

ORIGINAL ARTICLE

LAPAROSCOPIC BILE DUCT EXPLORATION: RESULTS OF 160 CONSECUTIVE CASES WITH 2-YEAR FOLLOW UP

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Background: Despite numerous reports showing the advantages of laparoscopic common bile duct exploration (LCBDE), many general surgeons, particularly those working outside of nonspecialist units, continue to rely heavily on endoscopic retrograde cholangiography with sphincterotomy (ERCP) to manage bile duct stones (BDS). This article investigates the performance of LCBDE when adopted as the preferred first-line management of both suspected and incidental BDS by general surgeons in a regional setting.

Methods: A retrospective review was conducted of all patients in whom LCBDE was attempted by a regional general surgical unit. The unit policy was to preferentially treat all incidental and suspected BDS (except in ascending cholangitis or severe pancreatitis) by LCBDE, with ERCP used only if unsuccessful. In addition to chart review, formal prospective follow up by telephone interview was carried out.

Results: A total of 160 consecutive patients with BDS (mean age 66.9 years, 65% suspected and 35% incidental) underwent attempted LCBDE between January 2000 and July 2005. Successful clearance was achieved in 84.3% according to chart review. However, four additional cases of retained choledocholithiasis shown by late telephone interview (median interval 2.5 years) yielded a more accurate clearance rate of 81.8%. Major morbidity occurred in 13.8%, including biliary leak in 7.5% and one late biliary stricture (0.6%). Median length of hospital stay was 4.8 days. In-hospital mortality was 0.6%.

Conclusion: Laparoscopic common bile duct exploration remains an effective, efficient and safe first-line treatment of BDS even when carried out in regional nonspecialist units. In spite of the wide availability of ERCP, general surgeons should be encouraged to continue performing LCBDE in order to optimise patient care and maintain important surgical skills.

Key words: bile duct exploration, choledocholithiasis, endoscopic retrograde cholangiopancreatography, gallstone, laparoscopy.

Abbreviations: BDS, bile duct stones; ERCP, endoscopic retrograde cholangiography with sphincterotomy; LCBDE, laparoscopic common bile duct exploration.

INTRODUCTION

Bile duct stones (BDS) are encountered in approximately 7–15% of patients undergoing cholecystectomy.¹ Although numerous reports exist that show the advantages of single-stage laparoscopic management,^{2–8} in reality most surgeons still rely heavily on endoscopic retrograde cholangiography with sphincterotomy (ERCP) to clear duct stones.^{9–11} The purpose of this study was to investigate the outcomes achieved when a policy of laparoscopic common bile duct exploration (LCBDE) was adopted by nonspecialist general surgeons in a regional setting.

METHODS

A retrospective review was conducted of all BDS managed over the past 5 years on an intention-to-treat basis by laparoscopic duct

exploration. The setting for the study was the general surgical department (four surgeons assisted by two training registrars and a Fellow) of a 150-bed regional/rural public hospital in northern New South Wales (the Tweed Hospital) and an adjacent private institution (John Flynn Gold Coast Hospital).

Data were retrieved both from a review of inpatient files, specialist notes and letters of correspondence and from a prospective telephone interview conducted between April and July 2005. This was carried out to show details of any undocumented biliary problems, investigations or interventions that may have occurred following their initial treatment.

All significant complications were recorded. Biliary leak was defined as having one or more of the following: (i) any bilious peritoneal drainage beyond the third postoperative day; (ii) reoperation for biliary peritonitis; or (iii) radiological drainage of a biloma.

To manage the series, a comprehensive database (Microsoft Access; Microsoft Corporation, Washington, USA) was created, and remains in use for the prospective collection of ongoing treatment episodes.

The unit had an agreed 'all-comers' policy in relation to the management of BDS. Irrespective of whether BDS were suspected clinically or discovered incidentally, their removal was attempted in the first instance by LCBDE rather than by ERCP,

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except when associated with acute suppurative cholangitis, severe pancreatitis, or in very high risk patients.

Operative technique

Laparoscopic cholecystectomy was carried out under general anaesthesia with routine use of intraoperative cholangiography (Ultravist-370; diluted 1:1 with normal saline; Schering AG, Berlin, Germany). Care was taken to avoid the introduction of air bubbles.

