Chapter 7
Benign Bile Duct Strictures and Bile Leaks

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Benign Biliary Strictures

Introduction

The clinical presentation of biliary obstruction can include multiple signs and symptoms depending on etiology and chronicity. Acute biliary obstruction can lead to abdominal pain, infection (cholangitis), and marked elevations in liver transaminases with delayed elevations in bilirubin, as is often seen in pancreaticobiliary lithiasis [1]. Subacute or chronic obstruction can result in varying degrees of abdominal symptoms including pain, nausea, and vomiting, as well as jaundice, pruritus, dark urine, light-colored stools, and significant elevation in bilirubin [2].

Case 1

A 62-year-old man with cirrhosis due to hepatitis C has undergone a liver transplant. Six months after transplant, the

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patient presented with elevated transaminases and mildly elevated total bilirubin, with concerns for development of biliary anastomotic stenosis. The patient had undergone a living donor liver transplant and received the right lobe of the donor liver. The right anterior duct was anastomosed to the recipient common bile duct via *a duct-to-duct anastomosis, while the right posterior duct was anastomosed* via *a Roux-en-Y hepaticojejunostomy.*

Diagnosis and Assessment

The clinical presentation of biliary strictures following liver transplant can be highly variable, with some patients remaining asymptomatic, while others presenting with anorexia, pruritus, fever, abdominal pain, and weight loss. In asymptomatic patients, elevated transaminases and total bilirubin should raise suspicion for biliary anastomotic stenosis.

Benign biliary strictures result in biliary obstruction and can lead to all of the above symptoms depending on etiology, which is determined by patient history, comorbid conditions, lab results, and imaging studies [3]. Noninvasive radiographic studies for evaluating the biliary system would include abdominal ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) of the abdomen.

Etiologies of benign bile duct strictures are diverse and can be divided into four categories: iatrogenic (postsurgical, post-sphincterotomy, postradiation), inflammatory (pancreatitis, cholangitis, autoimmune), ischemic, and others (papillary stenosis, extrinsic compression, trauma, etc.) [4]. Cholecystectomy and liver transplantation are the most common causes of postsurgical biliary strictures, with a bile duct injury occurring in 0.5% of patients following cholecystectomy and anastomotic stricture occurring in 13–25% of patients following liver transplant [5–8]. The incidence of common bile duct stricture in patients with chronic pancreatitis ranges between 3% and 46% [9, 10].

Treatment and Management

Endoscopic retrograde cholangiopancreatography (ERCP) is considered the first-line treatment option for benign biliary strictures and has been shown to be safe and effective, with excellent long-term results [4, 11, 12]. Techniques used for treatment during ERCP include dilation of the stricture and subsequent stent placement to bridge the stenosis with either multiple plastic biliary stents or a fully covered self-expandable metal stent (FCSEMS).

Balloon dilation followed by stent placement remains the mainstay of treatment for benign biliary strictures [4]. Specifically, for benign biliary strictures, the European Society of Gastrointestinal Endoscopy (ESGE) recommends placing temporary simultaneous plastic stents with re-evaluation and exchange every 3 months for up to 12 months [13]. More recent studies have shown that FCSEMSs are also effective and potentially preferable in certain circumstances.

Endoscopic management with ERCP is considered the first-line management approach to biliary strictures following liver transplant [4]. If a biliary anastomotic stenosis is encountered, a guidewire is advanced past the stricture, and balloon dilation is performed, followed by placement of plastic biliary stents. The stricture should be dilated to the diameter of the donor duct, typically ranging from 4 to 10 mm, progressively increasing in subsequent ERCPs. ERCP is repeated every 3 months to re-examine the stricture site, with greater number of plastic stents placed. Procedures can be stopped once resolution of the stricture is noted, and all stents have been removed [14]. This strategy is safe and effective, with about four ERCPs required, and resolution in 66–100% of patients [4, 12, 15].

