How I do it: laparoscopic treatment of common bile duct stones

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Abstract: The standard treatment for patients with symptomatic gallstones is laparoscopic cholecystectomy (LC). In patients undergoing LC the prevalence of common bile duct (CBD) stones ranges between 8% and 15% and it increases with advancing age, reaching up to 60% in elderly patients. Every patient who is candidate for LC should be evaluated for the presence of CBD stones and these should be treated if the diagnosis is confirmed. In the literature, the procedure of choice for CBD stones treatment is still debated. In many centers, pre- or postoperative endoscopic retrograde cholangiopancreatography (ERCP) with endoscopic sphincterotomy (ES) and LC (two-stage endo-laparoscopic management) is considered standard practice instead of open choledocholithotomy and cholecystectomy. Laparoscopic single-stage management of gallstones and CBD stones has demonstrated equivalent outcomes to the two-stage endo-laparoscopic approach in randomized controlled trials but with shorter hospital stay and fewer interventions. Moreover, the two-stage endo-laparoscopic management of CBD stones and gallstones may be associated with a higher additional procedures rate, and possibly increased costs, as compared to single-stage laparoscopic management. Another option is single-stage endo-laparoscopic management of gallstones and CBD stones, performing ERCP/ES during the same LC anesthesia (so called, "Rendez-Vous" procedure). Excluding patients with cholangitis, who should be managed by emergency ERCP with ES and stones removal, in the elective setting the ultimate choice for one procedure or the other largely depends on the local resources and expertise that are available in the individual center, notwithstanding the scientific evidence in favour of single-stage laparoscopic management. The authors report the surgical techniques that they follow during LC for CBD exploration and stones' removal by laparoscopic trans-cystic or choledochotomy approach.

Keywords: Gallstones; laparoscopic cholecystectomy (LC); common bile duct stones (CBD stones); laparoscopic common bile duct exploration (laparoscopic CBD exploration); trans-cystic duct exploration; choledochotomy

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Introduction

For patients with symptomatic gallstones the standard treatment is laparoscopic cholecystectomy (LC) (1). The prevalence of common bile duct (CBD) stones in patients undergoing LC ranges between 8% and 15%, and it increases with advancing age (2). Therefore, all patients who are candidate for LC should be suspected for harbouring CBD stones. If the diagnosis is confirmed, CBD stones should be removed (2).

The procedure of choice for CBD stones treatment is still debated (3). In many centers, endoscopic retrograde cholangiopancreatography (ERCP) with endoscopic sphincterotomy (ES) before or after LC (two-stage endo-laparoscopic management) is standard practice, replacing traditional open choledocholithotomy and cholecystectomy (3-7). Single-stage laparoscopic management of gallstones and CBD stones has more recently been introduced, showing equivalent outcomes to the two-stage approach in randomized controlled trials, with a shorter hospital stay (1,3,4,7). Moreover, the two-stage endo-laparoscopic management of CBD stones may be associated with higher additional procedures rate and related increased costs as well as increased recurrent ductal stones rate, as compared

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Figure 1 In this video, one case of laparoscopic trans-cystic exploration and one case of laparoscopic choledochotomy are reported, both with CBD stone extraction under choledochoscopic vision (9). CBD, common bile duct.
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to single-stage laparoscopic management (3,5,6,8).

The authors report the surgical techniques that they follow for laparoscopic CBD exploration by trans-cystic and choledochotomy approach during LC.

Operative techniques

The patient is positioned supine on the operative table with adducted legs (so called "American" position) with the surgeon standing to the left of the patient and first assistant standing on the surgeon's left side holding a 30° forward oblique optic. The second assistant stands on the right side of the patient. The camera with video monitor, the light source and insufflator are placed on the right side of the patient. Carbo-pneumoperitoneum is created at a pressure of 12–13 mmHg with a Veress needle and 10 mm optical trocar (T1) in supra-umbilical position. Alternatively, an open technique and Hasson cannula are employed to introduce T1 in supra-umbilical position, if the presence of adhesions from previous surgery is suspected and according to surgeon's preference. T1 is used for the camera. After creation of the pneumoperitoneum, another 10 mm trocar (T2) is introduced under vision in the epigastrium two fingerbreadths on the left of the midline and immediately below the left costal arch. Two more 5 mm trocars (T3 and T4) are introduced under vision. T3 is placed along the right anterior axillary. A grasper introduced from T3 is used to apply cephalic traction on the fundus of the gallbladder to raise the liver. T4 is positioned in the right hypochondrium above the infundibulum-cystic duct (CD) junction of the gallbladder. The working trocars that are used by the surgeon are T2 and T4.

Laparoscopic trans-cystic exploration and stone extraction

Step 1—CD identification and intraoperative cholangiography

After exposure of the inferior surface of the liver indocyanine green (ICG) fluorescence cholangiography (FC) is performed prior to dissection. The procedure begins with dissection and isolation of the CD and cystic artery. ICG-FC and angiography (FA) are used to improve visualization of the anatomy. The cystic artery is divided between 10 mm titanium clips. In this case the CD is dilated and thickened preventing complete closure of the CD by titanium clips, and the gallbladder infundibulum is closed with a ligature. The CD is then opened with scissors and it is cannulated with a 4 Fr percutaneous cholangiogram catheter. Intraoperative C-arm fluoro-cholangiography (IOC), not shown in this video, confirmed the presence of ductal stone (*Figure 1*).

