

The First Additional Port During Single-Incision Laparoscopic Cholecystectomy

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ABSTRACT

Background and Objectives: Single-incision laparoscopic cholecystectomy (SILC) has become increasingly popular. Regarding the difficulties of SILC in acute cholecystitis, additional port insertion is sometimes required. However, appropriate locations for additional port insertion have not been well studied. In the present study, the safety and effectiveness of the first additional port insertion in the epigastric region during SILC was assessed.

Methods: Additional port insertions were needed in 52 of 113 patients who underwent SILC for acute cholecystitis. The first port was inserted in the epigastric region and the second (if required) was inserted in the right lateral sub-costal area. A drainage catheter was positioned through the epigastric port.

Results: One additional port was inserted in 43 patients and two additional ports were inserted in 9 patients. Mean operation time was 45.0 minutes in the Pure SILC group and 83.3 minutes in Additional Port group. Mean hospital stay was 3.7 days in the Pure SILC group and 5.9 days in Additional Port group. There was no open conversion. Intra-operative (n = 5) and postoperative bile leakages

(n = 2) were identified in six patients. Timing of operation after onset of symptoms was significantly greater in the group with bile duct injury than in those without bile duct injury in patients who required additional ports.

Conclusions: The first additional port in the epigastric area during SILC for acute cholecystitis helps to complete the operation without open conversion. However, the procedure can be performed safely in selective patients with relatively short duration of symptoms.

Key Words: Single-incision laparoscopic cholecystectomy; Additional port; Acute cholecystitis.

INTRODUCTION

Since Muhe first performed laparoscopic cholecystectomy in 1985, laparoscopic cholecystectomy has become a standard technique for gallbladder disease.¹ When performed by an experienced surgeon, laparoscopic cholecystectomy is a safe modality for acute cholecystitis with acceptably low conversion and complication rates. Single-incision laparoscopic cholecystectomy (SILC) was developed to further minimize the invasiveness of laparoscopic cholecystectomy.² In early reports, SILC was performed in optimal cases of uncomplicated gallbladder disease without acute inflammation. However, the popularity of SILC has since increased, and the technique is now applied to cases of acute complicated cholecystitis.³⁻⁷

According to some studies, SILC has the advantages of shorter postoperative hospital stay and better cosmesis over conventional laparoscopic cholecystectomy for acute cholecystitis and has comparable complication rates. However, SILC for acute cholecystitis has also been associated with protracted operative times, a high rate of requirement for additional port(s), and a high rate of conversion to multiport laparoscopic cholecystectomy due to severe inflammation or adhesion around the gallbladder. When an additional port is required, surgeons must decide on an appropriate location that obviates the need for additional ports and reduces the risks of conversion to laparotomy and serious complications like bile duct injury. In this study, we

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evaluated the appropriateness of epigastrium as a location for the first additional port during SILC for acute cholecystitis.

MATERIALS AND METHODS

Patients

In March 2018, the indications for SILC were broadened to include acute cholecystitis at Dongguk University Gyeongju Hospital. Between March 2018 and December 2019, SILC was undertaken in 113 consecutive patients preoperatively diagnosed with acute cholecystitis by biliary ultrasonography and/or abdominopelvic computed tomography (CT). Of these 113 patients, an additional port(s) was required in 52 (46.0%) patients, as determined intraoperatively. The reasons for an additional port were as follows: dissection difficulty due to severe adhesion or severe inflammation, intra-operative bleeding, obesity, and/or poor general condition requiring that surgery be completed as soon as possible. Planned delayed surgeries after the percutaneous transhepatic gallbladder drainage were performed in some patients in whom emergency cholecystectomy could not be performed for reasons such as septic shock. All operations were performed by a single surgeon (JHL) with experience in > 500 SILCs and > 200 SILCs prior to March 2018. Medical records and surgical outcomes were reviewed retrospectively.

Surgical Techniques of SILC

With a patient placed supine and the surgeon and camera assistant positioned on the patient's left side and a monitor located on the patient's upper right side, a 1.5–2-cm transumbilical skin incision is made, and then a Gloveport 431-AS (Meditech Inframed, Seoul, Republic of Korea) is inserted through the wound. After carbon dioxide insufflation, exploration is performed using a 50-cm-long 5.5-mm camera at an angle of 30°. Decisions regarding the use of an additional port are usually made at this time. When required, a 5-mm first additional port is located in epigastrium to function as a right-hand-working port (**Figure 1**). When required, a second 5-mm trocar is inserted into the right subcostal region to obtain the desired field of view. When a critical safe view is convincingly achieved (**Figure 2**), the cystic duct and artery are separately ligated with a clip and a Hem-o-lok (Weck Surgical Instruments, Teleflex Medical, Morrisville, NC, USA). If the cystic duct is enlarged by obstruction, it is ligated using an Endoloop (Ethicon Endosurgery, Cincinnati, OH, USA). Sometimes, retrograde cholecystectomy is performed when Calot's triangle is not fully exposed. A drain is

inserted through the epigastric port when drainage is required.

