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BRIEF ARTICLE

Single-incision *vs* three-incision laparoscopic cholecystectomy for complicated and uncomplicated acute cholecystitis

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Abstract

AIM: To compare the clinical outcome of single-incision laparoscopic cholecystectomy (SILC) and three-incision laparoscopic cholecystectomy (3ILC) for acute cholecystitis.

METHODS: From July 2009 to September 2012, 136 patients underwent SILC or 3ILC for acute cholecystitis at a tertiary referral hospital. One experienced surgeon performed every procedure using 5 or 10 mm 30-degree laparoscopes, straight instruments, and conventional ports. Five patients with perforated gallbladder and diffuse peritonitis and 23 patients with mild acute cholecystitis were excluded. The remaining 108 patients were divided into complicated and uncomplicated groups according to pathologic findings. Patient demography, clinical data, operative results and complications were recorded and analyzed.

RESULTS: Fifty patients with gangrenous cholecystitis, gallbladder empyema, or hydrops were classified as the complicated group, and 58 patients with acute cholecystitis were classified as the uncomplicated group. Twenty-three (46.0%) of the patients in the complicated group (n = 50) and 39 (67.2%) of the patients in the uncomplicated group (n = 58) underwent SILC; all others underwent 3ILC. The postoperative length of hospital stay (PLOS) was significantly shorter in the SILC subgroups than the 3ILC subgroups (3.5 ± 1.1 d *vs* 4.6 ± 1.3 d, $P < 0.01$ in the complicated group; 2.9 ± 1.1 d *vs* 3.7 ± 1.4 d, $P < 0.05$ in the uncomplicated group). The maximum body temperature recorded at day 1 and at day 2 following the procedure was lower in the SILC subgroups, but the difference reached statistical significance only in the uncomplicated group (37.41 ± 0.56 ℃ *vs* 37.80 ± 0.72 ℃, $P < 0.05$ on postoperative day 1; 37.10 ± 0.43 ℃ *vs* 37.57 ± 0.54 ℃, $P < 0.01$ on postoperative day 2). The operative time, estimated blood loss, postoperative narcotic use, total length of hospital stay, conversion rates, and complication rates were similar in both SILC and 3ILC subgroups. The complicated group had longer operative time (122.2 ± 35.0 min *vs* 106.6 ± 43.6 min, $P < 0.05$), longer PLOS (4.1 ± 1.3 d *vs* 3.2 ± 1.2 d, $P < 0.001$), and higher conversion rates (36.0% *vs* 19.0%, $P < 0.05$) compared with the uncomplicated group.

CONCLUSION: SILC is safe and efficacious for patients with acute cholecystitis. The main benefit is a faster recovery than that achieved with 3ILC.

Key words: Single-incision laparoscopic cholecystectomy; Single-incision laparoscopic surgery; Laparoendoscopic single site surgery; Cholecystectomy; Acute cholecystitis; Complicated cholecystitis; Gangrenous cholecystitis

Core tip: single-incision laparoscopic cholecystectomy (SILC) is an alternative treatment for uncomplicated benign gallbladder diseases, but its role in acute cholecystitis remains unclear. This comparative analysis of SILC with three-incision laparoscopic cholecystectomy for treating acute cholecystitis represents the largest series to date and proportion of gangrenous cholecystitis patients (30.6%). The well-known drawbacks of SILC - longer operative time and higher cost - were alleviated by the larger paraumbilical incisions facilitating extraction of inflamed gallbladders and reliance on conventional instruments only. The low procedure conversion rate observed for SILC indicated its safety and efficacy for treating acute cholecystitis. SILC providing a faster recovery time was the main benefit to these patients.

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INTRODUCTION

Single-incision laparoscopic cholecystectomy (SILC) is a novel technique comparable to traditional multi-incision laparoscopic cholecystectomy (LC) for uncomplicated benign gallbladder diseases in respect of safety and efficacy[1-3]. In addition to well-established cosmetic advantage; decreased post-operative pain and faster recovery are potential benefits[4-6]. However, higher complication rates in SILC have been reported[7-9]. Therefore, application of this technique in cases of acute cholecystitis should be done with caution[10]. Published SILC studies contain a small number of patients with acute cholecystitis[11-15], while reports comparing SILC and traditional LC for acute cholecystitis are very rare[11].

