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Original Article

Outcome of single-incision laparoscopic cholecystectomy compared to three-incision laparoscopic cholecystectomy for acute cholecystitis

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Backgrounds/Aims: While single-incision laparoscopic cholecystectomy (SILC) has advantages in cosmesis and postoperative pain, its utilization has been limited. This study raises the possibility of expanding its indication to acute cholecystitis with the novel method of solo surgery under retrospective analysis.
Methods: We compared the outcomes of SILC (n = 58) to those of three-incision laparoscopic cholecystectomy (TILC; n = 117) for acute cholecystitis, being performed from March 2014 to December 2015.
Results: Intraoperative results, including the operation time, did not differ significantly, except for drain catheter insertion (p = 0.004). Each group had 1 case of open conversion due to common bile duct injury. There was no significant difference in the length of hospital stay. Either group by itself was not a risk factor for complications, but in preoperative drainage for intraoperative perforation, 3 factors of intraoperative perforation, biliary complication, and history of upper abdominal operation for additional port, only American Society of Anesthesiology (ASA) scores for postoperative complication of Clavien–Dindo grades III and IV were significant risk factors.
Conclusions: Our study findings showed comparative outcomes between both groups, providing evidence for the safety and feasibility of SILC for acute cholecystitis.

Key Words: Laparoscopic cholecystectomy; Acute cholecystitis; Minimally invasive surgical procedure

INTRODUCTION

Acute cholecystitis is one of the common indications for laparoscopic cholecystectomy (LC). Since it was first introduced in the 1980s [1], and improvements made to the surgical techniques and laparoscopic instruments, LC for acute cholecystitis has become feasible and safe [2].

Single-incision laparoscopic cholecystectomy (SILC) was introduced in 1997. Several meta-analyses have shown that SILC is associated with higher conversion rates, a longer operative time, and shorter hospital stay, but it has advantages in cosmesis and decreasing postoperative wound pain [3-5]. However, acute cholecystitis is still a contraindication of SILC according to many studies, because of the high possibility of morbidities. Sato et al. [6] reported that an American Society of Anesthesiology (ASA) classification of physical status score of 3 or more and acute cholecystitis are risk factors of complication following SILC. A systematic review by Allemann et al. [7] excluded

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emergency operation and acute cholecystitis as indications, because the rate of bile duct injury was 0.4% in a randomized controlled trial (RCT), and 0.7% in a non-RCT; thus, they concluded that the safety could not be assumed, and they could not recommend SILC as a standard treatment. Despite these surgical difficulties, indications of SILC have recently been expanding, owing to the increasing cosmetic demand from patients, and the improvement of surgical technique. As conventional LC has gradually expanded its indication to include acute cholecystitis, the use of SILC for acute cholecystitis may be increased due to the novel method of solo surgery and the laparoscopic parallel instrument approach.

In the present study, we compared intraoperative and postoperative results between SILC and three-incision LC to determine the safety and feasibility of SILC for acute cholecystitis in a single center.

MATERIALS AND METHODS

A total of 495 cases of LC (222 patients underwent SILC, while 272 patients underwent three-incision laparoscopic cholecystectomy [TILC]) were performed by one professor and six clinical fellows under the supervision of the same professor from March 1st, 2014 to December 31th, 2015. Among them, one hundred seventy-five patients who had undergone LC for acute cholecystitis (58 underwent SILC, while 117 underwent TILC) were retrospectively analyzed. Initially, SILC was performed for simple, non-inflamed benign gallbladder (GB) diseases; after overcoming the learning curve, its indication was expanded to acute cholecystitis. Thereafter, all the patients with acute cholecystitis who had been treated with TILC previously were considered to undergo SILC first. After overcoming the learning curve, SILC was performed on all patients with acute cholecystitis. Emergency cholecystectomy was indicated for patients with systemic inflammation sign or GB perforation in both groups.

Acute cholecystitis was diagnosed using the updated Tokyo guideline 2018 (TG18) criteria [8]. This study was approved by the Institutional review board (approval no.: B-1606-351-104).

Patients' clinical demographics information, including sex; age; height; weight; body mass index (BMI); a previous history of upper abdominal operation, preoperative biliary drainage, GB drainage and pancreatic duct drainage and emergency operation; interval time between the symptom onset and operation; and severity grade according to TG18 were collected.

Surgical outcomes and risk factors for complications

Intraoperative and postoperative outcomes were compared between the two groups.

