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Percutaneous Transhepatic Cholangiography and the Role of Interventional Radiology in Biliary Obstructions

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The biliary tree is a network of branching ducts responsible for draining the bile produced in the liver. Bile is created by the hepatocytes and altered through resorption and secretion by the biliary epithelium. Bile is 95% water and contains bile salts, cholesterol, amino acids, steroids, bilirubin phospholipids, enzymes, porphyrins, vitamins, heavy metals, and environmental toxins [1]. Bile functions to excrete bile salts and other substances too large to be readily excreted by the kidney. Bile salts emulsify dietary fats to aid absorption in the intestines. Bile is also a major source of the excretion of cholesterol, hormones, IgA, and pheromones. Furthermore, the exocrine pancreas secretes pancreatic enzymes and bicarbonate that break down carbohydrates, protein, and fat. Any traumatic, infectious, benign obstructive, or malignant alteration in the creation and excretion of bile can lead to a profound disruption in the function of the hepatobiliary system.

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Anatomy and Imaging of the Hepatobiliary System

The liver is composed of nine functional segments (left liver, II, III, IVA, IVB; right liver, I, V, VI, VII, VIII). Classically, the celiac artery branches into the splenic and common hepatic artery. Beyond the gastroduodenal artery, the proper hepatic artery branches into right and left hepatic branches. For the hepatic venous system, there are typically right (drains segments V, VI, and VII), left (drains segments II and III), and middle (drains segments IV, V, and VIII) hepatic veins which drain into the intrahepatic IVC. The caudate lobe (segment 1) typically drains directly into the IVC. In normal portal venous anatomy, the main portal vein bifurcates in the porta hepatis into right and left intrahepatic branches. The right portal vein branches into anterior and posterior branches [2].

Normal biliary tree anatomy occurs in approximately 58% of patients [3]. Anterior (segments VI and VII) and posterior (segments V and VIII) sectoral ducts drain the right liver into the right hepatic duct, while the left hepatic duct drains the left liver. The left and right hepatic ducts form the common hepatic duct. The cystic duct drains into the common hepatic duct to form the common bile duct.

The pancreatic duct most typically takes on a linear descending course but can have a sigmoid, vertical, or loop configuration. The most common

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configuration of the pancreatic duct is a bifid main pancreatic duct with dominant drainage through the duct of Wirsung and the sphincter of Oddi and minor drainage through the accessory duct of Santorini [4].

Malignant Biliary Obstruction

Malignant biliary obstruction occurs as a result of cholangiocarcinoma, pancreatic adenocarcinoma, hepatocellular carcinoma (HCC), gallbladder carcinoma, porta hepatis lymphadenopathy, duodenal carcinoma, and an ampullary carcinoma. Patients with biliary obstruction typically present with painless jaundice, scleral icterus, weight loss, nausea, and pruritus. A potentially catastrophic consequence of biliary obstruction is cholangitis presenting with leukocytosis, sepsis, and hemodynamic instability.

Imaging of biliary obstruction typically begins with right upper quadrant ultrasound which leads to cross-sectional imaging with contrast-enhanced CT if a biliary duct mass is suspected. MRCP and gadolinium-enhanced MRI of the abdomen continue to represent mandatory modalities in the preprocedure evaluation of the biliary system. When differentiating between benign and malignant strictures, MRCP is 96% sensitive and 85% specific [5, 6].

Percutaneous interventions usually represent second-line therapies when endoscopic interventions are technically unfeasible or complicated as with a history of Roux-en-Y gastric bypass. The choice between percutaneous biliary drainage and endoscopic biliary drainage remains controversial but has similar technical and therapeutic success rates. Drainage can be performed with pure external biliary bag drainage or internal-external stent drainage when the small bowel can be accessed. As a result of catheter dislodgement, clogging of the catheters, and cholangitis, the catheters should be assessed and changed every 3 months (Figs. 19.1 and 19.2).

