

Single-stage procedure for the treatment of cholecysto-choledocolithiasis: a surgical procedures review

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Abstract: While laparoscopic cholecystectomy is generally accepted as the treatment of choice for simple gallbladder stones, in cases in which common bile duct stones are also present, clinical and diagnostic elements, along with intraoperative findings, define the optimal means of treatment. All available options must be accessible to the surgical team which must necessarily be multidisciplinary and include a surgeon, an endoscopist, and a radiologist in order to identify the best option for a truly personalized surgery. This review describes the different techniques and approaches used based on distinctive recommendations and factors, according to the specific cases treated and the results achieved.

Keywords: bile duct clearance, cholecysto-choledocolithiasis, one-stage treatment

Introduction

The study of the anatomy of the biliary tract has always attracted the interest of numerous scientists, from Leonardo da Vinci to Abraham Vater (1790) although the first cholecystectomy was reported in 1882 by Langenbuc.¹ The progress made in recent decades has completely changed surgical approaches, especially with the advent of endoscopic and laparoscopic surgery. Today, the treatment of gallstone disease often requires a multidisciplinary approach involving a surgeon, an endoscopist, and a radiologist.²

While laparoscopic cholecystectomy (LC) is the treatment of choice for gallbladder stones,³ in those cases in which common bile duct (CBD) stones are also present (~10% of the overall cases) treatment options are still open to discussion.^{4,5} During the last 20 years, CBD stones were treated through endoscopic retrograde cholangiopancreatography (ERCP) which was proposed pre- or postcholecystectomy.⁶ However, despite the good results, several issues did arise such as the number of unnecessary procedures (10%),⁷ the not negligible complications' rate (between 0.8% and 11.1%),⁹ and the mortality rate (between 0.1% and 3.3%).⁸⁻¹⁰

The rapid expansion of laparoscopic surgery also demonstrated that it was possible to resolve cholecysto-choledocolithiasis through a single-stage approach.¹¹ Indeed, there are currently two treatment options for gallbladder and CBD stones: a single- or double-stage procedure. Studies have shown that results are similar in terms of efficacy, morbidity, and mortality.^{12,13}

However, it is now reported that single-stage treatment lowers costs with a shorter hospital stay and improves patient compliance.^{14,15} Additionally, the issue linked to the unexpected diagnosis of CBD stones remains, as the maximum accuracy of preoperative

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studies only reaches 80%–90% of the overall cases.¹⁶ There is also a possibility that the CBD stones pass through the papilla spontaneously.¹⁷ Therefore, the single-stage treatment allows the clearance of unsuspected CBD stones.¹⁸

The single-stage approach is particularly interesting because it has not been standardized and presents various technical options with a varying degree of complexity, from both a manual and technological standpoint, which depend on the method used.

In this review, we describe all the technical options currently available for the laparoscopic removal of gallbladder and CBD stones in a single procedure and analyze the results obtained.

We assess the degree of complexity of the methods and the clinical indications and instruments required for the best approach in each individual case.

Methods

A complete clearance of the bile duct via a laparoscopic approach in a single session can be obtained using three techniques:

- trans-cystic laparoscopic bile duct clearance (TC-CBDE);
- laparoscopic common bile duct exploration (LCBDE); and
- rendezvous intraoperative endoscopic retrograde cholangiography (RV-IOERC).

Intraoperative techniques

TC-CBDE

LC was performed using four trocars. After preparing the cystic duct and visualizing the bile duct, a fifth trocar cholangiography (intraoperative cholangiography [IOC]) was introduced through a small incision of the cystic duct and the catheter was secured by a clip. Once the diagnosis of lithiasis of the bile duct was confirmed (through IOC), the catheter was removed and drainage was performed via trans-cystic washing, passing through the Dormia basket, the balloon, and using, if necessary, a 3 mm choledoscope. In some cases, because the trans-cystic pathway required pneumatic dilation of the sphincter of Oddi to facilitate the passage of stones, a trans-cystic drain was left in place and removed at a later stage. At the end of the procedure, an IOC was performed to confirm correct clearance. A subhepatic drainage was left in place (Figure 1).

