

Laparoscopic Management of Common Bile Duct Stones

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Introduction: Common bile duct (CBD) stones are found in approximately 16% of the patients undergoing laparoscopic cholecystectomy (LC). Till recently, the gold standard for treating CBD stones was endoscopic removal, if that failed, then open surgery. However, in the laparoscopic era, the best treatment for CBD stones is a matter of debate and it continues to evolve.

The objective of the present study was to determine whether laparoscopic CBD exploration (LCBDE) is a safe, feasible and single-stage option for the management of CBD stones.

Patients and methods: All patients were done in our surgery department. Out of the 450 laparoscopic cholecystectomies between 2012-2015, we did selective intraoperative cholangiogram in 45 patients (10%) who were suspected to have CBD stones based on deranged liver function tests, dilated CBD with or without CBD stone on sonography or having the history of recent jaundice/ pancreatitis. If CBD stone was found, either a transcystic or transcholedochal exploration was done depending on the size, site, number of stones and CBD diameter. Choledochotomy was closed over a T-tube in few number of patients. Primary closure of CBD was done in the majority of patients and in one patient we placed an antegrade stent and in another one we placed endoscopic stent into the CBD laparoscopically which was removed after four weeks.

Results: Till date we have performed LCBDE in 34 patients. Transcystic exploration was done in 10 patients and transcholedochal exploration was done in 20 cases out of which 2 patients had minor biliary leak which settled on conservative treatment in 2-3 days. Four patients required conversion to open surgery as there were multiple stones. We did not have any major complication and on 6 months follow-up in 83.3% patients, none was found to have residual stones.

Conclusion: Treatment of CBD stones depends on the resources available, technical limitations and the surgeon's expertise. Laparoscopic CBD exploration is a safe, feasible and single-stage option for the management of CBD stones.

Key words: Laparoscopic surgery, common bile duct (CBD) exploration, selective intraoperative cholangiogram (IOC), choledocholithiasis.

Introduction:

Common bile duct (CBD) stones are found approximately in 10-16% of the patients undergoing laparoscopic cholecystectomy (LC).¹⁻⁴ Until recently, it was generally agreed that if stones are detected in CBD preoperatively, it seemed appropriate to remove them prior to LC by ERCP. If CBD stone could not be extracted by ERCP, then CBD stone was extracted by open

CBD exploration. However, in the present laparoscopic era, the best treatment for patients with choledocholithiasis is a matter of debate and the management of choledocholithiasis continues to evolve.⁵ If the stones are found by intraoperative cholangiography during LC, the surgeon may either do the LC and refer the patient to ERCP postoperatively, or he may convert to open CBD exploration, or in the current times, he may do LCBDE.

The advent of ERCP and ES dramatically changed the management of CBD stones. ERCP is a quick and often painless procedure, successful in >90% of the patients.⁶ However, there are few adverse effects of the procedure like pancreatitis, bleeding, failure to clear duct, cholangitis, recurrent stone formation.⁷ The second revolution in the management of the bile duct stones came with advancement in the laparoscopic surgery. The objective of the present study is to determine that laparoscopic CBD exploration is a safe, feasible and single-stage option for the management of CBD stones.

Patients and methods:

A retrospective analysis was done on the patients undergoing LC between January 2012 and April 2015. Thorough history and clinical examination was done and the patient was investigated in the form of routine blood tests, liver function tests including, amylase and abdominal sonography. If there was suspicion of CBD stone, on the basis of predictors of CBD stones as shown in **Table (1)**, patients were subjected to selective Intraoperative cholangiogram (IOC). We have not used any scoring system for predicting the CBD stone. Patients with choledocholithiasis associated with mild gall stone pancreatitis were operated during the same admission if the Ranson's score was 3 or less. If the Ranson's score was >3, surgery was postponed till the acute bout of pancreatitis subsided.

Patients who were unfit for operation or those with severe pancreatitis/ cholangitis, and those who were diagnosed to have CBD stone with bile duct diameter <6 mm were subjected to ERCP and were excluded from the present study. Also patients who had previous upper abdominal surgery were excluded from the present study. Patients who had previous ERCP with failure of stone extraction were subjected to LCBDE.

Technique: All operations were done supervised by senior consultants and we kept improving our learning curve to shorten the operation time, decrease complications rate, and transfer the experience to junior staff in our 8B unit.

The standard 4-port configuration for LC was used. A fifth port was made inbetween the right midclavicular and epigastric port just below the subcostal margin for inserting the choledochoscope, 2 mm for transcystic exploration and 5 mm for transcholedochal exploration.

