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Case Report

Single-Incision Laparoscopic Common Bile Duct Exploration and Cholecystectomy: An Innovative Transcystic Technique

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Abstract

Background: Common bile duct stones may be managed via 2-stage endoscopic retrograde cholangiopancreatography followed by single-incision laparoscopic cholecystectomy, or 1-stage laparoscopic common bile duct exploration and cholecystectomy (LCBDE+LC). This study reports early experience and technique in 1-stage single-incision laparoscopic common bile duct exploration and cholecystectomy (SILCBDE+SILC).

Case Presentation: This study analyzed 10 consecutive cases of choledocholithiasis that underwent SILCBDE+SILC from April 2022 to December 2023. The surgical technique involved the innovative use of an Endoscopic Applicator to better stabilize the choledochoscope for cystic duct cannulation. The mean (SD) operative time was 99 (34) minutes. All patients had 100% stone clearance rate and cholecystectomies with no complications. No conversion to multiport or open surgery was noted. Mean postoperative hospital stay was 1.5 days. Postoperative morbidity and mortality were 0%.

Conclusions: 1-stage SILCBDE+SILC is safe. This study's technique involving the use of an Endoscopic Applicator addresses the difficulties of manipulating the choledochoscope for cystic duct cannulation, despite its flexible nature and the extra distance between its entry port-site and the cystic ductotomy.

Keywords: Stones, Choledocholithiasis, Bile duct, Single-incision, Transcystic

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Introduction

Common bile duct (CBD) stones are estimated to be present in about 1% to 15% of individuals with gallstones. They can result in symptoms and complications such as biliary colic, jaundice, cholangitis, or pancreatitis.[1]

In the past, the treatment of choledocholithiasis involved an open CBD exploration and cholecystectomy in the same setting. With the first laparoscopic cholecystectomy (LC) performed by Mühe in 1985,[2] together with the option of removing bile duct stone via endoscopic retrograde cholangiopancreatography (ERCP), the strategy of performing 2-stage preoperative ERCP followed by LC became appealing. Subsequently, with the advancement in the laparoscopic technique, 1-stage multiport laparoscopic common bile duct exploration and cholecystectomy (LCBDE+LC) became a viable option. In 2 separate randomized controlled trials by Rogers et al[3] and Cuschieri et al,[4] both approaches demonstrated comparable success and adverse events, with shorter hospital stay for the latter.

Conventional LC utilizes 4 transabdominal ports – the first port is inserted at the umbilical region for the laparoscope, and the remaining 3 ports allow for abdominal access of laparoscopic instruments to perform the surgery. In conventional LCBDE+LC, the choledochoscope can be introduced via one of the 3 ports; instruments through one of the remaining ports are used to manipulate it. No additional port is typically required.

In recent years, single-incision laparoscopic cholecystectomy (SILC) via the umbilical region has been developed to minimize the number of transabdominal ports in an attempt to further reduce the pain associated with abdominal access as well as to improve cosmetic satisfaction.[5, 6] Anecdotally, it has also been observed that some patients with persistent pain at the site of one or more of the 3 instrument ports in conventional LC, which may be related to an underlying subcostal nerve injury, experience persistent neuralgia. With fewer port-sites in SILC, such nerve injury may be avoided and there is also a theoretically reduced risk of surgical site infection.

The main technical difficulties for SILC stem from the increased distance between the port-site and the cystic duct, limited angulation, and an inability to provide retraction in the conventional way due to the procedure's distinctive single axis approach of all instruments. Techniques have been described to overcome some of these difficulties.[5]

In the case of CBD stones, there is often a dilemma of deciding between forgoing the benefits of single-incision surgery with conventional LCBDE+LC or resorting to a 2-stage procedure with ERCP followed by SILC. In 2014, Chuang et al[7] reported safe and successful 1-stage single-incision laparoscopic common bile duct exploration with cholecystectomy (SILCBDE+SILC) in a comparative study of 34 patients with conventional LCBDE+LC via both transductal and transcystic approaches. With the need to introduce and manipulate a choledochoscope into the bile duct, a good control of it in the abdomen is thus required.

This study series describes 10 patients who underwent 1-stage SILCBDE+SILC via the transcystic approach with successful outcomes, and demonstrates how good control of the choledochoscope was obtained.