Statistical Analysis

The analysis was performed using SPSS version 21.0 (SPSS Inc., Chicago, IL, USA). Patient characteristics are shown as the mean and standard deviation. The χ^2 test, Fisher's exact test, and an independent Student *t*-test were used for pair-wise comparisons. Statistical significance was accepted for $P < .05$.

RESULTS

Demographics

SILCs were performed completely in 61 patients and additional ports insertions were required in 52 patients during SILC (**Table 1**). There were 64 male and 49 female patients with the mean age of 57.2 ± 15.4 years [range, 26–91 years], and overall mean body mass index 25.0 ± 3.8 kg/m² [range, 17.9–35.8 kg/m²]. Fifty-two patients (46.0%) had one or more comorbidities. American Society of Anesthesiology classes were I in 30 patients, II in 60 patients, and III in 23 patients. Four patients underwent percutaneous transhepatic gallbladder drainage prior to surgery. Endoscopic retrograde cholangiopancreatography with common bile duct stone removal before surgery was performed in 4 patients in SILC with additional port group and 2 in pure SILC group. Thirty-five patients (31.0%) underwent surgery at > 72 hours after symptom onset. According to the Tokyo guideline regarding severity of acute cholecystitis, 65 patients were of grade I (57.5%), 44 were of grade II (38.9%), and 4 were of grade III (3.5%). The SILC with Additional Port group showed older age, higher American Society of Anesthesiology classes, more inflammatory change (higher C-reactive protein (CRP)), longer duration of symptoms, and higher severity grade of acute cholecystitis when compared with the Pure SILC group.

Surgical Outcomes

Of 52 patients who required additional ports during SILC, 43 required one additional port and 9 required two (**Table 2**). There was no conversion to laparotomy. Mean operation time was 72.6 ± 46.9 minutes; 45.0 ± 10.0 minutes for the Pure SILC group and 83.3 ± 51.1 minutes for the SILC with Additional Port group. Mean hospital stay was 5.3 ± 2.4 days (range, 2–17 days); 3.7 ± 1.3 days for the Pure SILC group and 5.9 ± 2.5 days for SILC with Additional Port group. Three patients



Figure 1. Surgical setting of single-incision laparoscopic cholecystectomy with an additional port in epigastrium.

underwent combined procedures; primary repair of cholecystoduodenal fistula in one and appendectomies in the others. There was no reoperation or operative death. Intra-operative events and postoperative complications were occurred only in the SILC with Additional Port group. Six patients experienced an intra-operative complication due to bile duct injury (n = 5) and right hepatic artery injury (n = 1), and there were 3 postoperative complications; 1 wound complication and 2 bile leakages. A postoperative complication of Clavien-Dindo > grade III occurred in 1 patient (0.9%).

Intra-operative (n = 5) and/or postoperative (n = 2) bile leakage occurred in 6 patients; postoperative leakages were treated by endoscopic nasobiliary drainage or conservative management by intravenous antibiotic use and an in situ catheter drainage (the catheter was inserted at

epigastrium during operation) for 5 days. Drainage of bile into the drainage tube had been observed for the patient treated by endoscopic nasobiliary drainage, but endoscopic retrograde cholangiography showed no evidence of common bile duct injury. According to the Strasberg classification, bile duct injury types were as follows: 3 type A (1 intra-operative, 1 postoperative, and 1 combined intra-operative and postoperative), 2 type D (2 intra-operative; one of them had Mirizzi's syndrome), and 1 combined type A and D (intra-operative). Comparison between patients with or without bile duct injury was performed in those who required additional ports. Time to surgery from symptom onset was significantly greater in the group with bile duct injury than in those without bile duct injury. No other difference was found between these patient groups (**Table 3**).