SILC was developed as a step-by-step evolution of three-incision laparoscopic cholecystectomy (3ILC) and two-incision laparoscopic cholecystectomy (2ILC) in March 2010[16]. Importantly, only conventional instruments were used. Initially, this procedure was only adopted in patients with simple benign gallbladder disease. Since May 2011, however, SILC has been offered as an optional procedure for acute cholecystitis by our clinical practice. This study compares the clinical outcomes following SILC and 3ILC for acute cholecystitis over a period of 39 mo.

MATERIALS AND METHODS

From July 2009 to September 2012, 136 consecutive patients with acute cholecystitis underwent cholecystectomy by a single surgeon at a tertiary referral hospital in Hsin-Chu city, Taiwan. Five patients had perforated gallbladder and diffuse peritonitis and were excluded from the analysis. The role of laparoscopic operation in patients with perforated gallbladders and diffuse peritonitis remains controversial[17-19]. Twenty-three patients with "mild acute cholecystitis" were also excluded. The clinical course of this disease is similar to that of a biliary colic. To eliminate the bias related to disease severity, the enrolled 108 patients were divided into complicated and uncomplicated groups, according to operative and pathologic findings. Gangrenous cholecystitis, gallbladder empyema or hydrops were defined as complicated cholecystitis, while all other findings were defined as uncomplicated cholecystitis.

Patient demography, clinical data, operative results and complications were recorded. A modified APACHE Ⅱ was used as the preoperative prognostic score, namely, low risk: < 5 points, intermediate risk: 6-9 points, and high risk: ≥ 10 points[20]. The operative time was defined as the interval from initial skin incision to skin closure. Postoperative narcotic use was recorded as the intramuscular pethidine dose (mg) per kilogram of patient body weight (*i.e.*, 1 mg/kg). The postoperative length of hospital stay (PLOS) was defined as the duration between the day of surgery and the day of discharge in the same hospitalization. The total length of hospital stay referred to the total hospitalization duration including readmission for late-onset complications. The maximum body temperature (BT; ℃) of each day was recorded from postoperative day 1 to day 4 for patients who were still hospitalized. Any procedure that failed to be fulfilled as scheduled was regarded as converted. The complications were recorded according to the five-grade Clavien-Dindo classification system[21].

Surgical technique

The details of the surgical techniques have been described previously[16]. In SILC, two 5 mm straight instruments and a 5 mm 30-degree rigid laparoscope were inserted into the abdominal cavity *via* three 5 mm ports in a vertical line at a 2 cm paraumbilical incision on the left side. An optional 2 mm right subcostal incision was made for the passage of a transcystic duct catheter to perform an intraoperative cholangiography (IOC). An assistant controlled the retraction grasper in the middle port. The operator controlled the working instrument in the upper port with the right hand and the laparoscope in the lower port with the left hand (self-camera technique). At the end of the procedure, the lower 5 mm port was upgraded to a 10 mm reusable port for specimen extraction into a retrieval bag. All the fascial defects and the skin incision