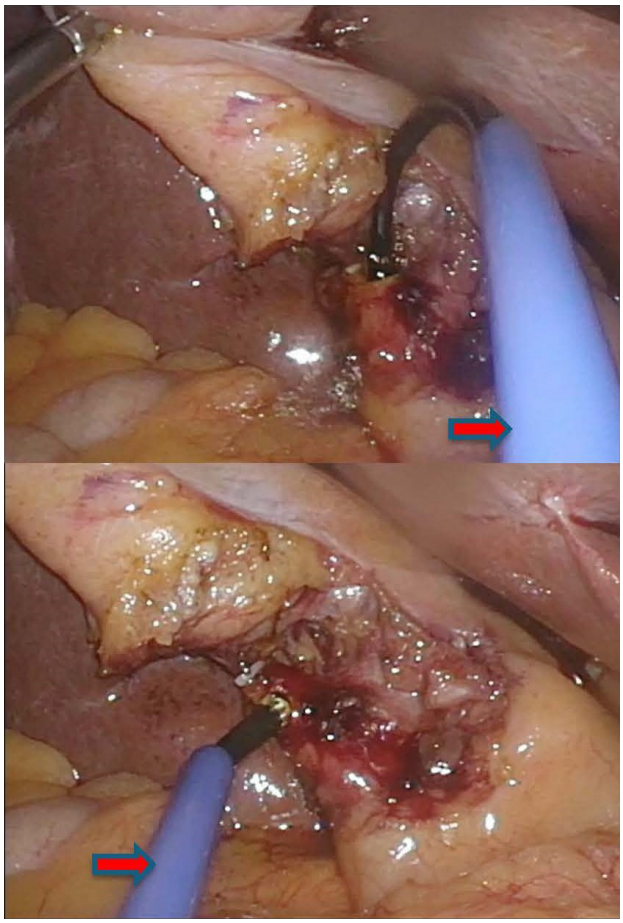
Case Presentation

Retrospective data analysis was conducted for 10 consecutive cases of choledocholithiasis that underwent 1-stage SILCBDE+SILC via the transcystic approach, performed by a surgeon (CSKY)-nurse team from April 2022 to December 2023. Patient demographics, clinical presentations, and operative results were recorded. Operative time was defined as the interval between initial skin incision and skin closure. Postoperative length of hospital stay (PLOS) was defined as the number of days between the day of surgery and the day of discharge.

A single 10-mm (8/10) or 15-mm transumbilical incision was made with open technique and an improvized multichannel glove port (9/10) or a TriPort+™ port (Olympus, Hachioji-shi, Tokyo, Japan) was inserted. Abdominal access and pneumoperitoneum were established. The gallbladder fundus and neck were each retracted with a laparoscopic grasper, Calot's triangle was dissected, and the cystic duct and cystic artery were identified (critical view of safety established). The distal cystic duct was secured with a hemolock clip and a cystic ductotomy was performed proximal to it. The cystic duct was then cannulated with a LithoVue™ Single-Use Digital Flexible Ureteroscope (Boston Scientific, Maple Grove, Minnesota, USA) through a Floseal™ Endoscopic Applicator (Baxter, Deerfield, Illinois, USA), which in turn was passed through one of the port channels. The Endoscopic Applicator

was employed in all 10 cases and served as a guide to direct the endoscope towards the cystic duct (Figure 1 and Supplementary S1). CBD stones were visualized with the endoscope and removed with a stone basket. Both the upper and lower tracts of the biliary duct were also explored to ensure complete stone clearance. Thereafter, the proximal cystic duct was clipped with 2 of 10-mm hemolocks and transected. The cystic artery was likewise clipped with hemolock and transected. Finally, the gallbladder was dissected off the cystic plate with care and placed in an endobag. With adequate haemostasis inspected, bile leak checked, and abdomen irrigated, the port was removed with the gallbladder specimen in the endobag. Local anaesthetic was infiltrated into the preperitoneal region of the single wound. The linea alba defect was closed with Polysorb™ 2/0 (Covidien, Mansfield, Massachusetts, USA) using 2 of figure-of-8 stitches and skin closure was performed with Biosyn™ 4/0 (Covidien, Mansfield, Massachusetts, USA).

Figure 1. Use of Endoscopic Applicator (Red Arrow) to Assist in Control and Manipulation of the Choledochoscope



Postoperatively, all patients were transferred to the general ward. Minimal analgesia was usually required. All patients were discharged with no complications and followed up at 3 days, 1 month, and 6 months later with biochemical tests (full blood count and liver function test) at the clinic where possible.

Most patients were female (6/10), of Chinese ethnicity (8/10), and had a mean (range) age of 47 (22-67) years. Two patients were referred to this study's surgeon after undergoing ERCP with stenting and had CBD stones in situ. None had prior gallbladder related procedures (Table 1). Eight patients had comorbidities and/or past surgical procedures, of which 5 had hepato-pancreato-biliary conditions or surgeries that involved the abdominal wall: the first had fibroid surgery in 2005, the second had ovarian adenocarcinoma surgery in 2019, the third had single-incision laparoscopic appendectomy 43 days before the SILCBDE+SILC procedure, the fourth had hepatitis B, had undergone total hysterectomy bilateral salpingo-oophorectomy in 2013, and had been on hormonal therapy after a breast-conserving surgery for breast cancer in 2016, and the fifth had lower segment caesarean section in 1982.

