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REVIEW

Complications of endoscopic retrograde cholangiopancreatography: an imaging review

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Abstract

Endoscopic retrograde cholangiopancreatography (ERCP) has currently become an inseparable tool in the gastroenterologist's armamentarium for treatment of pancreaticobiliary disorders. Given the increase in number of therapeutic ERCP procedures today, the need for prompt and correct diagnosis of its complications is pivotal. This review discusses the mechanisms, risk factors, imaging findings and general management aspects of common and rare complications of ERCP. Furthermore, the review elaborates on imaging indications, recommended protocol and normal imaging findings post ERCP.

Keywords Endoscopic retrograde cholangiopancreatography (ERCP) · Complications · Computed tomography (CT) · Post-ERCP pancreatitis · Post-ERCP haemorrhage · Post-ERCP perforation

Introduction

First introduced in 1968, endoscopic retrograde cholangiopancreatography (ERCP) involves initial examination of the major and minor duodenal papilla via an endoscope followed by selective cannulation of the pancreatic or bile duct to obtain pancreatogram or cholangiogram, respectively, by injection of iodinated contrast. Additionally, various therapeutic procedures can be performed in the same setting. However, the advent of non-invasive techniques such as helical computed tomography (CT) and magnetic resonance imaging (MRI) and improvements in other imaging modalities has significantly reduced the diagnostic role of ERCP, which at present, is primarily indicated for therapeutic procedures [1]. The American Society for Gastrointestinal Endoscopy (ASGE) formulated guidelines in 2005 and updated them in 2015, which recommends against performing ERCP for pancreaticobiliary-type pain in the absence of objective abnormalities on other pancreaticobiliary imaging or laboratory studies [2, 3]. A few therapeutic indications include sphincterotomy, calculi extraction, lithotripsy, biliary drainage, stricture dilatation and stent placement (biliary and pancreatic) [4]. Brush cytology and biopsies via the ERCP route are valuable diagnostic methods, especially in malignant conditions.

Despite its extensive use for nearly five decades, ERCP is an invasive procedure requiring expertise and is associated with post-procedural morbidity in the range of 4–10% [5–7]. A systematic survey, including 21 prospective studies with 16,855 patients done by Andriulli et al. [8], found that ERCP-specific morbidity secondary to pancreatitis, bleeding, perforations, and infections was 6.85%. Among these patients 5.17% had mild or moderate complications requiring less than 10 days of hospital stay and 1.67% of patients had severe complications requiring hospitalization for 10 or more days or admission in an intensive care unit, or underwent surgery [8, 9]. Acute pancreatitis forms the most common procedure related complication with an incidence rate of 3–10% [7]. Others include hemorrhage (0.3–2.0%), cholangitis (0.5–3%) and duodenal perforation (0.08 to 0.6%). Rare complications such as pneumothorax, air embolism, splenic injury and colonic diverticula perforation have also been occasionally documented [4, 10–14]. Mortality is very uncommon (0.3–1%) and is mostly associated with surgical procedures [8, 15].

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With the number of therapeutic ERCP procedures likely to increase significantly [16], the need to recognize and appropriately manage potential complications is pivotal to reduce morbidity and mortality associated with it. Imaging forms the cornerstone in the diagnosis of these complications and it is imperative that the radiologist is familiar with the imaging findings and management aspects of these conditions. This review focuses on the mechanisms, risk factors, imaging findings and management aspects for the most important complications of ERCP.

Indication, imaging protocol, and normal findings post ERCP

A combination of intraprocedural findings, symptoms, clinical signs and laboratory results often dictate the need for imaging. Difficult or repeated cannulation, difficult or precut sphincterotomy, suspected or confirmed duodenal perforation during the procedure, sudden or increasing abdominal pain, abdominal distension, fever, significant hypotension, decreasing hemoglobin, elevated leukocyte count, elevated acute phase reactants, elevated serum lipase or amylase are some of the factors which form the indication for imaging [4, 17]. Most severe complications present early following the procedure; however, some severe complications may present subacutely as the clinical signs do not manifest early due to the retroperitoneal location of the complications and insignificant alteration in the laboratory markers.

Contrast-enhanced CT (CECT) forms the imaging modality of choice for evaluating the complications developing after ERCP, especially in the acute setting [4]. We recommend the use of a multiple phase CT protocol, including a non-enhanced scan followed by late arterial (25–30 s) and venous phase (60–70 s) scans with oral contrast. At our institution, we use dual energy scans in the arterial phase to generate virtual non-enhanced images instead of a separate non-enhanced scan. Non-enhanced CT is helpful in identifying hyper-attenuating fresh blood or hematoma. Late arterial phase demonstrates any vascular injuries such as active contrast extravasation and pseudoaneurysms. Oral contrast is helpful in identifying the site of duodenal perforation.

Ultrasonography in the acute setting is severely limited by the presence of ileus, pneumobilia, pneumoperitoneum or pneumoretroperitoneum. It is currently recommended only for rapid assessment of biliary tree and gallbladder or to follow-up known collections [4]. Unenhanced T1 and T2-weighted MRI sequences with or without fat suppresion are helpful in the detection of post-ERCP pancreatitis, especially in young patients and in patients with renal failure. It is superior to other imaging techniques for characterizing peripancreatic collections [18]. Additionally, magnetic resonance cholangio pancreatography (MRCP) sequence helps in better delineation of biliary system and may be used in assessment of delayed complications such as cholangitis or stent block. However, ill or uncooperative patients, presence of pneumobilia, pneumoretroperitoneum and stents often render MRCP sequences uninformative limiting its role in the acute setting.

Some of the normal imaging findings post-ERCP which should not be confused with pathology include presence of intra and extrahepatic pneumobilia, which may even persist for months in case of sphincterotomy or stent placement. Retained contrast in the biliary system may be seen on imaging immediately following ERCP with its characteristic striated appearance [19]. Post ERCP acute duodenitis may manifest as oedematous wall thickening and is a reversible condition. The list of complications occurring after ERCP is shown in Table 1.