The fundus of the gall bladder was retracted towards the right shoulder and the Hartman's pouch was retracted downwards and outwards toward the right hip. Dissection began at the neck of the gall bladder and continued proximally until the junction of gall bladder with the cystic duct was clearly defined. Dissection was continued proximally on to the cystic duct until there was adequate length to perform cholangiogram. Then the cystic duct was milked to ward the gall bladder to dislodge any cystic duct stone into the gall bladder. A clip was applied on the gall bladder side to prevent any back slippage of gallstone into the CBD and to prevent biliary spillage into the operative field.

IOC was done using a ureteric catheter (4-5 Fr) or an infant feeding tube (no 5-6), which was passed through the cystic duct (after making a small nick in the cystic duct) into the CBD. After the insertion of the catheter, a clip was applied snugly to prevent any back leakage of the contrast medium. Digital C-arm fluoroscopy provided the real time imaging of the biliary tree. In cases where the cystic duct could not be cannulated, contrast was directly injected into the CBD through a lumbar puncture needle (24Fr) percutaneously **Figure (1)**.

On cholangiogram, we looked for any filling defect, its size, site, number of bile duct stones, and free passage of contrast into the duodenum and for any anatomical variations of the biliary tree. We selected transcystic or transcholedochal approach to remove CBD stones depending on the factors shown in **Table (2)**.

CBD stones were extracted with the help of Dormia basket /balloon catheter, irrigation/ suctioning or by simply manipulating bile duct using blunt forceps. After retrieving the stones, the cystic duct stump was closed with clips or suture ligature and the gall bladder

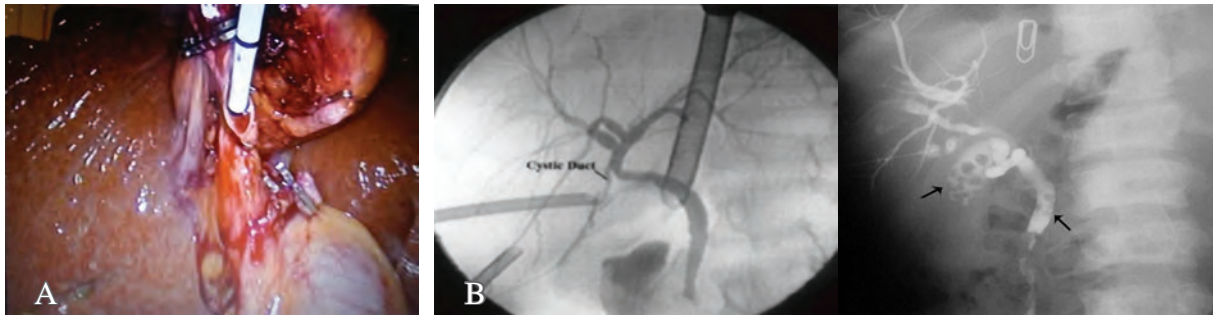


Figure (1): Intraoperative cholangiography (A) Transcystic catheter placement (B) C-arm image after contrast injection.

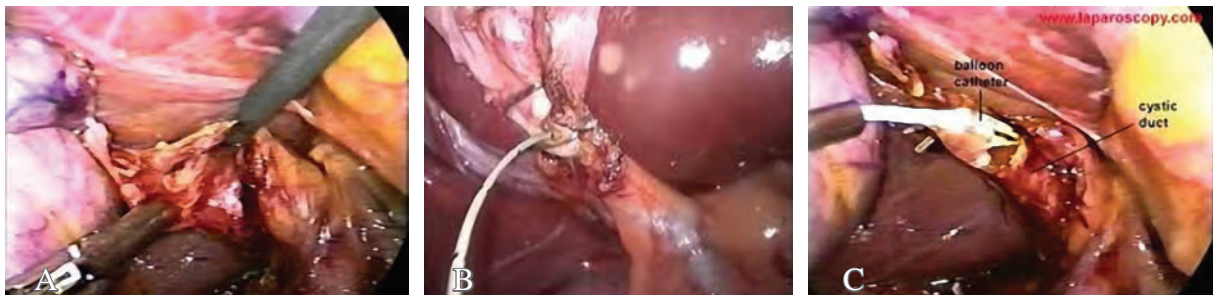


Figure (2): (A) Dissection of Calot triangle. (B) Insertion of ureteric catheter. (C) Transcystic exploration.