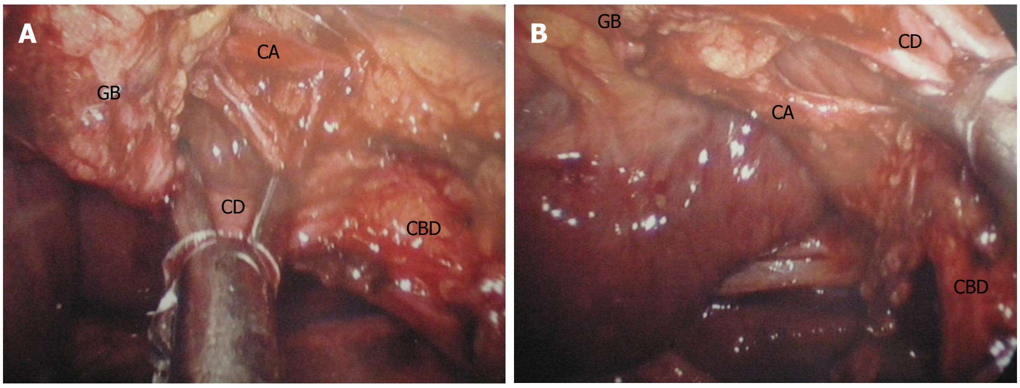

Figure 1 Critical view of safety during a single-incision laparoscopic cholecystectomy for acute cholecystitis. Anterior (A) and posterior (B) views are shown. GB: Gallbladder; CA: Cystic artery; CD: Cystic duct; CBD: Common bile duct.

were sutured. In 3ILC, a 10 mm 30-degree rigid laparoscope was inserted *via* a 10 mm reusable port at a 1 cm infraumbilical incision. The 5 mm working instrument and retraction grasper were inserted *via* two separate 5 mm ports at the epigastrium and right flank respectively.

When a severely inflamed gallbladder or dense pericholecystic fibrosis was encountered at an early stage of the procedure, the threshold for using additional port sites was low. A suction irrigation device was used for decompression of a severely distended gallbladder and meticulous dissection in an unclear operative field. Every effort was made to obtain the critical view of safety (Figure 1), following the recommendations by Strasberg *et al*[22]. If the anatomy of the Calot's triangle was obscure, dissection would be started from the gallbladder dome (retrograde cholecystectomy). In difficult situations, the gallbladder neck or posterior wall was not disturbed (subtotal cholecystectomy)[23,24]. The cystic duct stump or gallbladder neck was secured with intracorporeal suturing if the diameter was too big or the tissue was too fragile to be clipped. In infrequent cases, the liver bed was packed with gauze temporarily if the monopolar electrocautery had failed to achieve hemostasis. Wound extension to fit a firm and swollen gallbladder was usually carried out at the infraumbilical incision in 3ILC, but it was largely unnecessary in SILC. When a subhepatic drain was placed, it was always removed within 48 h after the operation if there was no bile leakage. After discharge, all the patients attended follow-up periods of more than 1 mo.

Statistical analysis

Data were analyzed using Pearson's χ^2 test and Student's t test. A P value of less than 0.05 was considered statistically significant.

RESULTS

The complicated group (gangrenous cholecystitis, gallbladder empyema or hydrops) consisted of 50 patients, and the uncomplicated group (acute cholecystitis) consisted of 58 patients. Twenty-three (46.0%) of the patients in the complicated group and 39 (67.2%) of the patients in the uncomplicated group underwent SILC; the remaining patients all underwent 3ILC. The demographic characteristics, clinical data, and pathologic findings showed no statistically significant differences between the SILC and 3ILC subgroups in either the complicated or uncomplicated groups (Table 1). Patients with gangrenous cholecystitis constituted a major portion of the complicated group (65.2% in the SILC subgroup and 66.7% in the 3ILC subgroup). Preoperative endoscopic retrograde cholangiopancreatography (ERCP) was performed on 13 patients during the same hospitalization to address suspicious concomitant choledocholithiasis (Table 2). Nine of the patients showed a positive result and subsequently underwent immediate therapeutic endoscopic sphincterotomy (EST) for stone clearance. Eleven patients had suspicious concomitant choledocholithiasis without preoperative ERCP and subsequently underwent IOC; the results for all were negative. In cases of positive IOC, common bile duct exploration was performed under laparoscopy.