RV-IOERC

Both procedures (single or double stage) were similar until the cholangiography demonstrated the presence of CBD



Figure 1 Trans-cystic clearance.

stones. At that point, we proceeded with the partial freeing of the gallbladder from the liver bed. The surgeon introduced a guide wire into the gallbladder while the endoscopist, without changing the patient's position, positioned the endoscope. Once the guide wire was confirmed to have reached the papilla, and the papilla was identified, the endoscopist extracted the guide wire and, using it as a guide, introduced the unit for the papillotomy, which was performed safely. The area was washed and the Dormia basket was employed. The surgeon withdrew the guide wire. At the end of the procedure, the endoscopist removed the gas previously introduced. A cholangiography was then performed to examine the drainage of the bile ducts. Finally, the surgeon completed the cholecystectomy (Figure 2).

LCBDE

The bile duct was prepared after confirming the presence of CBD stones. A vertical choledochotomy with a length of about 1–1.5 cm was performed. We proceeded with



Figure 2 Intraoperative papillotomy with “rendezvous.”

the clearance of the bile duct through washing and direct extraction of the stones. In the presence of impacted stones, a lithotripter was used. We evaluated the effectiveness of the clearance using a cholangioscope. The choledochotomy was closed with a running suture after positioning a T-tube that was left in place for about 3 weeks and then removed after cholangiography. In certain cases, direct closure of the choledochotomy was proposed. The subhepatic drainage was left in place (Figure 3).

The confirmation of concomitant stones of the CBD was obtained intraoperatively by performing a cholangiography (IOC). There is a consensus on the execution of IOC only in suspected cases¹⁹ and, although other methods can be used, they do not have the same sensitivity and specificity. Magnetic resonance cholangiopancreatography is the most sensitive, but has a significantly higher cost as well as a resolving power which cannot detect stones smaller than 0.5 cm.²⁰ The use of laparoscopic probes for intraoperative ultrasound studies was reported to produce very good results.²¹ However, the use of this method is not very widespread because of its high costs.

Trans-cystic clearance is the most natural method to clear the bile duct. In the vast majority of cases, the stones migrate from the gallbladder and can therefore be removed via the same physiological course. This technique also respects the integrity of the sphincter of Oddi, particularly important in young patients.²²

The success rate of the trans-cystic approach for the removal of CBD stones is around 75% of the cases treated.²³ One study reported a higher effectiveness of the method (85%–90%) with a rate conversion of 10%.²⁴ The mean operative time was 115±40 minutes.²⁵

Long-term results are also positive with a minimum percentage (3.1%) of recurrence.²⁶ Obviously, trans-cystic clearance cannot be performed in the presence of stones with

a diameter >1 cm, although it was shown by Vracko and Wiechel that, in 90% of the cases, the diameter of the CBD stones did not exceed by >1 mm the diameter of the cystic duct.²⁷ Trans-cystic clearance requires experience and the use of suitable laparoscopic instruments such as the Dormia basket, the balloon catheter, and washings. Another instrument which is very useful is the cholangioscope (3 mm) that is effective for the removal of the stones and in the assessment of complete clearance, although it remains difficult to examine the bile duct above the insertion of the cystic duct.

For this reason, IOC is advisable upon completion of surgery. The rate of major complications (bile leak) was 2.8%, while the minor complications were around 5%. The mortality rate was about 0%–1%. The average hospital stay was 48 hours.^{28,29}

Failure of the trans-cystic approach was due to local inflammation and anatomical constraints, as well as due to the number and size of the stones.³⁰ Other risk factors were jaundice and comorbidity.³¹

There are other technical aids which are useful in trans-cystic clearance: in the presence of small stones (<0.6 cm), some authors undertook trans-cystic pneumatic dilation of the papilla to facilitate the expulsion of the stones.³²