Step 2—choledochoscopy

The grasper introduced from T3 holding the fundus of the gallbladder is moved to raise the infundibulum of the gallbladder providing countertraction during the CBD exploration maneuvers from T4. Choledochoscopy is performed with a flexible choledochoscope and continuous saline irrigation. The tip of the choledochoscope is introduced through the CD opening and then inside the CBD and down to the papilla to identify the ductal stone.

Step 3—stone extraction

A flat, four wire stone extraction catheter is advanced through the choledochoscope inside the CBD and beyond the stone, and it is then opened deploying the basket. The catheter is then slowly withdrawn from the CD. Once the stone is inside the basket, the catheter is withdrawn to the tip of the choledochoscope, which is then retrieved. A milking maneuver of the CD helps ductal stone extraction. The stone is subsequently retrieved from the peritoneal cavity with a spoon forceps.

Step 4—completion of trans-cystic exploration

Completion choledochoscopy is performed showing no

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residual stones. Next, trans-cystic IOC is repeated to check for the absence of retained CBD stones. Once a negative IOC is obtained, the CD is closed with suture and titanium clips.

Step 5—cholecystectomy and gallbladder extraction

The CD is divided, and retrograde cholecystectomy is performed, followed by gallbladder removal with an extraction bag.

Laparoscopic choledochotomy

The indications are: ductal stones having a size larger than the size of the CD, multiple CBD stones (>5), low and medial junction between CD and CBD, common hepatic duct (CHD) stones. A prerequisite is the presence of a dilated CBD of at least 8–10 mm in diameter. Laparoscopic choledochotomy requires laparoscopic suturing experience and it may therefore be more difficult as compared to the trans-cystic approach, but CBD exploration is easier, including exploration of the CHD which may be difficult or impossible to explore trans-cystically.

For this approach, the first steps of the procedure are identical to the previously reported ones.

Step 1—preparation of the CD

The procedure begins with dissection and isolation of the CD and cystic artery. ICG-FC may be used to improve visualization of the CD. The cystic artery is closed with 10 mm titanium clips. In this case the CD is dilated preventing its complete closure with clips and the infundibulum is closed with a ligature.

Step 2—attempted trans-cystic CBD exploration

The CD is opened with scissors. IOC is omitted because preoperative cholangio-magnetic resonance imaging (MRI) demonstrated the presence of one ductal stone. Trans-cystic choledochoscopy is attempted in this case but it fails due to the presence of continent Heister valves. Since the CBD is dilated a choledochotomy is performed.

Step 3—laparoscopic choledochotomy and stone extraction

A short transverse choledochotomy is performed and direct exploration of the CBD and CHD is carried out with the flexible choledochoscope. The scope is inserted through the CBD opening, directing its tip towards the papilla. After the stone is visualized, a four wire, flat stone extractor catheter is advanced through the working channel of the choledochoscope and the basket is deployed after passing its tip beyond the stone. The catheter is then withdrawn from the CBD until the stone is entrapped. The catheter is then pulled back to the tip of the scope which is retrieved to the peritoneal cavity where the stone is released and retrieved. Next, the choledochoscope is directed towards the intrahepatic ducts to check for the absence of residual stones.

Step 4—choledochotomy closure

The choledochotomy is closed with a continuous 4.0 absorbable suture. The cystic artery is divided between clips. The thickened CD is closed with a suture and it is then divided.

Step 5—cholecystectomy and gallbladder extraction

After closure of the CD, retrograde cholecystectomy is performed, and the gallbladder is removed with a specimen retrieval bag.

Comments

The choice to perform laparoscopic CBD exploration by a trans-cystic or a choledochotomy approach depends on the patients' anatomy of the extrahepatic bile ducts and on the ductal stones' size and number. IOC provides these data. As compared to a choledochotomy, the trans-cystic approach is less invasive and should be the treatment of choice unless there are clear indications to perform a choledochotomy. The indications to perform a choledochotomy are: (I) CBD of at least 8–10 mm in diameter; (II) CBD stones larger than the size of CD; (III) more than 5 bile duct stones; (IV) low and medial junction of CD with CBD; (V) CHD stones.

Our choice to perform a transverse choledochotomy rather than a longitudinal one is because a transverse incision interrupts less ductal arterioles and its suture reduces the risk of ischemia. Should a larger stone be present, a transverse incision cannot be extended. Instead, with a longitudinal choledochotomy, there may be tendency on the part of the surgeon towards extending the ductal incision when large stones are present, and its subsequent

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suture narrows the CBD which gains an hourglass configuration, with consequent risk of bile stasis and recurrent primary brown stones formation.

The choice to place T2 on the left of the midline is made to increase the working angle between this trocar and T4, to facilitate suturing the CBD after choledochotomy. It is also important that T4 be placed exactly above the infundibulum-CD junction of the gallbladder, because all ductal exploration maneuvers are done through this port.

Should a stone be impacted at the papilla, that cannot be mobilized with the basket catheter, an electrohydraulic lithotripsy probe, if available, may be placed under vision in contact with the CBD stone and used to break the stone. The fragments are then removed with a basket catheter or washed away with saline irrigation after intravenous administration of glucagon (1 mg) to relax the papilla.

External biliary drainage should be avoided whenever possible. The indications for external biliary drainage, whether trans-cystic or T-tube (based on surgeon's preference), are the following: (I) persistence of fibrin debris or bile sludge at the end of CBD exploration; (II) if pneumatic dilation or passage of the basket catheter through the papilla have been carried out, that could be the cause of edema and cholangitis; (III) if it is not possible to extract a ductal stone which is knowingly left behind.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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