Pancreatitis

Post-ERCP pancreatitis (PEP) is the most common and a serious complication caused by the procedure. Patient-related risk factors include previous history of PEP, suspected sphincter of Oddi dysfunction, female sex, younger patient age, normal serum bilirubin levels, history of acute recurrent pancreatitis, pregnancy, and cannabis use [20–25]. Interestingly, patients with chronic pancreatitis have a decreased incidence, likely due to decreased exocrine function and parenchymal atrophy [26]. Procedure related factors, such as difficult cannulation (multiple attempts or duration > 5–10 min) and large-balloon dilatation of the papilla of an intact biliary sphincter (especially for short duration (< 1 min) significantly increase the risk of PEP [27, 28].

Patients usually present within a few hours with severe epigastric pain, often radiating to the back, nausea and mild fever with raised pancreatic enzyme levels [29]. Pancreatitis is diagnosed if two of the following three criteria is present; pain consistent with acute pancreatitis, raised serum amylase or lipase levels more than three times normal and (or) typical

Table 1 List of complications of ERCP

Pancreatitis
Haemorrhage
Bowel perforation
Cholangitis
Cholecystitis
Stent related complications
Air embolism
Others: Ileus, Pneumothorax, Hepatic abscess, Pseudocyst infection, Biliary or pancreatic duct fistulae, Splenic injury, Impacted Retrieval Basket

imaging findings [30].The incidence of PEP ranges from 3 to 10% [7, 8, 20].

CECT is the diagnostic modality of choice for PEP [30]. Although revised Atlanta classification does not recommend early imaging in acute pancreatitis, in cases of PEP, early imaging (< 24 to 48 h) is necessary to exclude other complications with similar manifestations (especially duodenal perforation) [30]. The type of PEP may be interstitial edematous (IEP) or necrotizing (NP). Higher infection, organ failure and mortality rate are observed in NP (12–30% vs. < 3% in IEP). Due to early imaging, majority of patients have subtle findings. In IEP, the pancreas is bulky and homogeneously enhancing with peripancreatic fat stranding and fluid collections (Fig. 1) [31]. In NP, there is necrosis of the pancreatic parenchyma or peripancreatic tissue which is seen as hypoenhancing areas. They may form non-encapsulated liquefied areas (acute necrotic collections), which may later (usually after 4 weeks) become organized and encapsulated to form walled off necrosis (Fig. 2). Early scans, done in the setting of PEP, can underestimate the severity of pancreatitis and often underdiagnose necrosis [32]. Hence, a repeat CT is often required at a later time frame.

CT Severity Index (CTSI) or modified CT Severity Index (M-CTSI) may be used to grade the severity of acute pancreatitis [33]. In a large single-center study conducted by Woods et al., PEP was graded as mild (≤ 2 points) in 53.6%, moderate (4–6 points) in 42.8% and severe (≥ 8 points) in 3.6% of cases, respectively [34].

Management of PEP is analogous to acute pancreatitis in other settings. Contrary to previous beliefs, a recent meta-analysis has shown that performing an early precut-sphincterotomy, in cases of difficult biliary access, significantly reduced the risk of PEP compared to standard techniques [35]. New evidence suggests that the prophylactic use of non-steroidal anti-inflammatory drugs, glyceryl trinitrate or somatostatin, guide wire cannulation before instrumentation and use of prophylactic pancreatic duct stents can significantly reduce the incidence of PEP [36].

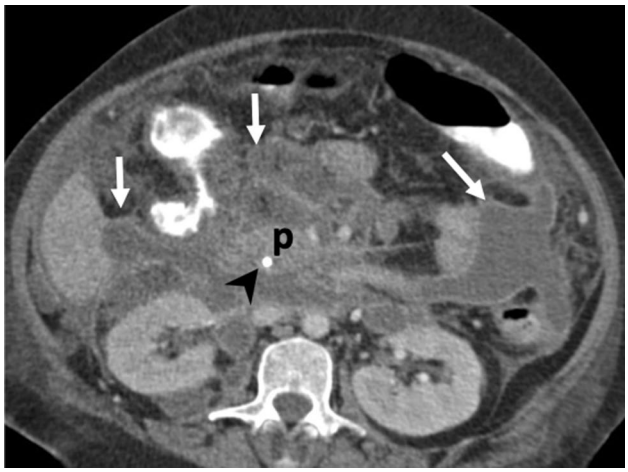

Fig. 2 45-year-old male presenting with severe pain in epigastrium, 1-week after ERCP. Axial CECT image showing necrosis in pancreatic head (p) with heterogeneous necrotic collections in the peripancreatic regions (arrows). Stent is noted in the bile duct (arrow heads)

Hemorrhage

Haemorrhage is an uncommon major complication occurring after ERCP, with an incidence of 0.3 to 2% [37]. It usually follows a sphincterotomy; other causes include stricture dilatation, biopsy and ablative therapy [38]. Risk factors for bleeding include coagulopathy, active cholangitis, anticoagulant therapy within 3 days of ERCP, operator inexperience (less than one case per week), observed bleeding during the procedure, pre-cut sphincterotomy and stenosis of the papillary orifice [37, 39]. According to the ASGE lexicon, bleeding with haemoglobin drop of less than 3 g/

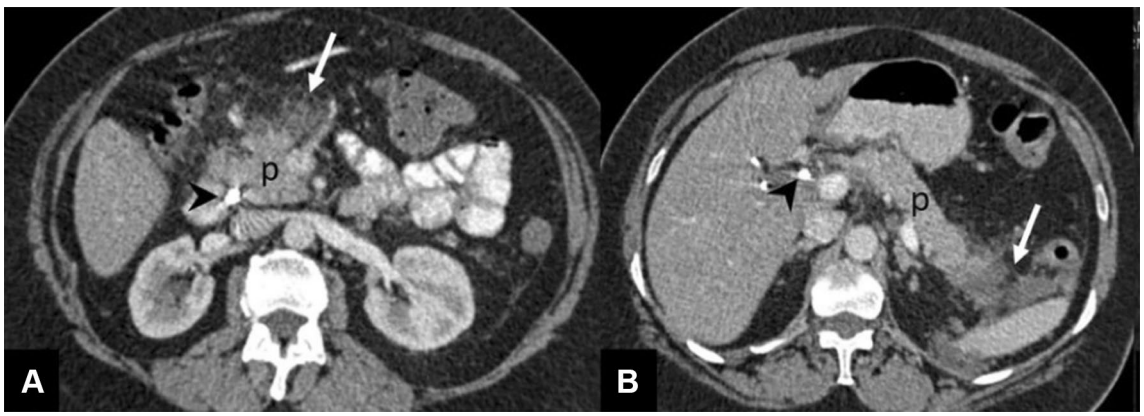

Fig. 1 58-year-old female presenting with pain in epigastrium, one day after ERCP. CECT images (**a**, **b**) showing bulky pancreas (p) with fat stranding and minimal fluid in the peripancreatic regions (arrows). Stent is noted in the bile duct (arrow heads)

