Chapter 7
Laparoscopic Transcholedochal Exploration

Miguel A. Hernández, B. Fernando Santos, and Morris E. Franklin Jr

Introduction

Laparoscopic transcholedochal common bile duct exploration (LTCD) represents the most versatile surgical approach for the treatment of choledocholithiasis. The transcholedochal approach was originally based on the gold standard technique of open common bile duct exploration and in the laparoscopic era has continued to evolve into an effective and safe option for treating the patient with choledocholithiasis. Compared with transcystic access, LTCD provides potential access to the entire proximal and distal biliary tree, obviates the need for devices necessary to cannulate and dilate the cystic duct, and may be utilized for removal of stones of any size or occasionally entrapped devices from prior failed endoscopic or percutaneous procedures. LTCD, however, is more technically challenging than transcystic exploration and has a higher risk profile, making proper patient selection and attention to technical detail important in order to ensure optimal outcomes.

Electronic supplementary material The online version of this chapter (doi: 10.1007/978-3-319-74503-9_7) contains supplementary material, which is available to authorized users.

M. A. Hernández, MD · M. E. Franklin Jr, MD, FACS (✉)
Department of Minimally Invasive Surgery, Texas Endosurgery Institute, San Antonio, TX, USA
e-mail: fellow@texasendosurgery.com; franklin@texasendosurgery.com

B. F. Santos, MD
Department of Surgery, Geisel School of Medicine, Dartmouth College, Hanover, NH, USA

Veterans Affairs Medical Center, White River Junction, Hartford, VT, USA

B. F. Santos, N. Soper (eds.), *Choledocholithiasis*,
https://doi.org/10.1007/978-3-319-74503-9_7

Patient Selection and Indications

The indications for LTCD are similar to those for transcystic exploration and include patients in whom choledocholithiasis is confirmed preoperatively or intraoperatively (Table 7.1). LTCD may be used as the primary strategy for laparoscopic common duct clearance or for patients in whom a transcystic approach has failed or is not feasible (Fig. 7.1). LTCD is ideally suited to patients undergoing concurrent cholecystectomy but may in certain situations be performed even after prior cholecystectomy (unlike transcystic exploration). LTCD in patients with a prior cholecystectomy is indicated when either endoscopic retrograde cholangiopancreatography (ERCP) is not available or most commonly for patients in whom ERCP is difficult or has failed (such as those with a history of a prior Billroth II or Roux-en-Y gastric bypass). The surgeon performing LTCD should have a high degree of confidence in the diagnosis of choledocholithiasis compared to when performing transcystic exploration, however, as LTCD represents a more technically challenging operation requiring laparoscopic suturing skills and with a higher risk profile.

It is advisable to avoid a choledochotomy in patients with a small-diameter bile duct (<7 mm) to reduce the risk of a biliary stricture, even when T-tubes are used. Patients with small-diameter bile ducts may be better approached with either transcystic exploration if the bile duct is larger than 3 mm or with endoscopic stone clearance.

Table 7.1 Indications and contraindications for laparoscopic transcholedochal exploration

Indications for laparoscopic transcholedochal exploration
Contraindicated or failed transcystic approach • Large bile duct stones (>6–8 mm diameter) • Multiple bile duct stones • Proximal ductal stones • Small or tortuous cystic duct • Severe inflammation of the cystic duct (not including common bile duct) • Prior cholecystectomy
Failure of endoscopic stone extraction • Large or obstructing stones • Retained devices (e.g., entrapped stone baskets) • Altered anatomy precluding endoscopic approach (e.g., prior gastric bypass or Billroth II) • ERCP unavailable
Contraindications to laparoscopic transcholedochal exploration
Technical factors • Inability to suture laparoscopically
Unfavorable anatomy • Small common bile duct (<7 mm diameter) predisposing to stricture • Severe inflammation in the porta hepatis precluding safe dissection of the common bile duct
Patient factors • Severe cholangitis (better served with initial endoscopic drainage) • Long-standing jaundice (prompting suspicion for malignancy) • Active chemotherapy or impaired wound healing (may be better served with endoscopic clearance)

ERCP endoscopic retrograde cholangiopancreatography

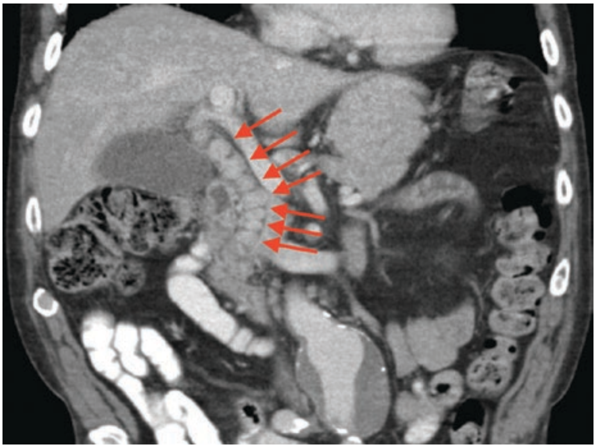

Fig. 7.1 Computed tomography (CT) scan with large stones. The CT scan shows a patient with a dilated common bile duct containing multiple large stones (red arrows). This patient is not appropriate for a transcystic approach. A transcholedochal approach was chosen instead

Informed consent prior to any cholecystectomy should include the possibility of requiring laparoscopic common bile duct exploration. If transcholedochal exploration is a possibility, the risk of bile leak, bile duct injury, and bile duct stricture should be discussed, as well as the possibility that the patient may require either internal (biliary stent) or external drainage (T-tube or closed suction drain) or secondary procedures such as ERCP or follow-up esophagogastroduodenoscopy (EGD) for stent removal if a biliary stent is used.

