Original Article

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Effect of Difficult Common Bile Duct Stone on Conversion Rate from Laparoscopic to Open Cholecystectomy

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Abstract:

Objective: This study aimed to evaluate the effect of difficult common bile duct (CBD) stone on conversion rate of Laparoscopic cholecystectomy (LC). In addition, this study evaluated the effect of difficult CBD stone on operative time and complications in LC procedures.

Material and Methods: The medical records at Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center, Srinakharinwirot University; from January 2017 to December 2021, were retrospectively reviewed. We enrolled patients with CBD stone having undergone endoscopic retrograde cholangiopancreatography (ERCP), followed by LC. Difficult CBD stones was defined as: a stone diameter >1.5 cm, biliary stricture, Mirizzi's syndrome, cystic duct stone or stone that could not be extracted in the first ERCP.

Results: Of the 140 patients, a total of 40.7% were male. The mean age was 60.8 years. From this 30% of patients had difficult CBD stones. The conversion rate was 10%. By univariate analysis, the difficult CBD stone was statistically significantly associated with a predictor of conversion rate (r=0.30, p-value<0.001). The odds ratio was 7.34 (95% confidence interval (CI) 2.15-25.05, p-value=0.001). From the result of LC, operation time (p-value=0.002), overall complications (p-value=0.003) and length of hospital stay (p-value=0.002) were significantly higher in difficult than non-difficult CBD stones.

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Conclusion: Difficult CBD stones could increase the conversion rate from laparoscopic to open cholecystectomy, which requires more operation time, has complications and longer length of hospital stay than non-difficult CBD stones in LC procedures. LC after ERCP in this group should be carefully performed by an experienced surgeon.

Keywords: common bile duct stone, conversion rate, laparoscopic cholecystectomy

Introduction

Common bile duct (CBD) stone is the most common benign biliary disease. The treatments of CBD stone include open CBD exploration, laparoscopic CBD exploration (LCBDE), and endoscopic retrograde cholangiopancreatography (ERCP) with stone removal. Endoscopic stone removal is currently the recommended treatment of bile duct stones, because open CBD exploration has more complications, and currently there are a limited number of surgeons experienced in LCBDE[1]. After complete removal of biliary stone by ERCP, it is advised to perform a subsequent cholecystectomy to prevent the migration of stones from the gallbladder into the CBD.

Laparoscopic cholecystectomy (LC) is a standard procedure for gallbladder removal, which had in fewer complications and shorter length of hospital stay compared to open cholecystectomy (OC). In some situations, wherein LC is difficult and dangerous, a surgeon would change from laparoscopy to the open procedure, which is called "conversion". A review of the literature reviews shows that the conversion rate from LC to OC range from 1-15%[1-3]. Various factors are associated with conversion including acute cholecystitis with a thickened gallbladder wall, previous upper abdominal surgery, obesity, bleeding, bile duct injury, and CBD stone[4-8]. Recent studies reported that the conversion rate is not depended on CBD stone or previous ERCP[2,3,9-12]. However, few studies have suggested that difficult CBD stones may be related to the conversion rate[11-13].

Due to the controversy surrounding the difficult CBD stone factor, this study aimed to evaluate the effect of difficult CBD stone on the conversion rate from laparoscopic to open cholecystectomy. The secondary objective was to evaluate the effect of difficult CBD stones on operation time and complications via the cholecystectomy procedure.

Material and Methods

This research is in line with the STROCSS criteria[14]. The medical records of patients with LC performed at Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center, Srinakharinwirot University; from January 2017 until December 2021, were retrospectively reviewed. Patients having undergone ERCP with stone removal followed by LC were enrolled. The exclusion criteria were: patients with a history of acute cholecystitis, ruptured gallbladder, or hepatobiliary cancer, LC performed before ERCP, or previous intraabdominal surgery; with the exception of appendectomy or post-partum sterilization. The study was approved by the Srinakharinwirot University Ethics Committee of Human Research: reference number SWUEC-M-040/2565E.

