
Biliary Stone Extraction

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Abstract

Bile duct stones are a common clinical scenario and their frequency may increase in the future given the rise in gallstones linked to the obesity epidemic. Over the last decade, improved therapeutic tools have been developed which have enhanced the overall success and safety of stone extraction. In some situations, mechanical lithotripsy may be required. Rarely will surgery be required for stone removal.

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Common bile duct (CBD) stone disease is one of the more common disorders managed by the therapeutic biliary endoscopist. With the worldwide rise in the obesity epidemic and its associated impact on cholelithiasis, this problem will only further amplify in magnitude. Most patients with CBD stones are managed electively; however, in patients with severe cholangitis, the procedure may require urgent intervention underscoring the importance of effective and safe techniques for management. In this chapter, the methods for successful stone extraction will be reviewed including an update on accessories required for success, and the outcome from such techniques.

Technique

Successful management of CBD stones first requires selective biliary cannulation. When the clinical suspicion for stones is high, cannulation should be initiated using a sphincterotome. In addition, if one cannot achieve an en face view of the papilla, the ability to bow a sphincterotome and change the angulation assists in selective cannulation (fig. 1). In the setting of CBD stones when the papilla is generous in size, selective cannulation can often be achieved. If not, wire-guided access may be necessary. Use of a 'slippery' angled-tip wire (Terumo glidewire®, Boston Scientific) is often times essential for cannulation of the ampulla with extruding biliary epithelium or for those cases where cannulation is difficult. Such wire-guided cannulation requires coordination between a skilled nurse and the endoscopist. A standard wire for cannulation is too stiff and will be traumatic to use. Slow injection of a small amount of contrast is important initially so that the biliary system is not overfilled thereby potentially missing a small stone. Some would use half strength contrast when stones are suspected although it is not necessary when contrast is carefully

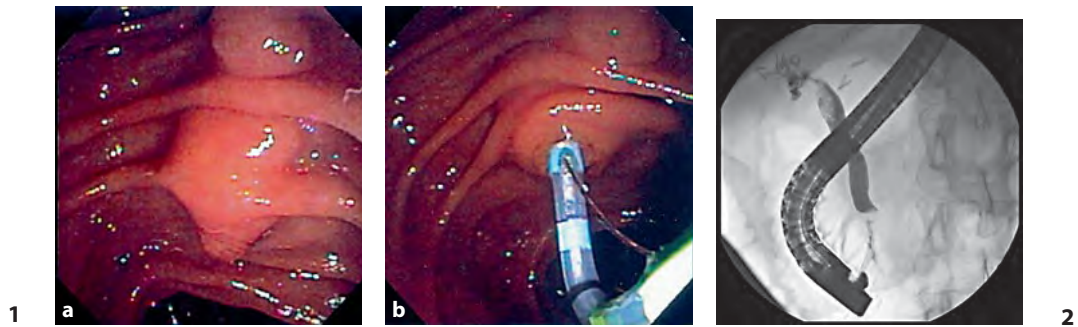


Fig. 1. Location of papilla (a) and utility of using a sphincterotome for cannulation when the angulation is acute (b) to achieve an upwards orientation for the bile duct. **Fig. 2.** Pseudocalculus sign. There appears to be a stone in the distal duct but this represents extrinsic compression on the ampulla.

injected. Excess pressure on the ampulla with the catheter may suggest a stone (pseudocalculus sign; fig. 2). Following slow injection and filling of the distal bile duct to confirm and characterize any abnormalities, further opacification of the more proximal biliary tree is performed.

Biliary sphincterotomy should be performed prior to stone extraction (fig. 3). Balloon dilation alone has been used although it is associated with pancreatitis [1]. The length of the biliary sphincterotomy will be dependent on the size of the papilla and characteristics of the stone(s). For example, if the major papilla is small and the stone is large, additional techniques (see below) for extraction may be required. In contrast, the bulbous papilla provides the opportunity for a generous incision at which point most stones can be extracted. It is important to gauge the size of the sphincterotomy by pulling a balloon through the incision as this confirms the likelihood of removing the identified stone(s) (fig. 3e). Generally stones should be removed separately to avoid impaction especially when large. Once all stones are removed, balloon cholangiography to fully opacify the proximal biliary tree should be done to confirm the absence of other stones and the more proximal biliary anatomy, as well as the location of the cystic duct which would be important for those with a gallbladder in situ when cholecystectomy is anticipated (fig. 3h).