PLOS and postoperative BT were the only two parameters that displayed a statistical difference between the two subgroups (Tables 2 and 3). The SILC subgroup had a shorter PLOS than the 3ILC subgroup in the complicated and uncomplicated groups ($P < 0.01$ and < 0.05, respectively). The SILC subgroups had a lower maximum BT than the 3ILC subgroups on the postoperative day 1 and day 2 (Figure 2), but the difference reached statistical significance only in the uncomplicated group ($P < 0.05$ for postoperative day 1 and $P < 0.01$ for postoperative day 2). Additional port sites were needed to fulfill the operations in eighteen patients of the complicated group and eleven patients of the uncomplicated group. Converted to an open cholecystectomy (OC) was not necessary in any case. The conversion rates in the SILC and 3ILC subgroups were similar (34.8% *vs* 37.0% in the complicated group; 17.9% *vs* 21.1% in the uncomplicated group).

Fourteen complications occurred in 11 patients (Table 4). The differences in complication rates between the SILC and 3ILC subgroups were statistically insignificant. Four patients experienced mild pulmonary effusion and/or atelectasis, a grade Ⅰ complication that resolved spon-

Table 1 Patient characteristics and pathology *n* (%)

	Complicated acute cholecystitis		*P* value	Uncomplicated acute cholecystitis		*P* value
	SILC group (*n* = 23)	3ILC group (*n* = 27)		SILC group (*n* = 39)	3ILC group (*n* = 19)	
Age (yr)	51.2 ± 15.3	58.0 ± 17.3	0.147	49.1 ± 13.9	54.6 ± 14.5	0.167
Sex (male/female)	7/16	10/17	0.623	24/15	9/10	0.306
Body mass index (kg/m^2)	25.24 ± 3.36	26.36 ± 3.59	0.272	25.01 ± 2.67	26.99 ± 4.35	0.081
Modified APACHE Ⅱ score (points)			0.318			0.595
0-5, low risk	21 (91.3)	22 (81.5)		36 (92.3)	17 (89.5)	
6-9, intermediate risk	2 (8.7)	5 (18.5)		2 (5.1)	2 (10.5)	
10-11, high risk	0	0		1 (2.6)	0	
Previous abdominal surgery	7	3	0.089	6	5	0.319
Previous biliary symptoms	12	10	0.283	30	11	0.135
Duration of acute symptoms > 72 h	14	14	0.522	34	13	0.087
Pathology			0.985			
Gangrene	15 (65.2)	18 (66.7)		-	-	
Empyema	6 (26.1)	7 (25.9)		-	-	
Hydrops	2 (8.7)	2 (7.4)		-	-	
Acute inflammation	-	-		39 (100)	19 (100)	

SILC: Single-incision laparoscopic cholecystectomy; 3ILC: Three-incision laparoscopic cholecystectomy.

Table 2 Operative modifications and results *n* (%)

	Complicated acute cholecystitis		*P* value	Uncomplicated acute cholecystitis		*P* value
	SILC group (*n* = 23)	3ILC group (*n* = 27)		SILC group (*n* = 39)	3ILC group (*n* = 19)	
Preoperative ERCP	0	3	0.099	0	1	0.148
Preoperative ERCP and EST	2	0	0.118	3	4	0.143
Intraoperative cholangiography	1	0	0.274	5	5	0.202
Operative time (min)	119.8 ± 38.8	124.3 ± 32.1	0.660	100.9 ± 42.1	118.4 ± 45.5	0.154
Estimated blood loss (mL)	43.2 ± 29.8	31.0 ± 26.6	0.156	24.2 ± 31.5	29.5 ± 29.9	0.548
Pethidine dose (mg/kg)	0.624 ± 0.505	0.535 ± 0.740	0.632	0.618 ± 0.485	0.549 ± 0.427	0.601
Postoperative length of hospital stay (d)	3.5 ± 1.1	4.6 ± 1.3	< 0.010	2.9 ± 1.1	3.7 ± 1.4	< 0.050
Total length of hospital stay (d)	6.0 ± 3.6	5.8 ± 3.1	0.814	4.1 ± 1.9	6.4 ± 4.7	0.053
Conversion						
Overall	8 (34.8)	10 (37.0)	0.869	7 (17.9)	4 (21.1)	0.777
2ILC	4	-		3	-	
3ILC	2	-		1	-	
4ILC (standard LC)	2	10		3	4	
OC	0	0		0	0	

SILC: Single-incision laparoscopic cholecystectomy; 2ILC: Two-incision laparoscopic cholecystectomy; 3ILC: Three-incision laparoscopic cholecystectomy; 4ILC: Four-incision laparoscopic cholecystectomy; OC: Open cholecystectomy; ERCP: Endoscopic retrograde cholangiopancreatography; EST: Endoscopic sphincterotomy.