The treatment of CBD stone in the hospital followed a two-stage approach; ERCP with stone removal performed, followed by LC. CBD stone having been diagnosed by ultrasound, computerized tomography (CT) scan, or Magnetic Resonance Imaging (MRI). The ERCP procedure was performed via the standard technique, using general anesthesia with an endotracheal tube. In the first ERCP, endoscopic sphincterotomy (EST) was performed. The stone was extracted with a balloon catheter, a four-wire basket catheter, or both as a tool. If complete stone removal was not possible, an endobiliary stent was placed and the

patient would then receive a sequential ERCP procedure within 3 months. Stone extraction in the second ERCP used mechanical lithotripsy or laser lithotripsy. If stone extraction failed, the patient would be scheduled for surgery or a sequential ERCP procedure every 3 months.

Patients with complete CBD stone removal were followed by elective laparoscopic cholecystectomy to prevent recurrent bile duct stones. This procedure was performed by eight surgeons, who were highly experienced in LC (more than 5 years of experience). All patients received intravenous prophylaxis antibiotics. The operation was carried out using the standard three or four port technique. pressure of the pneumoperitoneum was maintained in the range of 10 to 13 mmHg during the procedure. The Critical View of Safety was obtained., with the cystic artery and duct being clipped and transected; the gallbladder was then removed. The decision for conversion was undertaken by the surgeon using standard protocols, with the cause of conversion being recorded. There have been many cases of conversion however, the focus was on unclear anatomy, bile duct injury, and hepatic artery injury, because CBD stones can cause inflammation and adhesion around the Calot's triangle.

Difficult bile duct stone was defined as the presence of any of the following: stone diameter larger than 1.5 cm, stone with biliary stricture, Mirizzi's syndrome, cystic duct stone, and stone which cannot be extracted in the first ERCP procedure using the standard technique[5,12,15]. Duration between ERCP and LC was defined as the duration from the last ERCP to the LC procedure. The conversion rate was defined as an incidence when LC had to be converted to OC.

Demographic data and outcomes were collected; including age, gender, liver function test before ERCP, CBD diameter, CBD stone diameter, number of CBD stones, site of bile duct stone (common bile duct or cystic duct), frequency of ERCP, other characteristic of difficult CBD stone (stricture of small distal CBD, Mirizzi's syndrome), duration between ERCP and LC, operation time of LC, conversion rate, length of hospital stay, morbidity, and mortality. Statistical analysis was performed using SPSS (version 23) software (Statistical Procedures for Social Sciences; Chicago, Illinois, USA). Demographic data are presented as means or median, S.D., and percentage. The difference of variables was tested using an independent sample *t*-test or Mann-Whitney *U* test for quantitative variables, and a chi-squared test or Fisher's exact test for categorical data. A p-value of less than 0.05 was considered statistically significant. An odds ratio with a 95% confidence interval that did not include unity was considered significant.

Results

A total of 652 patients underwent laparoscopic cholecystectomy, and 140 patients were enrolled in the study. There were 57 men and 83 women; with the mean age being 60.8±16.2 years. They had a history of cholangitis (47.9%) and pancreatitis (7.9%). The mean CBD diameter and CBD stones diameter were 10.6±3.7 mm and 5.5±3.8 mm, respectively. The median number of CBD stones was 2 stones (range, 1-7). Thirty percent of patients had difficult CBD stone. The mean operation time in LC was 88.5±48.9 min: conversion rate was 10%. The most common reason for conversion was unclear anatomy due to dense adhesion and fibrosis around the Calot's triangle. The second most common reason was bile duct injury. The mean length of hospital stay was 4.1±2.5 days. Post-cholecystectomy complications occurred in 10% of cases. The most common complication was wound infection (7.1%), followed by bile duct injury (2.1%) and intra-abdominal collection (0.7%). One 77-year-old female patient died from a heart attack four days after surgery. Patient characteristics are shown in Table 1.

In the univariate analysis, only one variable, difficult CBD stone, was significantly associated with conversion

(p-value<0.001) (Table 2). The conversion was not depended on the surgeon. In the conversion group, 5 out of 9 patients (35.7%) were significantly associated with overall complications (p-value=0.001). The odds ratio for the predictor was calculated, with the odds ratio of difficult CBD stone being 7.34 (95% confident interval (CI) 2.15-25.05).

