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Laparoscopic exploration of the common bile duct: 10-year experience of 174 patients from a single centre

膽總管腹腔鏡探查術：一所機構十年來治療174名病人的經驗

Objectives. To evaluate the role of laparoscopic exploration of the common bile duct in the management of common bile duct stones.

Design. Retrospective study.

Setting. Regional minimal access surgery training centre in Hong Kong.

Patients. Patients undergoing laparoscopic exploration of the common bile duct from 1995 to 2005.

Main outcome measures. Demographic information, reasons for failed endoscopic retrograde cholangiopancreatography and open conversions, and operative morbidity and mortality.

Results. A total of 174 laparoscopic explorations of the common bile duct were performed. Indications for surgery (some overlapping) included: concomitant gallstones and common bile duct stones (n=68, 39%) in young persons (<60 years), previously failed endoscopic extraction (n=59, 34%), large (>2 cm) or multiple common bile duct stones (n=40, 23%), and need for laparoscopic bypass to improve bile drainage (n=34, 20%). Mean patient age was 63 (standard deviation, 16) years and 103 were female. Altogether 156 choledochotomies and 18 transcystic duct explorations were performed, with 12 (7%) open conversions. The mean operating time was 129 (standard deviation, 57) minutes. Additional procedures included: 54 laparoscopic operative cholangiographies, 34 laparoscopic biliary bypasses, and 31 instances of adhesiolysis in patients with a history of open upper gastro-intestinal surgery. Complete stone clearance was achieved in 160 (92%) patients. Non-lethal complications occurred in 34 (20%) patients and one died of sepsis after a major bile leak. The mean postoperative stay was 9 (standard deviation, 9) days. Stone recurrence ensued in seven (4%) patients after a mean follow-up of 37 (standard deviation, 29) months.

Conclusions. Laparoscopic exploration of the common bile duct is highly successful and can achieve satisfactory ductal clearance even after unsuccessful endoscopic extraction and previous upper gastro-intestinal surgery. In skilled hands, for selected patients laparoscopic bypass can also achieve improved bile drainage.

目的：評估在治療膽總管結石時，膽總管腹腔鏡探查術的作用。

設計：回顧性研究。

安排：香港微切口外科訓練中心。

患者：1995至2005年間，進行過膽總管腹腔鏡探查術的病人。

主要結果測量：人口學資料、內窺鏡下逆行膽道管造影術和開切手術失敗的原因、手術發病率和死亡率。

結果：該中心共進行過174次膽總管腹腔鏡探查術。適合接受這項手術的因素（部分重覆）包括年輕（60歲以下）及同時出現膽石和膽總管結石（68人，佔39%），曾嘗試以內窺鏡手術取出結石但失敗（59人，佔34%），結石屬大體積（超過2厘米）或多粒共生（40人，佔23%），和有需要進行腹腔鏡分流術改善膽汁流通的病人（34人，佔20%）。病人平均年齡為63歲（標準差16歲），女病人有103人。156人接受了膽道狹窄切開術，18人接受了通囊管探查術，其中12名病人有開切手術（佔7%）。手術平均需時129分鐘（標準差57分鐘），

Key words:
Cholangiopancreatography, endoscopic retrograde;
Cholecystectomy, laparoscopic;
Common bile duct/surgery;
Gallstones/surgery;
Sphincterotomy, endoscopic

關鍵詞：
膽道造影術，內窺鏡下逆行；
膽囊切除術，腹腔鏡；
膽總管／手術；
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其他額外的手術程序包括 54 次腹腔鏡膽道造影術、 34 次腹腔鏡膽道分流術，和在 31 名曾接受上胃腸開刀手術的病人進行黏連剝離術。 160 名病人（佔 92%）的結石得到徹底清除， 34 名病人（20%）出現併發症，另 1 人因嚴重膽汁漏出引致敗血病死亡。病人手術後平均住院時間為 9 日（標準差 9 日）。 7 名病人（佔 4%）在跟進期內（平均時間 37 個月；標準差 29 個月）出現結石復發情況。