Patient Positioning and Setup

The best situation is when the surgeon knows prior to the operation that a transcholedochal exploration will be required so that all the instruments are set up ahead of time (Table 7.2). Regardless, certain considerations can make biliary exploration easier such as having a C-arm set up in the room and routinely using an operating room table capable of cholangiography. Generally, it may be helpful to tuck the patient's arm on the side from which the C-arm approaches to facilitate cholangiography. Initial trocar placement is the same as for a four-port cholecystectomy. The initial exposure and dissection to a critical view of safety are done identical to a conventional laparoscopic cholecystectomy.

Cholangiography

Routine intraoperative cholangiography through the cystic duct is strongly recommended for most cases, as it will delineate the biliary anatomy and the location of stones and provide a roadmap for the exploration (Fig. 7.2). When there is clear confirmation of large stones on preoperative imaging, however, the preoperative

Table 7.2 List of equipment for transcholedochal exploration

Equipment for transcholedochal exploration		
Item	Manufacturer	Product no.
Core equipment		
• C-arm		
• Operating room table compatible with cholangiography		
• Liver retractor (in cases of prior cholecystectomy)		
• Choledochoscope (video scope preferable to fiber-optic scope to eliminate the need for extra light cord and camera)	Karl Storz	11292 VSUK
• Alton Dean irrigation pump (optional) with saline bag		
• Extension tubing for continuous irrigation		
Choledochotomy		
• Laparoscopic Berci micro-knife	Karl Storz	26169DO
• Laparoscopic scissors		
Ductal clearance		
• Laparoscopic suction irrigator		
• 14 French red rubber catheter		
• Assortment of wire baskets		
- Nitinol wire basket	Cook	G31027
- Segura hemisphere basket	Boston Scientific	380106
• Assortment of balloon catheters		
- 4F Fogarty balloon	Edwards Lifesciences	120804F
- Biliary extraction balloon plus wire guide	Olympus	B-230Q-A, G-240-2545S
Choledochotomy closure		
• Fine absorbable suture (4-0 Vicryl on RB-1 needle)		
• T-tube (optional, 8-14 French)		
• Biliary stent (optional)		
• 7F laparoscopic biliary stent	Cook	G36251
• 8.5F biliary stent	Boston Scientific	M00534630
• Closed suction drain	Cook	G31027

Note: Manufacturer and product numbers listed are examples—other suppliers may be available

cholangiogram is not mandatory. Likewise, in cases where purulent debris is noted to emanate from the cystic ductotomy, or in cases of cholangitis, an initial cholangiogram should be deferred in order to reduce the risk of bacteremia from pressurizing the biliary tree. Antibiotic prophylaxis preoperatively is recommended, especially for patients with prior biliary manipulation or suspected cholangitis.

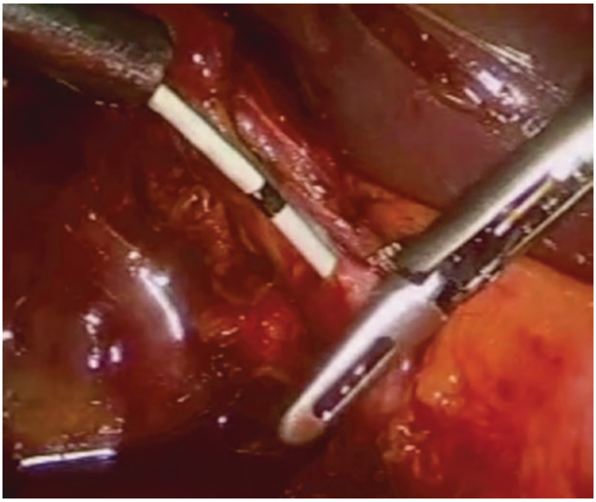

Fig. 7.2 Intraoperative cholangiography. A catheter is inserted into the cystic duct and secured with a locking instrument for cholangiography

Choledochotomy

Once the decision has been made to proceed with transcholedochal exploration, the surgeon may remain on the left side of the patient or move to the right side of the patient with placement of an additional trocar in the right lower quadrant between the most lateral trocar and the camera to facilitate the dissection. Working from the right side allows for a comfortable angle for making the ductotomy and for suturing. With the surgeon on the right side, the surgeon uses the lateral-most trocar plus the extra right lower quadrant trocar, while the assistant moves to the left of the patient and retracts the gallbladder cephalad using the subxiphoid trocar. The supraduodenal common bile duct may be seen as a bluish green tubular structure in the right anterior aspect of the porta hepatis (Fig. 7.3). The peritoneum covering of the hepatoduodenal ligament should be incised over the anterior aspect of the bile duct, and gentle blunt dissection should be used to expose the bile duct. Dissection along its lateral and medial aspects as well as any attempt to encircle the bile duct should be avoided to avoid injury to the “3 o’clock” and “9 o’clock” arteries supplying and running parallel to the bile duct. Exposure should be just enough to allow a 1–2 cm longitudinal incision over the duct. If the location of the bile duct is in doubt, a fine needle may be used to aspirate the bile, confirming the location of the bile duct. A longitudinal incision is preferred so as to not disrupt the blood supply to the common bile duct. The incision may be made with a laparoscopic knife or with fine scissors (Fig. 7.4a–d). Stay sutures are generally unnecessary and are at risk of being pulled through, tearing the duct. The incision length should generally remain less than 1.5 cm due to the ability of the CBD to distend and stretch. Care should be