Despite the success of endoscopic treatment with multiple plastic stents, fully covered self-expandable metal stents (FCSEMS) have been used in the treatment of posttransplant biliary anastomotic strictures in recent years. One small randomized trial showed similar efficacy of FCSEMS compared to multiple plastic stents resulting in similar success and complication rates, but with fewer overall number of procedures required, leading to cost-effectiveness of the FCSEMS [16]. However, stent migration of FCSEMS is of significant concern, occurring in 33% of patients in a recent prospective, randomized trial [17], and there is potential for a higher number of adverse events [18]. In another study using FCSEMS comparing patients who had failed multiple plastic stents and those who had no previous endoscopic therapy, the rate of stent migration of FCSEMS was still 33%, though stricture resolution was achieved in 72% of patients who had previously failed therapy [19]. Hence, the standard approach of multiple plastic stents is preferred as the primary modality in endoscopic therapy of posttransplant biliary anastomotic strictures, with the use of FCSEMS reserved for when the standard approach fails [14, 19].

Living donor liver transplants (LDLTs) constitute about 5% of all transplants in the United States, with the overall number significantly varying between UNOS regions, and only a few specific centers performing ten or more per year [20]. In the United States, LDLT has been shown to reduce mortality on the transplant waiting list and possibly improve 5-year survival when compared to deceased donor liver transplant (DDLT) [21, 22]. As noted above, biliary complications following liver transplant are common. However, the risk of biliary complications is significantly higher in patients undergoing LDLT when compared to DDLT, a finding that has been observed in multiple studies [23–26].

Patients having undergone LDLT who experience biliary anastomotic stenosis pose additional challenges to the endoscopist. For the typical duct-to-duct anastomosis, the donor duct is typically smaller when compared to DDLT and the biliary system often angulated, resulting in difficulty advancing a wire across the stenosis [27]. Indeed, failure to advance a guidewire through an anastomotic stenosis following LDLT ranges from 16% to 38% [27, 28]. More advanced techniques can be helpful in traversing anastomotic strictures following LDLT, with one case series showing moderate success using cholangioscopy-guided wire passage in those patients who failed initial passage [29].

Long-term outcomes of the treatment of posttransplant biliary anastomotic strictures in patients having undergone LDLT have yet to be studied in detail, but endoscopic therapies seem to be effective. One observational study noted a 21% recurrence rate of strictures, all of which were successfully retreated endoscopically over a total follow-up period of 70 months [28].

Few studies and case series have evaluated FCSEMS for patients experiencing anastomotic biliary strictures after LDLT. In a small study examining the use of FCSEMS as salvage therapy following failure of standard approaches, patients with biliary anastomotic strictures after LDLT had a stricture resolution rate of 83%, with stent migration observed in 6%; however, the covered metal stent used in that study is not available in the United States [30]. Stent migration of FCSEMS and the resultant consequences would be of equal concern in patients having undergone LDLT compared to DDLT, and thus, FCSEMS should likely be reserved for refractory cases.

ERCP in patients with bilioenteric anastomosis is especially difficult, usually requiring deep enteroscopy to reach the bilioenteric anastomosis. The use of balloon enteroscopes to reach the anastomosis limits the types of accessories that can be used for the procedure owing the length of the enteroscope itself. Additionally, further difficulties arise due to the lack of an elevator and the small working channel. A few meta-analyses have examined the success rates of these procedures, with one showing an overall procedural success rate of 61.7% [31]. Ultimately, there is a significant learning curve for ERCP in altered anatomy, which can be successful in experienced hands [4, 27]. Bilioenteric anastomotic strictures can be less recalcitrant when compared to duct-duct anastomotic strictures, often requiring balloon dilation alone [32].

