**Name of Journal: *World Journal of Gastrointestinal Surgery***

**ESPS Manuscript NO: 21810**

**Manuscript Type: Minireviews**

**Role of laparoscopic common bile duct exploration in the management of choledocholithiasis**

Gupta N. Role of laparoscopic CBD exploration

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**Author contributions:** Gupta N solely contributed to this paper.

**Conflict-of-interest** **statement:** No potential conflicts of interest. No financial support.

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**Received:** July 29, 2015

**Peer-review started:** September 1, 2015

**First decision:** December 7, 2015

**Revised:** February 5, 2016

**Accepted:** February 23, 2016

**Article in press:**

**Published online:**

**Abstract**

Surgical fraternity has not yet arrived at any consensus for adequate treatment of choledocholithiasis. Sequential treatment in the form of pre-operative endoscopic retrograde cholangio-pancreatography followed by laparoscopic cholecystectomy (LC) is considered as optimal treatment till date. With refinements in technique and expertise in field of minimal access surgery, many centres in the world have started offering one stage management of choledocholithiasis by LC with laparoscopic common bile duct exploration (LCBDE). Various modalities have been tried for entering into CBD [transcystic (TC) *vs* transcholedochal (TD)], for confirming stone clearance (intraoperative cholangiogram *vs* choledochoscopy), and for closure of choledochotomy (T-tube *vs* biliary stent *vs* primary closure) during LCBDE. Both TC and TD approaches are safe and effective. TD stone extraction is involved with an increased risk of bile leaks and requires more expertise in intra-corporeal suturing and choledochoscopy. Choice depends on number of stones, size of stone, diameter of cystic duct and CBD. This review article was undertaken to evaluate the role of LCBDE for the management of choledocholithiasis.

**Key words:** Choledocholithiasis; Laparoscopic common bile duct exploration; Choledochoscopy; Cholangiogram; Primary closure

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**Core tip:** Various treatment modalities are available for management of choledocholithiasis. Laparoscopic common bile duct exploration offers one stage management of cholelithiasis with choledocholithiasis. This review article was undertaken to evaluate this technique and its various aspects.

Gupta N. Role of laparoscopic common bile duct exploration in the management of choledocholithiasis. *World J Gastrointest Surg* 2016; In press

**INTRODUCTION**

The incidence of gallstones varies from 6%-10% in adult population[1]. Three percent to 14.7% of patients of gallstones have concurrent common bile duct (CBD) stones as well[2]. “Gold Standard” for management of gallstones is laparoscopic cholecystectomy (LC) but there is no consensus for treatment of CBD stones. In the era of open surgery, treatment was straight-forward; open cholecystectomy with open CBD exploration though it carried high morbidity and mortality. With the advent of non invasive and minimal invasive techniques, option of pre-operative endoscopic retrograde cholangio-pancreatography (ERCP) followed by LC emerged as adequate treatment. Major disadvantages of ERCP are that it is a two stage procedure and is associated with life threatening complications like pancreatitis, bleeding and duodenal perforation. It has also been reported that sphincterotomy may cause papillary stenosis and increased risk of bile duct cancer[2,3].

With refinements in technique and expertise in field of minimal access surgery, many centres in the world have started offering one stage management of choledocholithiasis by LC with laparoscopic CBD exploration (LCBDE). Only few randomized trials are available comparing pre-operative ERCP followed by LC with single stage LC and LCBDE[4,5]. There is no consensus even for the technique of LCBDE. Various modalities have been tried for entering into CBD [transcystic (TC) *vs* transcholedochal (TD)], for confirming stone clearance [intraoperative cholangiogram (IOC) *vs* choledochoscopy], and for closure of choledochotomy (T-tube *vs* biliary stent *vs* primary closure).

**REVIEW OF LITERATURE**

Literature search was performed to answer these questions. Online search engines like PubMed, Google, springer link library and Cochrane database systematic review were utilized and review articles, prospective and retrospective studies which detailed or compared the various treatment strategies for CBD stones were selected and analyzed.