結論：膽總管腹腔鏡探查術非常成功，即使病人曾有內窺鏡取石手術失敗和曾經進行過上胃腸手術，亦能清除其膽管內結石。技術純熟後，甚至可以挑選部分病人進行腹腔鏡分流術，改善膽汁流通情況。

Introduction

Since the introduction of endoscopic retrograde cholangiopancreatography (ERCP), preoperative clearance of common bile duct (CBD) stones prior to cholecystectomy has been widely adopted. Most surgeons believe that laparoscopic cholecystectomy (LC) results in a faster recovery, nonetheless they rarely perform laparoscopic operative cholangiography (LOC) or laparoscopic exploration of the CBD (LECBD). They generally prefer preoperative clearance. This two-stage approach has disadvantages as patients are exposed to the cumulative risks of complications from ERCP with or without endoscopic sphincterotomy (ES) and LC, affecting approximately 10% and 5% of subjects, respectively.[1,2]

Better outcomes result from ERCP than surgical exploration in severe biliary pancreatitis and acute cholangitis.[3-5] In addition, ERCP is commonly advocated in the management of postoperative recurrent stones and bile leak or in elderly patients who are unfit for surgery.[6-8] Nonetheless, if stones are large or multiple, the procedure may need to be repeated. Stones may also be 'endoscopically irretrievable' in the presence of Mirrizi syndrome or distorted anatomy (previous Billroth II gastrectomy, duodenal diverticulum, or if the stone remains proximal to a stricture).[9,10] In such cases, LECBD is undoubtedly useful.

Patients and methods

In this study, all LECBD data were prospectively collected from 1995 to 2005. The surgery was performed for the following indications: (1) concomitant gallstones and CBD stones in younger patients (<60 years), (2) previously failed endoscopic retrieval, (3) large or multiple CBD stones, and (4) recurrent pyogenic cholangitis (RPC) with multiple extrahepatic stones requiring stone extraction and drainage.

Diagnosis of CBD stones is based on clinical presentation, liver function tests, transabdominal ultrasound, and cholangiography. The latter may entail: ERCP, percutaneous transhepatic cholangiography, magnetic resonance cholangiopancreatography (MRCP) and LOC. In general, ERCP is preferred in patients with biliary sepsis (acute cholangitis or severe biliary pancreatitis), unless there is a history of previous gastrectomy. Percutaneous transhepatic biliary drainage (PTBD) is preferred for biliary decompression when ERCP has failed. The MRCP or LOC is performed to assess bile duct status in stable, non-septic patients.

Endoscopic sphincterotomy and stone extraction remain the mainstay treatment for CBD stones except when the stones are 'endoscopically irretrievable' or in young patients (<60 years) in whom it is preferable to preserve the sphincter of Oddi even when there are small CBD stones. If endoscopic extraction is unsuccessful or considered inappropriate, a biliary stent (Cotton-Leung Biliary Stent; Wilson-Cook Medical Inc, Winston-Salem, US) can be inserted and LECBD performed 4 to 6 weeks later. Endoscopic extraction can be difficult in patients who have multiple and large CBD stones. In this study, RPC with multiple extrahepatic CBD stones was also an important indication for LECBD. In addition to removal of CBD stones, creation of a laparoscopic choledochoenterostomy can help prevent stone formation.[11-13]

Patients with a history of previous upper abdominal surgery were excluded during the early period of the study (1995-2000). Nonetheless in 2001, as surgical skill and instrumentation improved, we started exploring the feasibility of LECBD in patients with previous gastrectomy and even biliary bypass.

Surgery was performed under general anaesthesia with the patient positioned supine on an X-ray table. All patients received routine prophylactic antibiotics. A five-port technique was employed using a 30-degree laparoscope—a 5 to 11-mm infra-umbilical port was inserted by an open method; one 5-mm subxiphoid and two 5-mm right subcostal ports were inserted under direct vision; and an additional 5-mm trocar port (for intracorporeal suturing) was inserted at the left iliac fossa if laparoscopic choledochotomy was planned.