Intraoperative outcomes included the presence of GB traction sutures, conversion to an additional port, open conversion rate, operative time, estimated blood loss (EBL), GB perforation during dissection, biliary complication, small bowel injury, and the presence of a drain catheter.

Postoperative outcomes included the length of hospital stay, quality of the patient's diet, presence of diarrhea, presence of abdominal and shoulder pain, condition of the wound, and postoperative complications that were graded according to the Clavien–Dindo classification [9]. We conducted interviews with patients during their hospitalization and outpatient visits to assess pain, diarrhea, and changes in dietary habits.

Patients' postoperative wounds and symptoms were assessed 2 weeks after discharge. Wounds were classified into three groups: grade I, clear; grade II, erythematous or presence of induration and pain; and grade III, presence of pus drainage. Diet restriction was classified as good, mild (I, suboptimal appetite), moderate (II, digestives are required), and severe (III, abdominal discomfort with digestives). Newly developed diarrhea postoperatively was classified as mild (I, relieved within 3 days), moderate (II, relieved within 7 days), and severe (III, an anti-diarrhea drug is needed). Abdominal or shoulder pain post-cholecystectomy was classified as mild (I), pain relieved within 3 postoperative days; moderate (II), pain relieved within 7 days; and severe (III), pain relieved over 7 days.

In addition, the TG18 diagnostic criteria for acute cholecystitis included local signs of inflammation and systemic signs of inflammation preoperatively, and results of imaging modalities and pathologic reports. Risk factors including either group by itself for intraoperative GB perforation during dissection, open conversion, addition port, and postoperative complication of Clavien–Dindo grades III and IV were analyzed.

Surgical procedures of single-incision laparoscopic cholecystectomy and three-incision laparoscopic cholecystectomy

All SILC for acute cholecystitis operations were performed by a surgeon alone using mechanical scope holder (Laparostat™, CIVCO Medical Solutions). Surgical methods were described in the previous report [10]. During SILC, the patient was under general anesthesia, and placed in the lithotomy position. The operator was positioned between the patient's legs, and a scope holder, the Laparostat™ was positioned on the left side rail of the patient's bed. A single transparent Glove port (Nelis) was inserted through a 2.5- to 3-cm trans-umbilical incision, and a pneumoperitoneum up to 12 mm Hg was made. As the operator adjusted the camera position by themselves, solo surgery was performed.

The patient's position was changed to the reverse Trendelenburg position, and the right side was elevated. The same instruments that were used during TILC were used during SILC. Then the parallel approach was performed, using a 10-mm flexible endoscope to reduce instrument collision. Critical view of safety was checked during the operation, except in cases with obliterated Calot's triangle due to severe inflammation.

Surgical procedures were the same with multiport LC. The cystic artery and cystic duct were ligated using a 5-mm or

10-mm Hem-O-Lok clip (Teleflex Medical, Research Triangle Park). The GB was dissected from the liver bed using an endobovie, and retrieved using a glove port. A Jackson–Pratt drain was inserted in patients who had a high risk of bleeding or who were highly suggestive of a bile leak. The fascia was closed using interrupted sutures with local injection of ropivacaine to control wound pain. The umbilical skin wound was left open, except for suturing the upper and lower ends of the wound.

During TILC, the patient was placed in supine position, and three trocars (one each on the umbilicus, subxiphoid, and right upper quadrant [RUQ]) were routinely used. Cholecystectomy was performed in the same manner as aforementioned, and the specimen was retrieved through the umbilicus using an endobag.

Statistical analysis

Continuous variables were analyzed using the Student's t-test, and categorical variables were analyzed using the chi-square test and Fisher exact test. Multivariable analysis was performed using logistic regression analysis. All statistical analyses were performed using IBM SPSS Statistics, version 20.0 (IBM Corp.). A p-value < 0.05 was considered significant.

RESULTS

None of the differences in patients' baseline characteristics was significant between the two groups. Patients' mean age and BMI in the TILC and SILC group were 61.6 ± 16.5 vs. 62.1 ± 16.4 years (p = 0.861) and 24.6 ± 3.8 vs. 25.2 ± 3.9 kg/m^2 (p = 0.30), respectively. Twenty-four and 18 patients (20.5% and 31.0%) in the TILC and SILC group, respectively, had undergone upper abdominal surgery.