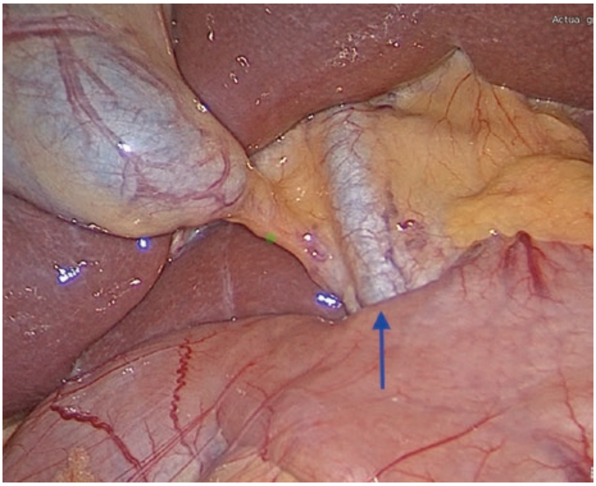

Fig. 7.3 Supraduodenal common bile duct. The common bile duct can usually be seen as a bluish green tubular structure in the right anterior aspect of the porta hepatis

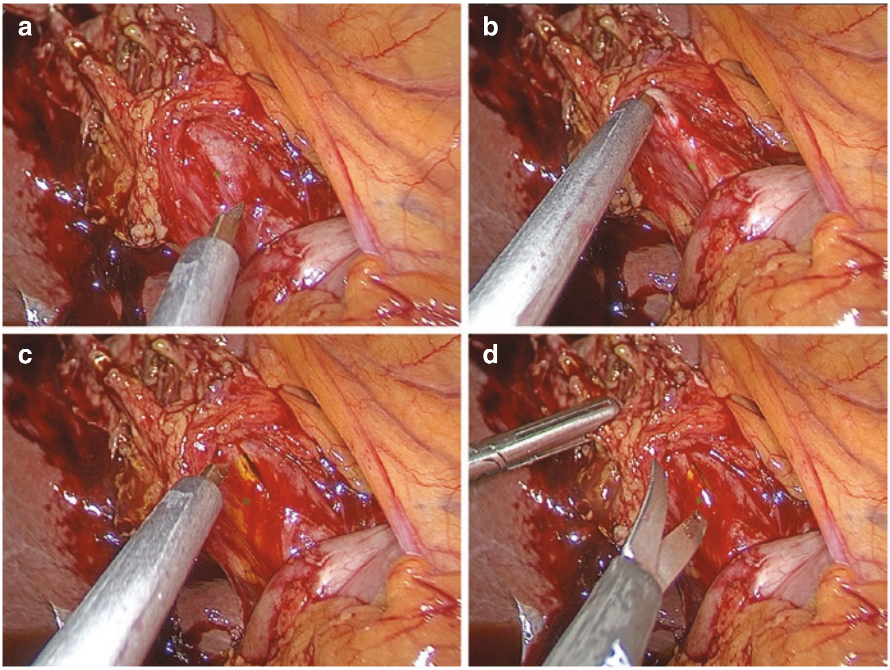

Fig. 7.4 Choledochotomy. The choledochotomy may be created with a laparoscopic knife (**a**) or with scissors. The knife is gently inserted into the common bile duct, with care not to injure the back wall of the duct (**b**). Once the initial incision has been made (**c**), it is extended further longitudinally with the knife or with scissors (**d**)

taken to not make the incision to the right of the midplane of the duct, so that the incision is not made into a cystic duct-common duct septum that is present in about 20% of patients when the cystic duct runs parallel to the common duct.

Stone Extraction

Extraction of stones through the choledochotomy may be accomplished with a variety of ways. In general it is recommended to begin with the simplest maneuver, proceeding to more complex maneuvers if necessary:

1. *Irrigation*: The surgeon places the tip of the suction irrigator into the choledochotomy to irrigate the duct. Small stones and debris are easily cleared with this simple maneuver, and larger, free-floating stones may be drawn toward the choledochotomy by following the flow of saline. Once seen at the choledochotomy site, these larger stones can be grasped and removed. A 14F red rubber catheter may also be inserted through a 5 mm trocar and passed distally or proximally and flushed vigorously as it is withdrawn to dislodge more distant stones (Fig. 7.5a–d).
2. *Balloon extraction*: A Fogarty balloon catheter or an ERCP stone extraction balloon passed over a wire (positioned across the papilla) is passed through the choledochotomy and guided distally. The balloon is guided just past resistance, and then slowly withdrawn and inflated, then gradually withdrawn through the