Transcystic LCBDE

Transcystic exploration was attempted when filling defects less than 1-cm diameter were observed in the common bile duct. This was carried out using the 5.5-Fr Nathanson basket kit (Cook Australia, Eight Mile Plains, Australia) under image intensification. If difficulties were experienced negotiating the cystic duct, it was skeletonized down to the common duct junction and recut closer to the bile duct. In the case of a small solitary distal filling defect, clearance was attempted by transcystic flushing before basket exploration. This was carried out using pressurized saline via the cholangiogram catheter, and intravenous hyoscine or glucagon. Closed suction drains were not routinely used following successful transcystic clearance.

Transcholedochal LCBDE

In contrast to transcystic LCBDE, which was liberally attempted, transcholedochal LCBDE was reserved as a second line surgical intervention. It was performed when stones could not be removed transcystically provided that: (i) the calibre of the common bile duct was at least 8 mm; (ii) the common duct and porta hepatis were not inflamed; (iii) there was no cirrhosis or other significant adverse abdominal findings; and (iv) the patient's ASA grade was 1 or 2.

A longitudinal choledochotomy was created using scissors and cutting diathermy. Stone retrieval was attempted by direct saline flushing, Fogarty balloon (Edwards Lifesciences, Irvine, CA, USA) or wire basket. Following transcholedochal exploration, primary closure by continuous 3/0 or 4/0 polydioxanone was preferred. To improve biliary drainage, a temporary internal biliary stent (Cotton-Leung biliary stents, 10 Fr, 12–15 cm; Wilson-Cook Medical, Eight-Mile Plains, Queensland, Australia) was frequently placed across the ampulla and retrieved by standard end-viewing endoscopy after 6 weeks. Closed suction drains were used routinely.

Clearance

Successful duct clearance was assessed by repeat cholangiography (or choledochoscopy following choledochotomy). If clearance could not be achieved by either method of LCBDE, the patient was referred for ERCP (performed by another hospital department). The role of open duct exploration following failed LCBDE was limited to rare cases such as very large impacted BDS or where previous gastric surgery had rendered endoscopic access to the duodenum impossible. When possible, a temporary biliary stent was placed laparoscopically to facilitate endoscopic management. (4 cm × 7 Fr Common Bile Duct Stent; Cook Australia)

RESULTS

A total of 160 consecutive patients, mean age of 66.9 years (median 73.5 years, range 21–96 years), underwent attempted LCBDE for detected BDS between January 2000 and July 2005 (Table 1). During the same time period, 1436 cholecystectomies were performed, giving an overall incidence of BDS of 11.1%. This included five patients referred from the gastroenterology service following an unsuccessful attempt to clear BDS at ERCP. Apart from these, no other patients had a planned preoperative ERCP. BDS were suspected preoperatively in 102 patients on the basis of previous jaundice or pancreatitis, abnormal hepatic biochemistry or biliary imaging, and over half of all LCBDE were carried out during an unplanned admission (Tables 2,3).

Medium-term follow up was conducted by telephone during April–July 2005. One hundred and forty patients (87.5%) were contacted, providing a median duration of follow up from the time of discharge of 2.54 years (range up to 5.2 years). (Seven of these patients had died of unrelated causes (myeloproliferative disease (68 years), head injury (82 years), subarachnoid haemorrhage (79 years), myocardial infarction (72 years), stroke (78 years), colon cancer (66 years) and cause not determined in one patient aged 72 years), with relatives in these cases answering the questionnaire.

At the time of surgery, successful LCBDE was believed achieved in 135 cases (84.3%). However, telephone questionnaire identified four patients who had gone on to have further stones retrieved by unplanned ERCP (discussed further), giving a LCBDE clearance rate of 81.8%. (Table 4) Three patients with

Table 1. Demographics

Mean age (years)	66.9
Median age (years)	73.5
Age range (years)	21–96
Male (%)	64 (40)
Female (%)	96 (60)

Table 2. Presentation

Pre-operative suspicion	No. patients
Incidental on intraoperative cholangiography	58 (35%)
Suspected by one or more of	
History of jaundice, dark urine or pale stools	41
History of pancreatitis	15
Abnormal hepatic biochemistry	79
Abnormal biliary imaging	79
Ultrasound	45
Computed tomography	14
Magnetic resonance cholangiography	7
Referral from gastroenterologist after failed ERCP	5

ERCP, endoscopic retrograde cholangiography with sphincterotomy.