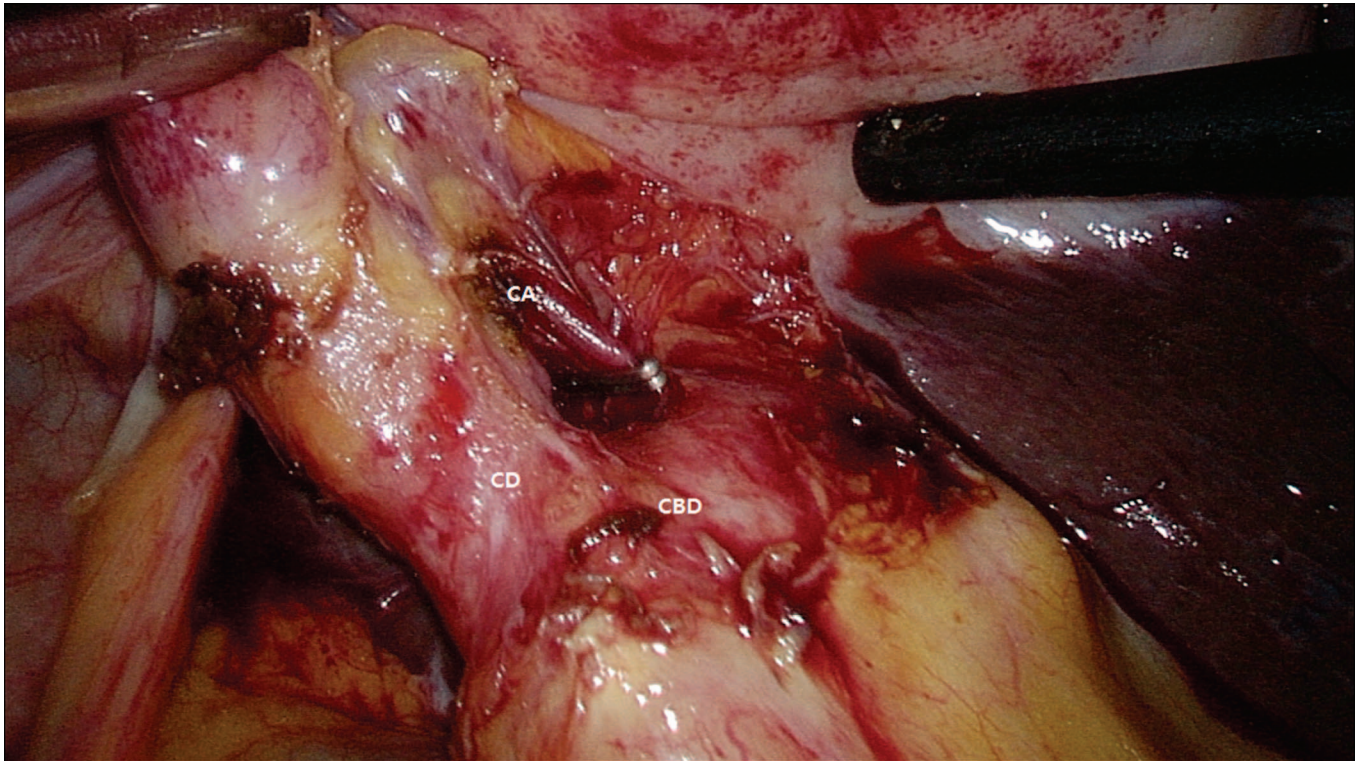


Figure 2. Intra-operative view of single-incision laparoscopic cholecystectomy with an additional port in epigastrium. CBD, common bile duct; CD, cystic duct; CA, cystic artery.

DISCUSSION

The obvious advantages of single port laparoscopic surgery over conventional laparoscopic surgery are less post-operative pain and better cosmesis.^{8,9} Although indications for SILC continue to expand, the role of SILC in acute cholecystitis is still the subject of debate, particularly with respect to the use of additional ports. In this study, an additional port was required in about 46% of patients who underwent SILC for acute cholecystitis, which is somewhat higher than those reported in most studies, although reported rates range from 9% to 60%.³⁻⁷ The relatively high rate observed in the present study is presumed to be due to the following: first, our hospital is a recognized referral center in South Korea, and thus, the proportion of patients in poor general condition was relatively high, which resulted in delayed surgery and greater surgical difficulty. Second, pure single-port surgeries were conducted as an initial approach in all patients receiving cholecystectomy, whereas one or two needlescopic devices were used in other studies. Additional 5-mm-sized ports were decided upon based on intra-operative findings. Third, because there was no conversion to laparotomy, patients normally requiring laparotomy were prob-

ably included among those treated using an additional port.

