Chapter 4
Difficult Bile Duct Stones

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Case 1

A 37-year-old female with a history of Billroth II gastrectomy, diabetes mellitus, hypertension, and hypercholesterolemia presents to the hospital emergency department with complaint of severe epigastric pain. Her onset of pain was 2 weeks ago, but it was on and off. The patient endorses nausea and two episodes of vomiting. On physical examination, the patient was seen to have yellow discoloration of the eyes and skin. Abdominal exam was normal, with no guarding or organomegaly. Vitals taken in the emergency department showed a fever of 100.3F. Laboratory results obtained showed elevated serum bilirubin and alkaline phosphatase.

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Transabdominal ultrasound was performed showing a dilated bile duct. A CT scan confirmed multiple stones in the common bile duct.

Diagnosis/Assessment

Often clinical evaluation and laboratory testing are not sufficient tools to diagnose choledocholithiasis. Imaging like transabdominal ultrasound and computed tomography is generally the first step to reaching a diagnosis. In patients with ascites or obesity, transabdominal ultrasound may not be sufficient to assess if stones are present in the common bile duct. Contrast agents administered during CT scanning may also cause unwanted side effects. When choledocholithiasis is equivocal, endoscopic ultrasonography (EUS) is a highly accurate modality to confirm the presence of stones prior to ERCP without the risk for complications such as pancreatitis. However, due to the anatomical changes after Billroth II gastrectomy or Roux-en-Y reconstruction, EUS may not be as accurate. ERCP is the first-line treatment for patients with confirmed, or high probability for, choledocholithiasis. In patients with altered anatomy, performing ERCP with therapeutic maneuvers can become difficult. In patients with a Billroth II gastrectomy, one option is to use a forward-viewing endoscope with a distal cap instead of a duodenoscope (Figs. 4.1 and 4.2).

Treatment/Management

The first step in common bile duct stone removal is an endoscopic sphincterotomy (EST). This has been the standard first-line therapy since it was first described in 1973. The main goal is to cut the sphincter of Oddi which may be the main obstruction to passage of the stone. Once the sphincter has been widened, the stone can be captured in a basket or removed with the help of a balloon tip catheter inflated

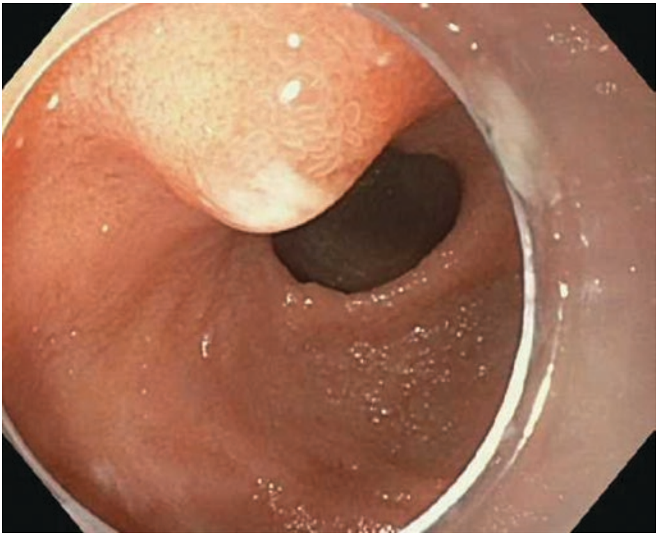

FIGURE 4.1 Pus emerging from the major papilla

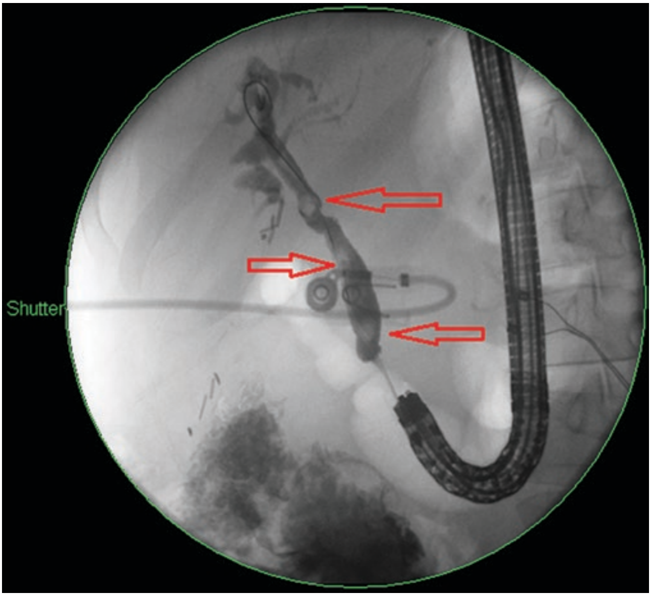

FIGURE 4.2 Fluoroscopic imaging showing multiple stones (red arrows) throughout the biliary tree

FIGURE 4.3 Extraction of biliary stone after sweeping the duct with a balloon

above the stone (Fig. 4.3). For standard stones, up to a 90% extraction rate can be achieved with EST. However, for larger stones (>15 mm), the extraction rate is much lower [1].