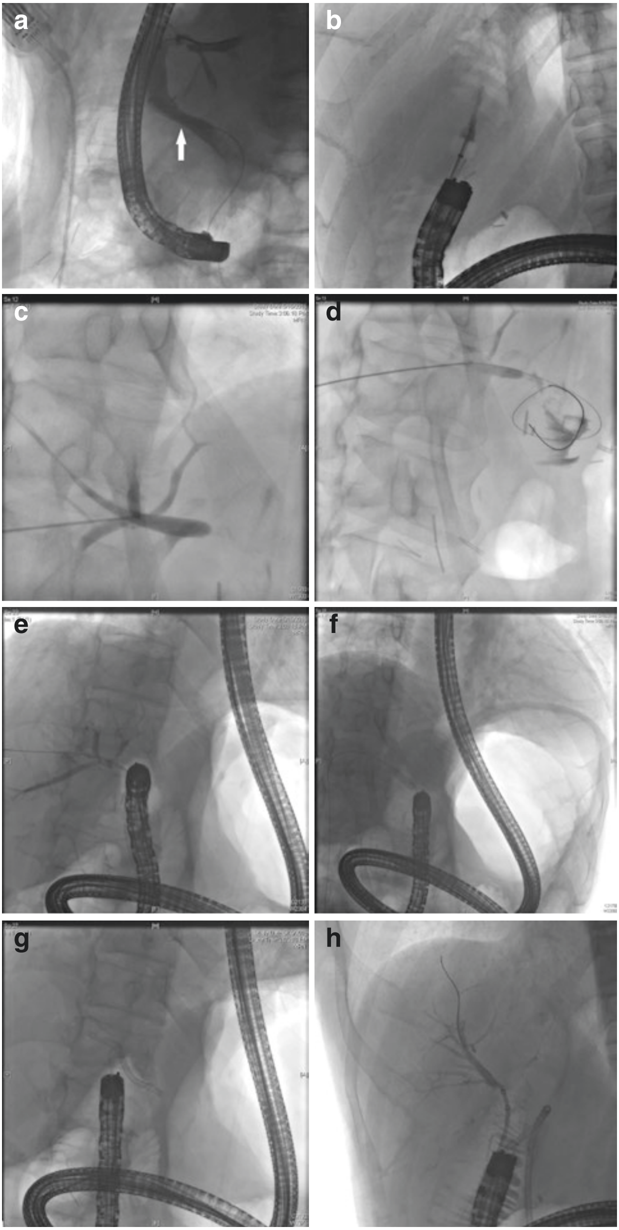
Case 1 Outcome

The patient underwent ERCP with cholangiography showing stenosis at the duct-to-duct anastomosis (Fig. 7.1a) *leading to the right anterior system. At the initial ERCP, this was dilated to 4 mm, and a 10 Fr plastic stent was successfully placed.*

An adult colonoscope was used to reach the hepaticojejunostomy with some difficulty, and limited cholangiography was performed, indicating stenosis at the hepaticojejunostomy. Given the severity of the stenosis, a guidewire could not be advanced into the right posterior system (Fig. 7.1b). *Percutaneous cholangiography was then performed by interventional radiology and was notable for dilated right posterior system leading to the stenosis at the hepaticojejunostomy* (Fig. 7.1c). *A percutaneous wire was able to traverse the hepaticojejunostomy and was coiled in the small bowel* (Fig. 7.1d). *The right posterior system was then able to be successfully accessed endoscopically using the rendezvous technique* (Fig. 7.1e). *The hepaticojejunostomy was balloon dilated* (Fig. 7.1f), *and a 10 Fr plastic stent was placed* (Fig. 7.1g).

The stenosis at the hepaticojejunostomy resolved quickly over subsequent ERCPs (Fig. 7.1h), *while the stenosis at the duct-to-duct anastomosis required further dilation and placement of multiple plastic stents. At 1 year, complete resolution of this stenosis was noted as well.*

Figure 7.1 Post living donor liver transplant biliary anastomotic strictures involving the duct-duct anastomosis and hepaticojejunostomy. Initial ERCP via the papilla showed stenosis at the duct-duct anastomosis in this patient who underwent LDLT (**a**, arrow), with associated upstream dilation of the right anterior system. A pediatric colonoscope was advanced to the hepaticojejunostomy, which was also noted to be stenosed, and a guidewire was unable to be passed into the right posterior system (**b**). A percutaneous cholangiogram was performed by interventional radiology (**c**), and a guidewire was able to traverse the stenosis at the hepaticojejunostomy and was coiled in the small bowel (**d**). Overall cholangiography findings of the right posterior system were notable for dilation of the bile ducts above the stenosis at the hepaticojejunostomy (**c**–**e**). Using the rendezvous technique, endoscopic access to the right posterior system was obtained (**e**). The stenosis at the hepaticojejunostomy was balloon dilated (**f**) and a 10 Fr plastic stent was successfully placed (**g**). This stenosis at the hepaticojejunostomy eventually resolved (**h**)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Case 2