Precut fistulotomy may be needed for those in whom free cannulation cannot be achieved but in whom endoscopic therapy is anticipated or when there is stone impaction (fig. 4). As noted above, selective cannulation can often be achieved using standard techniques when the papilla is generous in size; however, if the papilla is small, initial placement of a pancreatic stent may be necessary before precut incision to assist in identifying the biliary system as well as reducing complications of pancreatitis. Fistulotomy is generally straightforward when the papilla is bulbous, while, in contrast, others may elect precut using a sphincterotome angled toward the biliary orifice or a precut sphincterotome (fig. 4b) [2]. The type of precut incision should be dictated by prior experience.

Accessories

The full complement of biliary tools is mandatory prior to consideration of any stone extraction (table 1). Several sphincterotomes should be available in case of failure. A guidewire may be necessary for selective cannulation as well as a needle knife if precut fistulotomy is required (as noted above). Precut incision carries a higher risk of complications so it should only be performed by

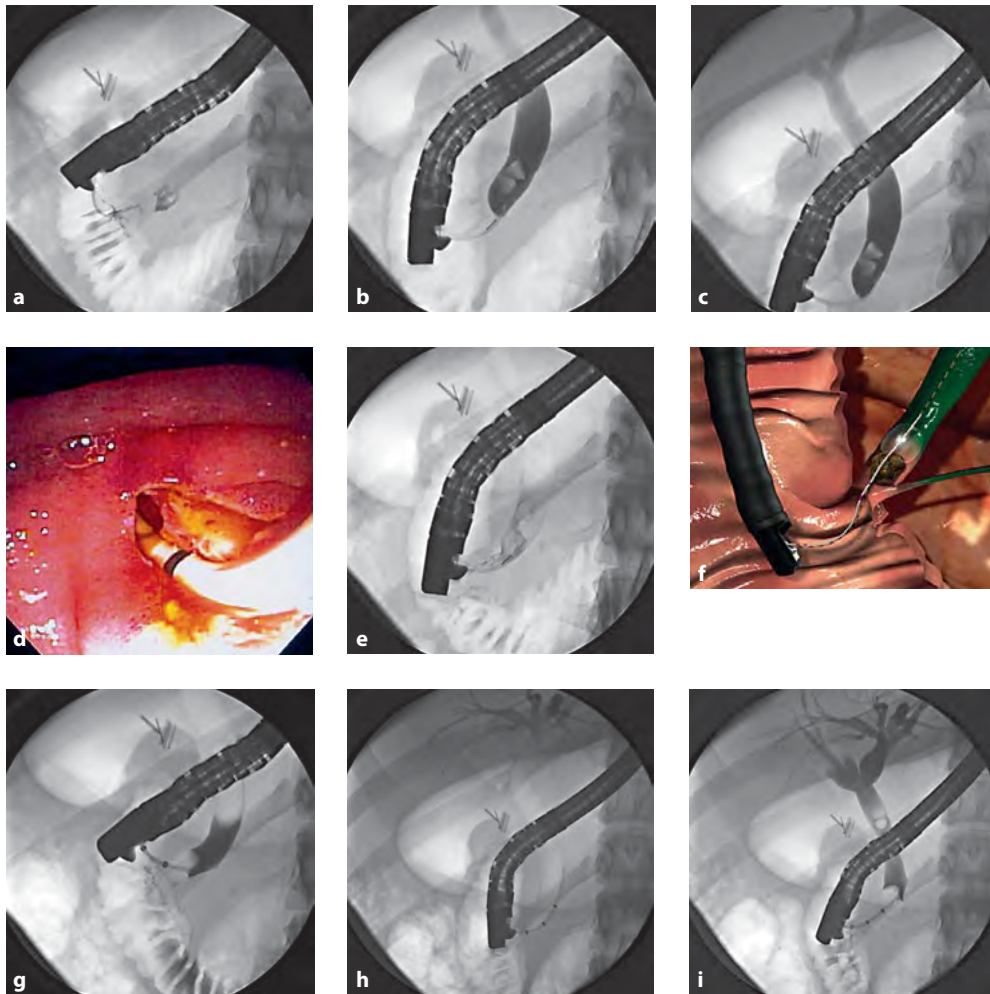


Fig. 3. Removal of several stones. **a** A small amount of contrast is injected showing a filling defect. **b** Further contrast injection confirms 2 stones in a minimally dilated duct. Cholecystectomy clips are seen. **c** Filling of the proximal biliary system shows no additional abnormalities. **d** Biliary sphincterotomy performed to the duodenal wall. **e** Following sphincterotomy