We adopted the policy of selective operative cholangiogram based on any perioperative suspicion of CBD stones. Transcystic duct exploration was generally preferred for tiny stones within the marginally dilated CBD (<1 cm). During the transcystic duct exploration, saline flushing with glucagon injection under fluoroscopic guidance was employed. Choledochoscopic examination via the cystic duct was carried out to confirm stone clearance on completion of exploration. For dilated CBD (>1 cm) with multiple stones, laparoscopic choledochotomy was preferred. The supra-pancreatic CBD was incised longitudinally using an ultrasonic dissector that achieves satisfactory haemostasis. Stone extraction was performed

Table 1. Indications for laparoscopic exploration of the common bile duct (LECBD)

Indications of LECBD*	Patients, n=174 No. (%)
Young patient (<60 years) with concomitant gallstones and common bile duct stones	68 (39)
Previously failed endoscopic retrograde cholangiopancreatography	59 (34)
Large (>2 cm) or multiple common bile duct stones	40 (23)
Recurrent pyogenic cholangitis (for drainage choledochoenterostomy)	34 (20)

* Overlapping indications were observed in 27 patients

using a combination of different methods, ie saline flushing, dormia basket, and balloon catheter under choledochoscopic guidance. When operative lithotripsy was unsuccessful, postoperative ERCP or open conversion was considered. The decision to have additional choledochoenterostomy was based on clinical presentation, evidence of biliary stasis on HIDA (hepatobiliary iminodiacetic acid) scintigraphy and any evidence of intrahepatic stones on computed tomography scan. Biliary decompression after exploration was achieved by insertion of a T-tube or placement of a biliary stent. From 2001, we started suturing the CBD primarily with promising results to date. A silicone drain was routinely inserted at Morrison's pouch to prevent collection. The silicone drain was removed 3 to 4 days postoperatively provided there was no bile leak, in which case biliary decompression by ERCP or PTBD was attempted.

A cholangiogram via the T-tube was routinely performed and if no abnormalities were detected, the T-tube was removed on day 14. Patients with biliary stenting underwent ERCP 4 weeks following surgery. Ductal clearance was confirmed by T-tube cholangiogram or by ERCP in patients with a biliary stent.

Patients were followed up in the out-patient clinic at 3-month intervals. Liver function tests and selective ultrasound were performed to exclude stone recurrence or other long-term complications.

Results

Between 1995 and 2005, 1144 patients underwent ES and endoscopic extraction of CBD stones and 22 patients underwent open exploration of the CBD. Laparoscopic exploration of the CBD was performed in 174 patients; mean age, 63 (standard deviation [SD], 16) years; 103 females.

At initial presentation, about two thirds of patients (n=118, 68%) had infective complications that included acute cholangitis (n= 91, 52%), biliary pancreatitis (n=18, 10%), and acute cholecystitis (n=9, 5%). Of the remaining 56 patients, 32 (18%) had biliary colic and 24 (14%) had obstructive jaundice/deranged liver function tests.

Endoscopic retrograde cholangiopancreatography was performed in 128 patients with diagnostic success in 101 (79%). A biliary stent was inserted preoperatively in 99 patients to relieve obstruction and treat biliary sepsis. Multiple endoscopic sessions were often required in patients with large or multiple CBD stones. The mean number of sessions for patients who underwent ERCP was 1.8 (SD, 1.7; range, 1-16). Emergency PTBD was required in 12 (7%) patients to achieve biliary decompression before surgical exploration.

Indications for surgery are listed in Table 1. In 68 (39%) patients with CBD stones younger than 60 years, LECBD was chosen because of the potential for long-term complications from ES in younger individuals. There were 40 (23%) patients with concomitant gallstones and multiple/large CBD stones (>2 cm).