dl and without need for transfusion is classified as mild, haemorrhage requiring blood transfusion or therapeutic angiographic procedures are classified as moderate and that requiring prolonged hospital (more than ten days) or intensive care unit stay (more than 1 day), or surgery is of severe variety [40].

Unenhanced CT scan may show hyperdense contents within the dilated biliary tract or in the duodenal wall (intramural hematoma) or lumen (Fig. 3). Hyperdense hepatic sub-capsular collection or hemoperitoneum may be seen due to rupture of the hepatic capsular vessels or biliary tree during guide wire manipulation or balloon dilatation (Fig. 4). Biliary stents may erode into the adjacent vessels and present with hematemesis or melena, due to hemobilia. Arterial phase CT scan images, in such cases, may show active contrast extravasation or a pseudoaneurysm adjacent to the stent requiring angioembolization (Fig. 5). The most common arteries or vascular territories involved in these cases are the anterior and posterior pancreaticoduodenal arteries [41].

Most of the patients who present with mild bleed are managed conservatively as they are self-limiting [36]. Moderate and severe bleeds need active management with repeat endoscopy and injection of epinephrine solution, fibrin or glue, hemoclip placement, balloon tamponade, electrocoagulation or temporary stent [42–45]. When endoscopic procedures fail, radiological or surgical intervention is required. Angiographic intervention is successful in 83–100% of the patients and should be considered before surgery [41, 46].

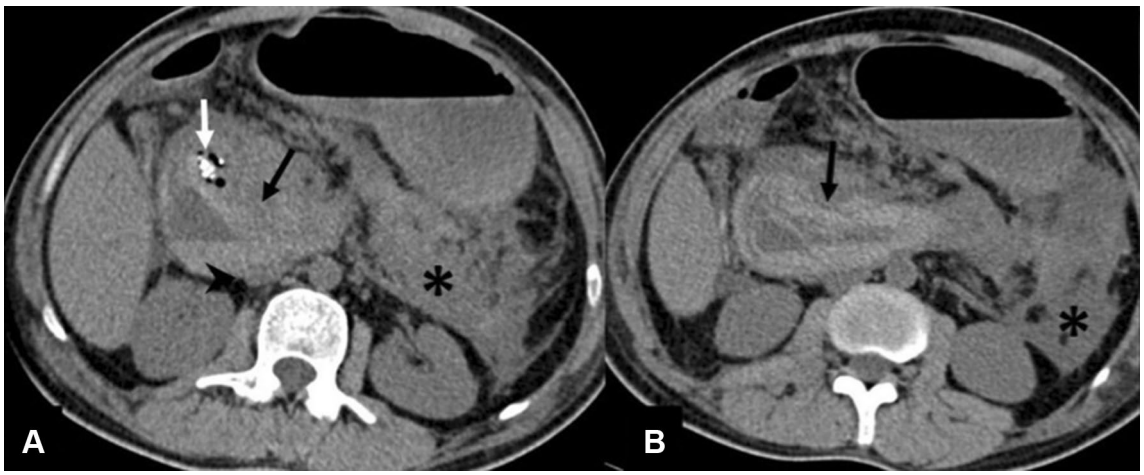

Fig. 3 34-year-old male presenting with acute pain abdomen, immediately after stenting. Axial (**a**, **b**) non-contrast CT scan showing thickened hyperattenuating duodenal wall with fluid level (black arrows) suggesting hematoma. Retroperitoneal inflammation (asterisk) and biliary stent (white arrow) is also seen

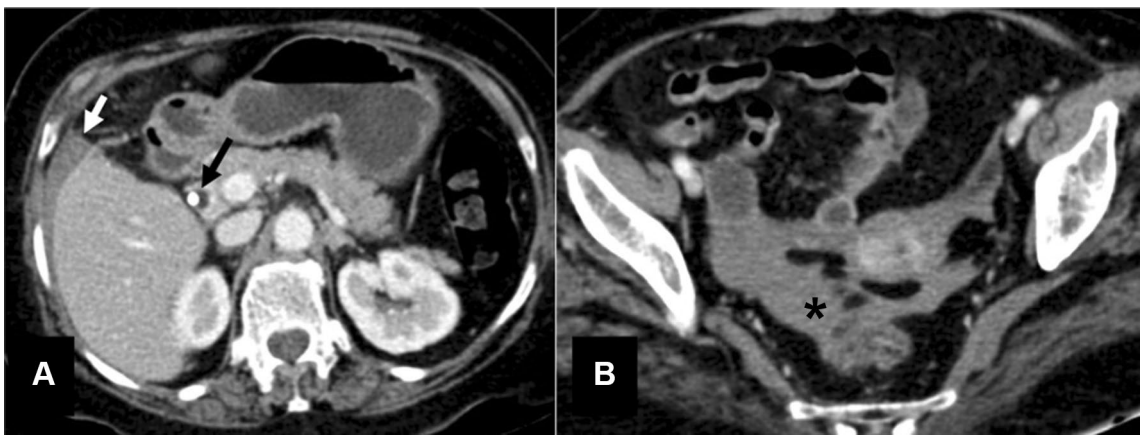

Fig. 4 69-year-old female presenting with pain abdomen and haemoglobin drop 1-day after ERCP. **a** and **b** Axial contrast enhanced CT scan showing high density fluid in perihepatic region (white arrow) and pelvis (asterisk), suggestive of hemoperitoneum. Stent is seen in the bile duct (black arrow). No source was identified on CT angiography

