International Journal of Surgery 12 (2014) 1254–1257

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

The real-world application of single incision laparoscopic cholecystectomy

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HIGHLIGHTS

- Most published studies investigating single incision laparoscopic cholecystectomy (SILC) are case series with limited numbers of cases.
- We have reviewed the outcomes of 500 cases of SILC performed by a single surgeon at our center.
- SILC is a safe and effective procedure for cholecystectomy. It may be the main surgical approach in a selected patient population.

ARTICLE INFO

Article history:
Received 17 July 2014
Received in revised form
6 September 2014
Accepted 18 September 2014
Available online 6 October 2014

Keywords:
Cholecystectomy
Laparoscopic surgery
Cholecystitis
Minimal invasive surgery

ABSTRACT

Objectives: Most previous studies that have investigated single incision laparoscopic cholecystectomy (SILC) are case series with limited sample sizes. We have reviewed the outcome of 500 consecutive cases of SILC performed by a single surgeon at our center. **Materials and Methods**: From April 2009 to October 2012, a single surgeon performed 1250 laparoscopic cholecystectomies for various gallbladder (GB) diseases. SILC was chosen as the surgical modality unless there was evidence of acute cholecystitis or GB empyema, the patient had a prior history of upper abdominal surgery, endoscopic sphincterotomy, or had comorbidities with an ASA score of III or higher. The clinicopathologic features and perioperative data of patients were retrospectively reviewed. **Results**: The mean age and BMI of included patients were 42.7 years and 23.6 kg/m^2, respectively. The mean operating time was 52 min. Patients stayed in the hospital for an average of 1.3 days postoperatively. In 55 patients, an additional 2 mm trocar was inserted for retraction of the GB. One patient was converted to an open cholecystectomy because of Mirizzi syndrome. There were no observed complications including incisional hernias in this patient population. **Conclusions**: SILC is a safe, effective procedure for cholecystectomy that may be considered the main surgical strategy in select patients.

1. Introduction

Laparoscopic cholecystectomy is the widely accepted gold standard treatment for various diseases involving the gallbladder. Navarra et al. first reported the use of laparoscopic cholecystectomy via a single incision (or "one wound laparoscopic cholecystectomy") in 1997 [1]. Since then, several reports have been published regarding single incision laparoscopic cholecystectomy (SILC). Previous reports have emphasized the cosmetic benefit of SILC [2,3], or its reduction of postoperative pain as compared to conventional laparoscopic cholecystectomy (CLC) [4]. In recent years, several randomized controlled trials regarding SILC have been published and SILC is gradually becoming a standard procedure in selected patients. However, there are still concerns that SILC has technical issues that prevent it from being applied to the general patient population. The authors have experience with over 500 cases of SILC at our institution. Here, we present our clinical experience with SILC.

2. Methods

Patients who had undergone laparoscopic cholecystectomy between April 2009 and October 2012 by a single surgeon (J.S.H) at

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http://dx.doi.org/10.1016/j.ijsu.2014.09.009
1743-9191/

Samsung Medical Center were included. Patients' medical records were retrospectively reviewed. Preoperative analysis included imaging studies (abdominal ultrasonography or computed tomography). When applicable, endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy (EST) were used to remove stones and/or biliary sludge from the common bile duct (CBD). Laparoscopic cholecystectomy was performed after preoperative imaging and ERCP/EST.

The laparoscopic surgeon involved has performed 500 cases annually since 1998. A list of criteria (below) was used to determine if a patient would receive a single incision laparoscopic cholecystectomy or a conventional laparoscopic cholecystectomy. All patients were primarily considered for single incision laparoscopic cholecystectomy unless they had one or more of the following:

1. Acute or gangrenous cholecystitis and GB empyema on CT or ultrasonography
2. Severe systemic disturbance categorized as ASA score > III
3. Prior history of ERCP and EST for CBD stones or sludge
4. Previous upper abdominal surgery (not lower abdominal surgery)
5. GB polyp >1 cm with a possibility of GB cancer