***Sequential vs one stage management***

Two randomized trials have compared pre-operative ERCP followed by LC with one stage LC and LCBDE[4,5]. Results of the two modalities were comparable in terms of stone clearance and complications but duration of hospitalization was shorter with LCBDE in both studies[4,5]. In a study done by Rogers *et al*[5], 122 patients were randomized into either group. Hospital stay was significantly shorter for LC + LCBDE [mean (SD), 55 (45) h *vs* 98 (83) h; *P* < 0.001]. There was no difference in patient acceptance and quality of life scores among the two groups. A prospective analysis done (*n* = 150) by Mohamed *et al*[6] showed that the laparoscopic management of CBD stones is as safe and effective as the sequential ERCP followed by LC with nearly the same stone clearance rate, hospital stay, and complications.

Liu *et al*[7] did a meta-analysis and found that there was no significant difference between laparoscopic CBD exploration group and pre-operative endoscopic sphincterotomy (EST) group in terms of complications or retained stones (*P* > 0.05). Success rate was higher in LCBDE group with reduced hospital expenses, mean operative time and duration of hospitalization (*P* < 0.05)[7].

Another meta-analysis done by Nagaraja *et al*[8], reported higher incidence of ERCP related complications in patients undergoing pre-operative ERCP [odds ratio (OR): 2.40, 95%CI: 1.21-4.75].

Costi *et al*[9] performed a case–control study comparing a single stage laparoscopic approach (*n* = 22) with sequential treatment (*n* = 15). They found two groups to be similar in terms of early and late complications. The postoperative hospitalization was significantly less in the single stage group[9]. Bansal *et al*[10] conducted a prospective randomized trial comparing single stage laparoscopic treatment with sequential treatment of CBD stones. Fifteen patients were randomized to each group. Stone clearance rates and complications were similar in both groups. They concluded that single stage approach seems to be better due to smaller number of procedures and hospital visits[10].

Cochrane systematic review was done by Dasari *et al*[11] in 2013. They included five trials (*n* = 580). Two hundred and eighty-five patients underwent LC + LCBDE and 295 patients received sequential treatment in the form of ERCP + LC. There was no significant difference among two groups in terms of mortality (0.7% *vs* 1%), morbidity (15% *vs* 135%) or incidence of retained stones (8% *vs* 11%).

A meta-analysis of single-stage *vs* sequential treatment for cholelithiasis with common bile duct stones was carried out by Zhu *et al*[12] recently. Eight RCTs, which involved 1130 patients, were included in this study. The meta-analysis revealed that the CBD stone clearance rate in the single-stage group was higher (OR = 1.56, 95%CI: 1.05 to 2.33, *P* = 0.03). The lengths of hospitalization (MD = -1.02, 95%CI: -1.99 to -0.04, *P* = 0.04) and total operative times (MD = -16.78, 95%CI: -27.55 to -6.01, *P* = 0.002) were also shorter in the single-stage group. There was no statistically significant difference among the two groups regarding postoperative morbidity (OR = 1.12, 95%CI: 0.79 to 1.59, *P* = 0.52), mortality (OR = 0.29, 95%CI: 0.06 to 1.41, *P* = 0.13) and conversion to other procedures (OR = 0.82, 95%CI: 0.37 to 1.82, *P* = 0.62).

***TC vs TD***

Hongjun *et al*[13] compared TC approach (*n* = 80) with TD approach (*n* = 209) and found that there was no significant difference between the two approaches for cystic duct diameter (0.47 ± 0.09 cm *vs* 0.47 ± 0.08 cm), procedure time (91.94 ± 34.21 min *vs* 96.13 ± 32.15 min), complications (2.5% *vs* 2.87%) and duration of hospitalization (9.82 ± 3.48 d *vs* 10.74 ± 5.34 d) (all *P* > 0.05). A significant difference was noticed in terms of the common bile duct diameter (1.18 ± 0.29 cm *vs* 1.04 ± 0.24 cm *P* < 0.05)[13].