air is now seen in the duct somewhat obscuring visualization of the calculi. **f** The balloon can be advanced into the biliary tree alone or over a wire. The use of the wire is generally helpful as it will allow for easier 'return' into the common bile duct. Occasionally, when the papilla becomes swollen and partially destroyed by the sphincterotomy and balloon extraction maneuvers, it may become difficult to regain access into the CBD again. (Permission for use granted by Cook Medical Incorporated, Bloomington, Ind.). **g** The 15-mm balloon is initially placed below the stones and withdrawn through the sphincterotomy to determine the size of the opening and thus gauge the ability to remove the stones. This is important prior to removal of any large stone to rule out the likelihood of impaction. **h** Air fills the duct which suggests complete biliary sphincterotomy. **i** Balloon cholangiogram at completion.

the experienced biliary endoscopist [3]. Most would use a 15-mm balloon with a large sphincterotomy and small stone; wire placement prior to stone extraction may not be necessary (fig. 5). Selective placement of a guidewire proximal to the stone and deep in the left or right intrahepatic ductal system ensures access is maintained if the stone is large or the endoscopic position is

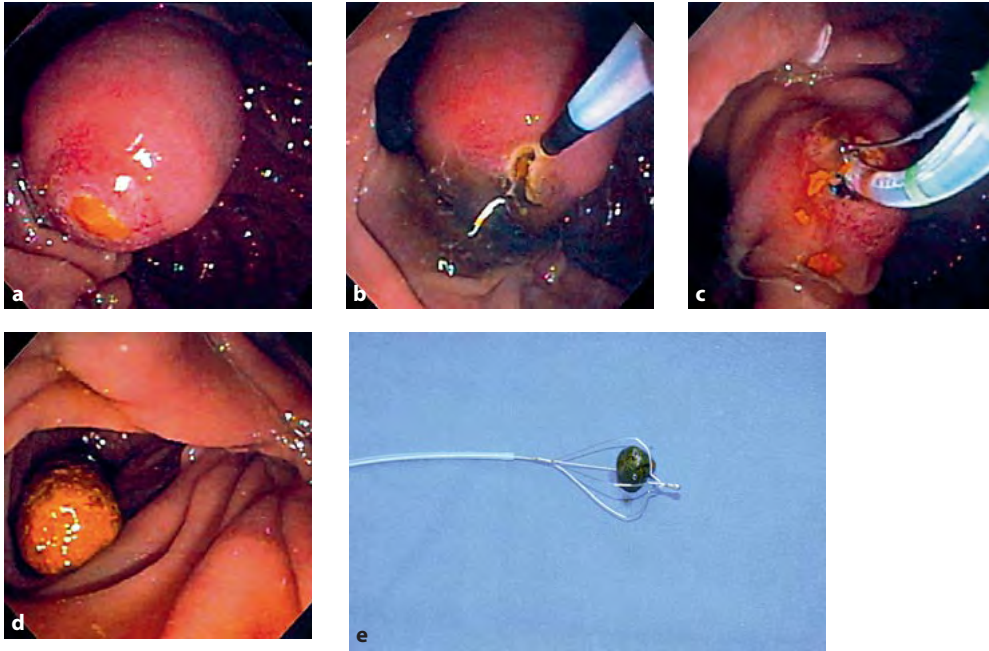


Fig. 4. Precut fistulotomy for impacted stone. **a** Impacted stone in bulbous papilla. **b** Needle knife used to incise papilla over the stone. **c** A standard sphincterotome is used to complete the incision. **d** Stone in the duodenum. **e** Stone captured in basket.