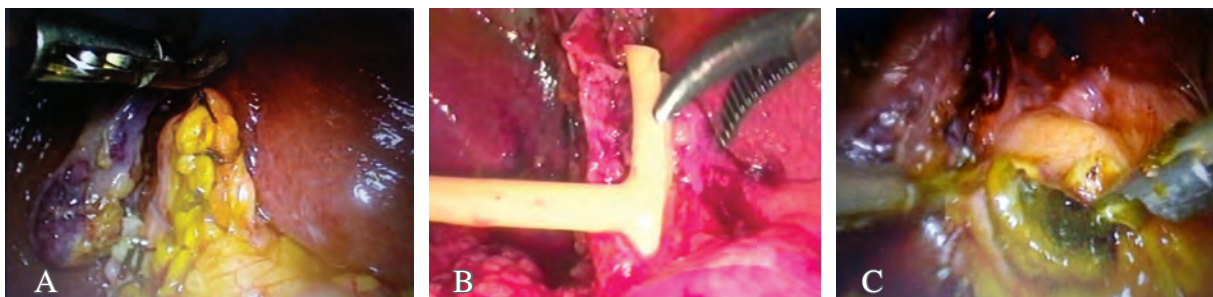


Figure (3): (A) Transcholedochal exploration with primary duct closure. (B) Closure over T-tube. (C) Choledochotomy incision with stone.



Figure (4): Choledochoduodenostomy.

was removed in the usual manner **Figure (2)**.
 Transcholedochal exploration was performed in the following manner. After

opening up of the Calot's triangle, the anterior surface of the CBD was dissected carefully and choledochotomy was performed by

Table (1): Predictors of CBD stone.

1) History / Clinical
Jaundice within 6 months
Pancreatitis within 6 months
2) Biochemical
- Bilirubin >10% of the normal at the higher side
- One or more liver function enzymes (Alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase) >10% of the normal at the higher side
- Amylase >10% of the normal at the higher side
3) Ultrasound
Dilated CBD >7 mm
CBD stone

Table (2): Factors influencing approach.⁷

Factor	Transcystic approach	Transcholedochal
No. of stones	<3 CBD stones	>3 CBD stones
Size of stone	Stone size <5 mm	Stone size >5 mm
CBD dilatation	CBD dilatation <1 cm	CBD dilatation >1 cm
Location of stone	Distal CBD stone	Proximal bile duct stones Failed transcystic approach

Table (3): Our experience.

Laparoscopic cholecystectomy	450
Intraoperative cholangiogram	45(10%)
Detected to have CBD stone	34 (75.6%)
Transcystic approach	10 (33.6%)
Transcholedochal approach	20 (66.4%)
Choledochotomy closure over t tube	3 (10%)
Primary CBD closure with endobiliary stent	15 (50%)
Choledochoduodenostomy	2 (6.6%)
Closure over an antegrade stent	01
Closure over an endobiliary stent	01

Table (4): Our complications

Conversion in 4 patients	11.7%
Minor bile leak in 2 patients	5.8%
Wound infection in 3 patients	8.8%
Ileus in 1 patient	2.9%
Pancreatitis in 2 patients	5.8%

a longitudinal incision with the help of endoscopic knife just below the insertion of the cystic duct into the bile duct. In the

initial few cases we used stay suture before performing choledochotomy but later we incised bile duct longitudinally without any

stay sutures. The stones were retrieved by spontaneous evacuation while incising the bile duct, blunt instrumental pressure with atraumatic forceps, Dormia basket, Fogarty balloon catheter or irrigation and suction.

Completion cholangiography or choledochoscopy was performed to assess the completeness of the procedure.

Choledochotomy was closed over t-tube with continuous 3/0 vicryl suture in 3 (10%) of patients Figure (3). We did primary closure of CBD in the majority of cases 15 (50%), after assessing the clearance of the CBD and in one case we placed a transcystic antegrade stent (using 5Fr ureteric catheter) which was brought out via cystic duct. The cystic duct was ligated twice with the antegrade stent in situ using 2/0 vicryl. In another case we placed a modified endobiliary stent (commercially available endobiliary stent, Fr 7 and 9 cm in length, with elimination of the proximal flap on the biliary side) into the distal CBD with distal flange through the papilla into the duodenum with the aid of choledochoscope. While choledochoduodenostomy have been performed in 2 patients **Figure (4)**.

After bile duct closure, cholecystectomy was performed in the usual manner. We placed an infrahepatic tube drain in all the cases which was usually removed on Day 3-4 post operatively as the output decreased below 30 ml/day.