Wang *et al*[14] reported that TC LCBDE is safe and effective in elderly population. TC approach was successful in 157 of 165 patients (95.15%). Five patients were converted to laparoscopic TD approach and T tube drainage whereas three patients were managed by laparotomy and open CBD exploration. No significant complications were reported in the study. The mean blood loss was 43 ± 20 mL and mean operative time was 102 ± 35 min. The postoperative hospitalization was 3 ± 0.5 d[14].

A systematic review done by Reinders *et al*[15] included eight randomized trials with 965 patients. Successful bile duct clearance varied between 80.4% and 100% in the TC groups and 58.3% and 100% in the TD groups. There were more bile leaks after TD stone extraction (11%) than after TC stone extraction (1.7%). They concluded that TD stone extraction is associated with an increased risk of bile leaks and should only be done by highly experienced surgeons; TC stone extraction seems a more accessible technique with lower complication rates[4,5,10,16-20].

Chander *et al*[21] have concluded that TD route is better in asian patients with multiple, large stones and dilated CBD.

***IOC vs choledochoscopy***

Only two studies were found comparing IOC with choledochoscopy for confirming stone clearance. Topal *et al*[22] found similar results with both techniques, though operative time was longer in IOC group. Vindal *et al*[23] in a prospective randomized study compared IOC (*n* = 65) with intra-operative choledochoscopy (*n* = 67). Mean operative time was 170 min in Group A and 140 min in Group B (*P*\0.001). There was no significant difference in complications among the two groups[23]. They found choledochoscopy to be better and less time consuming than IOC for determining bile duct clearance after TD LCBDE.

***Primary closure vs T-tube vs biliary stent***

In a retrospective study done by Yi *et al*[24], long term results of primary closure (group P, *n* = 91) after LCBDE were compared with T-tube drainage (group T, *n* = 51). The mean operative time was significantly less in group P than group T (168.9 ± 50.1 min *vs* 198.0 ± 59.6 min, *P* = 0.002). The duration of hospitalization was significantly less in group P than in group T (8.59 ± 6.0 d for group P *vs* 14.96 ± 5.4 d for group T, *P* = 0.001). The stone recurrence rates in group P and group T were 4.4% and 5.9%, respectively (*P* = 0.722) (mean follow-up 48.8 mo). There was no sign of biliary stricture or other biliary complications in follow-up in either group. They concluded that primary closure after LCBDE with choledochoscopy is as safe and effective as T-tube drainage in terms of long-term results[24].

Dong *et al*[25] compared primary closure (Group A, *n* = 101) with T tube drainage (Group B, *n* = 93) after LCBDE. The mean operative time was less in group A than in group B (102.6 ± 15.2 min *vs* 128.6 ± 20.4 min, *P* < 0.05). Postoperative hospitalization was longer in group B (4.9 ± 3.2 d) than in group A (3.2 ± 2.1 d). The hospital expenses were also significantly less in group A. Three patients experienced complications in postoperative period, which were related to T-tube usage in group B[25].

In other study, Leida *et al*[26] showed that patients with primary closure of the CBD returned to work faster (12.6 ± 5.1 d *vs* 20.4 ± 13.2 d). This group also showed advantages of significantly lower hospital expenses and less postoperative complications than T tube drainage group (15% *vs* 27.5%)[26].

Lyon *et al*[27] compared use of biliary stent (n = 82) with T- tube drainage (*n* = 34) after LCBDE in a prospective non-randomized study. The duration of hospitalization for patients who underwent biliary stent or T-tube insertion after LBCDE were 1 and 3.4 d, respectively (*P* < 0.001). In the T-tube group, two patients required laparoscopic washout due to bile leaks. They concluded that ante-grade biliary stent insertion is associated with low hospital expenses and increased patient satisfaction[27].