A 62-year-old man with a history of chronic pancreatitis presented with symptoms of right upper quadrant and epigastric abdominal pain associated with nausea, pruritus, jaundice, and dark urine, worsening over the course of 1 week. He has also been experiencing intermittent fevers and chills. Initial lab tests on arrival were notable for marked elevation in transaminases and alkaline phosphatase, a total bilirubin of 7.0, and leukocytosis. Abdominal ultrasound is notable for marked dilation of the intrahepatic bile ducts. CT scan shows changes in the pancreatic parenchyma consistent with chronic pancreatitis and mild interstitial acute pancreatitis, with difficulty visualizing the extrahepatic bile duct.

Diagnosis and Assessment

The initial evaluation of a patient presenting with abdominal pain and physical findings concerning for possible biliary obstruction includes laboratory evaluation and imaging, which are paramount in establishing the diagnosis. With this patient's history of chronic pancreatitis, and without imaging evidence of a malignant mass, the etiology of biliary obstruction is most likely due to pancreatic fibrosis in the head of the pancreas, with resulting distal biliary stricture. Distal common bile duct stricture in the area of the head of the pancreas results from progressive fibrosis of the pancreatic parenchyma and develops in 3–46% of patients with chronic pancreatitis [10, 13, 33, 34].

Traditionally, bile duct strictures due to chronic pancreatitis do not need intervention unless there are signs and symptoms of biliary obstruction. These would include infectious symptoms due to cholangitis associated with elevations in transaminases and total bilirubin, and symptoms of biliary pain due to the formation of sludge and stones in a partially obstructed, dilated biliary system. While there is no evidence of distal pancreatic mass on CT scan, and the etiology is most likely stricture due to pancreatitis, it is still important to rule out a primary biliary malignancy with brushings for cytology. Placement of transpapillary parallel plastic stents is effective in 60–90% of cases [35]. As previously mentioned, balloon dilation with placement of increasing number of stents is performed sequentially every 3–4 months for up to 12 months. The stricture is considered resolved when the stricture waist has disappeared and contrast is able to freely drain from the biliary system [33].

Treatment and Management

On the spectrum of benign bile duct strictures, strictures due to chronic pancreatitis can be recalcitrant and respond least well to therapy with plastic stents [36]. In one observational study of 58 patients, the overall success rate at 12 months was only 38% [37]. The only predictor of success at 12 months was evidence of concomitant acute pancreatitis. This may indicate that the high recurrence rate of biliary strictures secondary to chronic pancreatitis may be due to the fibrotic, calcific nature of the disease.

As an alternative to plastic stents, fully covered self-expanding metal stents (FCSEMS) have been used in the treatment of benign biliary strictures. There are many potential advantages with FCSEMS, including easier deployment of a single stent compared to multiple plastic stents, larger post-deployment diameter, and less frequent and fewer endoscopic sessions. The FCSEMS can stay in place for 6 months before requiring removal, after which time there is a risk of stent occlusion and embedment due to the hyperplastic reaction of the biliary mucosa [33]. Disadvantages to FCSEMS include higher cost than plastic stents and potential difficulty with removal.

In a randomized trial comparing FCSEMS and plastic biliary stents in benign biliary strictures, FCSEMS were as effective as plastic stents and achieved resolution of strictures with fewer procedures (2.14 vs 3.24) [38]. In a systematic review and meta-analysis comparing FCSEMS and plastic biliary stents specifically in benign strictures due to chronic pancreatitis, FCSEMS showed higher clinical success at 12 months (77% vs 33%), lower incidence of late adverse events, and a lower number of ERCPs (1.5 vs 3.9). Despite the higher cost of FCSEMS when compared to plastic stents, there is evidence to show that the use of FCSEMS in benign biliary strictures due to chronic pancreatitis is cost-effective given the fewer number of ERCPs required [39].