Table 3. Reason for admission

	Admission	No. patients (%)
Emergency (88 patients)	Acute cholecystitis	28 (18)
	Jaundice	8 (5)
	Acute pancreatitis	18 (11)
	Abnormal biliary imaging or hepatic biochemistry	33 (21)
	Elective	72 (45)

Table 4. Successful laparoscopic clearance, *n* = 131 (82%)

Method	No. successful	Procedure time (min)	Length of stay (days)	Morbidity	Mortality
Transcystic flushing	14	71.4	2.1	Nil	Nil
Transcystic exploration	74	88.3	2.5	9 (12%)	Nil
Choledochotomy	41	130.9	6.2	9 (21%)	1 (2%)
Choledochoduodenostomy	2	240.6	11.7	Nil	Nil
Total	131	115	3.8	16.4%	0.7%

previous open cholecystectomy and four patients referred from our gastroenterologist following failed primary ERCP were managed successfully by laparoscopic exploration. Laparoscopic clearance was carried out using transcystic methods in 67% and by laparoscopic choledochotomy in 34% (including two patients in whom laparoscopic choledochoduodenostomy was carried out to bypass a difficult firmly impacted distal calculus that could not be removed).

In 29 cases, complete removal of BDS was not achieved laparoscopically (18.2%) (Table 5). This was correctly identified at the time of surgery in 25 patients. Twenty patients were managed by postoperative ERCP (Table 6), facilitated by a laparoscopically placed stent in 10 cases, whereas 5 patients underwent open exploration (3.1%). All four patients with retained BDS were successfully managed by ERCP at 3, 6, 7 and 36 postoperative months, respectively.

T-tubes were used in seven patients. In four patients, this followed open exploration. In the remaining three patients, two of whom had a history of Billroth-2 distal gastrectomy, T-tubes were placed laparoscopically in case percutaneous access was needed. All other choledochotomies were closed primarily (85%).

Laparoscopically placed antegrade biliary stents were used in a total of 36 patients (Table 7). In 10 patients, they were placed in order to facilitate ERCP when laparoscopic exploration had been unsuccessful. In 26 patients, they were placed following successful laparoscopic choledochotomy for temporary internal drainage (see Discussion).

Major complications

Twenty-two major complications occurred in 21 patients (13.8%) (Table 8). Biliary leak occurred in 12 patients (7.5%) and was managed either conservatively in the absence of biliary peritonitis or by reoperation if present. ERCP was used to assist resolution of

a persistent high volume bile leak (>100 mL per day) in an otherwise stable patient. Eight patients responded to nonoperative management (percutaneous drainage alone in three, ERCP alone in four and both interventions in one patient), whereas four patients (2.5%) required reoperation. This was carried out as laparoscopic lavage and drainage in three, and by laparotomy in the fourth patient who died (see below).

One common duct stricture (0.6%) was confirmed by ERCP, carried out to investigate new biliary symptoms 6 months after laparoscopic choledochotomy of a 10-mm duct. He has required a total of three endoscopic procedures including balloon dilatation, last performed in February 2004. Thus far he has not required surgical intervention, and reports being free of symptoms 2 years later.

Stent-associated morbidity included one stent that had migrated wholly within the bile duct, necessitating removal by ERCP. In another patient, the stent was not seen at planned endoscopic removal, presumed passed distally. No stent-related perforation, impaction, infection or pancreatitis occurred during this study period.

Seven major nonbiliary complications occurred, including myocardial infarction (two), atrial fibrillation (two), pneumonia (one) and pleural effusion (two). No thromboembolic complications occurred.