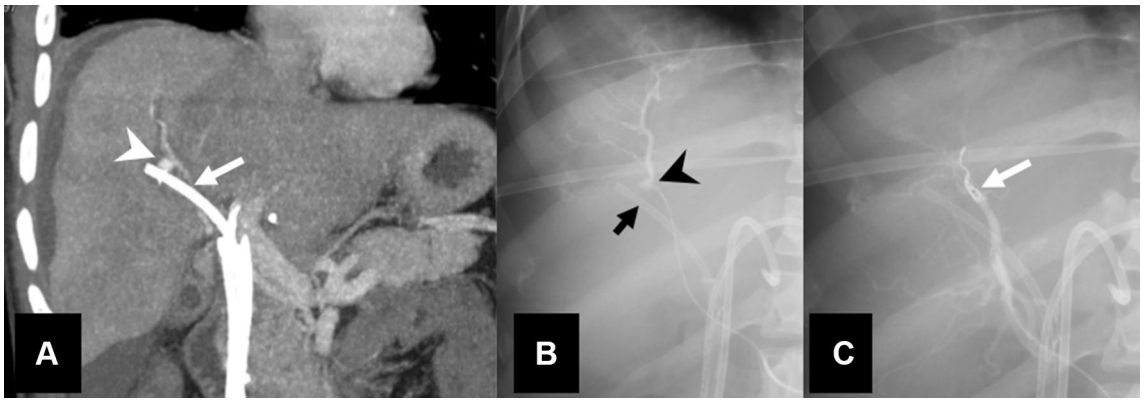

Fig. 5 32-year-old male presenting with history of melena, 2-months after biliary stenting. Coronal CT angiography (**a**) scan showing pseudoaneurysm (arrow head) from right hepatic artery (arrow) due to erosion by upper part of the stent. **b** and **c** Angiography showing the pseudoaneurysm (arrow head in **b**) from right hepatic artery, adjacent to the stent (black arrow in **b**), which was embolized using coils (white arrow in **c**)

Bowel perforation

Although, bowel perforation is rare, with an incidence of approximately 0.08% to 0.6%, it is one among the most lethal complications with a mortality rate of 9–18% [21]. Stapfer et al. [12] classified them into four types, based on the mechanism, anatomical location and decreasing order of severity to predict surgical necessity. Type I perforations include duodenoscope-induced duodenal wall perforations. Type II perforations include periampullary perforations of the duodenal medial wall due to biliary or pancreatic sphincterotomy or pre-cut papillotomy. Type III perforations comprise bile duct or pancreatic duct injuries. Type IV perforations are non-significant small retroperitoneal perforations due to excessive endoscopic insufflation combined with sphincter manipulation [12]. Risk factors include dilated CBD, stricture dilatation, sphincter of Oddi dysfunction, presence of peripapillary diverticula and previous Billroth II surgery [4, 10, 11].

Severe epigastric pain radiating to the back (mimicking PEP) dominate the clinical picture [36]. Initial epigastric tenderness may progress to generalized abdominal wall rigidity and subcutaneous emphysema and along with fever and tachycardia mark the onset of peritonitis often developing after 4 to 6 h. Untreated patients likely progress to Systemic inflammatory response syndrome (SIRS) after 12 h post endoscopy.

Post-ERCP duodenal perforation (DP) often mimics PEP and a delay in diagnosis could prove fatal. Therefore, there should be a low threshold to perform an abdominal CT scan (highest sensitivity) with water-soluble oral contrast material to assess for the presence of a perforation [47]. Presence of extra-luminal air is the imaging hallmark of DP. Additional signs include extra-luminal leak of contrast media and fluid collections. Air may be present in the duodenal wall, retroperitoneal or intraperitoneal compartments (Fig. 6). In type II DP, free air usually collects posterior to the duodenum and pancreatic head. It may also be seen in right perirenal and anterior pararenal space, and around the inferior vena cava (Fig. 7a). Rarely gas may be extending around the portal vein and splanchnic vessels, occasionally across the midline and also track into the posterior mediastinum (Fig. 7b). The amount of gas on imaging does not correlate with the patient outcome or invasive management as it is related to the amount of endoscopic air insufflation during the procedure after an undetected injury [48, 49]. Therefore, successful non-operative management is possible in type II DP even with extensive retroperitoneal air, if the patient is stable and without signs of peritonitis, fever or impending shock. Extra vigil must be kept in the elderly and chronically ill patients as they may not develop clinical signs of worsening.

The presence of peritonitis, SIRS, injury mechanism, location and degree of leakage determines medical or surgical management in the patients [49, 50]. Medical management is appropriate if the patient does not have peritoneal signs, SIRS or active leakage on CT. Such patients should be monitored clinically and with serial radiographs for 48 to 72 h to document the absence of progression. An oral contrast study may be done to rule out leak before the commencement of oral feeds on improvement of the patient's condition [51]. Small perforations usually seal-off by itself without signs of peritonitis. Larger perforation may lead to the formation of retroperitoneal or intraperitoneal collections, often bilious and infected (Fig. 8). These collections need drainage to prevent development of sepsis. Sometimes, when the perforation is diagnosed during ERCP, an endoscopic covered self-expandable metallic stent can be placed to seal the rent with reasonable success rates [52, 53].