Results:

45 patients were subjected to selective IOC due to the suspicion of CBD stones based on the predictors of CBD stones as given in **Table (1)**.⁸

Out of the 45 patients, 35 patients were female and 10 were male. The mean age group of the patients was 42 years (25-68 years). Out of the 45 patients undergoing IOC, CBD stones were detected in 34 cases (75.6%). Out of 34 cases, 15 cases had a preoperative diagnosis of CBD stones (US) and the rest were picked up on IOC. We removed CBD stones transcystically or by choledochotomy as shown in **Table (3)**.

Median duration of the procedure was 75 min (60-150min). At the beginning of our

experience the duration was longer, particularly in patients undergoing choledochotomy after failed trans-cystic extraction. The time taken for choledochotomy was 30-40 min more than that for the transcystic approach.

Post-operative course was similar to that of LC in the patients where transcystic exploration was done and the patient was discharged on post-operative Day (POD) 3.

In patients who had undergone transcholedochal approach, t-tube was clamped on (POD) 4 and was removed on (POD) 7 without routine T-tube cholangiogram. Intra-abdominal drain was removed as the patients started oral diet and the drain output <30 ml/day. All the patients were discharged on (POD) 7, except the 2 patients who had minor biliary leak which settled on conservative management discharged in 2-3 days later on.

In patients where we put antegrade stent, we removed the stent on (POD) 4 and the patient was discharged on day 5.

We placed modified endobiliary stent laparoscopically into the CBD across the duodenum in one patient and the stent was removed after 4 weeks by endoscopy.

We did not have any mortality and the various complications which we encountered during laparoscopic CBD exploration are shown in **Table (4)**.

We had to convert the laparoscopic procedure to conventional open CBD exploration in 4 patients. Out of these, we could not clear the bile duct in 3 patients due to multiple stones and in 1 patient there were severe adhesions present in the Calot's triangle and the bile duct could not be visualized properly. In 2 patients we had minor bile leak after removal of t-tube which settled on conservative treatment in 2-3 days. Minor wound infection in the form of erythema and serous collection at the port site occurred in 2 patients and 1 patient had small hematoma at the epigastric port site through which gall bladder was extracted had treated conservatively. Mild pancreatitis developed in 2 patients which resolved on conservative treatment in 2-3 days.

Follow-up after 6 months were completed

in 25 patients (83.3%) and no missed/ residual stone was found. Rest of the patients were lost to follow-up.

Discussion:

The best treatment of choledocholithiasis must be simple, reliable, readily available, cost-effective and patient-friendly. The incidence of CBD stones in patients undergoing LC is 10-16%, so the surgeon must be prepared to manage CBD stones appropriately, depending on whether the diagnosis is made preoperatively or during the surgery.¹⁰ If choledocholithiasis is suspected preoperatively, recommendations in past were to get an ERCP and if stones were found, ES and extraction of stones.

But there are a few important variables to consider before committing ourselves to this so-called old testimony. Firstly, ERCP is successful in >90% of the patients but it is highly dependent on the availability of an experienced endoscopist to achieve such a high success rate.¹¹ The second consideration is that of cost and the need for a second stage procedure.^{12,13} If a stent is placed then removal needs another endoscopy, usually after 4 weeks. The intervening period requires antibiotics in many cases which further increases the cost factor. Thirdly, there are no selective criteria that can accurately predict the presence of CBD stone.¹⁴ Taking into account all the positive predictors (history, clinical, biochemical, and sonography) for CBD stones, in most of the series reported in the literature, positive ERCP occurs in only up to 30-35% of the cases.¹⁵ On the other hand if we do routine IOC, we detect the stone in about 10% of cases and on selective IOC, CBD stones can be detected in about 25% of the cases.¹⁶

Finally, the risk of potential complications of ERCP should be considered. Although the complication rate is decreasing with increasing experience, pancreatitis continues to be a problem in most of the reported series, with an incidence of morbidity up to 7% and mortality of 0.2-2.3%.¹⁷ The sphincter of Oddi (SOD) provides a barrier that prevents duodeno-biliary reflux and this function is

permanently lost after sphincterotomy.¹⁸ ES increases duodenal reflux and a higher rate of bactibilia (60%) with the increasing rate of recurrent biliary stone formation.¹⁹

This duodeno-biliary reflux further causes biliary epithelium to adapt to a new environment. Chronic bactibilia, in addition to pancreatic reflux (which is proved to be responsible for higher rates of malignancy in case of congenital choledochal cyst, may lead to neoplastic changes in the biliary epithelium.^{20,21}

LCBDE has considerable advantages for treating both gall bladder and bile duct stones in a single stage without any preoperative examination to detect the presence of stones in CBD.^{22,23} The main drawback of LCBDE is the increased operative time and the cost involved, particularly with the use of choledochoscope.