Stones that cannot be extracted after endoscopic sphincterotomy are often categorized as difficult bile duct stones. Endoscopic papillary balloon dilation (EPBD) or sphincteroplasty (without sphincterotomy) has recently been advocated as a first-line intervention for patients with difficult bile stones (Fig. 4.4a, b). The goal here is to dilate the papilla using a dilation balloon so that the biliary orifice is larger than the diameter of the stone. The exact duration of inflation is not standardized, but generally, the balloon is left inflated at least until there is obliteration of the waist on the balloon. Then the stone can be extracted from the bile duct using a standard basket or extraction balloon. A randomized control trial done by Liao et al. found that increasing the time of dilation from

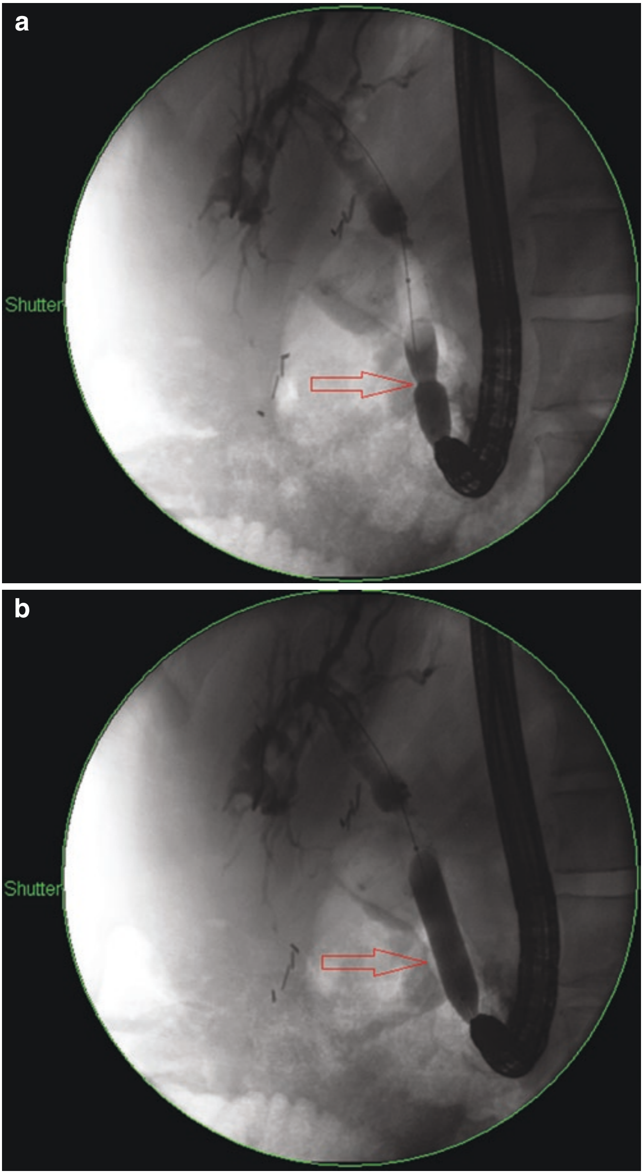

FIGURE 4.4 (**a**) Intraoperative fluoroscopic view from ERCP showing "waist" of sphincter (red arrow). (**b**) Intraoperative fluoroscopic view from ERCP demonstrating disappearance of sphincter "waist"

1 minute to 5 minutes improved efficacy and decreased the risk of pancreatitis [2]. This result is counterintuitive since pancreatitis would be expected to be higher the longer the pancreatic orifice is occluded. In fact, some studies have revealed an increased risk for pancreatitis with balloon dilation without EST compared to EST. Fujita et al. reported 100% and 99.3% clearance rate for EST and EPBD, respectively. They also found a rate of acute pancreatitis of 10.9% in the EPBD group compared to 2.8% in the EST group. Similarly, Ochi et al. found clearance rates of 98.17% and 92.7% in EST and EPBD groups, respectively [3, 4].