Araki et al.¹⁰ reported that severe inflammation, as indicated by a high CRP value, predicts the need for an additional port. Similar to the study, the present study showed that a higher CRP was observed more in the SILC with Additional Port group when compared with the Pure SILC group. However, the risk factor analysis is not appropriate in our study because the additional port insertion was the result of special reasons. The reasons for additional port use were dissection difficulties due to severe adhesion or severe inflammation, intra-operative bleeding, and obesity and/or poor general condition. Proper decision making regarding the use of additional port(s) should be considered to diminish serious type of bile duct injury and conversion rates to laparotomy.

To our knowledge, no study has addressed appropriate additional port location during SILC. Port location should be determined by surgeon's preference with consideration of how to reduce risks of further ports and conversion to laparotomy and how to prevent severe complications. The advantages of epigastrium as a location for the

Table 1.
Patient Demographics and Clinical Characteristics

	Pure SILC	SILC with Additional Port	P Value
n	61	52	
Mean age (year ± SD)	53.3 ± 13.4	61.8 ± 16.4	.003
Sex ratio			.332
Male	32 (52.5 %)	32 (61.5 %)	
Female	29 (47.5 %)	20 (38.5 %)	
Mean BMI (kg/m ²), range	25.1 ± 4.1	24.9 ± 3.4	.706
Comorbid diseases			.055
None	38 (62.3 %)	23 (44.2 %)	
≥ 1	23 (37.7%)	29 (55.8 %)	
ASA score			.036
1	19 (31.1%)	11 (21.2%)	
2	35 (57.4%)	25 (48.1%)	
3	7 (11.5%)	16 (30.8 %)	
Prior PTGBD	0 (0 %)	4 (7.7 %)	
Prior ERCP (CBD stone removal)	2 (3.3 %)	4 (7.7 %)	
Preoperative WBC (cell count/ μ L \leq SD)	8662.0 \pm 4472.9	10063.1 \pm 4353.1	.229
Preoperative CRP, mg/dL \leq SD	0.9 \pm 1.3	7.7 \pm 8.8	.003
Duration of Symptom			\leq .001
\leq 72 hours	57 (93.4%)	17 (35.4 %)	
\geq 72 hours	4 (6.6%)	31 (64.6 %)	
Severity grade			\leq .001
TG18, grade I	56 (91.8 %)	9 (17.3 %)	
TG18, grade II	5 (8.2 %)	39 (75.0 %)	
TG18, grade III	0 (0 %)	4 (7.7 %)	

ASA, American Society of Anaesthesiologists physical status; BMI, Body mass index; CBD, Common bile duct; CRP, C-reactive protein; ERCP, Endoscopic retrograde cholangiopancreatography; PTGBD, Percutaneous gallbladder drainage; SD, Standard deviation; SILC, single incision laparoscopic cholecystectomy; TG18, Tokyo Guidelines for the Management of Acute Cholangitis and Cholecystitis 2018; WBC, white blood cell counts.

*Excluding four patients who received prior PTGBD.

first additional port during SILC in patients with acute cholecystitis are as follows: First, combined gallbladder and liver retraction is possible by inserting the instrument through the epigastric port, which effectively creates a “safe” view of the surgical field. Second, the additional port is used as a right-hand working port by the operator, which minimizes external clashing and internal conflicts and makes meticulous dissection or suturing possible. Third, an additional port at the epigastrium enables proper drainage. In the present study, no case of fluid collection was encountered postoperatively and no additional percutaneous drainage insertion was required in

patients who experienced bile leakage postoperatively. Lastly, in view of the points mentioned above, an additional epigastric port provides a useful intermediate stage to pure single-port surgery during the learning curve period and for training.

Bile duct injury is a major complication of laparoscopic cholecystectomy and reportedly occurs at a rate of 0.4% to 0.5%.^{11,12} According to early data published by Joseph et al,¹³ SILC has been suggested to be associated with a higher rate of bile duct injuries than conventional laparoscopic cholecystectomy. However, surgical skills are

Table 2.
Perioperative Outcomes

	Pure SILC	SILC with Additional Port
No. Additional ports		
One	43 (82.7 %)	
Two	9 (17.3 %)	
Open conversion	0 (0 %)	0 (0 %)
Combined procedure	0 (0 %)	3 (5.7%)
Primary closure of cholecystoduodenal fistula	1 (1.9 %)	
Appendectomy	2 (3.8 %)	
Operative time, min \pm SD, (range)	45.0 \pm 10.0 (30–65)	83.3 \pm 51.1 (35–265)
Hospital stay, day \pm SD, (range)	3.7 \pm 1.3 (2–8)	5.9 \pm 2.5 (3–17)
Intra-operative event*	0 (0 %)	6 (11.5 %)
Bile leakage (liver cut surface)	3 (5.8 %)	
Bile leakage at CBD	3 (5.8 %)	
Rt. Hepatic artery injury	1 (1.9 %)	
Postoperative complications	0 (0 %)	3 (5.7%)
Wound complication	1 (1.9 %)	
Bile leakage	2 (3.8 %)	
Reoperation	0 (0 %)	0 (0%)
Mortality	0 (0 %)	0 (0%)

CBD, common bile duct; LFT, liver function test; SD, Standard deviation; SILC, Single-incision laparoscopic cholecystectomy.