The majority of this study's patients presented with epigastric pain or discomfort (6/10), jaundice (6/10), and had raised liver function tests (8/10), marginally dilated CBD (range 7.0-12.8 mm) (8/10), and CBD stones less than 10-mm in diameter (9/10). Data for the remaining CBD diameters of 2 patients were unavailable, with 1 of the 2 patients recently passing a CBD stone prior to the procedure. As a result, the diameter of this patient's CBD stone could not be determined. One patient had acute cholangitis, and 1 patient had acute pancreatitis secondary to small CBD stones in the ampullary region. None presented with fever, although 1 patient reported experiencing chills. Clinical presentations, imaging results, and values of all biochemical tests were obtained prior to the procedure (Table 2). Two patients were asymptomatic with 1 having a normal biochemical test. Both were referred to this study's surgeon for incidental findings of gallstones and CBD stones from previous imaging for other purposes.

The mean (SD) operating time was 99 (34) minutes (range 60-159 minutes), with the majority (6/10) between 60 minutes and 90 minutes inclusive. Four patients had longer operative times ranging from 110 minutes to 159 minutes. All patients had a 100% stone clearance rate and uneventful cholecystectomies, with minimal blood losses and no complications. There was no conversion to multiport or open surgery.

Postoperatively, pain was well-controlled with intravenous and oral analgesics. Mean (SD) PLOS was 1.5 (0.92) days (range 1-4 days). Most patients had a PLOS of 1 day (7/10). Among the 3 patients who had a PLOS of more than 1 day, the first had a PLOS of 4 days due to a small fluid collection at the gallbladder bed and raised liver enzymes on a downward trend; the second had a PLOS of 2 days for nausea and vomiting; and the third had a PLOS of 2 days for pain management. All patients were well upon discharge, recovered without complications, and reported satisfaction with the procedure. Postoperative morbidity and mortality were 0.0%: no recurrences of biliary colic or complications of bile leak, wound infection, or hernia were noted.

Table 1. Patient Characteristics	
Characteristic	**No. of Patients (N = 10)**
Age, mean (range), y	47 (22-67)
Sex, female/male	6/4
Ethnicity	
Chinese	8
Others	2
Nationality	
Singaporean	8
Indonesian	2
BMI, mean (range), kg/m^2	23.6 (19.4-30.0)
Past medical history/past surgical history	
Heart, kidney, or liver issue	1
Previous cholecystectomy, CBDE, or ERCP	2
Other condition(s), operation(s), or treatment(s)	8

Abbreviations: BMI, body mass index; CBDE, common bile duct exploration; ERCP, endoscopic retrograde cholangiopancreatography.

Table 2. Biochemistry Results	
Liver and Biliary Profile – Selected*	**No. of Abnormal Results (N = 10)**
Total bilirubin	5
AST	7
ALT	7
GGT	8
ALP	6

Abbreviations: ALP, alkaline phosphatase; ALT, alanine aminotransferase; AST, aspartate aminotransferase; GGT, gamma-glutamyl transpeptidase.

* Normal reference intervals were total bilirubin < 26 μmol/L, AST male < 51 U/L, AST female < 36 U/L, ALT male < 51 U/L, ALT female < 36 U/L, GGT male < 60 U/L, GGT female <40 U/L, ALP 39-117 U/L.

Discussion

There has been much debate over the benefits that single-port surgeries offer in exchange for the added challenges in performing the procedures safely.[5] Many single-port studies on SILC are available, with limited data on SILCBDE+SILC.[7-17] With the sharing of best practices in performing surgeries via the single-port approach, a greater number of variations have been added to the current types of surgeries that can be performed.[6, 9]

This study has demonstrated that SILCBDE+SILC is safe and feasible. The mean (SD) operating time of 99 (34) minutes for SILCBDE+SILC is comparable with commonly reported timings for multiport LCBDE+LC.[7, 8, 14, 18] Operative time is dependent on the surgeon's experience level, surgical technique, and patient characteristics.[9]

Before moving to the 1-stage SILCBDE+SILC procedure, this study's surgeon had operated on more than 500 patients with the single-port approach for LC.

The range of operative times for 4 patients (110-159 minutes) was noted to be longer than the rest (60-90 minutes). Those values may reflect the management of the following: the first had dense adhesions of the liver to the anterior abdominal wall and underwent subsequent diagnostic laparoscopy; the second had multiple small black pigmented CBD stones and underwent subsequent colonoscopy; the third had adhesions of the proximal transverse colon to the right hypochondrial anterior abdominal wall, an irregular 10-mm CBD stone, and fragments of black CBD stones; and the fourth had an acutely inflamed gallbladder which increased the dissection duration slightly.