Thus, while the use of simultaneous and increasing size/number of plastic stents in the treatment of benign biliary strictures is the generally preferred approach, when it comes to strictures due to chronic pancreatitis, we prefer the use of a fully covered self-expending metal stent.

Case 2 Outcome

The patient underwent ERCP, and a distal common bile duct stricture was confirmed (Fig. 7.2a). *Brushings of the stricture were performed, and the stricture was dilated to 6 mm with a biliary dilation balloon. A 10 Fr by 7 cm plastic stent was placed into the common bile duct* (Fig. 7.2b). *Cytology results from the brushings returned negative for malignancy. The patient's symptoms and lab findings improved significantly. He returned 3 months later for an ERCP, at which time the previously placed stent was removed, the stricture dilated to 8 mm, brushings repeated, and three parallel 10 Fr by 7 cm plastic stents were able to be placed. Cytology results again returned negative for malignancy, and the patient's stents were removed 3 months later, at which time the stricture was noted to have resolved.*

Four months after the removal of the biliary stents, the patient returned with similar symptoms to his original presentation (abdominal pain, itching, jaundice). Imaging confirmed a recurrent stricture. The patient underwent repeat ERCP, and the recurrent stricture was noted in the area of the head of the pancreas. At this time, a transpapillary 10 mm by 6 cm fully covered metal stent was successfully deployed (Fig. 7.2c).

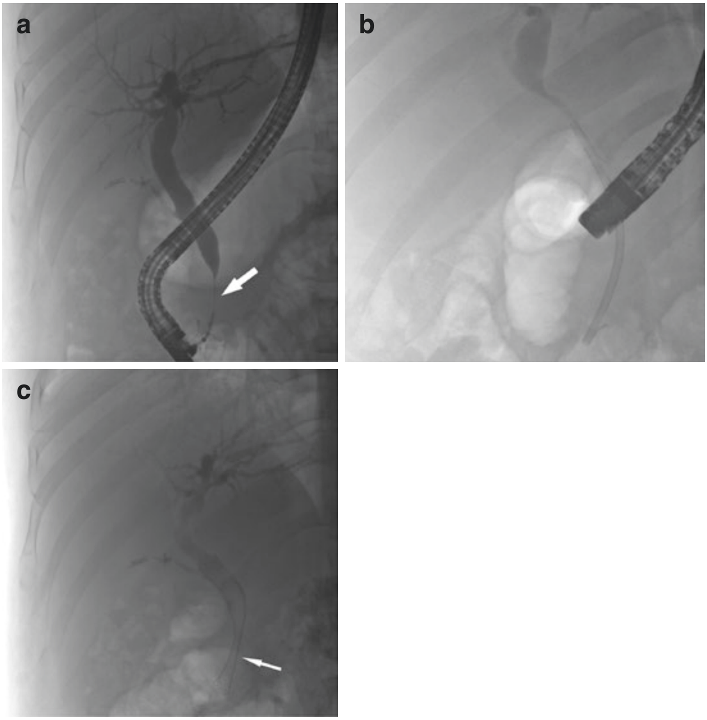

FIGURE 7.2 Biliary stricture due to chronic pancreatitis. Initial ERCP showed severe stricture of the common bile duct in the area of the head of the pancreas and associated upstream dilation of the main bile duct and intrahepatics (**a**, arrow). A transpapillary 10 Fr plastic stent was placed at the initial ERCP in order to traverse the stenosis (**b**). Eventually, the patient failed multiple plastic stents, and eventually, a transpapillary 10 mm by 6 cm fully covered self-expanding metal stent was placed to traverse the stricture (**c**). Note the waist in the body of the stent after initial placement in the area of the stenosis (arrow)

Bile Leaks

Introduction

Bile duct injury resulting in bile leak can occur following surgical procedures on the biliary system, including cholecystectomy, liver resection, and liver transplantation. The incidence of bile leak following cholecystectomy has varied and is estimated to occur in 0.4–1% of all cholecystectomies in the laparoscopic era, with some evidence to suggest a higher association with open cholecystectomies [40, 41]. The overall incidence of bile leaks following liver transplant is common, with one review of literature noting an incidence of 8.2%, and various studies showing a range of 2–25% [23, 42].