Multiple randomized controlled trials have assessed the safety and efficacy of EPBD vs EST. A majority of these trials found that though the rate of success for both procedures was similar, EPBD has a higher rate of pancreatitis when compared to EST [5–7]. In patients with a previous Billroth II gastrectomy, a standard EST may be difficult due to the inverted anatomy of the Billroth II state, and the design of the sphincterotome and cases where EST is attempted have an increased risk of bleeding [8]. EPBD has shown to have similar success rates but the rates of the bleeding are lower compared to EST [4, 5, 8]. In cases other than previous Billroth II gastrectomy and patients with increased bleeding risk, EST is still considered to be the gold standard due to the decreased risk of pancreatitis.

In cases of large stones, EST can be combined with large balloon dilation. A partial EST with large balloon dilation (ESLBD) was shown to be safe and has very good outcomes. A randomized trial by Heo et al. compared large stone removal in an ESLBD group and in an EST alone group. Successful stone removal was recorded in 94.4% of ESLBD group patients compared to 96.7% for the EST alone group [9]. Performing only a partial EST helps in reducing the overall bleeding risk, and the separation of the pancreatic and biliary orifices reduces the risk pancreatitis due to EPBD. Randomized controlled trials comparing ESLBD to EST alone found that though the success rate was relatively similar in both groups, the complication rates were lower in combined therapy patients. Teoh et al. also compared patients undergoing ESLBD to patients undergoing EST alone. They showed a clearance rate of 89% in both groups and complication rate of 10.3% in the EST alone group and 6.8% in the ESLBD group [3, 10]. Another study compared a group of patients subjected to ESLBD with a group subjected to EST followed by mechanical lithotripsy and found a success rate of 98% in the ESLBD group and 91% the EST plus mechanical lithotripsy group. Complications were reported at 4.4% and 20% for the ESLBD and EST group, respectively [11]. Complications for these procedures can be divided into short-term and long-term complications as shown in Table 4.1.

The success rate of EST, EPBD, and ESLBD is high, but it is not 100%. There are cases when multiple attempts are still unable to extract the stone in the common bile duct. The most common are patients where the diameter of the biliary orifice and distal CBD cannot be made large enough to accommodate the size of the stone. Biliary endoprosthesis/stenting is often performed to prevent impaction of the stone, to decompress the biliary tree to alleviate jaundice and cholangitis, and to act as a bridge for future curative therapy (Fig. 4.5). These also provide a mechanism for the stone to be gradually softened and fragmented over time due to the constant pressure of the stent on the stone. In many studies, a stent placement for 3–6 months resulted in the subsequent reduction in size of large stones, fragmentation into smaller stones, or complete clearance of the stone from the duct [12–14]. The stent is then removed, the bile duct is dilated and cleaned out to remove any stones that may be remaining. These stents can be either plastic or fully covered metal stents. However, in our experience, plastic stents are more effective in these cases.

Table 4.1 Complications of EST and ESLBD procedures

Early complications	**Late complications**
Pancreatitis	Recurrence of bile duct stones
Bleeding	Acute cholecystitis
Perforation	Bleeding
Cholangitis	

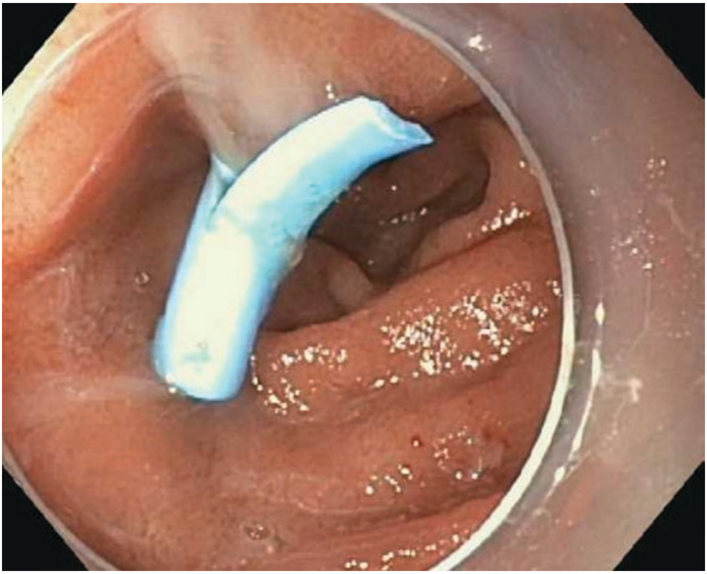

FIGURE 4.5 Plastic biliary stent with a single external flap and a single internal flap. Pus can be seen flowing from the stent