A hepaticogastrostomy which connects the hepatic duct to the stomach is a worthwhile option in patients with complete central or common bile duct obstruction and the inability to pass a wire into the duodenum. The cause of obstruction may be the result of iatrogenic bile duct injury during cholecystectomy or hepatectomy, a therapy which has become more frequent in the treatment

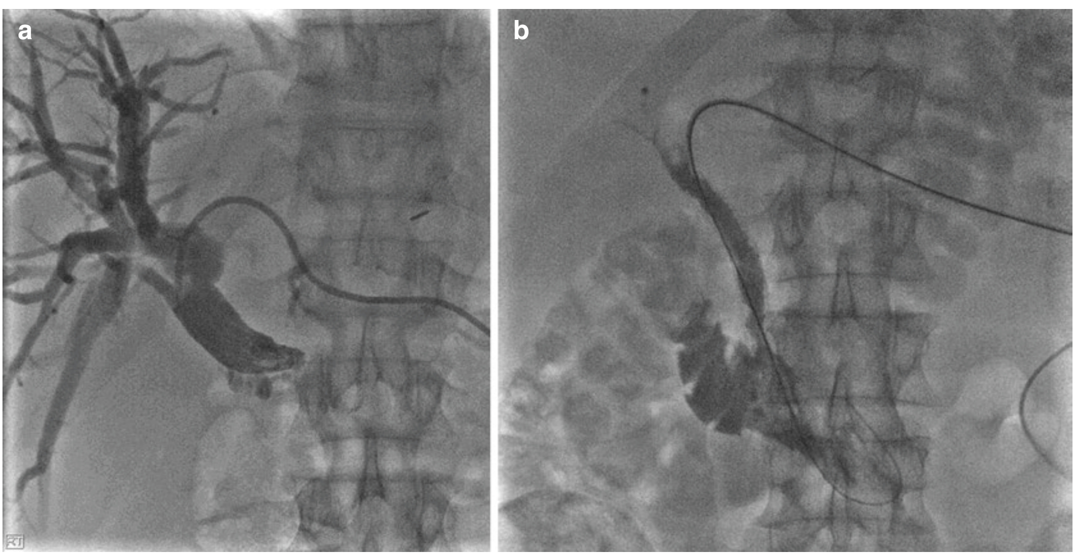

Fig. 19.1 (**a**) The image on the left demonstrates a left-sided approach for percutaneous biliary drainage using ultrasound guidance. There is complete obstruction of the distal common bile duct as a result of advanced gastric carcinoma. (**b**) Wire access to the duodenum and deployment of a self-expanding bare-metal stent