*Combined bile leakage from liver surface and CBD in one patient.

improving, and in a recent meta-analysis, no difference was found between SILC and conventional laparoscopic cholecystectomy in terms of bile duct injury rates.¹⁴ It is well known that acute cholecystitis is a significant risk factor of bile duct injuries during laparoscopic cholecystectomy, and it should be noted that the above-mentioned studies did not include sufficient numbers of acute cholecystitis patients. In patients who underwent SILC for acute cholecystitis, postoperative bile duct injury rates are reported to range from 0% to 2%.^{4–7} In the present study, postoperative bile duct leakage occurred in 2 (1.8%) of 113 patients in which SILC was attempted for acute cholecystitis, which compares well with previously reported rates, even though the rate was increased when the intra-operative events were included. Moreover, most of postoperative bile leakages were successfully controlled conservatively or interventionally in the present study and in other studies. In addition, almost all intra-operative bile duct injuries were well managed laparoscopically without open conversion by the use of additional ports at appropriate locations in our study. SILC should not be contraindicated even in patients with acute cholecystitis. How-

ever, patients requiring treatment a number of days after symptom onset should be approached with caution because longer duration of symptom was related to bile duct injury. This topic requires further study.

The incidence of umbilical hernia after single-port surgery is also of concern. Reported of umbilical hernia after single-port surgery range from 2.4% to 13.3%,^{15–18} and in a recent study, it was shown that the incidence of incisional hernia at the umbilical post site after long-term followup was greater for SILC than standard three-port cholecystectomy.¹⁸ In addition, obesity, old age, and pre-existing umbilical hernia were reported to predict postoperative incisional hernia after single-port surgery. However, no study has yet addressed the incidence of postoperative incisional hernia in patients treated by SILC for acute cholecystitis. Some topics bear further consideration in patients with acute cholecystitis. Umbilical incisions are often extended during specimen extraction during laparoscopic multiport cholecystectomy because of the bulk of inflamed specimens. Finally, the size of umbilical incision becomes similar in both SILC and laparo-

Table 3.
Comparison of Groups with Bile Duct Injury and without Bile Duct Injury of Patients who Required Additional Ports

	Group with BD Injury	Group without BD Injury	P Value
Strasberg classification			
Type A	3		
Type D	2		
Combined type A and D	1		
Sex			
Male	5	27	.243 [†]
Female	1	19	
Age			
<70 years	6	28	.058 [†]
>70 years	0	18	
Timing of operation after symptom onset, min ± SD	510.5 ± 590.5	116.4 ± 75.6	<0.001*
Severity grade according to TG18			
I	0	9	.323 [†]
II	6	33	
III	0	4	
ASA score			
1	0	11	.163 [†]
2	5	20	
3	1	15	
BMI, ± SD (kg/m ²)	24.9 ± 3.2	24.9 ± 3.2	.964*
WBC count, ± SD (cell count/μL)	10675.0 ± 2182.6	9983.3 ± 4570.6	.718*
CRP, ± SD (mg/dL)	4.1 ± 6.9	8.1 ± 9.0	.338*

ASA, American Society of Anaesthesiologists physical status; BD, Bile duct; BMI, Body mass index; CRP, C reactive protein; SD, Standard deviation; TG18, Tokyo Guidelines for the Management of Acute Cholangitis and Cholecystitis 2018; WBC, White blood cell count.

*T-test.

†Fisher's exact test.

scopic multiport cholecystectomy. In the present study, no patient suffered from postoperative incisional hernia, although the follow-up period was relatively short. Further study with long-term followup is needed to address this issue.

The present study shows that the first additional port at the epigastrium offers a good view of the operative field and provides adequate drainage when the additional port is required during SILC for acute cholecystitis. In addition, it helps to accomplish the operation without conversion to laparotomy. Future prospective studies with long-term followup are needed to address remaining questions regarding the incidence of umbilical hernia or usability of SILC in patients with symptoms for more than 3–4 days.

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