Endoscopic retrograde cholangiopancreatography was attempted in all but two of the 59 patients with endoscopically irretrievable stones, with diagnostic success achieved in 40 (70%) [Table 2]. One of the two excluded patients had previously undergone total gastrectomy and the other, a Whipple procedure. Cannulation failed in 19 patients secondary to anatomical difficulties. Thirteen patients had a history of Billroth II gastrectomy. Periampullary diverticulum was present in three patients and selective cannulation was again unsuccessful. Another three cannulation failures were due to previous Whipple operation, roux-en-y end-to-side choledochojejunostomy, and accidental oesophageal perforation during ERCP. Failed extraction occurred in the remaining 40 patients. Fifteen patients had impacted CBD stones and extraction was unsuccessful. There were also 14 patients with incomplete stone extraction despite multiple endoscopic sessions (≥2 sessions). Type II Mirrizi syndrome was identified in four patients. Common bile duct stricture prevented access to stone extraction in three patients and situs inversus was found in one patient who also had a pacemaker. Diagnostic ERCP was successfully attempted but ES was considered inappropriate due to altered anatomy and risk of interference with the pacemaker. Complications related to ERCP that led to LECBD occurred in three patients. The first had repeated post-ERCP pancreatitis (probably related to a juxtadiverticular papilla). In the second patient, the biliary stent migrated into the CBD and could not be retrieved endoscopically and the third had a post-ES retroperitoneal perforation and opted for surgery to remove gallstones and CBD stones rather than undergoing repeated ERCP.

A further 34 patients with RPC and multiple recurrent extrahepatic stones were selected for LECBD and construction of choledochoenterostomy. The drainage procedures included 32 side-to-side choledochoduodenostomies and two roux-en-y side-to-side choledochojejunostomies.

Table 2. Reasons for failed endoscopic retrograde cholangiopancreatography (ERCP)

Reasons for failed ERCP	No. of patients
Failure of cannulation	19
Previous gastrectomy	13
Periampullary diverticulum	3
Previous Whipple operation	1
Previous roux-en-y choledochojejunostomy	1
ERCP with oesophageal perforation	1
Failure of extraction	40
Impacted stone	15
Incomplete stone clearance after multiple attempts	14
Type II Mirrizi syndrome	4
Relative common bile duct stricture	3
Situs inversus	1
Stent migration into common bile duct	1
Repeated post-ERCP pancreatitis	1
Post-ES duodenal perforation	1
Total	59

Table 3. Open conversions

Reason for open conversion	No. of patients
Adhesions and unclear anatomy	5
Duodenal perforation	2
Jammed basket	1
Impacted stone	1
Missing and broken instrument tip	1
Torn cystic duct/CBD junction	1
Dissecting bile duct injury	1
Total	12

Altogether 156 choledochotomies and 18 transcystic duct explorations (excluding two patients finally converted to choledochotomy) were performed with 12 (7%) converted to an open procedure. Unlike western series, most LECBD procedures were performed via a choledochotomy approach because of multiple/large CBD stones; some may have become impacted with unsuccessful preoperative lithotripsy. Generally, transcystic duct exploration was performed in patients with small stones in a small-calibre CBD, although its role was not obvious particularly in those with unsuccessful ERCP. The mean operating time was 129 (SD, 57) minutes and additional procedures included 54 (31%) LOC, 34 (20%) laparoscopic biliary bypasses, and adhesiolysis in 31 (18%) patients with a history of open upper gastro-intestinal surgery.

On completion of exploration, a biliary stent was inserted in 44 (25%) patients and a T-tube in 60 (35%) patients. Primary closure was performed in 70 (40%) patients of whom 26 had undergone biliary bypasses and 17 had undergone transcystic exploration. In this last group, one patient had a double-loop stent inserted through the cystic duct for decompression because of incomplete clearance. The mean intra-operative blood loss was 42 (SD, 138) mL and no patient required postoperative transfusion. Complete ductal clearance was achieved in 160 (92%). Reasons for open conversion are summarised in Table 3.