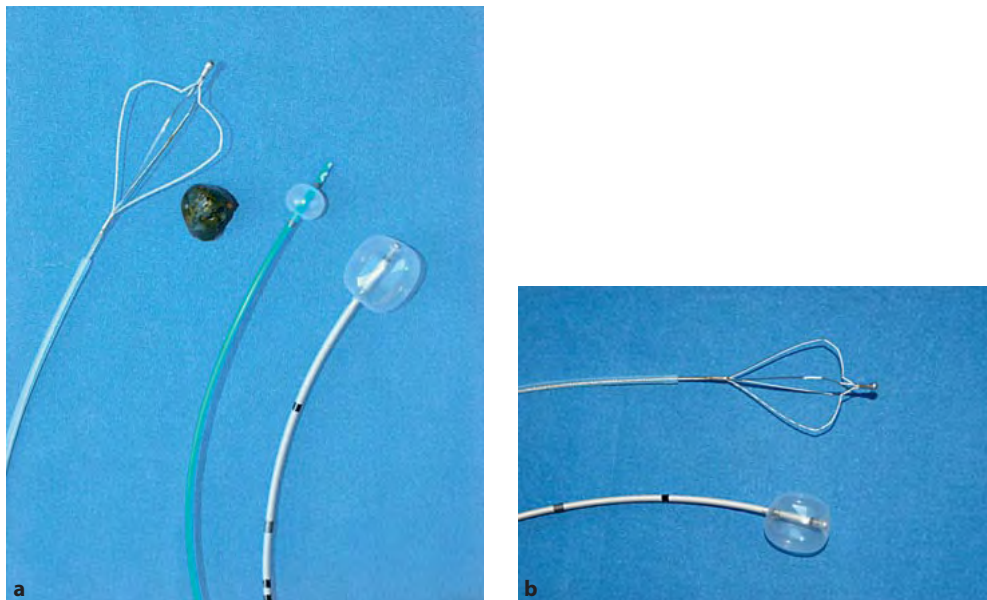


Fig. 5. Balloons and baskets to remove bile duct stones. **a** Note the different sizes of balloons. For slender bile ducts we prefer to use small diameter balloons. **b** Baskets have the advantage of allowing the retrieval of larger stones.

Table 1. Accessories required for extraction of common bile duct stones

Sphincterotomes
Balloons
10 and 15 mm
Basket
Mechanical lithotripter
Crank handle mechanical lithotripter
Sclerotherapy needle

Table 2. Summary of approach to common bile duct stone extraction

Adequate preparation to insure all accessories are available and functioning
For ill patients, assessment of platelet count and prothrombin time
Deep selective cannulation with minimal contrast injection to exclude stone(s)
Opacification of proximal biliary system to evaluate the location and entry of the cystic duct and anatomy of the proximal biliary system
Length of sphincterotomy performed depends on the size and characteristic of the stones
Availability of multiple baskets including mechanical lithotripter for large stones
Placement of a 10-Fr stent proximal to the stone if the stone(s) cannot be removed

tenuous. One must not pull too hard on the balloon above the stone if the stone cannot be easily removed to avoid the wire slipping out or impacting the stone. A mechanical lithotripter may be necessary and should be available. A crank lithotripter is essential to rescue a basket impaction and must be on hand. Laser lithotripsy is relegated to specialized centers given its cost [4]. SpyGlass® or a cholangioscope may occasionally be beneficial to exclude a tumor which may mimic stone disease. Intraductal ultrasound has been used to enhance detection of stones or even microlithiasis [5], but is not widely used.