Table 3 Postoperative body temperature

Maximum body temperature (℃)	Complicated acute cholecystitis		*P* value	Uncomplicated acute cholecystitis		*P* value
	SILC group	3ILC group		SILC group	3ILC group	
Post-op day 1	37.73 ± 0.57	38.03 ± 0.66	0.096	37.41 ± 0.56	37.80 ± 0.72	< 0.050
Post-op day 2	37.38 ± 0.59	37.58 ± 0.46	0.180	37.10 ± 0.43	37.57 ± 0.54	< 0.010
Post-op day 3	37.12 ± 0.49	37.30 ± 0.49	0.215	37.04 ± 0.45	37.04 ± 0.56	0.990
Post-op day 4	37.18 ± 0.44	37.19 ± 0.45	0.974	36.88 ± 0.41	36.86 ± 0.33	0.915

Including only patients who were still hospitalized. SILC: Single-incision laparoscopic cholecystectomy; 3ILC: Three-incision laparoscopic cholecystectomy; post-op: Postoperative.

taneously within a few days[21]. Three patients developed grade Ⅱ complications, including infected nonbilious subhepatic collection (*n* = 1), relapsed cholangitis with bacteremia (*n* = 1), and refractory diarrhea (*n* = 1); all were treated conservatively with intravenous antibiotics and fluid therapy. Three patients had grade Ⅲa complications, including infected nonbilious subhepatic collections (*n* = 2) and retained bile duct stones (*n* = 1); the first two patients were managed with percutaneous pigtail drainage and intravenous antibiotics, and the last underwent an ERCP with EST. One patient underwent a laparotomy to remove retained impacted bile duct stones, a grade Ⅲb

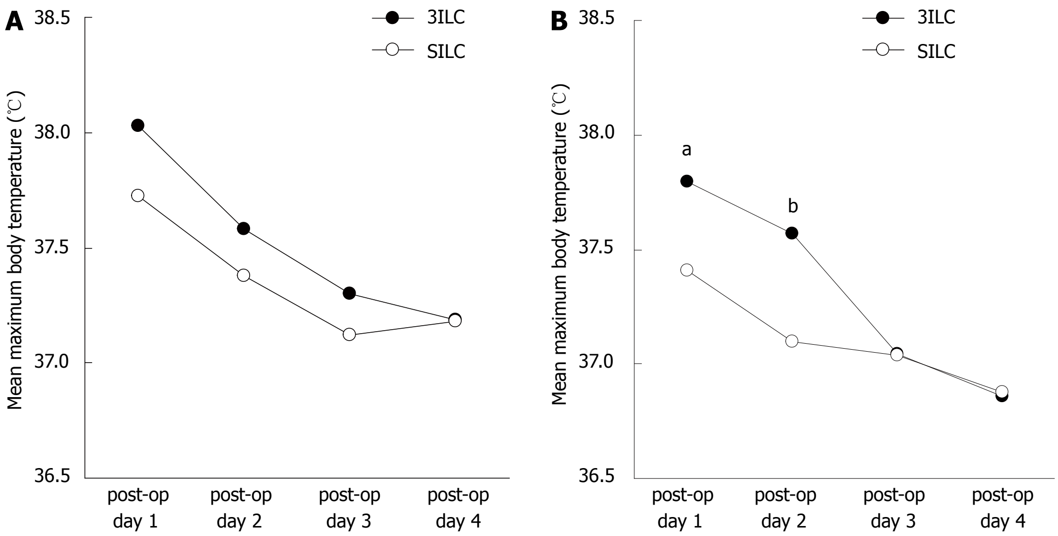

Figure 2 Postoperative mean maximum body temperature for the complicated acute cholecystitis group (A) and the uncomplicated acute cholecystitis group (B). [a]*P* < 0.05, [b]*P* < 0.01 *vs* SILC. 3ILC: Three-incision laparoscopic cholecystectomy; SILC: Single-incision laparoscopic cholecystectomy; post-op: Postoperative.