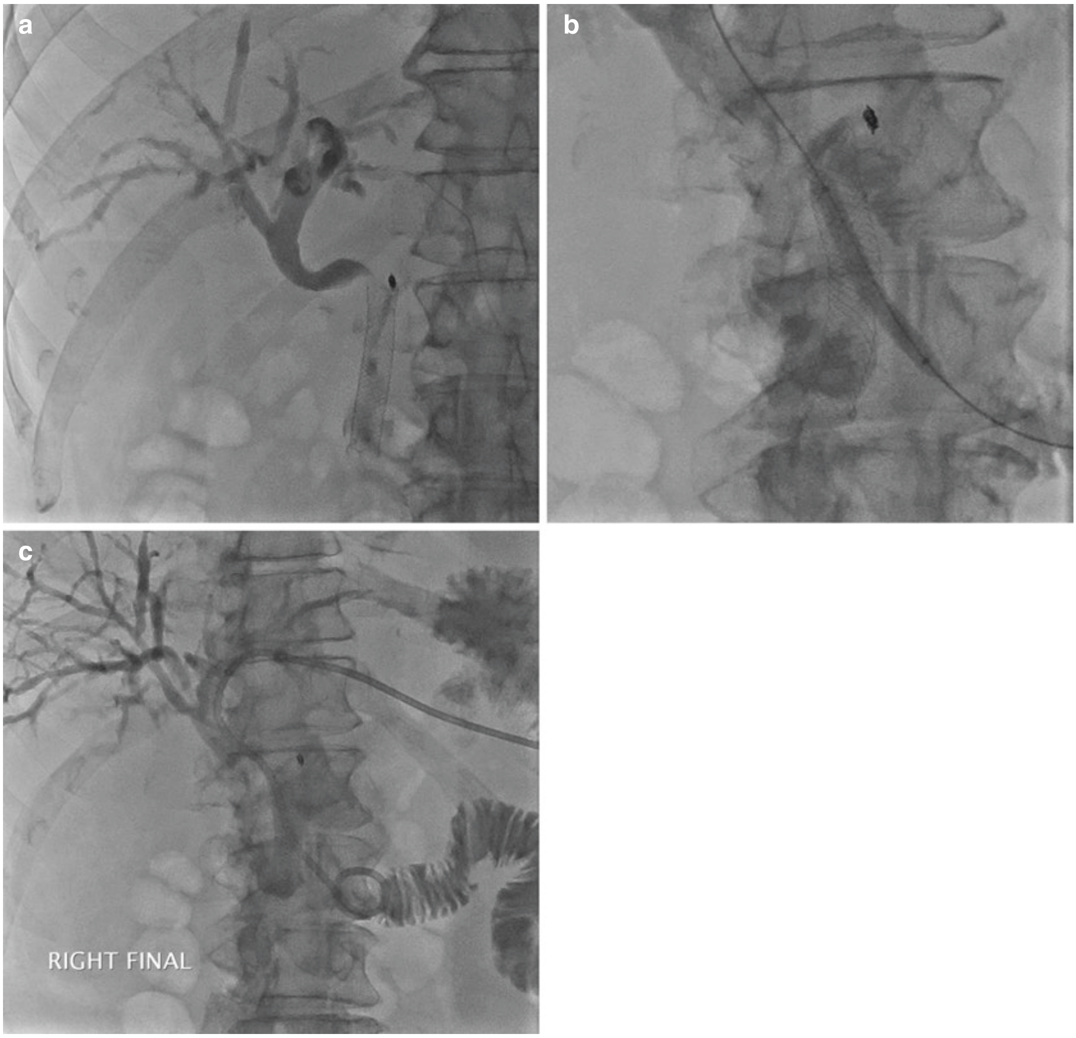

Fig. 19.2 (**a**) Occluded and migrated bare-metal stent previously placed endoscopically for malignant pancreatic carcinoma. (**b**) Wire access to the duodenum through the interstices of the stent was obtained, and they were ballooned open. (**c**) Internal-external biliary drainage catheter placement maintaining access in the event a tube change is required. The internal-external drain provides the characteristics of a metal stent while maintaining access

of metastatic colorectal carcinoma, or a central malignancy. The procedure can be done both endoscopically with EUS guidance and percutaneously, and it allows the biliary tree to drain into the stomach.

To perform a hepaticogastrostomy, a percutaneous biliary drain is initially placed, and CT cholangiogram is subsequently performed to evaluate for a straight segment III bile duct adjacent to the lesser curvature of the stomach. A nasogastric tube is placed to insufflate the stomach. Using CT guidance, a percutaneous, transhepatic pexy suture (similar to those placed during simple gastrostomy) is deployed within the stomach. Using the previously placed percutaneous biliary access, a TIPS needle is inserted through a sheath into the segment III bile duct. A needle is used to puncture through the wall of the stomach, and a wire is passed into the gastric lumen. An internal-external biliary drain can then be inserted over the wire similar to drainage into the duodenum. Once the tract has matured after 4–6 weeks, a self-expanding stent can be deployed into the hepaticogastric tract, and the percutaneous drain can be removed. In small-numbered studies, the mean patency was 234 days with jaundice-free rates of 100%, 96%, 93%, and 80% at 1-, 3-, 6-, and 12-month follow-up. The reintervention rate was approximately 14% [7].

The absence of intestinal bile can play a role in the development of septic complications in these patients [8]. Additionally, the rate of renal dysfunction can be as high as 25% in patients receiving external biliary bag drainage which may be the result of altered hemodynamics and dehydration or the nephrotoxic effects of increased serum bilirubin in the circulation [9]. Furthermore, percutaneous biliary drains can be associated with pain and discomfort which can significantly affect a patient's quality of life.

The complication rates of percutaneous and endoscopic interventions range from 4% to 7%. The risks include sepsis, bleeding, pancreatitis, and pneumothorax (which can lead to biliary pleural fistulae). Care is taken during biliary access and drainage of the biliary system under pressure as a result of obstruction due to the risk of intraprocedural sepsis and hypotension. Percutaneous biliary drainage can lead to bile peritonitis and subcapsular liver abscess. Hemobilia following percutaneous biliary drainage is suggestive of a fistulous communication between the biliary tree and hepatic vasculature. Angiography of the liver requires removal of the drain over a wire to remove the tamponade effect of the catheter which can obscure the culprit bleeder. Once the arterial bleed is identified, embolization can be performed.