Dietrich *et al*[28] compared biliary stent with T-tube drainage in a series of 48 patients who underwent LCBDE. Patients with T-tube drainage had more procedure-related complications (*P* < 0.0001) and a prolonged hospital stay (*P* = 0.03).

A retrograde study done by Morcillo *et al*[29], compared T-tube closure (*n* = 36), biliary stent (*n* = 133) and primary closure (*n* = 16). In the stented group, they found an 11.6% incidence of pancreatitis and a 26.1% incidence of hyperamylasemia whereas in the primary closure group, a clear improvement of complications and hospital stay was observed[29].

Chen *et al*[30] in their study observed that primary closure is safe after LCBDE (*n* = 194).

EstellésVidagany *et al*[31] did primary closure after LCBDE in 160 patients. Bile leakage was reported in 11 patients (6.8%). In 7 out of 11 patients (63.6%), no further intervention was needed and the leak closed on its own. Six patients were reoperated (3.75%), two for biliary peritonitis and four for haemoperitoneum. The success rate for stone clearance was 96.2%. No mortality or CBD stricture was reported in the study. They concluded that primary closure after LCBDE is a safe technique with excellent results[31].

Hua *et al*[32] studied rate of bile leak following primary closure in LCBDE *via* TD approach. Of 157 LCBDE procedures, 138 (87.9%) were successfully managed with primary closure of the choledochotomy. Eight patients (5.1%) underwent closure over a T-tube after LCBDE and 11 patients (7.0%) were converted to open surgery. The success rate for CBD stone clearance was 98.1%. Postoperative bile leak was seen in 6 patients (3.8%).

Gurusamy *et al*[33] published a cochrane systematic review comparing T-tube with primary closure after LCBDE. They included three trials randomizing 295 participants: 147 to T-tube drainage *vs* 148 to primary closure. The operative time was significantly more in the T-tube drainage group compared with the primary closure group (MD 21.22 min; 95%CI: 12.44 min to 30.00 min). The duration of hospitalization was significantly more in the T-tube drainage group compared with the primary closure group (MD 3.26 d; 95%CI: 2.49 d to 4.04 d). According to one trial, the participants randomized to T-tube drainage took approximately eight days more to return to work than the participants randomized to the primary closure group (*P* < 0.005). They concluded that T-tube drainage is associated with significantly longer operative time and hospital stay as compared with primary closure after LCBDE. They also emphasized that currently available evidence cannot justify the routine use of T-tube drainage after LCBDE[33].

Podda *et al*[34] did a meta-analysis of all studies comparing primary duct closure and T-tube drainage after LCBDE (Total 16 studies, 1770 patients). Primary duct closure showed a significant advantage over T-tube in terms of postoperative bile peritonitis (*P* = 0.02), operative time, duration of hospitalization, and median hospital cost (all *P* < 0.00001).

**DISCUSSION**

Pre-operative ERCP followed by LC is the most commonly used treatment modality for management of choledocholithiasis. ERCP carries a high rate of morbidity and mortality mostly due to post-procedure pancreatitis, duodenal perforation and bleeding. It also causes injury to sphincter of oddi which should be avoided in younger patients. LCBDE offers a one stage treatment with similar or better stone clearance rate and with a shorter hospital stay. It also preserves function of sphincter of oddi and hence prevents reflux related complications[2,3]. LCBDE has been found to be safe even in elderly population[14,35]. A Cochrane systematic review by Martin *et al*[36] concluded that a single-stage treatment in the form of LCBDE *via* TC approach is the procedure of choice for intraoperatively discovered CBD calculi.