Table 4 Complications *n* (%)

Complications	Complicated acute cholecystitis		*P* value	Uncomplicated acute cholecystitis		*P* value
	SILC group (*n* = 23)	3ILC group (*n* = 27)		SILC group (*n* = 39)	3ILC group (*n* = 19)	
Overall[1]	3 (13.0)	3 (11.1)	0.834	3 (7.7)	2 (10.5)	0.718
Grade Ⅰ	1 (4.3)[1]	1 (3.7)[2]		2 (5.1)[3]	0	
Grade Ⅱ	1 (4.3)[4]	0		1 (2.6)[5]	1 (5.3)[6]	
Grade Ⅲa	1 (4.3)[7]	2 (7.4)[8]		0	0	
Grade Ⅲb	0	0		0	1 (5.3)[9]	
Grade Ⅳa, Ⅳb, Ⅴ	0	0		0	0	

[1]Pleural effusion and atelectasis; [2]Pleural effusion; [3]One was pleural effusion and atelectasis; the other was pleural effusion; [4]Refractory diarrhea; [5]Infected subhepatic collection; [6]Relapsed cholangitis with bacteremia; [7]Infected subhepatic collection and pleural effusion; [8]One was infected subhepatic collection; the other was retained bile duct stones; [9]Retained bile duct stones. SILC: Single-incision laparoscopic cholecystectomy; 3ILC: Three-incision laparoscopic cholecystectomy.

Table 5 Overall comparison of complicated and uncomplicated acute cholecystitis groups

	Complicated acute cholecystitis (*n* = 50)	Uncomplicated acute cholecystitis (*n* = 58)	*P* value
Age (yr)	54.9 ± 16.6	50.9 ± 14.2	0.184
Sex (male/female)	33/17	33/25	0.333
Modified APACHE Ⅱ score			0.320
0-5, low risk	43 (86.0)	53 (91.4)	
6-9, intermediate risk	7 (14.0)	4 (6.9)	
10-11, high risk	0	1 (1.7)	
Operative time (min)	122.2 ± 35.0	106.6 ± 43.6	< 0.050
Estimated blood loss (mL)	36.1 ± 28.3	26.0 ± 30.8	0.092
Pethidine dose (mg/kg)	0.577 ± 0.633	0.595 ± 0.464	0.867
Postoperative length of hospital stay (d)	4.1 ± 1.3	3.2 ± 1.2	< 0.001
Total length of hospital stay (d)	5.9 ± 3.3	4.8 ± 3.3	0.098
Conversion	18 (36.0)	11 (19.0)	< 0.050
Complications	6 (12.0)	5 (8.6)	0.563

Data are expressed as absolute numbers (percentage) or mean ± SD.

complication. The seven patients with grade Ⅱ, Ⅲa and Ⅲb complications all needed a secondary hospitalization (range: 5-16 d) and recovered uneventfully.

In summary, the complicated group experienced longer operative times (*P* < 0.05), longer PLOS (*P* < 0.001), and higher conversion rates (*P* < 0.05) (Table 5).

DISCUSSION

SILC, also known as laparoendoscopic single site cholecystectomy, has increased in popularity worldwide in recent years. While multiple studies have reported this novel technique to be as safe as traditional LC for the treatment of uncomplicated benign gallbladder disease[1-3], some have demonstrated that SILC is associated with a higher complication rate[7-9]. Applying SILC in more complex circumstances, such as acute cholecystitis, becomes an interesting angle in which to study SILC in complex circumstances. To date, the published SILC studies have focused on only a small number of patients with acute cholecystitis and comparative studies have been rare[11-15].