One in-hospital death (0.6%) occurred in a 80-year-old man with a background of cardiac valvular dysfunction and ischaemic heart disease (American Society of Anaesthesiologists grade 3). He developed biliary peritonitis following clearance of eight incidental BDS by laparoscopic choledochotomy (closed primarily over a temporary stent). He underwent laparotomy (in preference to laparoscopy because of increasing cardiovascular instability) on the second postoperative day where a leak from the choledochotomy was identified and managed by insertion of a T-tube, his condition continued to deteriorate and

Table 5. Unsuccessful laparoscopic clearance, *n* = 29 (18%)

Surgical details	Reason for laparoscopic failure	Management	No. patients
Laparoscopic transcystic exploration	Unable to clear stones	Postoperative ERCP	18
	Retained stones on follow up	Open exploration (jammed stone)	1
		Unplanned ERCP at 7 months postoperation	1
Laparoscopic cholecystectomy	Unable to clear stones	Postoperative ERCP	2
	Retained stones on follow up	Unplanned ERCP at 3, 6, 36 months postoperation	3
Laparoscopic cholecystectomy	Unable to tolerate pneumoperitoneum Dense adhesions	Open cholecystectomy with duct exploration	4

ERCP, endoscopic retrograde cholangiography with sphincterotomy.

Table 6. Use of endoscopic retrograde cholangiography with sphincterotomy, $n = 27$ patients (five patients had overlapping indications)

Indication	No. patients
Failed laparoscopic transcystic exploration	18
Failed laparoscopic transdochal exploration	2
Late recurrent stones	4
Biliary leak	6
Retrieval of migrated stent	1
Management of biliary stricture	1

Table 7. Antegrade biliary stents, $n = 36$

Indication	No. patients	Type of stent	Time to removal (weeks)	Complications
Failed transcystic exploration	8	4 cm \times 7 Fr common bile duct stent	8.9 (6–12)	Nil
Failed transdochal exploration	2	Cotton-Leung biliary stent,	11 (both)	Stent not seen at ERCP (1)
Internal drainage following successful choledochotomy	26	12 or 15 cm 10 Fr	10.1 (4–21)	Stent migrated wholly within common bile duct removal by ERCP (1)

ERCP, endoscopic retrograde cholangiography with sphincterotomy.

Table 8. Complications

	Complication	No. patients (%)
Biliary	Leak	12 (7.5)
	Common duct stricture	1 (0.6)
	Stent migration	2/36 (5.6)
Nonbiliary	Myocardial infarction	2 (1.2)
	Atrial fibrillation	2 (1.2)
	Pneumonia	1 (0.6)
	Pleural effusion	2 (1.2)
Total morbidity		22 (13.8)
Mortality		1 (0.6)

he died on the fifth postoperative day during the attempted drainage of a pericardial effusion.

DISCUSSION

The benefits of surgical management of gallstones were well recognized by surgeons before the laparoscopic era, where it was considered a natural and logical extension of cholecystectomy to perform intraoperative cholangiography and surgically clear BDS in a single procedure.^{12,13} This strategy offered effective therapy with a morbidity under 15% and a mortality under 1% in patients up to 65 years old.¹⁴ It remained the mainstay of BDS management despite the availability of ERCP during the 1970s and 1980s. However, in the laparoscopic era, many surgeons now rely heavily on ERCP to diagnose and manage BDS,^{9–11} despite

the availability of data supporting the feasibility, safety and effectiveness of laparoscopic clearance.^{2–8} This may be due to a perception by many surgeons that LCBDE is tedious, time consuming and excessively demanding on skills and equipment.¹⁵ Although these concerns may be true in part, they may reflect better the needs of the surgeon than those of the patient. This study shows that LCBDE can be carried out by busy nonspecialist general surgeons working within both public and private settings, allowing for balance between evidenced-based practice and workplace efficiency.

The effectiveness of LCBDE is compelling. In a recent meta-analysis involving 1762 patients from 19 studies from all over the world, laparoscopic exploration achieved a mean duct clearance in over 80% of cases (59–100%), with average morbidity under 10% (4–16%) and mortality under 1% (0–2.7%).¹⁶ Furthermore, when BDS can be cleared transcystically, the recovery may be very similar to laparoscopic cholecystectomy alone.^{3,17} Whilst disagreement may continue on the relative safety of ERCP versus transcholedochal LCBDE, transcystic LCDBE, which can successfully deal with approximately two-thirds of patients with BDS, is generally agreed to be extremely safe. We believe that patient care would be better optimised if greater use of transcystic LCBDE was practiced and encouraged.