Case 3

A 34-year-old man with a history of cirrhosis due to alcohol use undergoes a living donor liver transplant and receives a donor right lobe. The transplant is initially uneventful, and the patient is discharged. A few days following discharge, the patient is seen urgently in transplant surgery clinic, where he is noted to have a distended/tender abdomen and bilious discharge from the incision site. He is admitted to the hospital and taken for a laparotomy, at which time a large amount of bile is washed out of the peritoneum, and leakage of bile is noted from the cut surface of the liver, which was repaired surgically. A Jackson-Pratt drain was left in place. Over the next 2 days, there was continuous drainage of bile from the JP drain, concerning for an ongoing bile leak.

Diagnosis and Assessment

Bile leaks are diagnosed clinically, often presenting as a biloma resulting in bile peritonitis or as persistent drainage of bile from a percutaneous drain in the right upper quadrant. Combined with a history of hepatobiliary surgical intervention, the presence of a collection of fluid on imaging, such as transabdominal ultrasonography or computed tomography, should raise significant suspicion for a bile leak. While US and CT scan are useful, these methods cannot reliably distinguish bile leaks from other postoperative fluid collections such as blood, serous fluid, or pus. In this way, MRCP, combined with hepatobiliary contrast-enhanced MR imaging, is useful in detecting biliary leak and differentiating it from other postoperative complications [43].

With respect to bile duct injuries following cholecystectomy, various classification systems have been proposed [44]. The Bismuth classification is based on the location of the injury in the biliary tract, specifically according to the distance from the biliary confluence [45]. However, this system does not include the wide spectrum of possible biliary injuries. The Strasberg classification consequently sought to expand the Bismuth classification and includes different types of injuries and leaks [46]. The most useful classification for endoscopists is likely the Amsterdam classification proposed by Bergman et al., where there are four types of postoperative bile duct injury: type A being a cystic duct or aberrant duct leak, type B being a major bile duct leak with or without concomitant stricture, type C being a bile duct stricture without a leak, and type D being a complete transection of the bile duct [47].

Bile leaks following hepatobiliary surgery such as liver resection and liver transplant are common and can be more complex when compared to cholecystectomy, occurring in up to 15% of all liver resections [48]. In a meta-analysis, the rate of biliary leakage after liver transplant was 8.2%, without significant difference between DDLT (7.8%) and LDLT (9.5%) [23]. Bile leaks following hepatobiliary surgery make up about 17% of all postsurgical bile leaks, with post-cholecystectomy leaks accounting for the rest [49].

Known risk factors for the development of bile leak following liver transplant include surgical technique, hepatic artery thrombosis, donors after cardiac death, prolonged warm and cold ischemia times, ABO blood group mismatch, and T-tube use [50].

Following liver transplant, leakage may develop at the anastomotic site, from the cystic duct remnant, from the cut surface of partial liver grafts in the case of LDLT, and following T-tube removal [25]. Anastomotic leaks or leaks resulting from anastomotic strictures are the most common type to occur in post-liver transplant patients, followed by complications due to the presence of a T-tube if a T-tube is placed at the time of surgery [51]. It should be mentioned that the current trend is toward no longer using T-tubes in the prevention of anastomotic strictures [52].

Treatment and Management

In early years prior to the development of minimally invasive endoscopic techniques, surgical repair or conversion to hepaticojejunostomy was primarily used, with resultant morbidity and mortality [48, 53–55]. However, in the era of therapeutic ERCP, the vast majority of bile leaks are able to be successfully treated endoscopically with a combination of sphincterotomy and placement of biliary stents, given that the continuity of the bile ducts is maintained, and the main ducts have not been completely transected. The goal of sphincterotomy and stent placement is twofold: to potentially bridge and cover the leak if possible, thereby allowing healing and/or to lead to preferential flow of bile through the papilla resulting in a reduced pressure gradient, thereby diminishing flow through the leak [53, 55].