The RV-IOERC method was reported to be particularly indicated in bile duct clearance. It is important to adequately define this technique because the guide wire used in the “rendezvous” distinguishes this method from simple papillotomy. As reported by La Greca et al, not everyone uses this technique, but many perform a simple intraoperative papillotomy after LC.³³ For this reason, it is difficult to compare the various reported results. Many reports, however, showed the superiority of this method compared to the double-stage approach.³⁴

This technique also reduced the incidence of post-ERCP pancreatitis.³⁵ In RV-IOERC, the sphincter of Oddi is destroyed; this can have important consequences in young patients.³⁶

The duration of the endoscopic portion of RV-IOERC varied between 9 and 82 minutes (mean 35 minutes) and, of course, the presence of an endoscopist in the operating room was necessary. The success rate was very high (92.3%) with reduction of the hospital stay.³⁷ Certainly, in the presence of concomitant stenosis of the sphincter of Oddi, RV-IOERC becomes an absolute indication.

The complication rate was on average 5.1% with a conversion rate of 4.7% and recurrence rate of 1%.³⁸

In cases in which a combined laparoscopic–endoscopic approach is used, when papillotomy is performed before or after the LC, it is necessary to change the position of the patient with a further loss of time.³⁹



Figure 3 Laparoscopic choledochotomy.

The direct approach to the bile duct through choledochotomy must be reserved in cases of a CBD caliber >1 cm, thickened walls, and in the presence of numerous stones having a diameter >1 cm.⁴⁰ This method is technically more difficult, with a longer operative time,⁴¹ but it maintains the integrity of the sphincter of Oddi. The cholangioscope proved useful also in this approach as it allowed the inspection of the intrahepatic bile ducts. With this method, the percentage of success was high (96.7%) with a rate of postoperative bile leak of 3.3% and reduced complications (8%).⁴²

The closure of a choledochotomy requires the positioning of a T-tube sec Kehr which is removed after about 3 weeks. This technique has recently been replaced by the proposal of direct closure of the CBD. Many reports showed that this approach was safe and reduced both operative time and hospital stay.^{43,44} Factors that negatively affected the results were jaundice and comorbidities with a conversion rate of 8.3%. Postoperative hospital stay varied between 3 and 12 days and depended on the use of a T-tube and on complications.⁴⁵

Discussion

A consensus in the optimal treatment of gallbladder and bile duct stones has not been reached. Normally, symptoms (which include pain, jaundice, and cholangitis, along with the presurgical workup) lead to a diagnosis. In some cases, however, the discovery of CBD stones can be a fortuitous finding during LC. The first issue is whether or not to treat the CBD stones even if they are asymptomatic.

Although it was reported that approximately one third of the stones with a diameter <6 mm pass spontaneously,¹⁷ there are no highly indicative prognostic factors to quantify this possibility. Therefore, as stated in the European Association of Endoscopic Surgery consensus, all cases of bile duct stones discovered during LC should be treated.⁴⁶

Another preliminary aspect that must be clarified is how to diagnose CBD stones. Performing a routine IOC in all patients who undergo LC is not recommended since it will not reduce the lesions of the bile ducts and asymptomatic gallbladder stones are rare.⁴⁷ There is no unanimous consensus and some authors report a minor incidence of biliary lesion with the routine use of IOC.⁴⁸ Therefore, we propose IOC only in suspected cases, also because it is more sensitive than preoperative magnetic resonance cholangiography.⁴⁹ Intraoperative ultrasound is another reliable and sensitive method although it is not widespread due to its high cost and a long learning curve.⁵⁰

When a diagnosis of cholecysto-choledocolithiasis has been confirmed, treatment must be chosen. There are many

possibilities to obtain complete clearance. In the past, the treatment of choice was a sequential two-step procedure in which clearance was achieved by performing an ERCP first and an LC later. This is currently still the most widespread method⁵¹ and can produce good results. However, we must remember the high number of unnecessary tests and the non-negligible increase in major complications and mortality.⁵² The consequences linked to the loss of function of the sphincter of Oddi are also relevant.⁵³