Outcomes

Using the above techniques, selective biliary cannulation as well as stone extraction can be anticipated in more than 90% of patients (fig. 6). Multiple small stones are relatively easy to remove but if not, stent placement will be required. The stents should be of sufficient size and length to remain in the duct and proximal to all stones and of sufficient length that proximal migration will not occur especially if the sphincterotomy is generous.

Large stones are notoriously difficult to remove especially in those with a slender distal CBD. Thus, the initial cholangiogram is important to evaluate proximal anatomy. Recently ampullary dilatation varying from 12 to 15 mm or larger has been proposed as the method for removing large bile duct stones [6, 7]. Caution must be exercised in choosing the appropriate size for dilatation to avoid perforation. Using such dilatation, larger stones can be removed although giant stones (>2 cm) generally require a mechanical approach which is successful in most but not all patients [8, 9].

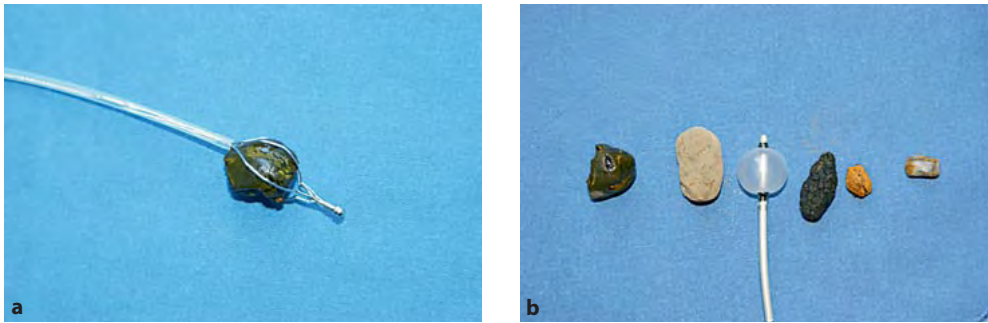


Fig. 6. Removal of stones with basket or balloon. **a** Baskets allow for a tight gripping of the stone. **b** The diameter of the balloon is useful to determine the approximate size of the stones.

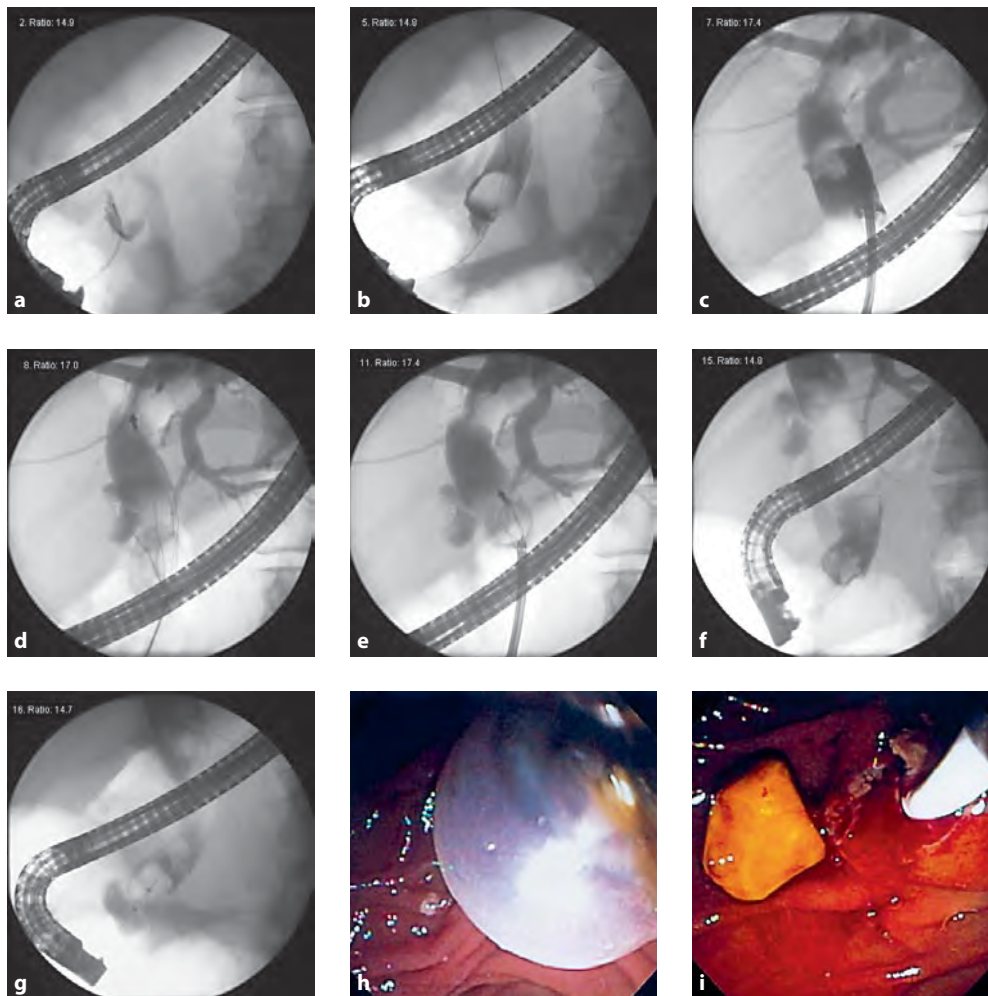
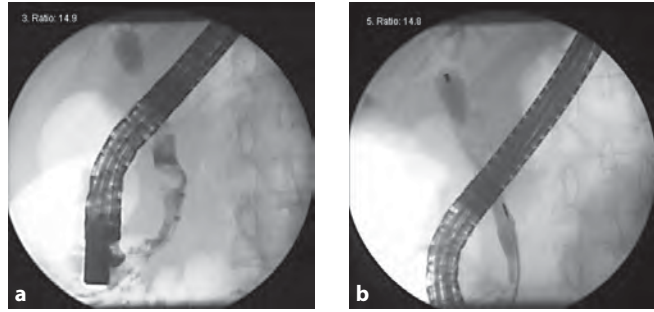