The ASA score did not differ between the two groups. Preoperative combined diseases included acute cholangitis (2 vs. 1) patients (1.7% vs. 1.7%), acute pancreatitis in (1 vs. 1) patient (0.9% vs. 1.7%), common bile duct stone in (2 vs. 1) patients (1.7% vs. 1.7%), and GB perforation (4 vs. 0) patients (3.4% vs. 0%) in the TILC and SILC groups, respectively. Emergency operation was performed in 28 and 11 patients (23.9% and 19.0%) in the TILC and SILC group, respectively. The interval between symptom onset and operation was 86.9 ± 96.2 and 114.9 ± 158.2 hours in the TILC and SILC group, respectively. Neither finding was significantly different (Table 1).

The TG18 severity grade for acute cholecystitis and its factors, including the Murphy sign, RUQ mass/pain/tenderness, fever, C-reactive protein level, and white blood cell count, and results of imaging studies, did not differ significantly between the two groups (Table 2).

Table 1. Patient characteristics

	TILC (n = 117)	SILC (n = 58)	p-value
Age (yr)	65 (50.3–73.8)	65 (47.5–75.5)	
Sex (male:female)	64 (54.7):53 (45.3)	33 (56.9):25 (43.1)	0.872
Height (cm)	163.3 (157.1–169.4)	162.3 (157.2–170.5)	
Weight (kg)	64.0 (56.1–73.0)	67.2 (59.6–74.2)	
BMI (kg/m^2)	24.2 (21.9–26.8)	24.8 (23.1–27.3)	
Abdominal operation history	24 (20.5)	18 (31.0)	0.136
Upper abdominal operation history	5 (4.3)	4 (6.9)	0.481
ASA score (1:2:3)	43 (36.8):64 (54.7):10 (8.5)	22 (37.9):29 (50.0):7 (12.1)	0.715
Associated disease			0.704
Acute cholangitis	2 (1.7)	1 (1.7)	
Acute pancreatitis	1 (0.9)	1 (1.7)	
Common bile duct stone	2 (1.7)	1 (1.7)	
Gallbladder perforation	4 (3.4)	0 (0)	
Preoperative biliary drainage			
ERCP, ERBD, and CBD stone removal	20 (17.1)	12 (20.7)	0.492
PTGBD or ERGBD	50 (42.7)	22 (37.9)	0.657
Emergency operation	28 (23.9)	11 (19.0)	0.582
Interval between the onset to operation (h)	55 (28.0–113.0)	63.5 (31.5–139.3)	

Values are presented as median (interquartile range) or number (%).
TILC, three-incision laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy; BMI, body mass index; ASA, American Society of Anesthesiology; ERCP, endoscopic retrograde cholangiopancreatography; ERBD, endoscopic retrograde biliary drainage; CBD, common bile duct; PTGBD, percutaneous transhepatic gallbladder drainage; ERGBD, endoscopic retrograde gallbladder biliary drainage.

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Table 2. Updated Tokyo Guideline (TG18) diagnostic criteria of acute cholecystitis

	TILC (n = 117)	SILC (n = 58)	*p*-value
TG18 diagnostic criteria for acute cholecystitis			
Local sign's of inflammation, etc.			-
Murphy sign	53 (45.3)	26 (44.8)	
RUQ mass/pain/tenderness	1 (0.9)/107 (91.5)/108 (92.3)	1 (1.7)/50 (86.2)/54 (93.1)	
Systemic signs of inflammation etc.			-
Fever (℃)	37.5 (37–38.1)	37.3 (36.9–38.3)	
Increased CRP (mg/dL) level (n = 102/58)	6.08 (1.64–17.28)	4.01 (0.59–13.6)	
Increased WBC count (/μL)	13,100.0 (9,800.0–17,585.0)	12,350.0 (8,985.0–14,850.0)	
Imaging finding			-
Modality (CT:US:EUS:MRCP:HIDA scan)	116 (99.1):22 (18.8):17 (14.5):3 (2.6):2 (1.7)	56 (96.6):7 (12.1):11 (19.0):3 (5.2):0 (0)	
TG18 severity grading of acute cholecystitis			0.556
Grade I	65 (55.6)	37 (63.8)	
Grade II	43 (36.8)	18 (31.0)	
Grade III	9 (7.7)	3 (5.2)	
Histologic diagnosis			0.077
Acute cholecystitis	20 (17.1)	6 (10.3)	
Acute and chronic cholecystitis	25 (21.4)	16 (27.6)	
Acute suppurative cholecystitis	2 (1.7)	4 (6.9)	
Acute gangrenous cholecystitis	33 (28.2)	9 (15.5)	
Gall bladder adenocarcinoma	1 (0.9)	0 (0)	
Chronic cholecystitis	36 (30.8)	22 (37.9)	
Xanthogranulomatous cholecystitis	0 (0)	1 (1.7)	