Table 1 Demographic data of patients (n=140)

Characteristics	
Male (%)	57 (40.7)
Age (years; mean ± S.D.)	60.8±16.2
History of cholangitis (%)	67 (47.9)
History of pancreatitis (%)	11 (7.9)
Blood test	
Bilirubin (mg/dL; mean±S.D.)	3.6±4.9
Aspartate transaminase (U/L; mean±S.D.)	129.8±184.3
Alanine transaminase (U/L; mean±S.D.)	138.0±183.1
Alkaline phosphatase (U/L; mean±S.D.)	241.0±202.5
ERCP finding	
CBD diameter (mm; mean±S.D.)	10.6±3.7
CBD stone diameter (mm; mean±S.D.)	5.5±3.8
Number of CBD stone (stones; median, range)	2 (1-7)
Difficult bile duct stone (%)	42 (30.0)
ERCP >1 times (%)	35 (25.0)
Biliary stricture (%)	8 (5.7)
Stone diameter >15 mm (%)	5 (3.6)
Cystic duct stone (%)	5 (3.6)
Mirizzi's syndrome (%)	4 (2.9)
LC finding	
Duration time between ERCP and LC (days; mean ±S.D.)	84.6±103.4
Operation time of LC (min; mean±S.D.)	88.5±48.9
Conversion rate (%)	14 (10.0)
Complication (%)	14 (10.0)
Wound infection	10 (7.1)
Bile duct injury	3 (2.10)
Intra-abdominal collection	1 (0.70)
Length of hospital stay (days; mean±S.D.)	4.1±2.5
Mortality (%)	1 (0.7)

ERCP=endoscopic retrograde cholangiopancreatography, LC=laparoscopic cholecystectomy, S.D.=standard deviation, U/L=unit/liter

Patient characteristics were compared between non-difficult bile duct stones and difficult bile duct stones. There was no significant difference in age, gender, history of cholangitis or pancreatitis, aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), and duration time between ERCP and LC. From the results of the cholecystectomy procedure, operation time (p-value=0.002), overall complications (p-value=0.003), and length of hospital stay (p-value=0.002) were significantly higher in difficult than non-difficult CBD stone (Table 3).

Early LC having undergone LC of less than or equal to 6 weeks after ERCP did not have a statistically significant association with operating time (p-value=0.113), overall complications (p-value=0.533), length of hospital stay (p-value=0.74), or conversion (p-value=0.533) (Table 4).

Discussion

During cholecystectomy procedures, bile duct injury (BDI) is the most severe complication, which has a significant impact on long-term quality of life. Although, LC is a standard treatment, open surgery is better able to avoid bile duct injury than LC. In other situations; such as severe inflammation, dense adhesion, or massive hemorrhage, a surgeon would convert from laparoscopic to an open procedure. The conversion rate from LC to OC is 1-15%[1-3]. This study was in the common range, with the conversion rate being 10%.

Cinar et al.[11] reported that patients with difficult CBD stones would be more likely to convert to open surgery in LC following ERCP. Supporting this notion, Konsue et al.[12] found a larger proportion of difficult CBD stones in the conversion group, with statistical significance. This study was in line with this, in that 23.8% of patients with difficult CBD stones required conversion. There was a statistically significant association with the conversion rate.

Table 2 Single-variable comparison of various risk factor for conversion to open cholecystectomy

Characteristics	LC (N=126)	Conversion (N=14)	p-value
Male (%)	52 (41.3)	5 (35.7)	0.688
Age (years; mean±S.D.)	60.9±16.2	59.7±16.4	0.659
History of cholangitis (%)	62 (49.2)	5 (35.7)	0.338
History of pancreatitis (%)	11 (8.7)	0 (0.0)	0.249
Blood test			
Bilirubin (mg/dL; mean±S.D.)	3.4 ±4.8	4.9±6.6	0.160
Aspartate transaminase (U/L; mean±S.D.)	132.1±190.8	109.3±113.2	0.967
Alanine transaminase (U/L; mean±S.D.)	137.1±182.9	146.4±192.4	0.994
Alkaline phosphatase (U/L; mean±S.D.)	232.2±175.3	320.6±367.6	0.830
Difficult bile duct stone (%)	32 (25.4)	10 (71.4)	<0.001*odds ratio=7.34 (95%CI 2.15-25.05)
LC finding			
Duration time between ERCP and LC (days; mean±S.D.)	85.2±107.5	79.3±56.7	0.756