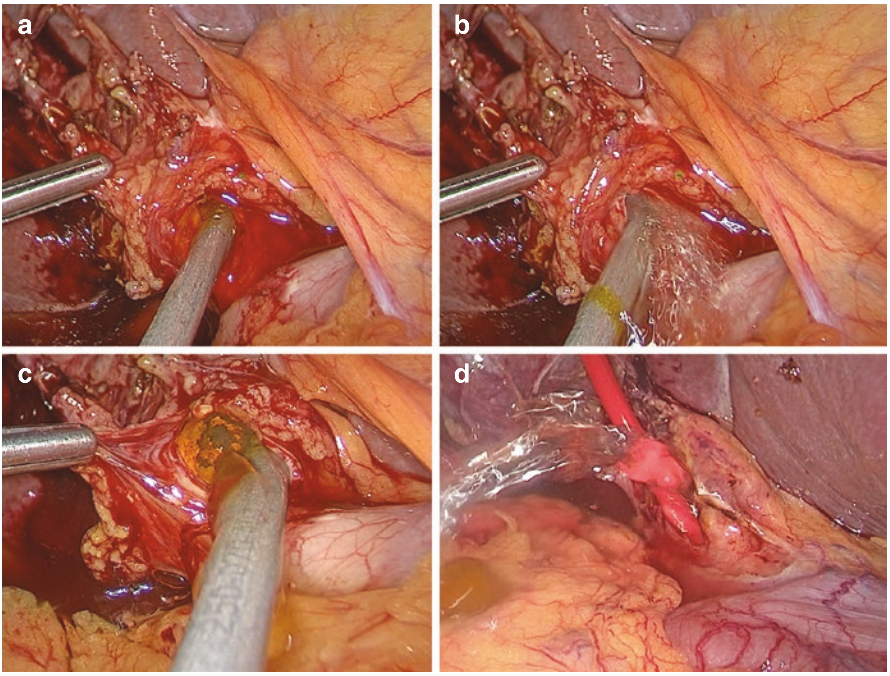

Fig. 7.5 Irrigation. The suction irrigator is placed at the ductotomy (**a**) and vigorous flushing is performed (**b**). The flow of water clears debris and brings a stones to the ductotomy (**c**). More distal or proximal flushing can be performed by passing a 14F red rubber catheter and vigorously flushing as the catheter is withdrawn. A stone that has been flushed out this way is seen on the left side of the image (**d**)

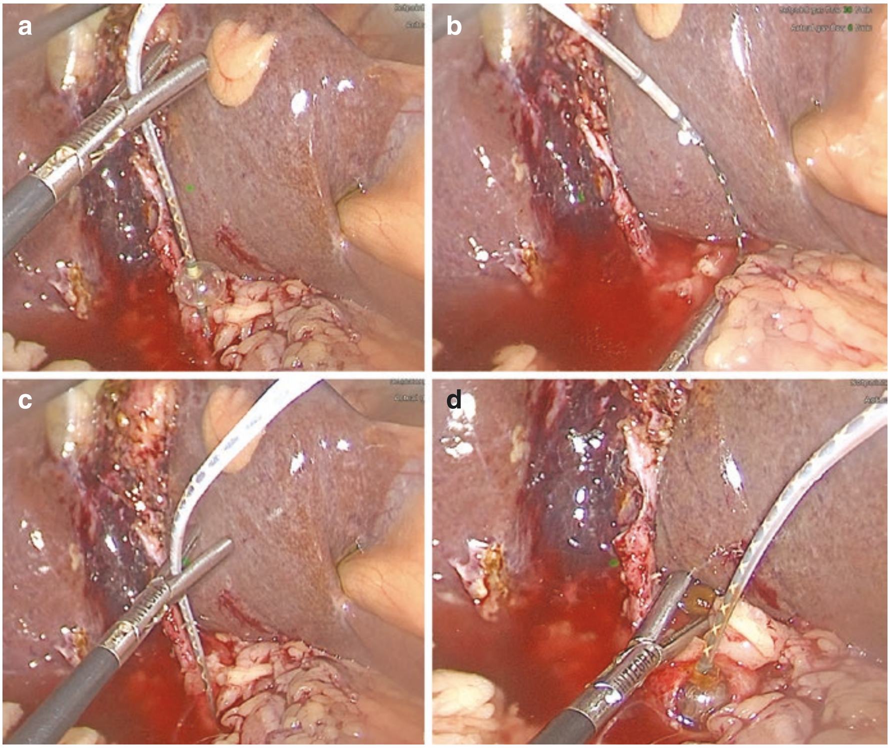

Fig. 7.6 Balloon extractor. An embolectomy catheter or balloon extraction device passed over a wire (**a** and **b**) is inserted distally past the papilla (**c**). The balloon is withdrawn until resistance is felt at the papilla, then the balloon is let down, slightly withdrawn, and reinflated to sweep stones out of the choledochotomy (**d**)

choledochotomy to remove debris. This technique may require several passes of the balloon to remove all the debris (Fig. 7.6a–d).

3. *Choledochoscopy*: If the aforementioned attempts at clearing the duct are unsuccessful or if there appear to be no more stones to remove, then direct visualization of the duct via choledochoscopy should be done to confirm stone clearance. The irrigation is connected to the scope and tested. A bag of saline may be pressurized using an arterial line cuff, or alternatively an Alton Dean irrigation pump may be used to more reliably pressurize a larger saline bag. The scope is placed through an introducer sheath (to prevent leakage of pneumoperitoneum) and inserted into a 5 mm trocar (right upper quadrant trocar at the midclavicular line). The saline should be turned on to clear debris and distend the ducts during choledochoscopy. The scope should be directed proximally (Fig. 7.7a–e) and distally to visualize the entire biliary tree to confirm ductal clearance. If stones are found, a wire basket through the scope, or a balloon extractor passed beside the scope, is used to remove stones. The closed basket or balloon is passed beyond the stone and then opened or inflated and withdrawn to capture the stone. Slight back and forth manipulation with an open wire basket may be necessary