Fig. 7. Removal of large stones with basket lithotripsy. **a, b** Injection shows a large filling defect confirmed with further injection. ERC shows a solitary 11-mm stone. **c** The lithotripter is passed to the level of the stone. **d** The basket is opened and placed around the stone. **e** The stone is captured and lithotripsy begun. **f** Large fragments in the distal duct. **g** Balloon withdrawn through sphincterotomy to gauge size. **h** Balloon withdrawn at 15 mm. **i** Large cholesterol stone removed by the balloon.

Fig. 8. Bile duct stone and a tapered distal bile duct may require lithotripsy for removal. **a** Stone with tapered distal duct. **b** The basket of the mechanical lithotripter is used to grasp the stone.



When performing mechanical lithotripsy, it is important that the stone is engaged in a dilated portion of the duct (fig. 7). Otherwise, if the stone is in the distal duct and not free floating, it may be difficult for a basket to surround the stone. It is also imperative to maintain adequate position when using the mechanical lithotripter given the difficulty in selective cannulation. In this setting, cannulation with the basket portion alone enhances cannulation. Lithotripsy may also be required when the stone is of modest size but there is tapering of the distal duct (fig. 8).

Post-Procedure Care

Depending on the difficulty of the procedure, the majority of patients can be discharged home following successful stone extraction. High-risk patients may be those in whom the procedure was prolonged, and those at greatest risk of pancreatitis. Bleeding may occur after sphincterotomy in approximately 1–2% of patients but is usually not life-threatening; epinephrine injection of the ampulla delivered via a sclerotherapy needle is generally effective for hemostasis [10–12]. As noted above, balloon dilatation following sphincterotomy also may heighten the risk of bleeding. For patients with large stones that cannot be extracted and in whom a stent is placed, a follow-up procedure in 4–6 months is appropriate. At that time, stones are often times softer and easier to remove. The use of Actigal® is common in this setting although there is very little literature supporting its use.

Conclusions

CBD stones can be removed in most patients. The techniques for extraction are well recognized. Nuances occur in those with altered anatomy and with large calculi. Knowledge of the required equipment or accessories is essential not only for success, but to prevent complications (table 2).

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