*significant at the level of 0.05
LC=laparoscopic cholecystectomy, ERCP=endoscopic retrograde cholangiopancreatography, S.D.=standard deviation, U/L=unit/liter, CI=confidence interval

Table 3 Comparison between patients with and without difficult bile duct stone

Characteristics	Non-difficult bile duct stone (N=98)	Difficult bile duct stone (N=42)	p-value
Male (%)	40 (40.8)	17 (40.5)	0.97
Age (years; mean± S.D.)	60.8±15.9	60.8±17.0	0.861
History of cholangitis (%)	46 (46.9)	21 (50.0)	0.74
History of pancreatitis (%)	8 (8.2)	3 (7.1)	0.837
Blood test			
Bilirubin (mg/dL; mean±S.D.)	2.5±2.7	6.1±7.6	0.054
Aspartate transaminase (U/L; mean±S.D.)	144.5±207.8	95.5±106.1	0.307
Alanine transaminase (U/L; mean±S.D.)	145.0±194.0	121.8±155.9	0.209
Alkaline phosphatase (U/L; mean±S.D.)	251.5±209.7	216.6±184.7	0.405
LC finding			
Duration time between ERCP and LC (days;mean±S.D.)	82.8±118.6	88.9±54.1	0.751
Operation time of LC (min; mean±S.D.)	80.0±42.9	108.3±56.5	0.002*
Conversion rate (%)	4 (4.1)	10 (23.8)	<0.001*
Complication (%)	5 (5.1)	9 (21.4)	0.003*
Wound infection (%)	4 (4.1)	6 (14.3)	0.032*
Bile duct injury (%)	1 (1.0)	2 (4.8)	0.161
Intra-abdominal collection	0 (0.0)	1 (2.4)	0.125
Length of hospital stay (days; mean ±S.D.)	3.6±1.6	5.2±3.7	0.002*
Mortality (%)	0 (0.0)	1 (2.4)	0.125

*significant at the level of <0.05
LC=laparoscopic cholecystectomy, ERCP=endoscopic retrograde cholangiopancreatography, mg=milligram, S.D.=standard deviation, U/L=unit/liter

Table 4 Comparison between early LC and delayed LC after ERCP

Characteristics	Early LC[1] (N=40)	Delayed LC[2] (N=100)	p-value
Operation time of LC (min; mean±S.D.)	80.2±46.6	91.8±48.7	0.113
Conversion rate (%)	3 (7.5)	11 (11)	0.533
Overall complication (%)	5 (12.5)	9 (9)	0.533
Length of hospital stay (days; mean±S.D.)	4.05±2.2	4.06±2.66	0.740
Mortality (%)	0 (0.0)	1 (1)	0.526

*significant at the level of 0.05
[1]Early LC-underwent LC 6 weeks after ERCP
[2]Delayed LC-underwent LC >6 weeks after ERCP
LC=laparoscopic cholecystectomy, ERCP=endoscopic retrograde cholangiopancreatography

the relationship between biliary stone and the conversion rate is explained by the bile duct stone, ERCP procedure, biliary pancreatitis, and cholangitis inducing inflammation and adhesion around Calot's triangle[11]. Stones in the bile duct resulted in more inflammation than stones in the gallbladder[13]. The passage of stones through the cystic duct can cause inflammation and adhesion around both the cyst and bile ducts, resulting in unclear anatomy. The ERCP procedures, especially sphincterotomy or stone extraction, have potentially traumatic tissue manipulation and increased inflammatory cytokines[13,16]. These induce more inflammation and adhesion around both the cyst and bile ducts. Due to the above reasons, difficult bile duct stones induce adhesion and an increased conversion rate. By contrast, this study did not show a relatively significant relation between conversion rate and biliary pancreatitis or cholangitis.

To the best of our knowledge, no previous studies have reported that LC in the difficult CBD stone group has an effect on operation time, overall complications, and length of hospital stay. There has been only one study conversely showed that LC in a multiple-ERCP group and a single ERCP group having similar post-operative complications[13].