As in post-cholecystectomy bile leaks, ERCP with sphincterotomy and stent placement is the minimally invasive treatment of choice in bile leaks following liver transplant. Overall, endoscopic therapy solves the problem in 85% of patients [13, 25, 56, 57]. However, when compared to bile leaks after cholecystectomy, the rates of success are somewhat lower in patients who undergo liver transplant or liver resection [58]. In one study, multiple ERCPs were successful in treating 95% of leaks following cholecystectomy, but only 86% of leaks following liver transplant or other hepatobiliary surgery [58].

Based on experience and literature, a general protocol for endoscopic therapy of bile leaks can be proposed [47, 48, 53–55, 58, 59]. Treatment should consist of cholangiography to localize and assess the severity of the leak, followed by sphincterotomy, and placement of a plastic biliary stent. The stent should cover or span the bile leak if possible (i.e., not in patients with a very peripheral leak or a terminal leak). Bilious output from the percutaneous drain should be monitored, and when complete resolution is suspected, repeat ERCP with stent removal and reassessment should be performed (typically 4–6 weeks following initial procedure). For persistent leaks (i.e., no improvement in bilious output within 2–3 days following initial ERCP), repeat ERCP with multiple plastic stents should be considered. For those who fail this treatment, ERCP with placement of a fully covered self-expanding metal stent (FCSEMS) can be attempted if the stent can be placed above the leak site [53, 59].

If endoscopic therapy has failed, then referral for surgery would be appropriate.

While some specific classification systems exist for bile leaks following cholecystectomy, a clinically useful method for the endoscopist to assess a postoperative bile leak would be a two-category system delineating low-grade (small) leaks and high-grade (large) leaks. Low-grade leaks would be classified as such if the leak is identified only after filling of the intrahepatic duct with contrast during cholangiography. High-grade leaks would be classified when there is substantial extravasation of contrast prior to filling of the intrahepatic bile duct at the time of cholangiography [48, 55, 60]. In one study, bile leak severity was the only independent factor associated with eventual success of endoscopic treatment following hepatobiliary surgery.

The use of FCSEMS in the treatment of posttransplant bile leaks has not been studied in detail. In one study examining the outcomes of FCSEMS in posttransplant bile leaks, there was a high rate of resultant common bile duct strictures, and removal was difficult in some cases, despite achieving resolution of bile leak [61]. Therefore, at this time, the use of FCSEMS is only recommended in select cases of refractory bile leaks, if at all [13, 25].

The success of endoscopic treatment for post-cholecystectomy bile duct leaks has been shown to be greater than 90% [53]. The success rate approaches 100% for Amsterdam type A bile duct injuries, which is the most common type of injury seen after a cholecystectomy [58, 62, 63]. For other types of leaks, the success rate is significantly lower. For patients with Amsterdam type B leak, the success rate has been reported to vary between 60% and 80%, and nearly all patients with a complete transection of a main bile duct (Amsterdam type D) typically require surgical repair [58, 62, 63].

Case 3 Outcome

The patient underwent ERCP 2 days following laparotomy. On cholangiography, there was immediate extravasation of contrast at the posttransplant biliary anastomosis. Additionally, it was noted that the leak also involved the branch leading to the right posterior ductal system. The intrahepatic ducts in the right posterior system and right anterior system eventually opacified with *contrast* (Fig. 7.3a). *With some difficulty, guidewires were able to be passed into both the right anterior and right posterior system* (Fig. 7.3b). *Two 8.5 Fr plastic stents were placed, both ending upstream above the location of the leak, with one in the right posterior system and one in the right anterior system* (Fig. 7.3c).

One day following the procedure, the patient's output of bile from the percutaneous drain was noted to be significantly reduced, and continued to improve the following day, at which time the patient was discharged.