Despite the simplicity and success of LCBDE, many surgeons across the globe are still not comfortable or confident regarding the procedure. Baucom *et al*[37] did a web based survey among US surgeons regarding their choice for managing choledocholithiasis. For preoperatively known CBD calculi, 86% preferred preoperative ERCP. Those in metropolitan areas were more likely to choose preoperative ERCP than those in nonmetropolitan areas (88% *vs* 79%, *P* < 0.001). For CBD stones discovered intraoperatively, 30% chose LCBDE as their preferred method of management with no difference between metropolitan and nonmetropolitan areas (*P* = 0.335). The top reasons for not performing LCBDE were: availability of a reliable ERCP, lack of equipment, and lack of skill performing LCBDE. They concluded that many surgeons are uncomfortable performing LCBDE, and advanced training may be needed. There is a risk of surgeons loosing the art, which may still be required in cases of unavailability or failure of ERCP[38].

Both TC and TD approaches are safe and effective. TD stone extraction is associated with a increased risk of bile leaks and requires more expertise in intra-corporeal suturing and choledochoscopy[21]. TC stone extraction seems a more accessible technique with lower complication rates. Choice depends on number of stones, size of stone, diameter of cystic duct and CBD (Table 1)[39].

Stone clearance during LCBDE can be confirmed by IOC or choledochoscopy. Intra-operative choledochoscopy is better than IOC for determining ductal clearance after TD LCBDE and is less cumbersome and less time-consuming.

Choledochotomy after LCBDE (TD approach) is conventionally managed by T-tube closure. Primary closure of choledochotomy is a safe and effective option with less operative time and hospital stay. Biliary stent also reduces cost and hospital stay as compared to T-tube. There is lack of randomized trial comparing primary closure with biliary stent.

In patients having cholangitis, it is advisable to go for drainage of biliary obstruction by ERCP followed by LC. LCBDE can be offered to all other patients with CBD stones if expertise is available[21]. If laparoscopic exploration fails, it is prudent to convert it to open bile duct exploration and removal of ductal stones.

**REFERENCES**

1 **Sharma A**, Dahiya P, Khullar R, Soni V, Baijal M, Chowbey PK. Management of common bile duct stones in the laparoscopic era. *Indian J Surg* 2012; **74**: 264-269 [PMID: 23730054 DOI: 10.1007/s12262-012-0593-6]

2 **Shojaiefard A**, Esmaeilzadeh M, Ghafouri A, Mehrabi A. Various techniques for the surgical treatment of common bile duct stones: a meta review. *Gastroenterol Res Pract* 2009; **2009**: 840208 [PMID: 19672460 DOI: 10.1155/2009/840208]

3 **Lee HM**, Min SK, Lee HK. Long-term results of laparoscopic common bile duct exploration by choledochotomy for choledocholithiasis: 15-year experience from a single center. *Ann Surg Treat Res* 2014; **86**: 1-6 [PMID: 24761400 DOI: 10.4174/astr.2014.86.1.1]

4 **Cuschieri A**, Lezoche E, Morino M, Croce E, Lacy A, Toouli J, Faggioni A, Ribeiro VM, Jakimowicz J, Visa J, Hanna GB. E.A.E.S. multicenter prospective randomized trial comparing two-stage vs single-stage management of patients with gallstone disease and ductal calculi. *Surg Endosc* 1999; **13**: 952-957 [PMID: 10526025 DOI: 10.1007/s004649901145]

5 **Rogers SJ**, Cello JP, Horn JK, Siperstein AE, Schecter WP, Campbell AR, Mackersie RC, Rodas A, Kreuwel HT, Harris HW. Prospective randomized trial of LC+LCBDE vs ERCP/S+LC for common bile duct stone disease. *Arch Surg* 2010; **145**: 28-33 [PMID: 20083751 DOI: 10.1001/archsurg.2009.226]

6 **Mohamed MA**, Bahram MA, Ammar MS, Nassar AH. One-Session Laparoscopic Management of Combined Common Bile Duct and Gallbladder Stones Versus Sequential ERCP Followed by Laparoscopic Cholecystectomy. *J Laparoendosc Adv Surg Tech A* 2015; **25**: 482-485 [PMID: 25951293 DOI: 10.1089/lap.2014.0582]