In patients with gallstone and CBD stone, two options are recommended to treat gallstone and CBD stone; either LCBDE, or ERCP followed by LC. Although systematic reviews and meta-analysis showed that both procedures have no significant differences in mortality and morbidity, ERCP is preferred in most countries, because LCBDE requires surgical expertise[1,5]. Moreover, there are innovative endoscopic treatment technologies; namely cholangioscopy, electrohydraulic lithotripsy (EHL) and laser lithotripsy, which can be used to manage difficult CBD stones. Most studies recommended performing a single-stage approach using LC with intraoperative ERCP[1,5,17,18]. This procedure can reduce complications, decrease the length of stay, and reduce costs[18]. Unfortunately, these require sufficient resources; such as operating rooms and specialists to do both ERCP and LC in a single day. Thus, the two-stage approach involving ERCP with stone removal, followed by LC is chosen. Length of time between ERCP and LC is still debatable. De Vries et al[19]. reported that the conversion rate decreases more as the time from ERCP to LC is shortened. Kostro et al.[20] demonstrated in complicated a cholecysto-choledocholithiasis group that the tendency of a higher conversion rate of LC after ERCP was more than 6 weeks post ERCP, as fibrous tissue and adhesion mature at about 6-8 weeks. The postponement of surgery may result in difficulty in identifying the Calot's triangle[21, 22]. However, Cinar et al.[11] and Bostanci et al.[13]

found that the length of time between ERCP and LC did not affect the conversion to open surgery. Abdalkoddus et al.[23] reported that delayed cholecystectomy following ERCP (>6 weeks) was clinically safe and not associated with complication or conversion-to-open rates. This study found that the post-ERCP time interval and conversion rates were not associated with each other. Additionally, early LC, in which LC was performed less than or equal to 6 weeks after ERCP, did not have a statistically significant correlation with operating time, overall complications, or length of hospital stay. Some studies have reported that LC performed within 3 days (<72 h) after ERCP could protect patients from complications, due to a reduced waiting time and a decreased the risk of conversion[24-26]. Nevertheless, our hospital, with limited resources, has no data of rapid LC being performed. This point is interesting for future studies into difficult CBD stones.

The incidence of BDI after LC was 0.4-1.5%[27-30]. The incidence in this study was quite high (2.1%), because it included only patients who underwent ERCP, and the overall BDI in our hospital was 0.5%. Factors associated with BDI included: anatomical factors, disease severity, surgeon's experience, and technical errors[27-29]. The most common strategy for the prevention of BDI is the Critical View of Safety (CVS) technique. Routine use of CVS minimizes the risk of iatrogenic intraoperative complications.[28-30] Unfortunately, complete CVS is easily obtained in only 50% of cases due to severe fibrosis and adhesion around this area. The alternative strategies are the: "fundus-first" (top-down) approach and subtotal cholecystectomy (STC), which are called: "bailout procedures". Most studies demonstrate that the bailout procedure reduces BDI as well as the conversion rate[28-30]. Intraoperative cholangiography (IOC) is an imaging technique that defines the biliary anatomy. However, routine use was not associated with a significant reduction in BDI during LC[29,31]. The other strategies to reduce the conversion rate and BDI were indocyanine green fluorescence cholangiography (ICG-C) and robotic cholecystectomy[32-33]. Routine use is contentiously debated.[28]

This study has several limitations. As it was a retrospective study, this increased the potential for bias in the data collection. Moreover, the study had a relatively small sample size for subgroup analysis. In addition, the patients came from a single center; resulting in less diversity of the data and conditions. Future studies with larger samples drawn from diverse communities are required for the generalization of the results to the global population.

Conclusion

Difficult CBD stones could increase the conversion rate from laparoscopic to open cholecystectomy, which involves more operation time, complications, and longer hospital stays than non-difficult CBD stones via the cholecystectomy procedure.

Ethics approval

Approval was granted by Srinakharinwirot University Ethics Committee of Human Research: SWUEC-M-040/2565E.

Conflict of interest

The authors declare that they have no conflicts of interest.

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