Although ERCP is an extremely valuable tool in the management of BDS, its routine use as first-line treatment may have significant disadvantages. When used preoperatively, it is found to be unnecessary in at least 50% who are still exposed to its risks.^{18,19} When used postoperatively to clear confirmed stones, up to 10% may require a second surgical procedure following failure to cannulate the duct.¹⁹ ERCP carries well-established risks, with morbidity in most series of between 5 and 10% and a 1 in 200 risk of death.^{5,16,20,21} In well-designed prospective randomized trials by Rhodes *et al.* and Cuschieri *et al.*, laparoscopic exploration was found to be superior to postoperative ERCP, with advantages that included fewer procedures, less time spent in hospital and reduced costs.^{22,23} There may also be a lower mortality rate, particularly in younger patients.⁵ Furthermore, in many regional and rural settings, ERCP may be less available, resulting in further delays and/or the disruption associated with patient transfer to other facilities.

However, as a second-line therapy, ERCP has an important role to play in the management of BDS. It is safer than surgical clearance when duct stones cause ascending cholangitis or severe pancreatitis, and in high anaesthetic risk patients.²⁴ It avoids the risk of biliary stricture associated with choledochotomy in small ducts. It helps investigate the possibility of pancreaticobiliary neoplasia. Additionally, it can be an important rescue tool for the management of postoperative biliary leak.

Using intraoperative cholangiography to assess patients with possible BDS also greatly simplifies the diagnostic work-up. BDS will be readily detected and the full-range therapeutic strategies left open to consider (including postoperative ERCP). A more extensive work-up with the aim of preoperative BDS detection, including computed tomography cholangiography, magnetic resonance cholangiography, endoscopic ultrasound or preoperative ERCP, may be more costly, less accurate and potentially harmful.^{11,25} The other advantage is that removal of the gallbladder provides better long-term outcomes than when BDS are managed by ERCP alone.^{26,27}

Increasing use was made of antegrade biliary stents in this series under two distinct situations. In the first situation, stents

were used to facilitate postoperative ERCP if LCBDE was unsuccessful. This may reduce the risks of interval duct obstruction, failed cannulation and pancreatitis.¹⁹ In the second situation, stents were used to achieve improved biliary drainage in lieu of T-tubes following successful clearance by laparoscopic choledochotomy. There is growing awareness of the dangers of T-tube use.^{4,7,28} In a recent retrospective analysis of 274 cases, T-tubes were found to be associated with a direct morbidity of 15% and two deaths.²⁸ Primary duct closure over a stent instead of using T-tubes is safer, allows a quicker discharge from hospital and is better tolerated by patients.^{29,30} Although stent insertion is relatively straightforward, it does necessitate a second procedure for removal (albeit relatively easily by end-viewing endoscopy as a short-day procedure), and can be complicated by migration and rarely perforation (8% migration rate in the present series, and a recent experience with duodenal perforation outside the study period). Furthermore, in this study, there did not appear to be any difference in the risk of biliary leak whether stents were used or not. Some prominent authors have suggested that many ducts can be safely closed primarily without a stent, and recommend selective stent use when purulent material, sludge or numerous stones have been extracted from the duct.⁷ This area remains controversial.

The risk of missed or recurrent stones following surgical exploration has been reported between 0.7 and 10.3%.^{3,31,32} The importance of continued patient follow up was shown in our study, with our telephone questionnaire identifying four patients who had required further unplanned treatment for BDS. A biliary stricture was also identified, arising in a 10-mm duct, from 48 choledochotomies (2.1%).

CONCLUSION

Laparoscopic bile duct exploration is a safe and effective therapy for duct stones when carried out by general surgeons, including those working within nontertiary settings. Many stones can be quickly and simply cleared by transcystic means, providing patients with single-stage management and a recovery similar to laparoscopic cholecystectomy alone. When laparoscopic choledochotomy is required, closure can be safely carried out without T-tubes in the majority of patients, with consideration given to the use of temporary biliary stents. ERCP holds an important role in the primary management of duct stones associated with acute cholangitis and severe pancreatitis, and in poor anaesthetic risk patients, or as a second-line strategy following failed LCBDE.

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