The expanding skills in laparoscopic surgery have made it possible to treat gallbladder and bile duct stones in a single step. In recent years, this method has attracted considerable attention. The advantages are a reduction in cost and better patient compliance.⁵⁴

In this review, single-stage management methods of CBD stones are described, evaluating indications, results, and technical and organizational complexity. Trans-cystic clearance is the simplest approach and is recommended in the majority of cases.⁵⁵ It has clear indications regarding the size and number of stones and requires a good laparoscopic technique and a minimum organizational commitment.⁵⁶ It yields good results also in the case of acute cholecystitis.⁵⁷ When trans-cystic clearance cannot be performed, two techniques can be used: direct access to the CBD and RV-IOERC.

Both are methods that require a greater amount of time.⁵⁸ Laparoscopic choledochotomy is technically more difficult,⁵⁹ while RV-IOERC requires the presence of an endoscopist and therefore considerably more organization.⁶⁰

Even with these methods there are absolute indications: in the case of concomitant papillary stenosis, RV-IOERC is more indicated, while in the presence of stones that are larger than 1 cm and a dilated CBD, choledochotomy is preferable.

There are very few studies that compare these techniques. Another difficulty stems from the nonuniform terminology used in the literature: often in intraoperative papillotomy, the guide wire is not used.³⁹ Additionally, with the term "CBD exploration," it is not clear if access is trans-cystic or through a choledochotomy.⁶¹

Undoubtedly, the methods used require specific technical skills that cannot be extended to all centers without proper training. In particular, the method of rendezvous involves the presence of an endoscopist in the operating room and this is difficult to arrange in many centers.

Hong et al compared the laparoscopic exploration of the bile duct with intraoperative papillotomy and did not find differences in terms of surgical time, postoperative complications, retained CBD stones, and hospital stay.⁶¹ In a review

by La Greca et al, RV-IOERC appeared to decrease the risk of residual stones compared to choledochotomy.³⁸ In a study by ElGeidie et al, two groups of patients underwent either intraoperative papillotomy or direct clearance of the biliary tract yielding equivalent results in terms of success rate, surgical time, and hospital stay.⁶² In our work, we compared the trans-cystic clearance with RV-IOERC and did not find differences in terms of success rate and postoperative complications. However, the surgical time was significantly longer and the cost was higher in the group who underwent RV-IOERC.⁶³

In general, trans-cystic access to the bile duct is the method most widely used especially in Western countries, while in Eastern countries this approach is restricted to a few cases, probably due to a difference in the natural progression of the disease.⁶⁵

Direct approach to the bile duct is technically more difficult, resulting in increased intraoperative time and hospital stay, especially when a T-tube is used.⁶⁶ Several studies have, however, reported that it was possible to use a direct closure of the CBD to save time.⁶⁷ There are conditions in which the use of a T-tube is essential, for example, when the diameter of the CBD is <1 cm, the walls are thin, and the biliary outflow

is uncertain. In the various reported cases, the percentage of choledochotomy that is closed earlier than expected is about 30%–40% of the total.⁵⁵ However, as indicated by Cochrane in 2013, multiple randomized trials with long-term results are required in order to exclude complications such as biliary stricture or recurrence.⁶⁷

A multicenter study should be used to evaluate preoperative conditions indicating which technique is the most appropriate for that specific clinical case, also because the centers do not always have at their disposal all available methods.

RV-IOERC is the treatment that requires the most organization and is therefore not very widespread.³⁹ The success rate is greater and the number of complications is reduced compared to sequential treatment.^{69,70} Jaundice and the presence of comorbidities are negative factors in this technique.^{71,72} Close cooperation between the surgeon and the endoscopist is absolutely necessary. This approach reduces the risk of the destruction of the sphincter of Oddi in young patients.