Values are presented as median (interquartile range) or number (%).
TILC, three-incision laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy; RUQ, right upper quadrant; CRP, C-reactive protein; WBC, white blood cell; CT, computed tomography; US, ultrasonography; EUS, endoscopic ultrasonography; MRCP, magnetic resonance cholangiopancreatography; HIDA, hepatobiliary iminodiacetic acid; -, not available.

Intraoperative result

A GB traction suture was used early in only 8 cases (13.8%) of SILC, and 1 case (0.9%) of partial cholecystectomy due to severe inflammation in the TILC group. There were 8 and 2 cases (6.8% and 3.4%) of conversion to an additional port in the TILC and SILC group, respectively.

Each group had 1 case of open conversion because of common bile duct injury.

In the TILC group, there was one other patient with common bile duct injury who was treated with laparoscopic primary repair with T-tube insertion. There was 1 case of small bowel perforation because of severe adhesion from a previous operation, for which primary repair was performed. In the SILC group, there was 1 case of duodenal perforation during adhesiolysis, and two cases of bile leak during cholecystectomy. Except for one case of open conversion due to common bile duct injury, laparoscopic bile duct primary repair was performed with additional port for the other patient. However, no statistically significant difference in the rate of intraoperative bile duct injury was seen between the two groups ($p = 0.60$).

The operative times were 63.7 ± 36.0 and 69.4 ± 28.3 minutes in the TILC and SILC groups, respectively. Additionally, the EBL was scarce in most cases in both groups.

The number of intraoperative GB perforations during its dissection was higher in the TILC group than in the SILC group, but this was not significantly different (36 vs. 14) (30.8% vs. 24.1%, $p = 0.44$). However, the use of an indwelling drainage catheter was higher in the TILC group than in the SILC group ($p = 0.004$) (Table 3).

Postoperative result

The mean postoperative hospital stays were 2.3 ± 1.7 and 2.2 ± 1.8 days in the TILC and SILC groups, respectively ($p = 0.58$). The postoperative diet habit change ($p = 0.91$), new onset diarrhea ($p = 0.56$), abdominal pain ($p = 0.60$), and wound complication rate ($p = 0.18$) at the 2-week follow-up visit did not significantly differ between the two groups.

There was a higher incidence of postoperative complications in the TILC than in the SILC group, but it did not show significance ($p < 0.001$). Seventy-four patients had complications in the TILC group: grade I, II, IIIa, IIIb, and IVa (n = 54, 10, 6, 1, and 3 [46.2%, 8.5%, 5.1%, 0.9%, and 2.6%]), respectively. Thirty patients had complications in the SILC group: grade I, II, and IIIa (n = 18, 9, and 3 [31.0%, 15.5%, and 5.2%]), respectively.

In the TILC group, grade IIIa complications included a liver function abnormality that required endoscopic ultrasound;

Table 3. Intraoperative result

	TILC (n = 117)	SILC (n = 58)	*p*-value
Traction suture	-	8 (13.8)	-
Conversion to an additional port	8 (6.8)	2 (3.4)	0.500
Open conversion	1 (0.9)	1 (1.7)	> 0.999
Operation time (min) (n = 117)	55.00 (45.00–70.00)	62.50 (48.75–91.25)	-
EBL (mL) (n = 117)	5 (5–50)	5 (5–50)	-
Perforation	36 (30.8)	14 (24.1)	0.441
Biliary injury during operation	2 (1.7)	2 (3.4)	0.600
Small bowel injury (duodenal injury)	1 (0.9)	1 (1.7)	> 0.999
Drain catheter insertion	39 (33.3)	7 (12.1)	0.004

Values are presented as median (interquartile range) or number (%).
TILC, three-incision laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy; EBL, estimated blood loss; -, not available.

cystic duct leakage that required endoscopic retrograde biliary drainage; liver function aggravation with hepatitis C that required hospital re-admission; common bile duct stone that required repetitive admission and stone removal through endoscopic retrograde cholangiopancreatography; and pleural effusion that required percutaneous catheter drainage insertion and intravenous site injury during intensive care unit stay. One patient with a IIIb complication required exploratory laparoscopy due to adhesive ileus. The IVa complications included postoperative hepatitis B flare-up, seizure, and acute kidney injury. In the SILC group, percutaneous drainage or biliary internal drainage was required in 3 patients due to abdominal bile or fluid collection. Otherwise, there was no complication above IIIa. No significant differences in the rate of postoperative biliary complications were seen (TILC group: 1 case, SILC groups: 2 cases; $p = 0.25$) (Table 4).