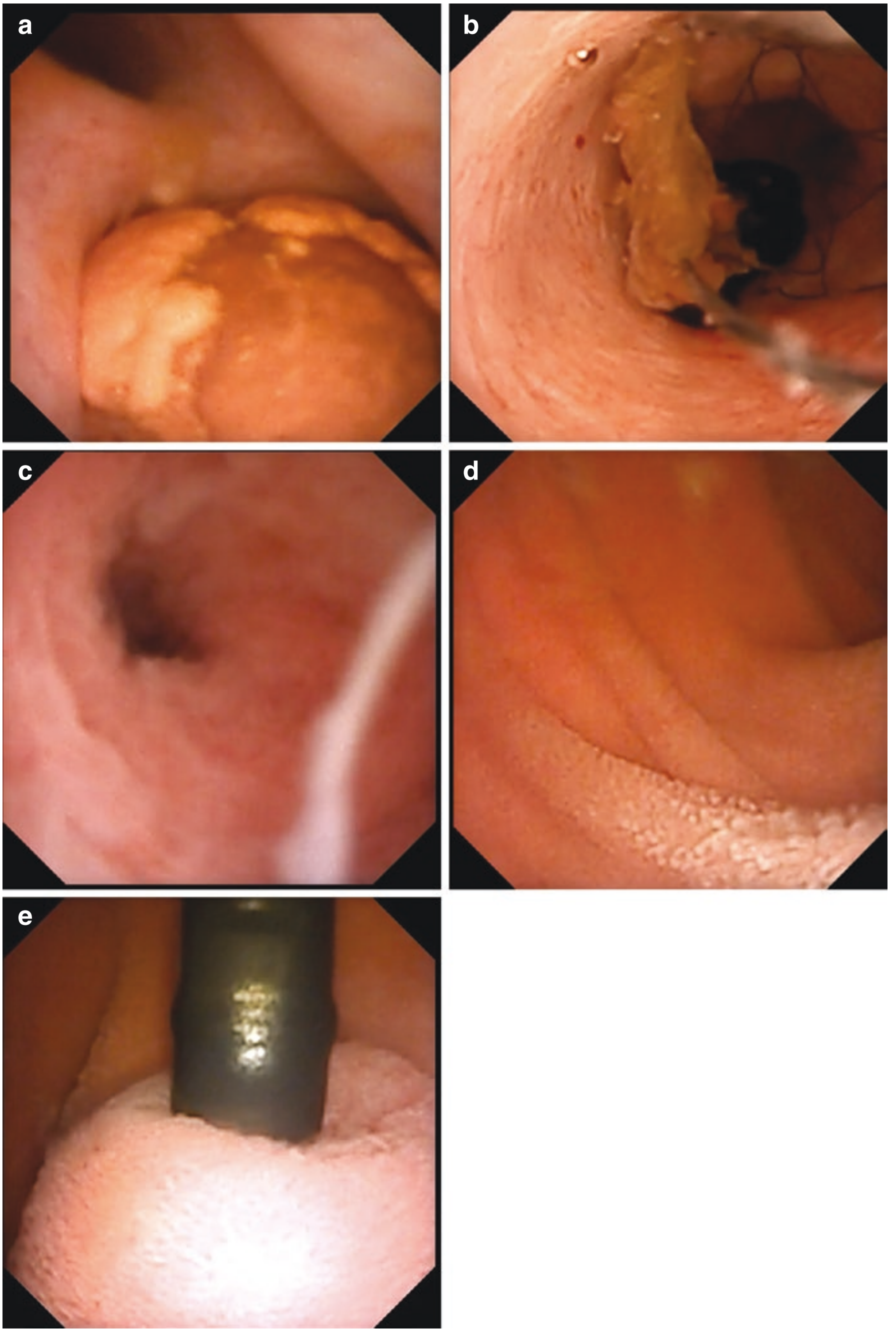

Fig. 7.7 Choledochoscope views. An intrahepatic stone is visible (**a**). A distal stone is captured using a wire basket through the scope (**b**). The papilla is seen from the common duct side (**c**). The scope is gently advanced through the papilla into the duodenum to confirm no stones remain (**d**). Some scopes with high degrees of flexion allow retroflexion in the duodenum to examine the duodenal aspect of the papilla (**e**)

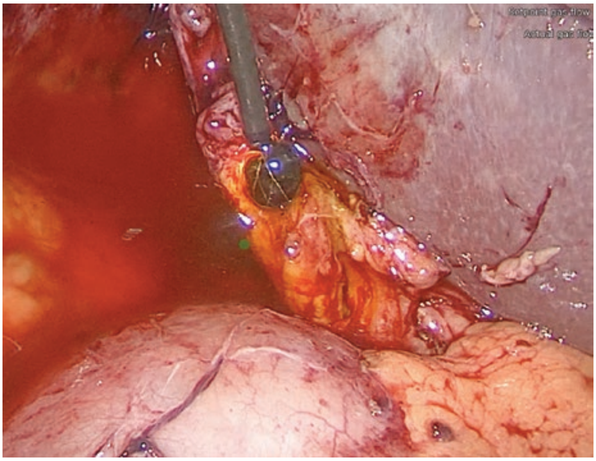

Fig. 7.8 Stone basket. The stone basket and choledochoscope are withdrawn as a unit through the choledochotomy

to capture the stone prior to closing the basket around the stone. The scope and captured stone are then withdrawn together out of the choledochotomy (Fig. 7.8) and retrieved with a laparoscopic instrument. A small-diameter choledochoscope can usually be gently guided past the papilla into the duodenum, confirming that no distal stones are left. Retroflexion to view the papilla may sometimes be performed with the newer, video scopes capable of 270° flexion. Likewise, the scope should be directed proximally to visualize the proximal hepatic ducts to confirm no stones remain.

Choledochotomy Closure

The choledochotomy closure may be accomplished in several ways including primary closure, closure over a T-tube, and primary closure plus internal drainage with a biliary stent. A closed suction drain should be placed adjacent to the repair in case of an early bile leak, regardless of the closure technique. While closure over a T-tube was commonly performed in the "open" era, there has been a trend away from T-tube closure in the literature, with some studies showing an advantage for primary closure compared to T-tube closure in terms of reducing operative time, decreased hospital length of stay, and possibly even a decreased risk of bile leak. Likewise, biliary stents have emerged as an option to provide postoperative internal drainage without the use of a T-tube. Selection of the proper closure technique for each patient should be individualized and depends on surgeon experience, patient factors, and technical considerations.