The treatment in a single step of the gallbladder and bile duct stones includes several techniques that together allow the treatment of almost all cases.⁷² The degree of technical

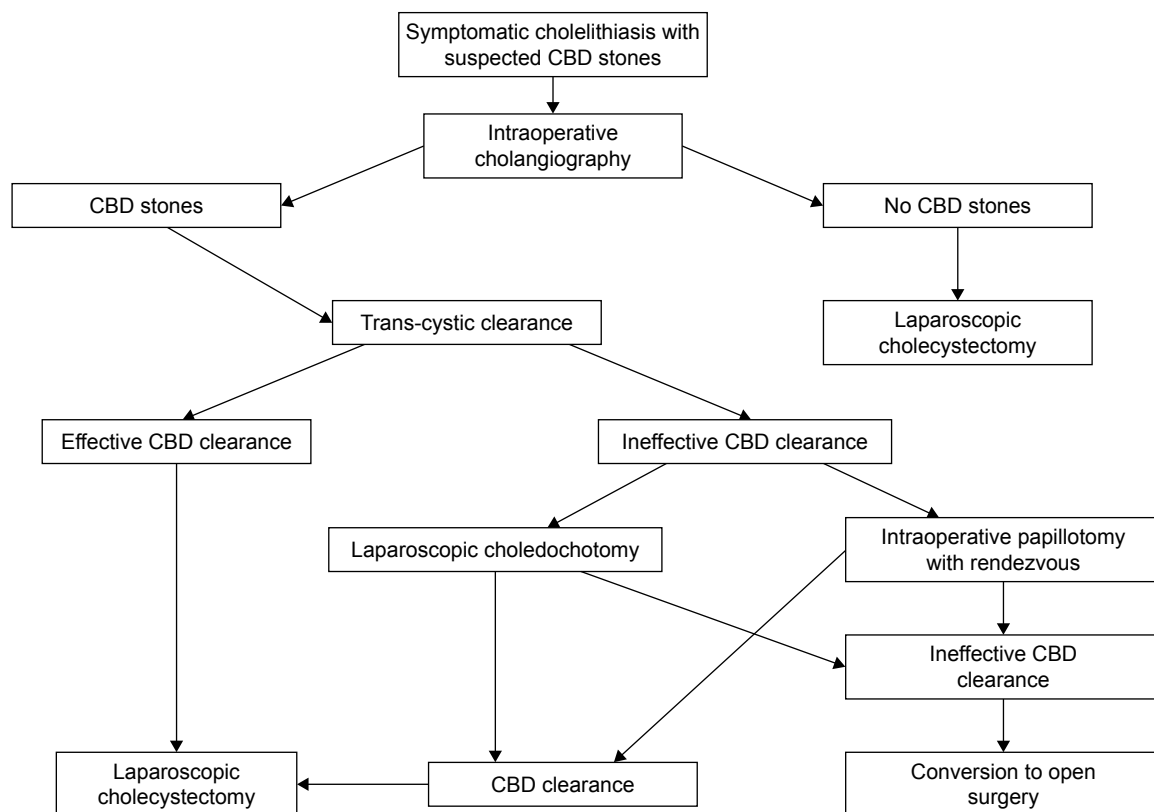


Figure 4 Flowchart for the treatment of cholecysto-choledocolithiasis.
Abbreviation: CBD, common bile duct.

difficulty and organizational requirements undoubtedly vary among the various techniques and the most suitable approach to treat each individual case should be chosen. It is very difficult to compare the different techniques because the reported cases are not homogeneous and often report different methods.

The clinical and diagnostic characteristics, along with intraoperative findings, define the ideal technique to be used, as shown in a flowchart (Figure 4).

A team that intends to treat cholecysto-choledocolithiasis should ideally work and cooperate closely with interdisciplinary collaborations. In other words, the surgeon should collaborate closely with an endoscopist and a radiologist.

The approach in a single step is therefore the method of choice in the treatment of gallbladder and CBD stones and all available options must be accessible to the surgical team. Subsequent studies should indicate the predictive parameters in order to choose the best option for a truly personalized surgery.

Disclosure

The authors report no conflict of interests in this work.

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