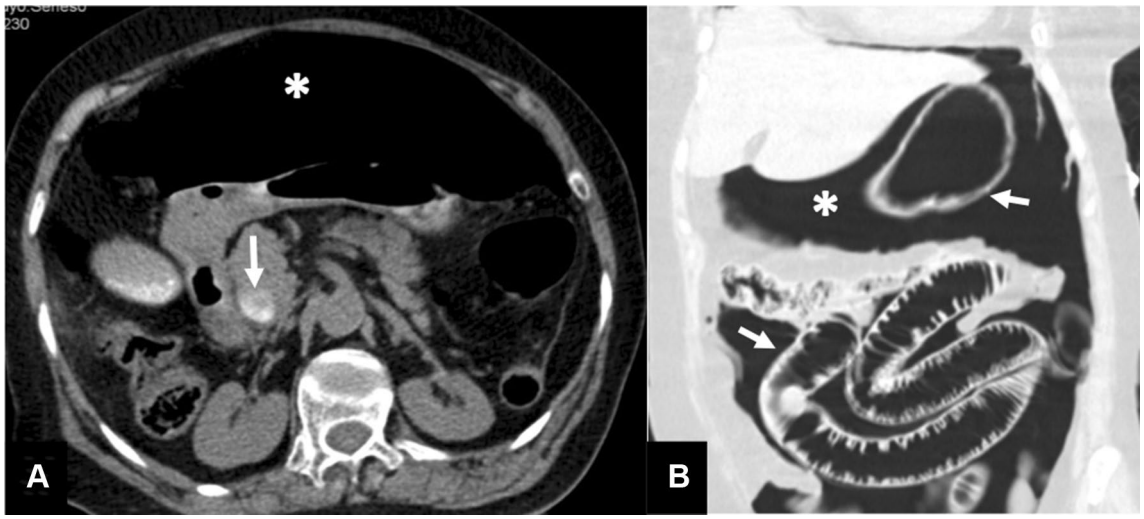

Fig. 6 60-year-old female presenting with abdominal pain, during ERCP. Non-enhanced CT scan, soft tissue (**a**) and lung (**b**) windows showing pneumoperitoneum (asterisk), outlining bowel (arrows in **b**). Contrast of ERCP is noted in the bile duct with characteristic layered appearance (arrow in **a**)

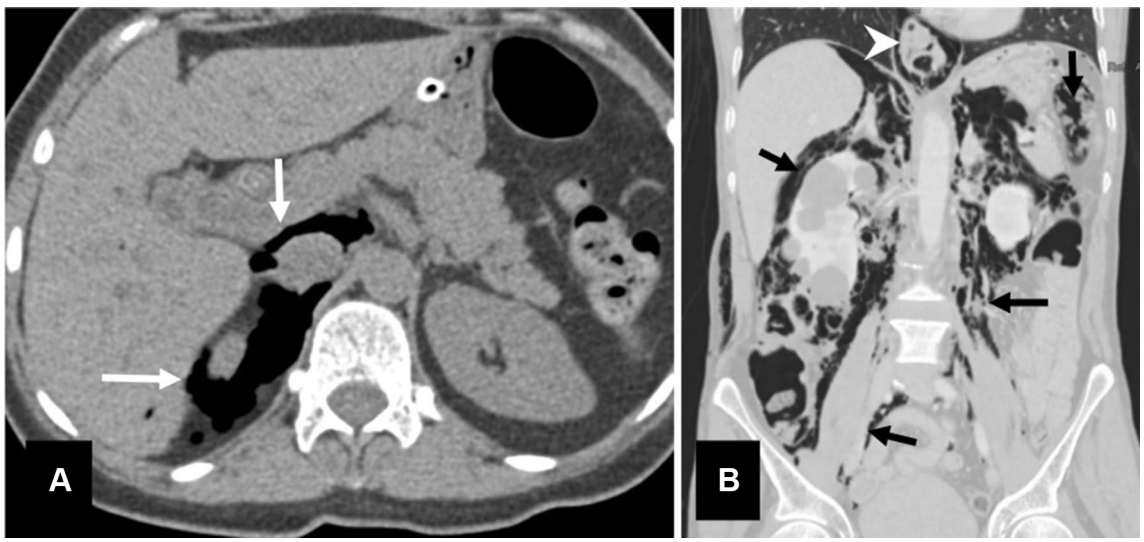

Fig. 7 **a** Axial non-contrast CT scan of a 52-year-old female presenting with abdominal pain, during ERCP, showing air in the retroperitoneum, around right kidney and inferior vena cava (arrows). **b** Coronal CT lung window image of a 65-year-old male, with abdominal pain, 1-day after ERCP showing extensive pneumo-retroperitoneum (arrows) and pneumo-mediastinum (arrow head)

Surgical management is necessary if peritonitis sets in. Imaging features such as pneumoperitoneum, periduodenal or retroperitoneal fluid collections, contrast leak at ERCP, CT or upper GI study, retained stones or foreign body warrant laparotomy. Presumed type 1 perforation and failure of conservative management are other indications for surgery [36, 54]. Surgery may include perforation closure or duodenal exclusion, drainage procedures, bile duct exploration and T-tube insertion.

One of the worst complications with high mortality following ERCP is combined severe acute pancreatitis and perforation which usually is a complication of a difficult ERCP procedure (Fig. 9) [55]. These patients are managed with an immediate surgical bypass for perforation and with standard management of pancreatitis.

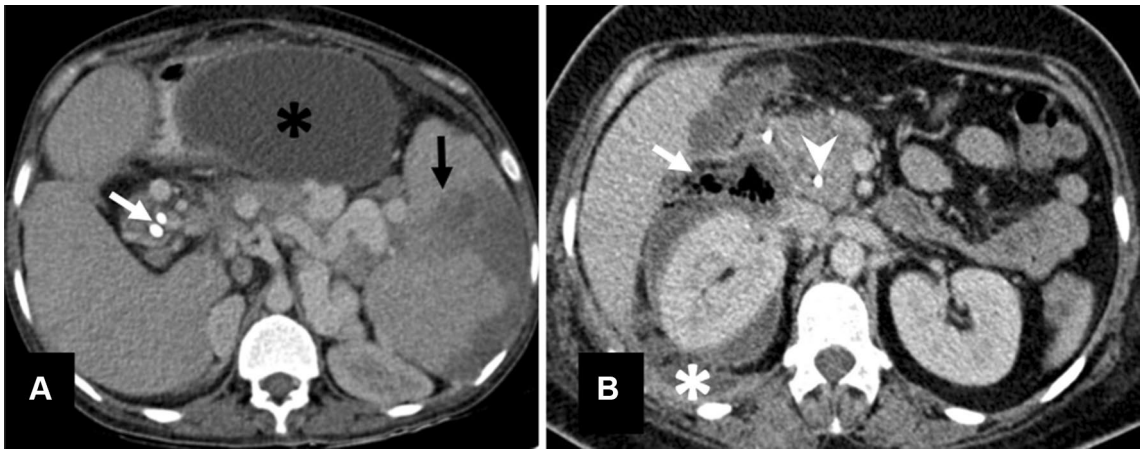

Fig. 8 **a** 22-year-old female with portal biliopathy, presenting with fever with chills, 1-week after stenting. Axial contrast enhanced CT scan showing sub-hepatic collection (asterisk), suggesting biloma. Stents are noted in bile duct (arrow). Black arrow indicates splenic infarct. **b** Axial CT images of a 42-year-old female with fever and pain in right lumbar region, 5-days after ERCP showing collection in right perinephric region (asterisk), with air foci (arrow), suggesting sealed-off perforation with abscess. Stent is noted in bile duct (arrow head)