Case 2

A 66-year-old male has a 2-month history of intermittent right upper quadrant pain. He has a history of alcohol abuse and chronic pancreatitis. He is ill appearing and jaundiced. On examination, there is tenderness on palpation of the right upper quadrant. Laboratory results show hyperbilirubinemia, elevated alkaline phosphatase, and an elevated white cell count with left shift. Temperature was 101.1F. Transabdominal ultrasound showed dilated gallbladder with stones along with a dilated common bile duct. ERCP performed outlined a 15 mm stone in the common hepatic duct with a narrow intra-pancreatic CBD without overt stricture. At the time of ERCP, ESLBD was performed but was unsuccessful in removing the stone due to the large size of the stone and inability to dilate the distal CBD.

When these methods of extraction fail, lithotripsy is the next best option. There are three main types of lithotripsy therapy:

- Mechanical lithotripsy.
- Electrohydraulic lithotripsy (EHL).
- Laser lithotripsy.

Mechanical lithotripsy involves capturing a stone in a lithotripter compatible metal basket and advancing a metal cable to the center of the stone by cranking a handle to apply pressure on and fragment the stone (Figs. 4.6 and 4.7). The

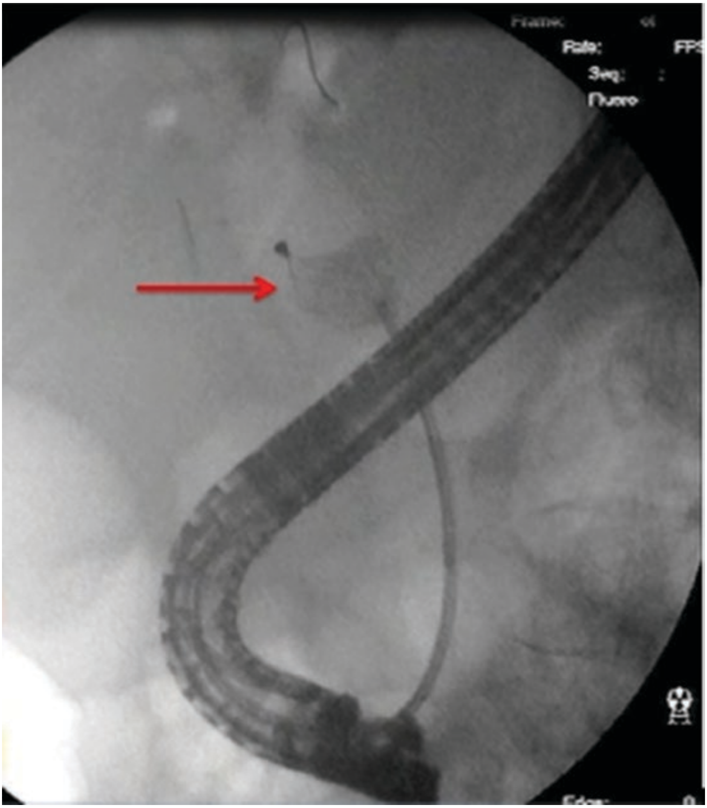

FIGURE 4.6 Fluoroscopic view of basket (red arrow) encapsulating stone

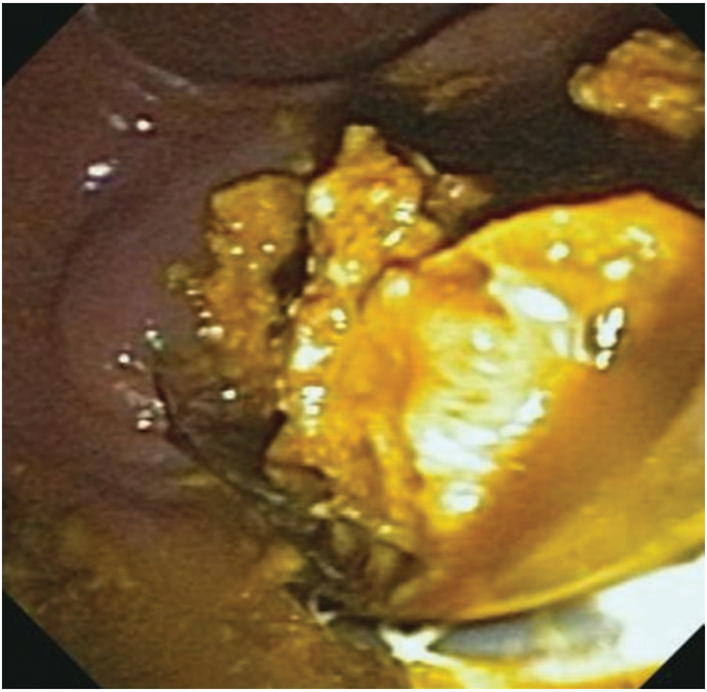

FIGURE 4.7 Extraction of biliary stone using a basket

stone fragments can then be retrieved with standard extraction techniques. In cases of excessively large stones, mechanical lithotripsy may need to be repeated several times to achieve complete extraction. The success rates of mechanical lithotripsy are about 80–90%; however, multiple attempts may be required. [15–17] The major complication associated with this procedure is basket impaction. Other complications include pancreatitis, cholangitis, and bleeding but at lower rates.

Electrohydraulic lithotripsy and laser lithotripsy are most useful for stones too large to be captured in a basket for mechanical lithotripsy. The preferred option for laser lithotripsy has become pulsed solid-state lasers like the holmium:YAG and q-switched neodymium:YAG. Less commonly used are the flashlamp-pumped pulsed dye lasers containing coumarin dye or rhodamine 6G dye. This procedure involves advancing an EHL or laser fiber through a cholangioscope as close as possible to the stone. A preset wattage pulse is then delivered for 1–2 seconds until the stone fragments. Constant saline irrigation is required for this procedure, as this helps in visualization and clearing of debris and in EHL it aids transmission of the shock wave. The fragments are then removed using standard extraction techniques. Successful fragmentation is achieved in about 75–80% of EHL cases, but combination of EHL with laser lithotripsy achieves stone clearance rates of up to 90% [18, 19]. The main complication of EHL and laser lithotripsy is perforation of the bile duct. Extra