Stenting

Across multiple studies, the patency rate for metal stents lies within a 5-month range which matches survival rates for metastatic pancreatic adenocarcinoma [10]. Furthermore, the higher reintervention rate seen with plastic stents makes metal stents desirable for maintaining biliary patency.

Preservation of the sphincter of Oddi is important when possible to maintain sphincteric integrity and to avoid reflux of small bowel contents which can lead to ascending cholangitis. Different configurations of stent deployment can be used: isolated common bile duct, Y-shaped, and inline stent deployment to preserve the functioning lobe contralateral to a lobe with significant cirrhotic change. Care should be given not to "jail" biliary tributaries when placing covered stents. Exopolysaccharide matrices and intestinal microbes can form a biofilm which on self-expanding bare-metal stents can create a configuration similar to covered stents further contributing to stent failure and biliary obstruction [11].

Benign Biliary Obstruction

There are multiple potential causes of benign biliary strictures. Benign biliary strictures are iatrogenic from orthoptic liver transplantation or cholecystectomy 80% of the time; but other causes include primary sclerosing cholangitis, IgG4 cholangitis, HIV cholangiopathy, recurrent pyogenic cholangitis, chronic or autoimmune pancreatitis, and chemotherapy-induced cholangitis [12]. Biliary stricture can occur in 0.2–0.89% of laparoscopic cholecystectomies [13]. The Bismuth classification is used to characterize benign biliary strictures. Type I biliary strictures occur 2 cm from the hepatic confluence, Type II occur within the confluence, Type III involve the confluence, Type IV disrupt the confluence, and Type V extend into an aberrant right hepatic duct branch.

Endoscopic management includes the use of balloon angioplasty, plastic stents, and covered stents. In 43% of cases, restenosis occurs following balloon angioplasty [14–16]. Uncovered bare-metal stents are rarely used due to the risk of becoming embedded as a result of epithelial hyperplasia [17].

Postoperative changes in the GI anatomy may preclude treatment via an endoscopic approach. Aside from irreversible coagulopathy, there are no contraindications to percutaneous biliary access. Occasionally, a *rendezvous* procedure can be performed in collaboration with the endoscopists [18]. After obtaining wire access across a benign stricture, balloon dilation and placement of an internal-external biliary drain can be performed. Similar to the endoscopic approach, stones can be retrieved or pushed through the sphincter of Oddi using cutting balloons to perform a sphincterotomy. In some tertiary care centers, cholangioscopes can be inserted through a dilated antegrade percutaneous tract [19]. Ballooning of a postoperative anastomosis should not be performed in the perioperative period since this can result in further damage and a biliary leak. In cases of complete occlusion, sharp recanalization techniques can be employed using TIPS needles, the back end or a stiff wire, or an RF wire [20]. Sequential cholangiograms with upsizing of the biliary drains for a period of 6–12 months can lead to drain removal. The 1-year patency rate using this technique reaches 84%, 5-year patency rate of 74%, and 10-year patency of 67% [21]. When placed percutaneously, fully covered common bile duct stents have a 1-year patency rate of 91% [22]. The downfalls of both endoscopically and percutaneously placed stents include stent migration and restenosis at each end of the stent. Retrievable biliary stents have gained favor in the treatment of benign biliary strictures. In a study by Gwon et al., 100% of the stents were retrieved, and repeat stent placement for recurrent strictures was performed in 9% of the patients [23] (Fig. 19.3).

