization of blood arising from the ampulla or the presence of fresh blood in the second portion of the duodenum may indicate a biliary etiology.

When endoscopy is nondiagnostic, patients often proceed to CT or fluoroscopic angiography. CT angiography (CTA) allows for evaluation of both the arterial anatomy and hepatobiliary parenchyma and is useful in planning endovascular interventions. Direct findings of hemobilia include contrast extravasation into the biliary tract or liver parenchyma. [34] Indirect findings may also help localize the bleeding, such as high attenuation hemorrhagic bile or thrombus within bile ducts or gallbladder, pseudoaneurysms, arteriovenous fistulas, vascular malformations, hepatic tumors, or evidence of blunt liver injury.

MRI/MRCP is less frequently indicated in evaluation of hemobilia due to lengthier examination times and suboptimal evaluation of the peripheral vasculature, but can effectively demonstrate blood products within the biliary system. Hemorrhagic bile appears as increased signal on T1-weighted MRI and decreased signal on T2-weighted MR. Blood products within the biliary system usually appear as filling defects on MRCP. Once the site of bleeding is identified, the site can be embolized in the interventional fluoroscopy suite using either microcoils or liquid embolic agents (Figure 6).[34] Surgical intervention is often unnecessary, as success of endovascular management at experienced centers approaches 100%.[36] Depending on the patient's situation, percutaneous biliary drainage may also be necessary for successful drainage of biliary obstruction from intraluminal blood products.

Biliary leaks after liver transplant

Biliary complications remain a major source of morbidity after liver transplant, with an incidence of 5-15%, and are usually observed within the early postoperative period (≤3 months after surgery).[27,37,38] Potential complications include anastomotic and non-anastomotic strictures, leaks, stones, ampullary dysfunction, biliary necrosis, and cholangitis.

The type of biliary reconstruction is a major determinant of the risk of biliary complications after liver transplant [39,40] The most common biliary reconstruction procedure is choledochocholedochostomy: an anastomosis between the donor CBD and the recipient common hepatic duct. With this anastomosis, a T tube is usually left in the duct for approximately six weeks postoperatively. T-tube cholangiography provides better evaluation of the biliary system than MRCP due to better distention of the bile ducts with contrast. The use of T-tubes has been associated with bile leak and cholangitis at the time of their removal, however (Figure 7).[38]

Choledochojejunostomy, in which the donor CBD is anastomosed directly to the recipient jejunum, is usually performed in patients with pre-existing biliary disease such as primary sclerosing cholangitis, prior history of biliary surgery, or when a size mismatch exists between donor and recipient ducts. Post-transplant bile duct leaks may be due to ischemia, relative downstream obstruction, sphincter of Oddi hypertension, or from T-tube removal, and most commonly occur at the biliary-enteric anastomosis or T-tube exit site. Leaks may manifest as extravasation of contrast material from the T-tube site into the peritoneal cavity on direct cholangiography, or as single or multiple bilomas.[41]

Initial evaluation of suspected transplant biliary complication should include laboratory evaluation and transabdominal grayscale and Doppler ultrasound. When no T-tube is present, MRI/MRCP, with or without hepatocyte specific gadolinium agents, is the preferred imaging tool for further evaluation of the biliary tree and avoids the potential complications associated with ERCP. ERCP has a high failure rate in patients with Roux-en-Y reconstruction, except when double balloon enteroscopy is available to assess the biliary tree. Percutaneous transhepatic cholangiography is usually reserved for cases in which ERCP cannot be performed.

Conclusion

Biliary tract emergencies have the potential to result in significant patient morbidity but frequently present with nonspecific and overlapping clinical features, thus presenting unique challenges in diagnosis and management. Imaging in this setting often requires a multimodality approach, particularly in complex or postoperative patients. Ultrasound remains the first-line imaging tool for investigation of suspected biliary obstruction, while MRCP with hepatobiliary contrast agents has emerged as a valuable tool in the evaluation of biliary tract injury. Advances in MRI and MRCP have likewise reduced the requirement for diagnostic ERCP. Appropriate selection and interpretation of imaging studies in acute biliary tract disease can aid in timely and accurate diagnosis and guide management of these conditions.

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