Table 4. Postoperative mortality and morbidity in laparoscopic exploration of the common bile duct (LECBD)

Morbidity/mortality	Patients* No. (%)
Morbidity	34 (19.5)
Bile leak/stent migration/collection	15 (8.6)
Residual stones	14 (8.0)
Wound infection/bleeding	4 (2.3)
Bile duct injury	4 (2.3)
Blocked stent	2 (1.1)
Cholangitis	2 (1.1)
Retained stent inside peritoneal cavity	1 (0.6)
Duodenal injury	1 (0.6)
Intra-abdominal collection	1 (0.6)
Intestinal obstruction	1 (0.6)
Mortality (secondary to bile leak and collection)	1 (0.6)

* Some patients had more than one complications

Table 4 is a summary of the mortality and morbidity in our patients undergoing LECBD. Duodenal injury was identified intra-operatively and the procedure immediately converted to open laparotomy. The patient with postoperative intestinal obstruction recovered uneventfully with conservative treatment. The retained stent inside the peritoneal cavity was identified on postoperative X-ray and retrieved laparoscopically. The four patients with wound infection/wound bleeding were managed conservatively and none required further surgery. Despite the intrinsic problems with T-tubes including dislodgement, kinking, and need for longer hospital stay to undergo postoperative cholangiogram, there were no major complications related to T-tube insertion. All patients except one with a bile leak were successfully managed by postoperative ERCP. During ERCP, the position of the migrated stent and the site of contrast extravasation were ascertained. The stent was grasped and removed using a dormia basket. A new stent was inserted to decompress the CBD. One patient died of multi-organ failure following a major bile leak and unsuccessful laparotomy and drainage of an intra-abdominal collection.

The stone clearance rate was 92%. Residual stones persisted in 14 patients but in most cases were cleared by postoperative ERCP. The mean postoperative stay was 9 (SD, 9) days. Stone recurrence was identified in seven (4%) patients at a mean follow-up of 37 (SD, 29) months. Stone clearance was achieved following repeated LECBD together with creation of a biliary bypass in three patients and by ERCP in four.

Discussion

Both surgical endoscopists and gastroenterologists played an important role in the management of CBD stones when open surgery was the only option. Despite this, there was no advantage of a two-stage approach over a single-stage open cholecystectomy and exploration of CBD, except in patients with acute cholangitis and severe biliary pancreatitis.[3-5,14,15]

Data collected during the 1990s indicated that open exploration (including open conversions) was performed in 30 to 65% of all patients with CBD stones although this declined to 10 to 15% in the later years of the decade.[16-18] The decline was primarily due to increased utilisation of perioperative endoscopic clearance, not the impact of LECBD. As LECBD is considered technically demanding and success requires ancillary support and devices (eg fluoroscopy, choledochoscopy, lithotripsy instruments, and accessory devices), it is not popular. As a result, most patients with concomitant gallstones and CBD stones continue to have two-stage procedures. Nevertheless, the last decade has seen the maturation of LECBD in the hands of many surgeons, such that the vast majority of patients with CBD stones could now be safely managed by laparoscopic surgery alone. To date, two randomised trials have compared a two-stage with a one-stage approach (preoperative or postoperative ERCP with LC, and single-stage LC with LECBD).[19,20] These revealed equivalent success and morbidity rates but also shorter hospital stays in the transcystic exploration group. Despite this evidence, a recent large-scale German survey[21] found that endoscopic management was performed in 75% of patients with a preoperative diagnosis of CBD stones. Most patients were offered postoperative ERCP if stones were diagnosed intra-operatively, except for 16% who proceeded to open exploration and 4% who underwent LECBD.