7 **Liu JG**, Wang YJ, Shu GM, Lou C, Zhang J, Du Z. Laparoscopic versus endoscopic management of choledocholithiasis in patients undergoing laparoscopic cholecystectomy: a meta-analysis. *J Laparoendosc Adv Surg Tech A* 2014; **24**: 287-294 [PMID: 24809784 DOI: 10.1089/lap.2013.0546]

8 **Nagaraja V**, Eslick GD, Cox MR. Systematic review and meta-analysis of minimally invasive techniques for the management of cholecysto-choledocholithiasis. *J Hepatobiliary Pancreat Sci* 2014; **21**: 896-901 [PMID: 25187317 DOI: 10.1002/jhbp.152]

9 **Costi R**, Mazzeo A, Tartamella F, Manceau C, Vacher B, Valverde A. Cholecystocholedocholithiasis: a case-control study comparing the short- and long-term outcomes for a "laparoscopy-first" attitude with the outcome for sequential treatment (systematic endoscopic sphincterotomy followed by laparoscopic cholecystectomy). *Surg Endosc* 2010; **24**: 51-62 [PMID: 19466493 DOI: 10.1007/s00464-009-0511-6]

10 **Bansal VK**, Misra MC, Garg P, Prabhu M. A prospective randomized trial comparing two-stage versus single-stage management of patients with gallstone disease and common bile duct stones. *Surg Endosc* 2010; **24**: 1986-1989 [PMID: 20135172 DOI: 10.1007/s00464-010-0891-7]

11 **Dasari BV**, Tan CJ, Gurusamy KS, Martin DJ, Kirk G, McKie L, Diamond T, Taylor MA. Surgical versus endoscopic treatment of bile duct stones. *Cochrane Database Syst Rev* 2013; **12**: CD003327 [PMID: 24338858 DOI: 10.1002/14651858.CD003327.pub4]

12 **Zhu HY**, Xu M, Shen HJ, Yang C, Li F, Li KW, Shi WJ, Ji F. A meta-analysis of single-stage versus two-stage management for concomitant gallstones and common bile duct stones. *Clin Res Hepatol Gastroenterol* 2015; **39**: 584-593 [PMID: 25936687 DOI: 10.1016/j.clinre.2015.02.002]

13 **Hongjun H**, Yong J, Baoqiang W. Laparoscopic common bile duct exploration: choledochotomy versus transcystic approach? *Surg Laparosc Endosc Percutan Tech* 2015; **25**: 218-222 [PMID: 25799258 DOI: 10.1097/SLE.0000000000000133]

14 **Wang B**, Ding YM, Nie YG, Zhang AM, Wang P, Wang WX. The Clinical Evaluation of Laparoscopic Transcystic Duct Common Bile Duct Exploration in Elderly Choledocholithiasis. *Hepatogastroenterology* 2014; **61**: 892-896 [PMID: 26158137]

15 **Reinders JS**, Gouma DJ, Ubbink DT, van Ramshorst B, Boerma D. Transcystic or transductal stone extraction during single-stage treatment of choledochocystolithiasis: a systematic review. *World J Surg* 2014; **38**: 2403-2411 [PMID: 24705779 DOI: 10.1007/s00268-014-2537-8]

16 **Rhodes M**, Sussman L, Cohen L, Lewis MP. Randomised trial of laparoscopic exploration of common bile duct versus postoperative endoscopic retrograde cholangiography for common bile duct stones. *Lancet* 1998; **351**: 159-161 [PMID: 9449869 DOI: 10.1016/S0140-6736(97)09175-7]

17 **Nathanson LK**, O'Rourke NA, Martin IJ, Fielding GA, Cowen AE, Roberts RK, Kendall BJ, Kerlin P, Devereux BM. Postoperative ERCP versus laparoscopic choledochotomy for clearance of selected bile duct calculi: a randomized trial. *Ann Surg* 2005; **242**: 188-192 [PMID: 16041208 DOI: 10.1097/01.sla.0000171035.57236]