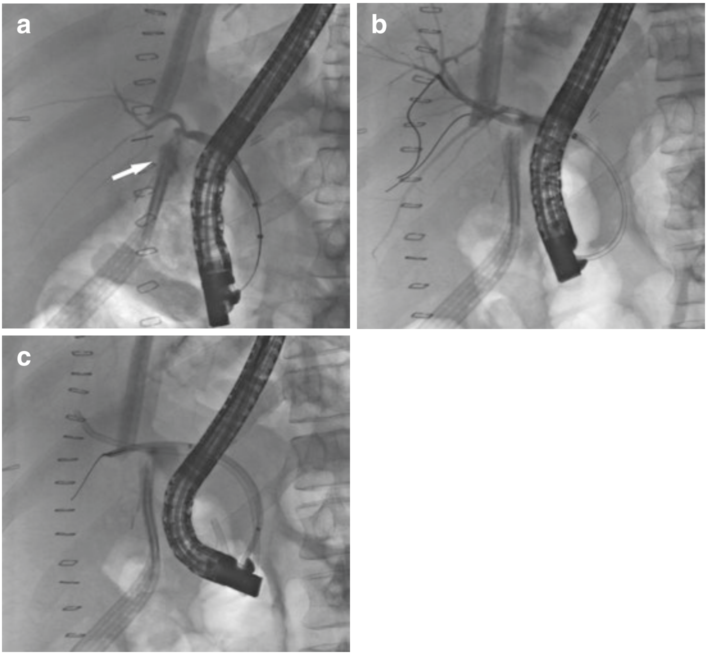

FIGURE 7.3 Bile leak at the anastomosis following living donor liver transplant. Initial ERCP showed immediate extravasation of contrast at the posttransplant biliary anastomosis, indicating a large bile leak involving the right posterior system (**a**, arrow). With significant difficulty due to the small, angulated ducts, two guidewires were placed into the biliary system, with one in the anterior system and one in the posterior system such that the bile leak was traversed (**b**). Two 8.5 Fr plastic stents were placed, both ending upstream above the location of the leak, with one in the right posterior system and one in the right anterior system (**c**)

Pearls and Pitfalls

- Endoscopic retrograde cholangiopancreatography (ERCP) is considered the first-line option for treatment of benign biliary strictures and has been shown to be safe and effective, with strong long-term results.
- A standard approach for the treatment of benign biliary strictures includes ERCP with sphincterotomy, balloon dilation of the stricture to the width of the bile duct, and placement of multiple plastic stents. ERCP is repeated with stent exchange every 3 months for up to 1 year until stricture resolution is achieved.
- Fully covered self-expanding metal stents (FCSEMS) are effective in treating benign biliary strictures, requiring a lower number of ERCPs; however, stent migration can be a significant concern.
- In patients having undergone living donor liver transplant (LDLT), the donor duct is typically smaller when compared to deceased donor liver transplant (DDLT), and the biliary system is often angulated, resulting in difficulty advancing a wire across the stenosis.
- FCSEMS are preferred in the treatment of bile duct strictures due to chronic pancreatitis because these strictures tend to be more recalcitrant and respond least well to therapy with plastic stents.
- The vast majority of bile leaks are able to be successfully treated endoscopically with a combination of sphincterotomy and placement of biliary stent, given that the continuity of the bile duct is maintained, and the main ducts have not been completely transected.
- The stent should cover or span the bile leak if possible (i.e., not in patients with a very peripheral leak or a terminal leak).
- Classifying bile leaks as low grade and high grade at the time of cholangiography can be helpful in determining treatment success.
- Anastomotic leaks or leaks resulting from anastomotic strictures are the most common type to occur in post-liver transplant patients.

- While multiple ERCPs may be beneficial in treating bile leaks following cholecystectomy, the success of subsequent ERCPs after failure of initial ERCP in bile leaks following hepatobiliary surgery and liver transplant is much lower.
- In both benign bile duct strictures and bile leaks following liver transplant, the use of FCSEMS should be reserved only for refractory cases.

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