Primary Closure

Primary closure alone may be adequate in straightforward cases, in which there has been minimal to no manipulation of the papilla, where there is no purulence in the bile duct, and where there is a low concern for retained stones and in relatively fit patients. The duct may be closed in an interrupted or running fashion using fine absorbable 4-0 sutures such as Vicryl (polyglactin 910) or PDS (polydioxanone). The running technique has the advantage of greater expediency compared with the interrupted technique. The suture bites should be full thickness, about 1–2 mm from the cut edge of the duct, and be spaced about every 2 mm (Fig. 7.9a–d; Video 7.1). The suture line should be tested by flushing saline through the cystic duct using a cholangiogram catheter, while observing for leakage of saline. Additional interrupted sutures are placed at the site of any leaks, and the closure is rechecked. A closing cholangiogram should also be performed to check for extravasation of contrast and confirm ductal patency and the absence of filling defects. The main advantage of primary closure is that the patient does not need an extended period of T-tube drainage and avoids the potential discomfort and potential complications associated with having a T-tube. One of the downsides of primary closure, though, is that there is a potentially greater risk of bile leak should pressurization of the bile duct occur

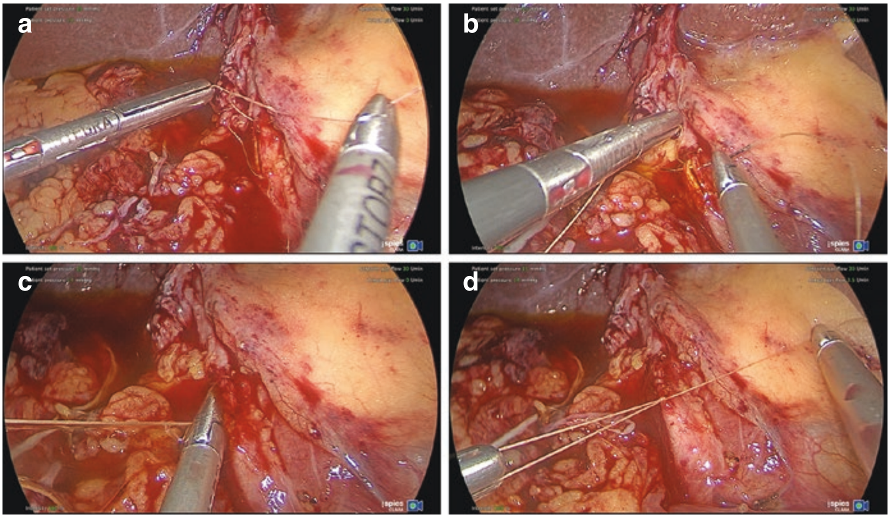

Fig. 7.9 Primary closure. The suture line is begun at the apex of the incision using 4-0 Vicryl on an RB-1 needle (**a**). A running suture line is performed taking 1–2 mm bites in each side of the incision (**b**). It is important to cinch after each bite to prevent the suture line from loosening (**c**). The suture line is completed and tied (**d**)

postoperatively as in cases with extensive papillary manipulation or in cases with a high risk of retained stones. There is also the possibility of impaired biliary drainage in cases of ampullary edema or cholangitis. Nevertheless, for the well-selected patient, there is evidence that this technique reduces operative time, shortens hospital length of stay, and may actually have lower complication rates than T-tube closure.

T-Tube Closure

T-tubes are the traditional adjunct to choledochotomy closure and are routinely used by some surgeons, including the senior author. Routine users argue that instrumentation of the common bile duct and the maneuvers used for stone removal may result in edema of the papilla and elevated pressures in the biliary tree, creating an environment that places the closure at risk for biliary leak. Placement of a T-tube allows for resolution of edema and spasm while preventing biliary stasis. In patients with cholangitis, ensuring this continued drainage of bile is especially important to prevent recurrent cholangitis and ensure resolution of sepsis. The T-tube also provides continued access to the biliary tree for interval cholangiography, stone extraction for any retained stones, or to facilitate wire access for subsequent ERCP. The T-tube technique has an advantage over the use of an internal biliary stent in that the biliary prosthesis is removed by simply pulling the T-tube at the bedside, without the need for an additional endoscopic procedure as in the case of a biliary stent. Although transcystic drainage can also be achieved in some patients (as an alternative to a T-tube), the placement of a T-tube in the common bile duct is more widely applicable and will be the only technique described. There is variation in the size of T-tubes used by surgeons, with some surgeons advocating the use of a 14F T-tube to allow easier access for percutaneous interventions should these be necessary. The senior author prefers the use of an 8F tube, as it reduces patient discomfort and requires a smaller opening in the bile duct. The T-tube is prepared by trimming the crossbar of the T to approximately twice the size of the choledochotomy with one short and one long limb. The crossbar segment is then incised longitudinally to open the back wall, and the tube is inserted into the duct with the long limb in the distal duct (Fig. 7.10). A 4-0 Vicryl running suture is used to close the choledochotomy in a continuous manner. The first bite is the most important and is taken close to the tube with care to not incorporate the tube. This first bite should snug up the tube to the duct and is crucial in terms of anchoring the tube and preventing migration or leaking. Subsequent bites are placed moving in a caudal direction until the duct is completely closed (Video 7.2). The T-tube is then exteriorized at the end of the surgical procedure through one of the right upper quadrant 5 mm trocar sites. It is important to allow for a small amount of laxity in the tube so that postoperative abdominal distention does not create tension on the tube and cause it to become dislodged. Even with placement of a T-tube, placement of a closed suction drain adjacent to the T-tube is recommended to help detect and control a possible