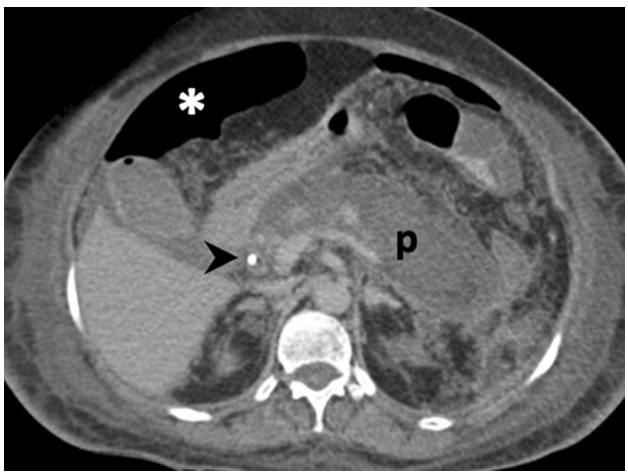

Fig. 9 50-year-old female presenting with diffuse pain abdomen, three-days after ERCP. Axial contrast enhanced CT scan showing diffuse necrosis of pancreas (p) with inflammation in the peripancreatic region and pneumoperitoneum (asterisk). Stent is noted in the bile duct (arrow head)

Cholangitis

Cholangitis is seen in 0.5–3% of patients following ERCP [56, 57]. Typical clinical presentation includes fever, jaundice, and abdominal pain (Charcot's triad) [8]. Additionally, hypotension and altered mental status (Reynold's pentad) develops when systemic sepsis sets in.

Cholangitis is more likely seen in patients in whom incomplete biliary drainage is performed (Fig. 10a) or in liver transplantation recipients. The obstructed system, once infected, leads to reflux of the microorganisms into the bloodstream, due to raised intrabiliary pressure, subsequently leading to sepsis. Therefore, if incomplete biliary drainage is anticipated, prophylactic antibiotic coverage against biliary flora is indicated. Stents which are placed via ERCP may get blocked leading to a delayed presentation of cholangitis (Fig. 10b).

In a patient with clinically suspected cholangitis, the role of imaging is to identify the cause. Ultrasonography should be performed initially to look for biliary dilatation or cholangitic abscesses. CT scan and MRI may demonstrate nonspecific findings such as enlarged (> 10 mm), hyperenhancing bulging papilla, thickened enhancing bile duct walls, and periportal T2 hyperintensity and (or) diffusion restriction in addition to biliary dilatation [58, 59]. Liver parenchyma may show marked inhomogeneous enhancement in the late arterial phase or (and) parenchymal cholangitic abscesses (Fig. 10c) [58].

Management necessitates immediate drainage of the obstructed system either via the percutaneous or endoscopic route along with systemic antibiotics. To minimize the risk of chemical cholangitis, only the ducts of the non-atrophic segments that could be stented and drained should be injected with contrast. Patients in whom complete stone removal is not possible must be stented.

Cholecystitis

Acute cholecystitis is thought to occur due to the contamination of the gall bladder by contaminated iodinated contrast in the setting of gall bladder dyskinesia or obstruction of

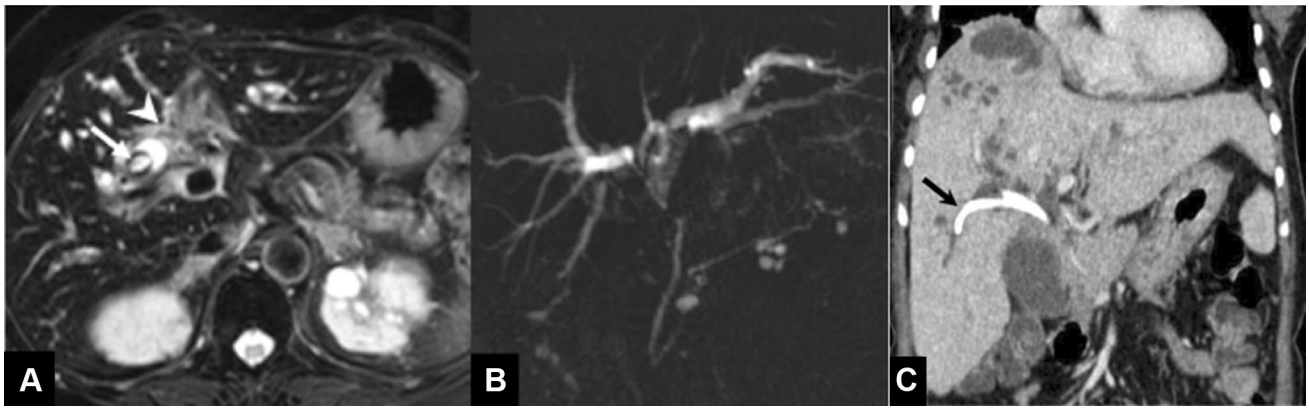

Fig. 10 **a** 61-year-old male with mid common bile duct cholangiocarcinoma, post stent placement, presenting with fever with chills after 1 month. **a** Axial T2-weighted MR image showing blocked stent (arrow) with bile duct wall thickening (arrow head) suggesting cholangitis. **b** MRCP shows bilobar biliary dilatation due to stent block. **c** Coronal CT of a 45-year-old female with history of stent placement for proximal bile duct cholangiocarcinoma, presenting with fever with chills, two-months after stenting showing multiple abscesses in right lobe of liver, suggesting cholangitis due to stent block. Stent is noted in the bile duct (arrow)

the cystic duct [36]. The obstruction in the cystic duct may act as a ball-valve allowing contrast to enter the gall bladder during the injection of contrast but not allowing drainage. A recent study by Cao et al. [60] found history of acute pancreatitis or chronic cholecystitis, metallic stent placement in biliary duct, elevated leucocyte counts before ERCP as additional risk factors. Clinical presentation may be similar to cholangitis with abdominal pain and imaging is necessary to make the correct diagnosis. Ultrasonography may show a distended gall bladder with thickened wall and (or) pericholecystic fluid. Cross-sectional imaging may show an additional finding of abnormal wall enhancement (Fig. 11a) [61]. Non treated advanced cases may lead to gall bladder perforation significantly increasing the rate of morbidity and mortality (Fig. 11b).