Results of multivariable analysis showed that the significant risk factors for intraoperative GB perforation were percutaneous transhepatic drainage of the GB, or endoscopic retrograde GB drainage at the site. A history of upper abdominal operation, intraoperative perforation, and intraoperative biliary complication were significant risk factors for conversion to an

Table 4. Postoperative result

	TILC (n = 117)	SILC (n = 58)	*p*-value
Hospital stay (day)	2 (1–3)	2 (1–2)	
Diet (I:II:III)[a]	4 (3.4):15 (12.8):3 (2.6)	3 (5.2):9 (15.5):3 (5.2)	0.911
Diarrhea (I:II:III)[b]	13 (11.1):7 (6.0):3 (2.6)	6 (10.3):2 (3.4):2 (3.4)	0.559
Abdominal pain (I:II:III)[c]	8 (6.8):3 (2.6):1 (0.9)	3 (5.2):1 (1.7):0 (0)	0.595
Shoulder pain (I:II:III)	-	5 (8.6):2 (3.4):0 (0)	-
Wound (I:II:III)[d]	86 (73.5):2 (1.7):0 (0)	4 (6.9):0 (0):0 (0)	0.179
Incisional hernia	0	0	
Postoperative complication			
Biliary complication	1 (0.9)	2 (3.4)	0.255
Clavien–Dindo classification			< 0.001
I	54 (46.2)	18 (31.0)	
II	10 (8.5)	9 (15.5)	
IIIa	6 (5.1)	3 (5.2)	
IIIb	1 (0.9)	0 (0)	
Iva	3 (2.6)	0 (0)	
Ivb	0 (0)	0 (0)	

Values are presented as median (interqurtile range) or number (%).
TILC, three-incision laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy; -, not available.
[a]Diet: good, mild (I) with a suboptimal appetite; moderate (II), digestives required; severe degree (III), with abdominal discomfort even with digestives. [b]Diarrhea: mild (I), relieved within 3 days; moderate (II), relieved within 7 days; severe (III), an anti-diarrhea drug is needed. [c]Post-cholecystectomy abdominal or right shoulder pain was classified as mild (I), pain relieved within 3 postoperative days; moderate (II), pain relieved within 7 days; severe (III), pain relieved within over 7 days. [d]Wound: grade I, clear; grade II, erythematous or with induration and pain; grade III, with pus drainage. Incisional hernia has not been found but long-term follow-up is necessary.

Table 5. Results of multivariable analysis for perforation, conversion, and Clavien–Dindo grades III and IV

	Odds ratio	95% CI	*p*-value
Intraoperative perforation			
PTGBD or ERBD	2.314	1.186–4.516	0.014
Additional port			
History of upper abdominal operation	7.854	1.171–52.661	0.034
Intraoperative perforation	6.616	1.492–29.337	0.013
Intraoperative biliary complication	24.885	2.370–261.294	0.007
Open conversion			
PTGBD or ERGBD	0	0	0.995
Intraoperative biliary complication	1.92	0	0.993
Clavien–Dindo grades III and IV			
ASA score	2.655	1.100–6.409	0.030

Neither solo single-incision laparoscopic cholecystectomy nor conventional three-incision laparoscopic cholecystectomy was a risk factor of any of the listed complications.
CI, confidential interval; PTGBD, percutaneous transhepatic gallbladder drainage; ERGBD, endoscopic retrograde gallbladder biliary drainage; ASA, American Society of Anesthesiology.

additional port. Only the ASA score was a risk factor for Clavien–Dindo grades III and IV. Neither SILC nor TILC alone was a risk factor for any of the aforementioned complications (Table 5).

DISCUSSION

Compared to traditional open cholecystectomy, LC has been advantageous to patients with respect to decreasing their pain and hospital stay and improving cosmesis. Minimally invasive surgery has been applied to all areas of general surgery, and the goals of this method are a minimal incision and decrease in postoperative pain. Following this trend, single incision is being performed for LC, and it has been used for patients with symptomatic GB stone without severe inflammation, resulting in a comparable outcome to multiport LC. The present study's results were comparable between TILC and SILC in terms of the intraoperative and postoperative outcomes. This study emphasizes the technique of solo surgery and provides evidence for expanding the indications of SILC to include acute cholecystitis.