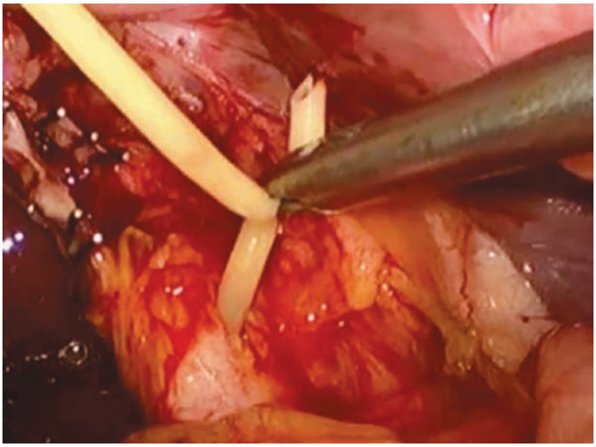

Fig. 7.10 T-tube. The T-tube is inserted with the long limb in the distal duct

postoperative bile leak. Although postoperative T-tube management is highly variable among surgeons, most surgeons keep the tube in for at least 2–6 weeks.

The technique of the senior author using 8F T-tubes will be described. After the operation, the surgeon places the drainage bag at the level of the floor for approximately 12 h, while the closed suction drain is checked for any evidence of bile leak. If the drainage is not bilious, the T-tube is repositioned at the level of the bed for another 12 h. After this time period, the bag is placed at the head of the bed. If the bile is not seen in the closed suction drain, the T-tube is clamped. It is thought that this method, with its various positional changes, may allow testing of the integrity of the repaired choledochotomy by sequentially varying the intraductal pressure. The closed suction drain is then removed prior to discharge, and the patient is scheduled for a cholangiogram 10–15 days postoperatively. If there are no retained stones or bile leak, the T-tube is removed. Should retained stones be present, they are removed endoscopically.

Primary Closure with Biliary Stent

Primary closure with a biliary stent is a newer technique that combines the ease of a primary closure with the internal drainage provided by a transampullary stent. Prior to choledochotomy closure, the surgeon inserts a biliary stent through the choledochotomy. Either a laparoscopic 7F biliary stent may be used (Fanelli stent, Cook Medical) (Video 7.3) or an 8.5F biliary stent designed for ERCP deployment may be used. If using an ERCP-type stent, a preloaded 5–7 cm stent that is fixed to the delivery catheter with a suture (Fig. 7.11) and is able to be repositioned by withdrawing the catheter is recommended (e.g., Advanix™ stent, Boston Scientific) (Video 7.4). The surgeon obtains wire access across the papilla and then backloads the stent delivery system onto the wire. The stent delivery system generally has fluoroscopic markers that are positioned across the papilla, and, once in position, the

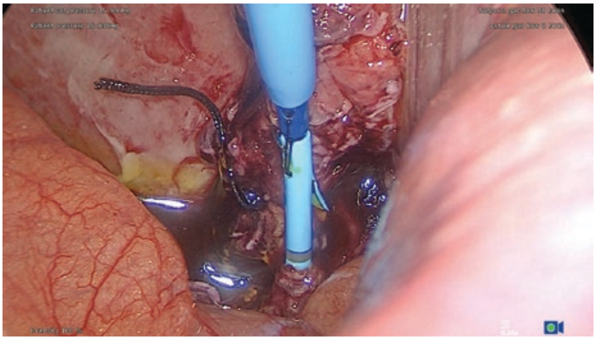

Fig. 7.11 Biliary stent with suture fixation. A biliary stent delivery system with fixation of the stent to the delivery catheter allows the surgeon to withdraw the stent if necessary, unlike delivery systems with a push catheter mechanism only

stent is deployed. The choledochoscope can be used to confirm the position of the stent across the papilla from the common bile duct side (Fig. 7.12a, b). The stent does not need to lie across the choledochotomy closure site but rather functions to ensure continued internal drainage once the choledochotomy is closed, to prevent pressurization of the bile duct and the possibility of a bile leak as a result. Once the stent is in place and the choledochotomy is closed, the surgeon performs a closing cholangiogram to confirm a watertight closure of the choledochotomy and that no filling defects remain. A closed suction drain is placed adjacent to the choledochotomy closure to monitor for postoperative bile leak. The drain is generally removed prior to the patient's discharge from the hospital. An EGD is scheduled as an outpatient to remove the biliary stent after 2–4 weeks. The stent is removed using either foreign body forceps or a snare, using a standard gastroscope. A clear cap may be fitted to the end of the gastroscope to facilitate visualization of the papilla and grasping of the stent if necessary (Fig. 7.13).

Outcomes

The clinical experience at the Texas Endosurgery Institute from 1991 to 2016 includes a total of 8591 patients having undergone laparoscopic cholecystectomy with intraoperative cholangiography. Of these patients, 626 (7.2%) were diagnosed with choledocholithiasis, of which 400 (64%) patients were women. Of the 626 patients with choledocholithiasis, 150 (24%) underwent successful laparoscopic transcystic common bile duct exploration, with the remaining 476 (76%) patients undergoing transcholedochal bile duct exploration. The choledochotomy was closed using a T-tube in 457 (96%) patients. Postoperative complications included four (0.6%) patients with bleeding that was controlled nonoperatively, two (0.3%) patients with jaundice, six (0.9%) patients with pancreatitis, six (0.9%) patients with wound infections, four (0.6%) patients with a biloma, and two (0.3%) patients with cholangitis. Retained stones were found in 11 (1.7%) patients with those