Stent-related complications

Acute complications due to biliary or pancreatic stent are relatively uncommon and include hemorrhage (Fig. 3), pancreatitis, stent misplacement (Fig. 12a, b) and injury to the CBD or main pancreatic duct [62]. Patients with stent-induced perforations without clinical manifestations of peritonitis are managed by endoscopic removal. If complicated by peritonitis or fluid collections surgical management is required [63].

Stent obstruction (most common, 25–30%), migration, fracture and collapse are chronic complications. Stent migration occurs in about 6% of cases, especially with plastic stents and may be proximal or distal, commonly

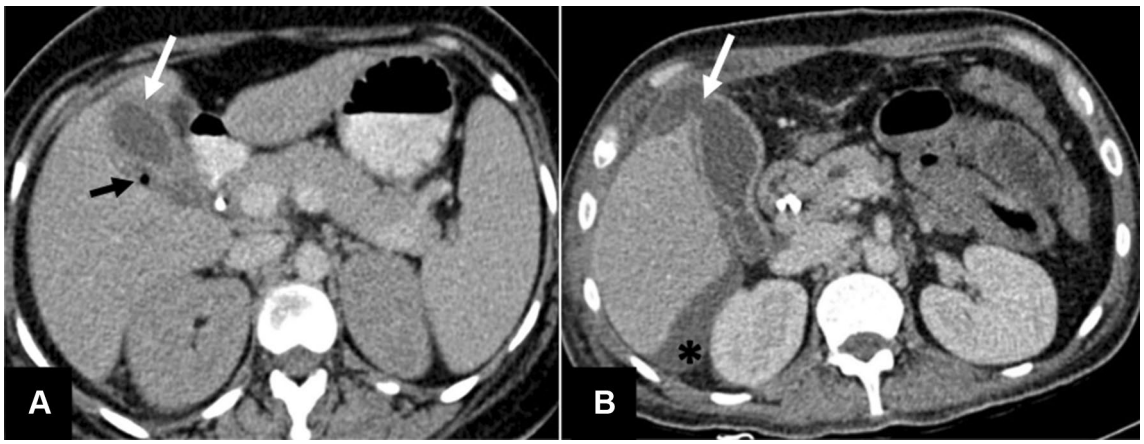

Fig. 11 **a** Axial CT scan of a 32-year-old female presenting with pain in right hypochondrium, 3-days after stenting, showing diffuse wall thickening of the gall bladder (white arrow) with air focus in the wall (black arrow) suggesting acute cholecystitis. **b** Axial CT scan of a 38-year-old male presenting with pain in right hypochondrium, 6-days after stenting showing rent in the wall of the gall bladder (white arrow) with perihepatic collection (asterisk) suggesting perforation

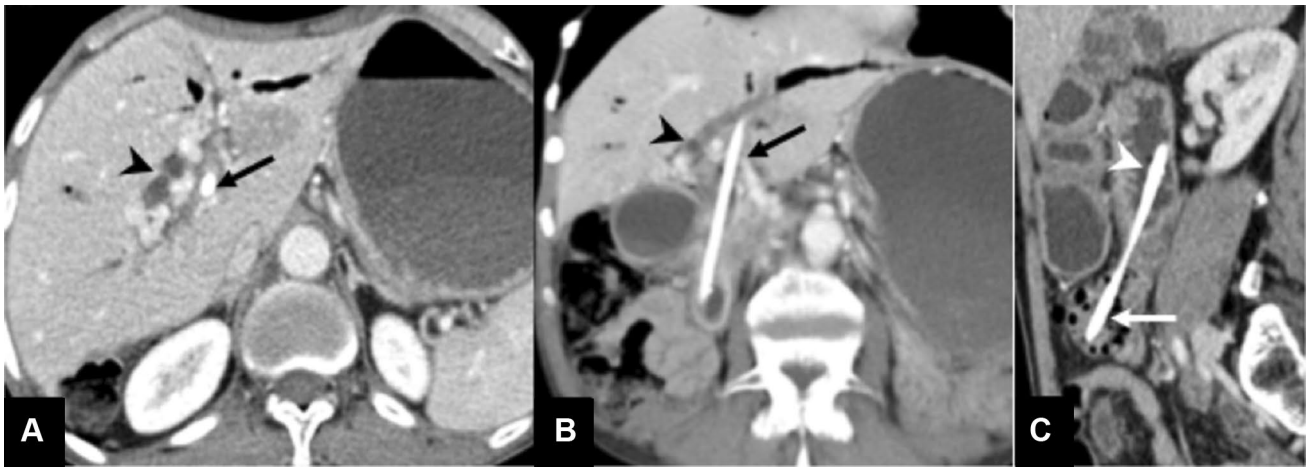

Fig. 12 Axial (**a**) and Coronal (**b**) CT scan of a 65-year-old male with portal biliopathy, presenting with abdominal pain, 3-weeks after stenting, showing misplaced stent perforating through bile duct wall (arrow) with dilated ducts (arrow head) and pneumobilia. **c** Sagittal CT scan of a 45-year-old female with abdominal pain, 1 month after stenting, showing upper part of stent in the duodenum (arrow head) and lower part in transverse colon (arrow) suggesting perforation into colon (distal migration)

into the intestine [64] (Figs. 12c, 13). Obstructed stents are conspicuous by the absence of pneumobilia in the bilary tree in addition to biliary dilatation [65]. The obstructed plastic stents are replaced via endoscopic approach. In case of metallic stents, a second stent within the lumen of the occluded stent is recommended. Endoscopic stent retrieval is recommended for migrated stents that are not spontaneously expelled [66].