care should be used to prevent the EHL and laser probes from touching the wall of the bile duct. However, the rate of perforation is only about 1%.The underlying principle and indications for laser lithotripsy are similar to EHL. Laser lithotripsy provides a focused high-energy shock wave to fragment stones through pulsed laser systems. The fragmented stones are then extracted through standard techniques. Trials comparing laser lithotripsy with conventional lithotripsy show that laser lithotripsy achieves higher rate of clearance of large bile duct stones. However, there is an extra cost to this procedure, and it is not readily available. Hemobilia due to tissue damage during the laser pulse is one of the main complications of this procedure. Other complications include cholangitis and pancreatitis, but to a lesser extent.

Outcomes

- Case 1: This patient presented with multiple large stones in the bile duct on CT imaging and was admitted for stone removal. Following an unsuccessful ESLBD for stone removal, a plastic stent was placed and the patient was discharged. The patient was reevaluated after 3 months with repeat ERCP confirming resolution of stones, and the stents were successfully removed.

- Case 2: This patient was diagnosed with a large (15 mm) stone in the common hepatic duct by ERCP at which time ESLBD was attempted but unsuccessful due to the large stone size. Mechanical lithotripsy was utilized to fragment the stone, and fragments were removed with basket retrieval and the patient was discharged.

Once stones have been successfully removed, any stents that were placed are also removed and not replaced. We do not use ursodiol for stone dissolution. The patient's liver function is evaluated 2–4 weeks post procedure to ensure normal levels of liver enzymes. Recurrence of choledocholithiasis following an endoscopic bile duct clearance ranges between 4% and 25% [20, 21]. Thus, the patient is counseled on the risk of recurrence and the monitor for any signs and symptoms of recurrence. The patients are also asked to follow up in the clinic to ensure that they are asymptomatic. We do not use regular surveillance, blood testing, or imaging for follow-up with patients.

Pearls and Pitfalls

- To remove a bile duct stone, the endoscopist must either make the biliary orifice and distal CBD diameter larger than the stone (through EST, EPBD, or ESLBD) or make the stone smaller than the diameter of the biliary orifice/distal CBD (through lithotripsy).
- Our practice is to perform EST (even partial EST) prior to balloon dilation of the papilla (i.e., ESLBD) in patients with difficult bile duct stones to reduce the risk of pancreatitis associated with EPBD alone.
- Biliary endoprosthesis has shown to reduce the size of and fragment large stones and can be utilized as bridging therapy.
- In patients with a narrow/strictured distal CBD, lithotripsy (EHL and/or laser lithotripsy) should be considered early.

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