2.1. Surgical technique

A 2 cm transumbilical incision was made and the umbilical stalk was completely separated. In order to prevent burning the umbilical skin, a #12 blade was used to dissect down to the fascia and peritoneum. An Alexis® Wound Retractor (Applied Medical, Rancho Santa Margarita, CA, USA) was inserted into the peritoneal space. Small openings were then made at the tips of the thumb, 3rd and 5th fingers of a size 6 glove. Two 5 mm trocars were inserted in the two end openings, and a 10 mm trocar was inserted in between. The glove was placed over the wound retractor making an airtight single port system. The two 5 mm trocars served as action ports and the endoscope was inserted through the middle 10 mm trocar. Carbon dioxide was insufflated and the patient was placed in the reverse Trendelenburg position with his/her right side tilted up, to ensure good GB exposure. The surgeon used an Autonomy Laparo-Angle Maryland Dissector (Cambridge EndoTM, Framingham, MA, USA) to retract the GB. The GB was brought upward and toward the patient's right side to expose the Calot's triangle. When the Calot's triangle was not visualized clearly, an additional 2 mm trocar was inserted in the right subcostal area for retraction of the GB. Then the surgeon used his other hand to control a hook cautery or dissector to dissect the cystic artery and cystic duct. Before dividing the cystic artery and cystic duct, 5 mm laparoscopic clips were applied doubly. After dividing the cystic duct and cystic artery, the GB was freed from the liver bed using a hook cautery. The specimen was withdrawn via the umbilical incision. Local anesthetics (0.5% bupivacaine) were injected around the fascia before absorbable sutures were used to close the subcutaneous tissue and skin layers.

During conventional laparoscopic cholecystectomy, a 1 cm transumbilical incision was made and a 12 mm trocar was inserted. A 5 mm trocar was then inserted in the epigastrium. Two 2 mm trocars were inserted in the right subcostal area and at the anterior axillary line. The surgical technique was then identical to SILC, and has been described previously [5].

2.2. Statistical analysis

Statistical analysis was done using SPSS 20.0 statistical software (SPSS, Inc., Chicago, IL, USA). Chi-squared tests and Mann–Whitney tests were used for discrete variables. A two-tailed p-value <0.05 was considered statistically significant.

3. Results

A total of 1246 patients were analyzed, of which 500 underwent SILC and 746 underwent CLC. The mean patient age was 42.5 years in the SILC group and 58.0 years in the CLC group. Mean BMI at the time of surgery was similar across the two groups: 23.2 kg/m^2 in the SILC group and 24.5 kg/m^2 in the CLC group. One patient in the SILC group and 29 patients in the CLC group had ASA scores > III. Five patients in the SILC group and 30 patients in the CLC group had previous history of abdominal surgery (Table 1).

The mean operation time was 49 min in the SILC group and 51 min in the CLC group. Patients stayed in the hospital an average 1.2 days and 1.6 days postoperatively in the SILC group and CLC group, respectively. The blood chemistry results on the first postoperative day were not different between the two groups (Table 2). Due to the large sample size, every variable was found to be statistically significant between the two groups ($p < 0.05$). However, these differences are not clinically significant.

Fifty-five cases in the SILC group required insertion of an additional 2 mm trocar during the procedure. One patient in the SILC group was converted to an open hepaticojejunostomy because there was difficulty dissecting between the cystic duct and the CBD. This patient was suspected to have type I Mirizzi syndrome. The patient had prolonged hospital stay (22 days) due to leakage in the hepaticojejunostomy site. Ten patients in the CLC group were converted to open surgeries due to adhesions from previous upper abdominal surgery (6), adhesions due to GB empyema (2), or Mirizzi syndrome (1). One patient was converted to open surgery because xanthogranulomatous cholecystitis was suspected. These patients in the CLC group had prolonged hospital stay. One patient was a 75 year old male with multiple comorbidities and GB empyema. The surgery was converted to open laparotomy and subsequent wound problems led to 35 days in the hospital postoperatively. Another patient had xanthogranulomatous cholecystitis and was converted to open laparotomy. This patient was diagnosed with aplastic anemia postoperatively and was transferred to the hematology department for further management for 22 days. One patient with Mirizzi syndrome had postoperative biloma in the abdominal cavity that required percutaneous drainage for 13 days. Two patients who were converted to open laparotomy had previous history of abdominal surgery. These patients had delayed return of intestinal motility and were discharged at postoperative day 8.