Air embolism

Trauma or inflammation of the bile ducts can lead to direct communication of its vasculature with air in the bile duct or the gastrointestinal tract. Due to the pressure gradient which could be exacerbated by air insufflation during endoscopy, air freely enters into the circulation. Venous embolism is diagnosed by portovenous gas on imaging and is managed conservatively [67]. On suspicion of intracardiac or intracerebral air embolism, after initial resuscitation, CT scan of the chest, head and a transthoracic echocardiogram should be performed to assess for air foci [68].

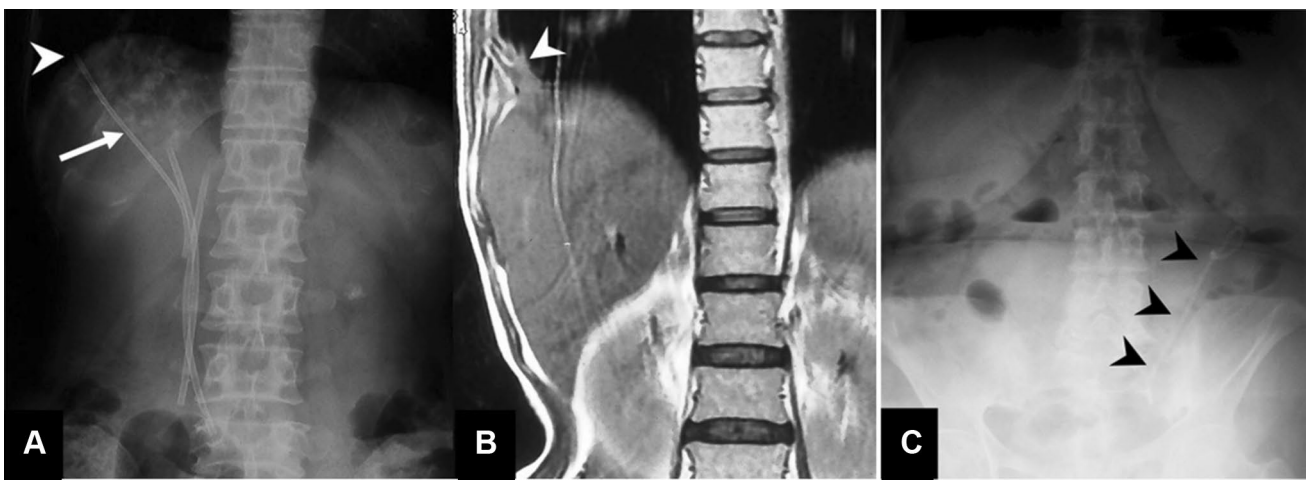

Fig. 13 **a** and **b** 44-year-old female with biliary stones, presenting with chest pain, 2-weeks after stenting. Plain radiograph (**a**) and coronal MRI (**b**) showing course of stent through the liver (arrow) into right pleural cavity (arrow head) suggesting perforation (proximal migration). **c** Abdominal radiograph of a 73-year-old female showing migrated biliary stent in the descending colon (arrow heads)

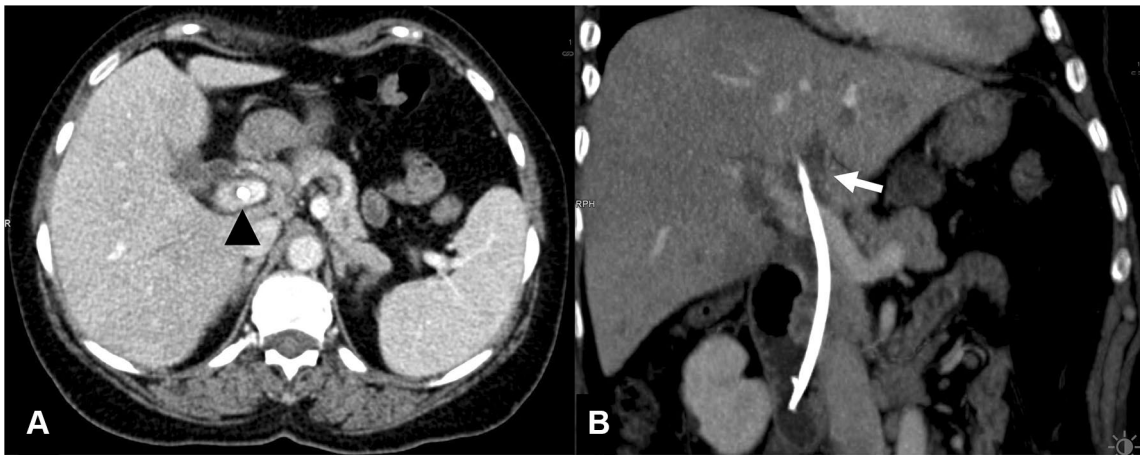

Fig. 14 53-year-old female with periampullary tumour presenting with abdominal pain and melena, 2 days after ERCP stenting. Axial (**a**) and coronal (**b**) CECT sections show stent perforating the main portal vein (arrowhead in **a**) and thrombosis of left portal vein (arrow in **b**)

Other complications

ERCP has also been associated with ileus, pneumothorax, hepatic abscess formation, pseudocyst infection, and biliary or pancreatic duct fistulae after the procedure [36]. Accidental portal vein cannulation or stenting and thrombosis are other reported complications(Fig. 14) [69, 70]. Rarely, splenic injury has been reported due to traction forces applied while passing the endoscope through the stomach's greater curvature [71]. ERCP accessory related complication such as impacted retrieval basket around a large calculi has also rarely been reported [72].

Conclusion

Complications after ERCP, though relatively uncommon, can cause significant morbidity and mortality if not diagnosed early and treated appropriately. Close vigil should be kept on these patients immediately following ERCP keeping a low threshold for immediate CT scan whenever necessary. Knowledge of the techniques of ERCP with their potential complications and familiarity with the correct imaging technique, normal findings and imaging appearances of complications are crucial in the appropriate management of these conditions.

Compliance with ethical standards

Conflict of interest We authors declare that there are no disclosures to make.

IRB statement This review article does not need IRB clearance.

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