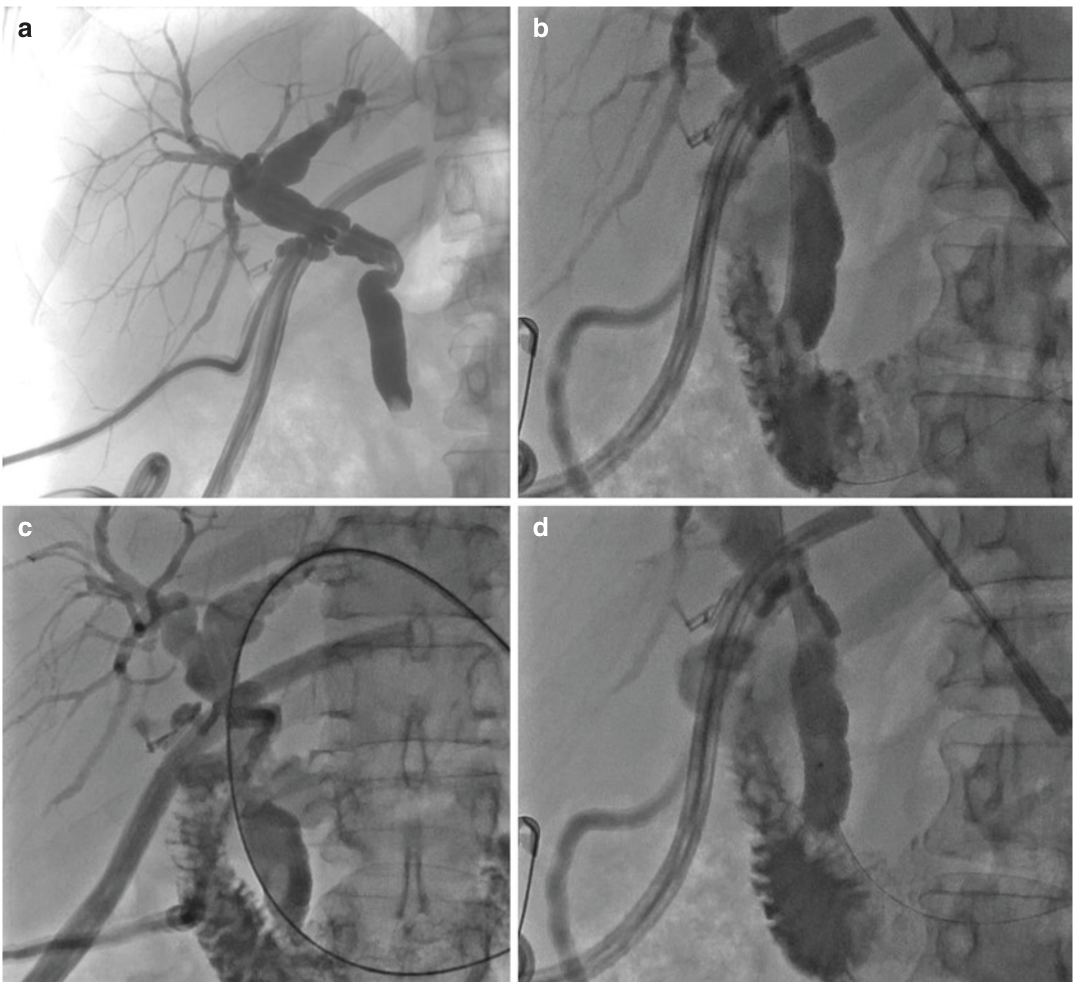

Fig. 19.3 (**a**) T-tube cholangiogram in a 28-year-old female following cholecystectomy at an outlying facility. An obstructive stone is noted in the distal common bile duct. The patient's past medical history is significant for previous gastric bypass precluding endoscopic treatment. (**b**) Left-sided biliary access was obtained. (**c**) Access to the duodenum was subsequently obtained, and a sphincterotomy was performed using a cutting balloon. (**d**) Completion images demonstrate absence of the stone and patency of the distal common bile duct

Future Therapies

Magnetic compression anastomosis (MCA) is a compelling technique that can be used in short inline anastomoses. MCA functions by placing high strength magnets both percutaneously and endoscopically on either side of the obstruction. Over time, the magnets attract one another, and through necrosis of the tissues between magnets, a biliobiliary fistula is formed [24].

On the horizon, biodegradable biliary stents may represent the future in the treatment of benign biliary strictures. Studies performed mostly in Europe have shown that the placement of biodegradable biliary stents is safe and feasible; however additional studies are required [25, 26].

Conclusions

The role of interventional radiology is crucial in the treatment of acute cholangitis to relieve the obstructed common bile duct, especially if the biliary tree cannot be accessed by endoscopic means. Hemodynamically unstable patients should be addressed with the utmost urgency if the instability is thought to be due to the ascending cholangitis from an acute obstruction. But IR therapy can also play an important role in the relief of biliary obstruction due to malignancies, strictures, or pancreatitis. IR maneuvers can be utilized to help decompress the biliary tree, and new techniques using magnets are also being deployed to bypass the obstructed segment. The endoscopic and IR therapies can prevent the use of technically demanding surgeries in the acute setting and allow for transfer from the acute care surgeon's care to a hepatobiliary specialist, who is probably better suited to performing a biliary-enteric anastomosis.

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