18 **Sgourakis G**, Karaliotas K. Laparoscopic common bile duct exploration and cholecystectomy versus endoscopic stone extraction and laparoscopic cholecystectomy for choledocholithiasis. A prospective randomized study. *Minerva Chir* 2002; **57**: 467-474 [PMID: 12145577]

19 **Noble H**, Tranter S, Chesworth T, Norton S, Thompson M. A randomized, clinical trial to compare endoscopic sphincterotomy and subsequent laparoscopic cholecystectomy with primary laparoscopic bile duct exploration during cholecystectomy in higher risk patients with choledocholithiasis. *J Laparoendosc Adv Surg Tech A* 2009; **19**: 713-720 [PMID: 19792866 DOI: 10.1089/lap.2008.0428]

20 **ElGeidie AA**, ElShobary MM, Naeem YM. Laparoscopic exploration versus intraoperative endoscopic sphincterotomy for common bile duct stones: a prospective randomized trial. *Dig Surg* 2011; **28**: 424-431 [PMID: 22236538 DOI: 10.1159/000331470]

21 **Chander J**, Vindal A, Lal P, Gupta N, Ramteke VK. Laparoscopic management of CBD stones: an Indian experience. *Surg Endosc* 2011; **25**: 172-181 [PMID: 20535498 DOI: 10.1007/s00464-010-1152-5]

22 **Topal B**, Aerts R, Penninckx F. Laparoscopic common bile duct stone clearance with flexible choledochoscopy. *Surg Endosc* 2007; **21**: 2317-2321 [PMID: 17943379 DOI: 10.1007/s00464-007-9577-1]

23 **Vindal A**, Chander J, Lal P, Mahendra B. Comparison between intraoperative cholangiography and choledochoscopy for ductal clearance in laparoscopic CBD exploration: a prospective randomized study. *Surg Endosc* 2015; **29**: 1030-1038 [PMID: 25154888 DOI: 10.1007/s00464-014-3766-5]

24 **Yi HJ**, Hong G, Min SK, Lee HK. Long-term Outcome of Primary Closure After Laparoscopic Common Bile Duct Exploration Combined With Choledochoscopy. *Surg Laparosc Endosc Percutan Tech* 2015; **25**: 250-253 [PMID: 25856136 DOI: 10.1097/SLE.0000000000000151]

25 **Dong ZT**, Wu GZ, Luo KL, Li JM. Primary closure after laparoscopic common bile duct exploration versus T-tube. *J Surg Res* 2014; **189**: 249-254 [PMID: 24746254 DOI: 10.1016/j.jss.2014.03.055]

26 **Leida Z**, Ping B, Shuguang W, Yu H. A randomized comparison of primary closure and T-tube drainage of the common bile duct after laparoscopic choledochotomy. *Surg Endosc* 2008; **22**: 1595-1600 [PMID: 18202889 DOI: 10.1007/s00464-007-9731-9]

27 **Lyon M**, Menon S, Jain A, Kumar H. Use of biliary stent in laparoscopic common bile duct exploration. *Surg Endosc* 2015; **29**: 1094-1098 [PMID: 25249145 DOI: 10.1007/s00464-014-3797-y]

28 **Dietrich A**, Alvarez F, Resio N, Mazza O, de Santibañes E, Pekolj J, Clariá RS, de Santibañes M. Laparoscopic management of common bile duct stones: transpapillary stenting or external biliary drainage? *JSLS* 2014; **18**: [PMID: 25489219 DOI: 10.4293/JSLS.2014.00277]

29 **Abellán Morcillo I**, Qurashi K, Abrisqueta Carrión J, Martinez Isla A. Laparoscopic common bile duct exploration. Lessons learned after 200 cases. *Cir Esp* 2014; **92**: 341-347 [PMID: 24559592 DOI: 10.1016/j.ciresp.2013.02.010]