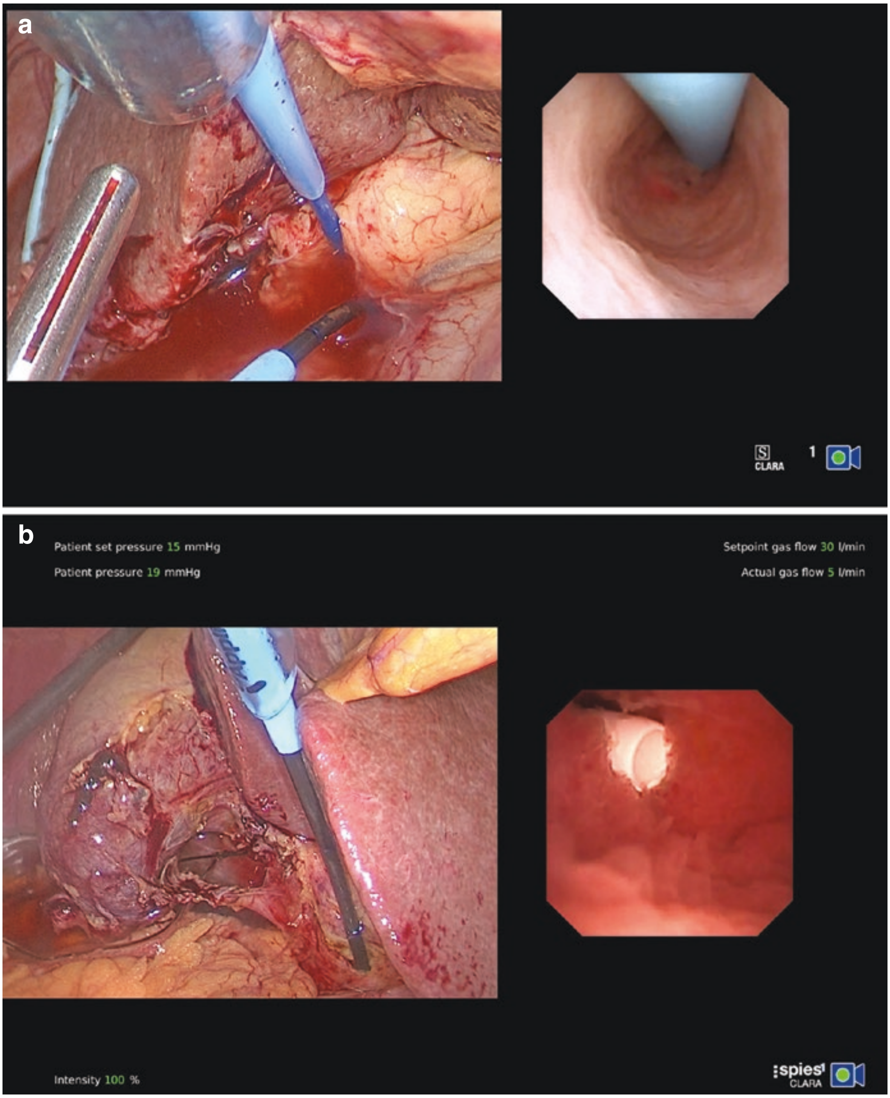

Fig. 7.12 Biliary stent seen from choledochoscope. The stent may either be positioned across the papilla by fluoroscopy or it may be guided across the papilla by the choledochoscope (**a**). Once deployed, the proximal side of the stent can be seen by the choledochoscope (**b**)

patients requiring ERCP for stone clearance. Bile leaks from the T-tube closure occurred in 27 (4.3%) patients, of whom 11 (1.7%) required re-exploration. Other T-tube complications occurred in five patients (0.8%).

Fig. 7.13 Stent removal with esophagogastroduodenoscopy (EGD). The stent may be removed 2–4 weeks after the operation using foreign body forceps or a snare. A clear cap placed on the end of the scope facilitates visualization of the papilla and removal of the stent

Conclusion

Laparoscopic transcholedochal common bile duct exploration represents a versatile and well-established technique for the clearance of common bile duct stones. This technique does require advanced laparoscopic skills including suturing, but allows the surgeon to safely and effectively manage the vast majority of patients with choledocholithiasis, even in the setting of large stones.

References

1. Dorman JP, Franklin ME Jr. Laparoscopic common bile duct exploration by choledochotomy. Semin Laparosc Surg. 1997;4:34–41.
2. Petelin JB. Laparoscopic common bile duct exploration. Surg Endosc. 2003;17:1705–15.
3. Trazuma S. Epidemiology, pathogenesis, and classification of biliary stones (common bile duct and intrahepatic). Best Pract Res Clin Gastroenterol. 2006;20:1075–83.
4. Phillips EH. Laparoscopic common bile duct exploration: long-term outcome. Arch Surg. 1999;134:839–43.
5. Varban O, Assimos D, Passman C, Westcott C. Laparoscopic common bile exploration and holmium laser lithotripsy: a novel approach to the management of common bile duct stones. Surg Endosc. 2010;24:1759–64.
6. Rogers SJ, Cello JP, Horn JK, Siperstein AE, Schecter WP, Campbell AR, et al. Prospective Randomized Trial of LC+LCBDE vs ERCP/S+LC for common bile duct stone disease. Arch Surg. 2010;145(1):28–33.

7. Campagnacci R, Baldoni A, Baldarelli M, Rimini M, De Sanctis A, Di Emiddio M, et al. Is laparoscopic fiberoptic choledochoscopy for common bile duct stones a fine option or a mandatory step? Surg Endosc. 2010;24:547–53.
8. Hanif F, Ahmed Z, Abdel Sanie M, Nassar AHM. Laparoscopic transcystic bile duct exploration: the treatment of first choice for common bile duct stones. Surg Endosc. 2010;24:1552–6.
9. El-Geidle AAR. Is the use of T-tube necessary after laparoscopic choledochotomy? J Gastrointest Surg. 2010;144:844–8.