Table 1
Patient characteristics.

	SILS ($n = 500$)	CLC ($n = 746$)	P value
Age (Mean)	42.5	58.0	<0.001
Male, n (%)	169 (33.8)	409 (54.8)	<0.001
BMI (kg/m^2)	23.28 (16.5–34.7)	24.56 (17.3–34.0)	<0.001
ASA score			<0.001
I	280	194	
IE	7	9	
II	114	263	
IIE	3	11	
III	1	27	
IIIE	0	1	
IV	0	1	
Previous abdominal surgery	5	30	<0.001

Data are mean with ranges.
SILC, single incision laparoscopic cholecystectomy; CLC, conventional laparoscopic cholecystectomy; BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 2
Comparisons of postoperative parameters.

	SILS ($n = 500$)	CLC ($n = 746$)
Operative time (min)	49.0 (21–138)	51.83 (18–118)
Postoperative hospital stay (days)	1.21 (1–22)	1.62 (1–35)
Postoperative chemistry		
AST (IU/L)	33.95 (15–461)	42.24 (14–376)
ALT (IU/L)	32.74 (8–626)	38.52 (5–489)
ALP (IU/L)	51.27 (24–230)	65.96 (17–522)
Total bilirubin (mg/dl)	0.92 (0–3)	0.93 (0–18)

Data are mean with ranges.
SILC, single incision laparoscopic cholecystectomy; CLC, conventional laparoscopic cholecystectomy; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase.

Patients were followed in the clinic one week after surgery. There was no further follow-up required if no abnormal findings were seen after one week. There were no cases of wound complications or incisional hernias in either group.

4. Discussion

With regard to any surgical procedure, surgeons strive for less invasive, less painful and more cosmetic approaches. Preliminary data on SILS cholecystectomy have been reported since 2009 [6]. Randomized controlled studies, review articles and reports that suggest a consensus guideline are currently in publication [7].

The most notable advantage of SILS is its cosmetic benefit. The authors of a large, early study on SILS cholecystectomy argued that while SILC had better cosmetic outcomes than did CLC, further studies were necessary to assure its safety [8]. Aprea et al. reported that SILC patients had significantly higher wound satisfaction than CLC patients [9]. Studies have also argued that SILC patients experience less postoperative pain and have higher quality of life than CLC patients. Lirici et al. not only demonstrated that SILC was associated with less postoperative pain, but also demonstrated superior patient satisfaction with SF36 in SILC patients compared to CLC patients [10]. However, some authors argued that CLC provided sufficient patient aesthetic satisfaction [11,12], with insignificant differences between the two groups [13].

In contrast, some reports claim that SILC is associated with more severe postoperative pain and leads to increased analgesic use postoperatively [3]. Aprea et al. reported that SILC and CLC patients were not different in severity of postoperative pain [9]. Also, Ma et al. claim that SILC procedures are longer, associated with more postoperative complications and pain, and are not superior in QOL compared to CLC procedures [14,15].

These arguments are not only based on retrospective observational studies, but also on randomized controlled studies (albeit with small sample sizes). The largest randomized controlled study by Phillips et al. involved 117 patients in the SILS group and 80 patients in the CLC group [16]. Most other randomized studies have fewer than 50 patients enrolled in either group.