In transcystic SILCBDE, this study noted that the most challenging part of the procedure was the cannulation of the scope into the cystic duct. First, the choledochoscope (or a similar scope) was introduced through the abdomen via the umbilicus which is further from the cystic duct than the conventional epigastric port or subcostal port. In conventional LCBDE, the epigastric or subcostal port, through which the scope is introduced, can be used to manipulate the flexible scope through the cystic ductotomy. However, with transcystic SILCBDE, due to the increased distance of the port to the cystic duct, the steeper angle when approaching the latter, and the scope being flexible in nature, an adequate control of the scope was thus difficult to attain. As such, an additional firm 'equipment' to stabilize and direct the flexible scope towards the cystic duct was required. Appropriate control of the scope was achieved by adopting the use of a Floseal™ Endoscopic Applicator, which is stiffer and relatively long. The Endoscopic Applicator's internal diameter was sufficiently large to enclose the scope firmly without slipping, and this study's surgeon could adjust the scope further in or out by holding its end together with the Endoscopic Applicator. In this study authors' opinion, the control of the scope is crucial, particularly for the transcystic approach, and this study's case series demonstrates the use of the Endoscopic Applicator in achieving this.

To the study authors' knowledge, the SILCBDE procedure has been published in 8 studies[7, 8, 10-15] and 3 reviews.[9, 16, 17] All but 2 authors have reported using the transductal approach only.[8, 11-13] Between the 2 authors, Chuang et al[7, 14] predominantly employed the transductal approach, with occasional use of the transcystic approach, while Yeo et al[10] only operated transcystically with the use of a 5.5-Fr Nathanson basket kit (Cook Australia, Eight Mile Plains, Australia) under image intensification guidance where the use of a scope was not mentioned.

In the articles reported by Chuang et al[7, 14] an atraumatic grasper was highly recommended to manipulate the scope, with Steri-Strips™ (3M Corporation, St Paul, Minnesota, USA) wrapped around its distal end to protect the scope's coating. In this study authors' opinion, this method may still damage the scope and the transcystic approach seems to remain difficult. It is also unclear how the cystic duct was stabilized in the transcystic approach with the fine adjustments required for successful ductotomy and cannulation. In this study's series, as the Endoscopic Applicator was inserted via one of the working port channels, the same port channel was subsequently reused to introduce the scope into the abdomen. One remaining port channel was thus available for a grasper to retract the gallbladder neck laterally to stabilize the cystic duct during its cannulation. Finally, the longitudinal cystic ductotomy for the scope insertion was performed differently in Chuang's series and this study. Chuang et al[14] created a ductotomy up to the cystocholedochal junction and conducted subsequent repair with interrupted

figure-of-8 sutures, whereas this study's surgeon created a ductotomy just large enough for the scope cannulation, proximal to the distal hemolock clip. Once complete stone clearance in the biliary tree was obtained under direct visual guidance, one or more hemolock clips were secured to the proximal cystic duct and the cystic duct was then transected. Therefore, there was no need for repair of the cystic duct-bile duct junction.

The authors acknowledge that this study has a small sample size of 10 patients who underwent 1-stage SILCBDE+SILC, and more data is required to further validate the effectiveness of the procedure and this method.

Conclusions

1-stage SILCBDE+SILC is safe and produces similar clinical outcomes to conventional multiport surgeries. The use of an Endoscopic Applicator has helped this study to overcome the difficulties of managing a flexible scope when covering the extra distance between its port-site and the cystic duct with limited angulation, obtaining successful cystic duct cannulation, and performing the bile duct exploration itself.

Additional Information

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Informed Consent: This study was deemed not required for review by the Institutional Review Board in Singapore as it is a retrospective review of results of deidentified patients and verbal consent was obtained from each patient during consultation. Past medical and surgical history, relevant imaging, and biochemical test results were accessed. Personal information such as age, sex, ethnicity, nationality, and body mass index were collected and anonymized. Inclusion into the study was made known to the patient as entirely voluntary, and any question could be directed to the corresponding author by email.

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Author Contributions:
Conceptualization: Stephen Chang
Formal Analysis: Yidao Chua
Investigation: All authors
Writing – Original Draft: Yidao Chua, Stephen Chang
Writing – Review & Editing: Yidao Chua, Stephen Chang

Supplementary Material: Download Supplementary S1 from the following link: https://he02.tci-thaijo.org/index.php/ramajournal/article/view/271640/187175

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