30 **Chen D**, Zhu A, Zhang Z. Laparoscopic transcystic choledochotomy with primary suture for choledocholith. *JSLS* 2015; **19**: e2014.00057 [PMID: 25848193 DOI: 10.4293/JSLS.2014.00057]

31 **EstellésVidagany N**, Domingo Del Pozo C, PerisTomás N, Díez Ares JÁ, VázquezTarragón A, Blanes Masson F. Eleven years of primary closure of common bile duct after choledochotomy for choledocholithiasis. *Surg Endosc* 2015: Epub ahead of print [PMID: 26201414 DOI: 10.1007/s00464-015-4424-2]

32 **Hua J**, Lin S, Qian D, He Z, Zhang T, Song Z. Primary closure and rate of bile leak following laparoscopic common bile duct exploration via choledochotomy. *Dig Surg* 2015; **32**: 1-8 [PMID: 25613528 DOI: 10.1159/000368326]

33 **Gurusamy KS**, Koti R, Davidson BR. T-tube drainage versus primary closure after laparoscopic common bile duct exploration. *Cochrane Database Syst Rev* 2013; **6**: CD005641 [PMID: 23794201 DOI: 10.1002/14651858.CD005641.pub3]

34 **Podda M**, Polignano FM, Luhmann A, Wilson MS, Kulli C, Tait IS. Systematic review with meta-analysis of studies comparing primary duct closure and T-tube drainage after laparoscopic common bile duct exploration for choledocholithiasis. *Surg Endosc* 2015: Epub ahead of print [PMID: 26092024 DOI: 10.1007/s00464-015-4303-x]

35 **Shelat VG**, Chia VJ, Low J. Common bile duct exploration in an elderly asian population. *Int Surg* 2015; **100**: 261-267 [PMID: 25692428 DOI: 10.9738/INTSURG-D-13-00168.1]

36 **Martin DJ**, Vernon DR, Toouli J. Surgical versus endoscopic treatment of bile duct stones. *Cochrane Database Syst Rev* 2006; **100**: CD003327 [PMID: 16625577]

37 **Petelin JB**. Laparoscopic common bile duct exploration. *Surg Endosc* 2003; **17**: 1705-1715 [PMID: 12958681 DOI: 10.1007/s00464-002-8917-4]

38 **Baucom RB**, Feurer ID, Shelton JS, Kummerow K, Holzman MD, Poulose BK. Surgeons, ERCP, and laparoscopic common bile duct exploration: do we need a standard approach for common bile duct stones? *Surg Endosc* 2016; **30**: 414-423 [PMID: 26092008 DOI: 10.1007/s00464-015-4273-z]

39 **Puhalla H**, Flint N, O'Rourke N. Surgery for common bile duct stones--a lost surgical skill; still worthwhile in the minimally invasive century? *Langenbecks Arch Surg* 2015; **400**: 119-127 [PMID: 25366358 DOI: 10.1007/s00423-014-1254-y]

**P-Reviewer:** Kaya M, Lee HC **S-Editor:** Ji FF **L-Editor: E-Editor:**

**Table 1 Effective and important factors in common bile duct stones approach**

|  |  |  |
| --- | --- | --- |
| Factor | Trans-cysticapproach | Trans-ductalapproach |
| Single stone | Yes | Yes |
| Multiple stones | Yes | Yes |
| Stones < 6 mm diametereach | Yes | Yes |
| Stones > 6 mm diametereach | No | Yes |
| Intrahepatic stones | No | Yes |
| Diameter of cystic duct< 4 mm | No | Yes |
| Diameter of cystic duct> 4 mm | Yes | Yes |
| Diameter of common bileduct < 6 mm | Yes | No |
| Diameter of common bileduct > 6 mm | Yes | Yes |
| Suturing ability-poor | Yes | No |