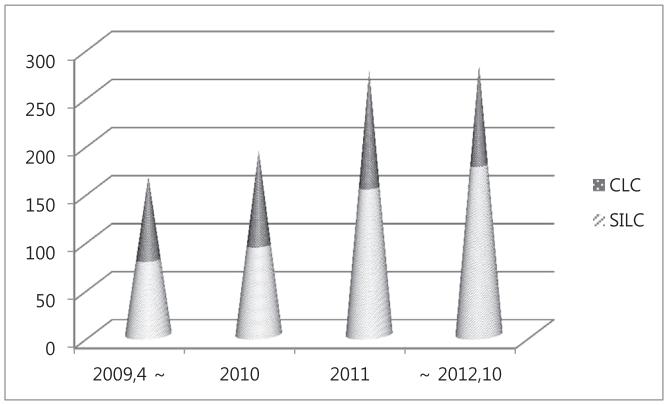
Previous RCTs are limited in applicability due to the characteristics of the enrolled patients. For example, Aprea et al. and Lee et al. excluded severely obese patients with a BMI >30 kg/m^2 in their analysis [3,9]. Cao et al., Lirici et al., and Tsimoyiannis et al. also applied a BMI <30 kg/m^2 among their inclusion criteria [4,10,17]. In the present study, 18 patients in the SILS group and 23 patients in the CLC group had BMI >30 kg/m^2. There were no significant differences in operation time, length of hospital stay and postoperative blood chemistry results between patients with BMI>30 kg/m^2 and those with BMI <30 kg/m^2 (data not shown). However, patients who presented with obesity-related comorbidities corresponding to ASA scores of III were not indicated for SILS. Many publications have previously shown that SILS procedure times are significantly longer than those of CLC. Therefore, we do not suggest using SILC in patients with ASA scores of III because extended operation and anesthesia time in these patients may increase postoperative morbidity [14].

Although Lai et al. and Ma et al. excluded patients with large gallstones (>3 cm or >2.5 cm), we believe that SILC is actually more applicable to patients with large gallstones. This is because it is easier to remove a gallbladder containing a large gallstone through the longer SILC umbilical incision [14,18]. Lirici et al. excluded patients with acute cholecystitis, CBD stones, or pancreatitis from their study population [10]. We also did not perform SILC in patients with acute cholecystitis, CBD stones, or pancreatitis. However, the presence of GB polyps may be a good indication for SILC, in cases where malignancy is not suspected.

Several studies, including RCTs, regarding SILC are currently in publication. However, most published studies lack a sufficient number of cases or indication criteria to establish a practical guideline for clinical SILC application. Therefore, we proposed the following indication criteria for SILC in clinic practice. Our recommendations are based on years of experience and 500 cases of SILC and they include:

1. Acute or gangrenous cholecystitis and GB empyema on CT or ultrasonography
2. Severe systemic disturbance categorized as ASA score > III
3. Prior history of ERCP and EST for CBD stones or sludge
4. Previous upper abdominal surgery (but not lower abdominal surgery)
5. GB polyp >1 cm with a possibility of GB cancer

Aside from the above-stated circumstances, SILC may be still indicated if a surgeon is skilled in laparoscopic cholecystectomy. There are several different methods of SILC. We do not recommend puncturing the GB, because this introduces the risk of bile spillage. Retraction of the GB using a laparoscopic instrument is more appropriate. In our experience, when SILC is performed according to our described procedure, the operation time, hospital stay, postoperative chemistries, and rate of conversion to open surgery are not different compared to those of CLC. In this study, 55 patients required the insertion of an additional 2 mm trocar for traction of the GB. The authors recommend this procedure when the surgeon finds that it is necessary. Our indications may provide a guideline for future multicenter trials with regard to SILC's feasibility in certain patients (Fig. 1).



SILC, single incision laparoscopic cholecystectomy ; CLC, conventional laparoscopic cholecystectomy

Fig. 1. Comparison of SILS and CLC incidence.

In conclusion, we have performed 500 cases of SILC in a selected patient population following our guidelines for inclusion. It is important that the surgical community reaches a consensus on the application of the SILC method in cholecystectomy. We believe that other institutions will find that our indications are safe and effective for application in their respective clinical settings.

Ethical approval

None required.

Financial support

There are no conflicts of interest.

Author contribution

Study design: Hyo Jun Park, Juhee Cho, Jin Seok Heo.
Data collections: Hyo Jun Park, Dong Hoon Kim, Jaehong Jeong, Hui Song Le.
Data analysis: Hyo Jun Park.
Wright: Hyo Jun Park.
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Conflicts of interest

There are no conflicts of interest.

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