Solo surgery helps overcome insufficient manpower, and a surgeon can achieve a stable surgical view by replacing an inexperienced scopist with a scope holder during operation. The limited space with single incision can also be overcome. However problematic issues, such as emergent situations or malfunction of the scope holder, can arise. Despite these issues, Kim and Lee [11] reports that its indications are broadening to multiple quadrants and malignant diseases. The present study showed comparative results between TILC and SILC for acute cholecystitis, indicating the possibility of using solo surgery for LC. However, prospective intraoperative and postoperative results, including the operative time and complications, should be compared in further studies [12].

Soltes and Radoňak [13] reported nine risk factors for predicting the difficulty of LC, including male sex, biliary colic within the last 3 weeks prior to surgery, a history of acute cholecystitis treated conservatively, previous upper abdominal surgery, RUQ pain, rigidity in the RUQ, and ultrasound parameters (thickening of the GB wall ≥ 4 mm, hydropic GB, and shrunken GB). Ikumo et al. [14] concluded that SILC is safe for acute cholecystitis, and in Sasaki et al.'s study [15], there were no differences in the operative time, open conversion rate, and complication rate between SILC and traditional LC for acute inflamed GB, despite the small study population and delayed operation. Chuang et al. [16] divided complicated and uncomplicated cases of acute cholecystitis, and reported a similar operative time, EBL, postoperative narcotic use, total length of hospital stays, conversion rates, and complication rates in the SILC and TILC subgroups, although the conversion rates were high.

However, Allemann et al. [7] did not recommend SILC due to biliary complication. Joseph et al. [17] reported that SILC-associated bile duct injury occurred in 0.72% of cases during early period; this rate was higher than that compared to the standard LC (0.4%–0.5% of cases). Thus, patient selections are crucial, and risk factors for conversion have been studied [18,19]. Lee and Kim [20] reported a postoperative bile leakage rate of 3.8%, which is higher than that reported in other studies. Funamizu et al. [21] reported that in patients who underwent percutaneous transhepatic gallbladder drainage, the incidence of bile leakage was 12.5% in SILC, which was higher compared to TILC.

In the present study, each case of open conversion did not have a risk factor, according to the results of multivariate analysis. This result may be different in large-scale study. Risk factors for conversion to an additional port were a history of upper abdominal operation, intraoperative GB perforation, and intraoperative bile duct injury. The rate of GB perforation was relatively high in both groups. This may be caused by inflammation, or biased due to small sample size. However, there was no difference between Clavien–Dindo grade III and IV complications.

The rate of bile duct injury including intraoperative bile duct injury and postoperative biliary complication was relatively high in the SILC group in this study. This is due to the early phase in its learning curve of SILC. After overcoming the initial phase, the rate of bile duct injury has declined. There was one case of postoperative bile leak in each group after emergency surgery. Therefore, during emergency surgery, the possibility of a bile leak should be carefully monitored.

This study had some limitations.

Since our study did not have a prospective design, the decision to perform SILC was made according to the development of surgical skill. Initially, SILC was performed for simple, non-inflamed benign GB diseases; and after overcoming the learning curve, it has expanded its indication to acute cholecystitis. Thereafter, all the patients with acute cholecystitis who had previously been treated with TILC were considered to undergo SILC first. This may have caused selection bias. Preoperative data showed no difference between the two groups, but more severe cases were included in the TILC group, which was not significantly different. Moreover, all patients diagnosed as having GB perforation underwent TILC, and the intraoperative perforation rate was higher with TILC than with SILC. The proportion of gangrenous cholecystitis was higher with TILC than with SILC. These factors may have caused the significant difference in drain catheter insertion. Lastly, our study lacked a long-term follow-up. In addition, only short-term results were compared, while long-term complication, including an incisional hernia, was not analyzed. Incisional hernia was not found, but long-term follow-up is necessary.

Despite these limitations, our study results showed comparative intraoperative and short-term outcomes between TILC and SILC, providing evidence for the safety and feasibility of SILC for acute cholecystitis.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTIONS

Conceptualization: YRC. Data curation: BL. Methodology: JYC. Visualization: YSY, HSH. Writing - original draft: SS, SC. Writing - review & editing: SS.

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