There is a possibility of false positive cholangiograms in open procedure but did not encounter this problem. LCBDE is successful in 75-95% of the patients and is comparable to the endoscopic treatment. Moreover, if the endoscopic treatment fails, particularly in the postoperative setting, this may require a third stage open procedure. While if LCBDE fails, one can convert at the same time. Also as the experience is increasing in LCBDE, the success rate will further improve. (Liebermann et al), and (Martin et al); found that the single stage procedure had significant lower morbidity and shorter hospital stay resulting in lower cost than those of staged ERCP and LC.^{24,25}

In our study, patients who were unfit for operation or those with severe pancreatitis/ cholangitis or with previous upper abdominal surgery or with CBD stone but bile duct dilatation <6 mm subjected to ERCP and were excluded from the current study. We have deliberately not done ERCP in the study group patients considering the cost, two-stage procedure, risk of complications and the possibility of failure.

Certainly, ERCP has been an important modality for treating leftover CBD stone after LC. The current trend is to utilize ERCP less, preoperatively, while expanding its role

in the postoperative setting.²⁶

Various randomized controlled studies comparing the two-stage (ERCP with LC) procedure and one-stage LC with LCBDE, showed that the one-stage procedure resulted in a shorter stay and similar stone clearance rates.^{26,27}

Transcystic CBD exploration is preferred as it is easy, more physiological, associated with less complications, does not require t-tube placement and intra-corporeal suturing and the post-operative course is almost similar to patients undergoing LC alone. However, a transcholedochal approach is a must if there are—multiple stone (>5), stone >6 mm, proximal stone, CBD size <6 mm, cystic duct size <4 mm (too narrow to pass choledochoscope), and if there is any anatomical variation of the biliary tree.²⁸

Traditionally, CBD exploration is accompanied by t-tube drainage of CBD. Nevertheless, there are a few disadvantages, inconvenience, and discomfort, delayed recovery, longer stay, risk of tube displacement, risk of infection and rarely, fracture of tube fragment, and retention in the CBD.²⁸

Lange et al; first reported laparoscopic CBD primary closure with antegrade stent.²⁹ Recently, many studies have shown feasibility and potential advantages of antegrade stent which include decompression of CBD postoperatively, facilitation of ERCP cannulation postoperatively and early return to full activity.³⁰

Nowadays the combined laparo-endoscopic approach to CBD stone is talked about in which a modified plastic biliary stent is used (modified by breaking the proximal flange).⁸ Potential problems with the plastic stent are bile leak, stent occlusion, early stent migration and the need of future endoscopy for the removal of the stent.^{31,32}

Out of 45 patients we found CBD stones in 34 patients. We were able to successfully remove stones in 30 patients and in 4 patients, we had to convert to open CBD exploration as we were not able to remove completely all the stones laparoscopically.

Now we have every confidence in the technique of LCBDE, our success rate is

88.2% (4 conversions out of 34 explorations), there was no major complication, and in follow-up, no residual stone was found. Our operating time is also decreasing as all the team members are getting familiarized with the technique and equipments. Although we still rely on ERCP and ES for high risk patients or those who are unfit for operation or those with severe pancreatitis/ cholangitis or those who are diagnosed as to have CBD stone with bile duct diameter <6 mm.

Our results are good and improving; we need time and more efforts to be comparable to the published data in the literature, in terms of stone clearance, minimal complications, a shorter hospital stay, and rapid recovery time.^{33,34} The optimal management of choledocholithiasis remains unclear in the present laparoscopic era. Management at a single stage is the optimal approach in terms of safety, patient satisfaction and cost-effectiveness.

Conclusion:

CBD stones are associated with about 10-16% of the patients undergoing cholecystectomy. Treatment algorithms have changed for CBD stones with the advent of endoscopic management which is now getting further modified with the advancement in laparoscopic surgery.

The treatment of CBD stones depends on the resources available, technical limitations, and the surgeon's expertise. Laparoscopic CBD exploration is a safe, feasible and single-stage option for the management of CBD stones. In spite of its difficulty and learning curve is slow and demanding, it is improving in our department 8B unit, more data and time are needed to improve our technique and outcome.

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