Various short- and long-term complications of ERCP and ES have been reported in young patients.[2,22] The short-term complications include bleeding, pancreatitis, and perforation. In 5 to 24% of patients there are long-term complications (recurrent stone formation, duodenal reflux, ascending cholangitis, and papillary stenosis). Thus a cautious approach is required when electing a two-stage approach.[22] In our unit, single-stage LC and LECBD is the primary approach for patients younger than 60 years, except in the presence of severe biliary sepsis.

According to this study protocol, failed endoscopic retrieval was defined as unsuccessful stone extraction by an experienced endoscopist on at least two occasions. The difficulties are essentially related to anatomical anomalies, such as duodenal diverticulum next to the papilla, situs inversus, relative stricture below the CBD stone, Mirrizi syndrome, or previous Billroth II gastrectomy. In which case stone extraction is very difficult if not impossible. Unrealistic attempts at removal may result in a jammed basket or even visceral perforation.[10]

Laparoscopic exploration can effectively clear CBD stones (92% success rate) but is not without complications. In our series, one fifth (19.5%) of patients developed postoperative complications; in part due to 'difficult' CBD stones and the learning curve effect. Most complications (except bile leak) resolved with conservative treatment. Postoperative bile leak (probably due to dislodged T-tubes or migration of a biliary stents) are most alarming, though most patients can be successfully managed by endoscopic stenting.[7] T-tube placement is the most common practice for bile duct diversion in open exploration and provides access for percutaneous lithotripsy as well as a route for a subsequent cholangiogram. T-tubes also have intrinsic problems (dislodgement, kinking, longer hospital stay to undergo a postoperative cholangiogram). Moreover, adhesion formation may not be as good as after open surgery; the T-tube tract probably needs longer to mature before its removal. Despite these drawbacks, T-tubes are still preferred, particularly in post-gastrectomy patients because they maintain an endoscopic access (required to deal with residual stones or other complications).[10,23,24] Placement of a biliary stent is an attractive alternative but stent-related complications were common in our series. An additional ERCP session is also required to remove the stent, although this approach was shown to shorten the postoperative hospital stay. Primary CBD closure without any diversion is the third option. We have attempted this approach in almost 30 patients with encouraging results. The patients must have a sizeable CBD (>1 cm) and no history of distal stone impaction or Billroth II gastrectomy.[25] The practice of primary closure nonetheless needs careful application. The controversy surrounding post-exploration biliary decompression will persist until the results of randomised controlled studies to compare these different methods become available.

Biliary bypass entails joining the biliary tree (the bile duct or gallbladder) to the small bowel. Although laparoscopic hepaticojejunostomy is generally preferred in malignant obstructions and recurrent CBD stones, it is a technically demanding operation, particularly when roux-en-y reconstruction is chosen. This may explain the sparse literature on the subject and why it is mainly restricted to animal studies.[26,27] In contrast, laparoscopic choledochoduodenostomy is an attractive alternative means of preventing recurrent primary CBD stones or benign bile duct stricture. It is technically less complicated and endoscopic access is preserved when a side-to-side construction is fashioned.[11,12] Besides, concerns about postoperative bile reflux, ascending cholangitis, and sump syndrome have not been substantiated.[28,29] Recurrent cholangitis occurs in less than 4% of patients and is more often related to stenosis of choledochoduodenostomy rather than ascending causes. This hypothesis is supported by experimental work.[30] Sump syndrome refers to pain and mild symptoms of cholangitis and may be caused by debris lodged in the non-functional distal CBD. The incidence varies from 0.14% to 3.3%. To avoid this potential complication, the anastomosis should be constructed at the most distal part of the CBD so as to minimise the length of the blind CBD segment. The anastomosis should be at least 14 mm in size and carefully constructed to avoid postoperative stenosis. The resulting widely patent stoma allows food debris to enter and leave easily.[31,32]

Conclusions

Exploration of the CBD is not an obsolete approach in the management of CBD stones. Laparoscopic exploration of the CBD is highly successful and can achieve satisfactory ductal clearance for 'endoscopically irretrievable' stones. With improved skill, in selected patients laparoscopic bypass can also be performed to improve bile drainage.

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