According to the 2010 Society of American Gastrointestinal and Endoscopic Surgeons guideline for the clinical application of laparoscopic biliary tract surgery, the indications, contra-indications and preoperative preparation for SILC are the same as those for multi-port cholecystectomy[17]. Both procedures should share the same safety standards with a low conversion threshold. We strictly followed these safety guidelines. Before adopting this technique for acute cholecystitis in May 2011, we had performed over 50 complication-free SILC procedures for simple benign gallbladder disease. Additionally, we are proficient at modified techniques to manage gallbladder complications, such as decompression, meticulous dissection with a suction irrigation device, retrograde cholecystectomy, subtotal cholecystectomy, and intracorporeal suturing the cystic duct stump or gallbladder neck. In SILC, a subhepatic drain always passed through an additional port site. Firm, fragile or severely inflamed gallbladders are usually difficult to retract. Therefore, conventional straight instruments were used in our cases, as the more elastic nature of curved or angulated instruments are not suitable. Because we only used conventional instruments, the procedures could be easily and rapidly converted to multi-incision laparoscopic or open operations for safety concerns.

Pathologic findings often have an effect on operative results of LC[25-27]. To eliminate this bias, we divided patients into two groups according to disease severity. The comparison between complicated and uncomplicated groups showed significant differences in operative time (P < 0.05), PLOS (P < 0.001), and conversion rates (P < 0.05) (Table 5). The findings implicated that the two groups were different. The difference in complication rates did not reach statistical significance. This may be due to inadequate patient number and low complication rates.

The finding that the SILC subgroups had a shorter PLOS than the 3ILC subgroups was consistent with our previous study (Table 2)[16]. Even small traumatic effects can influence postoperative recovery. In case of acute cholecystitis, we followed a rule that patients who tolerated oral feeding well and had a BT under 37.5 ℃ for more than 24 h should be discharged. In this study, all the patients resumed oral feeding the morning after the operation, and most of them tolerated it well. Accordingly, postoperative fever became the critical factor leading to longer PLOS. The finding that the SILC subgroups had a lower maximum BT than the 3ILC subgroups on the postoperative day 1 and day 2 explained the shorter PLOS in the SILC subgroups (Table 3, Figure 2). Although the difference in maximum BT reached statistical significance only in the uncomplicated group, we were more concerned about the postoperative fever in patients with complicated acute cholecystitis. We tended to associate the febrile episodes with postoperative infection in these patients. Accordingly, the small difference in maximum postoperative BT between the SILC and 3ILC subgroups in the complicated group influenced the PLOS significantly. The occurrence of postoperative fever was related to the inflammatory response to cholecystitis, atelectasis, and postoperative septic sequelae. Considering the similar pathologic distributions (disease severity) and postoperative complication rates in the SILC and 3ILC subgroups, it is possible that atelectasis may account for the difference in postoperative BT. Upper abdominal incision (upper midline or subcostal incisions) is a well-established risk factor for the development of atelectasis after abdominal surgery[28], and traditional multi-incision LC was associated with impaired postoperative pulmonary function and an incidence of atelectasis up to 30% in several studies[29-31]. A lower incidence of febrile episodes following LC correlated with improved postoperative pulmonary function and minimal surgical trauma was observed[32]. Thus, 3ILC caused more febrile episodes in the first two postoperative days, and small upper abdominal incisions played a role in impaired postoperative pulmonary function (atelectasis) for patients with acute cholecystitis. We hypothesize that the faster recovery following SILC may be derived not from decreased pain severity, but rather location.

The operative duration and pethidine dose showed no significant difference between the two subgroups (Table 2). It is our opinion that the longer SILC duration in our previous study simply reflected an effect of the learning curve[16,33,34]. The typical SILC procedure for simple benign gallbladder disease takes less than one hour. In addition, the 1 cm infraumbilical incision in a 3ILC was too small to fit a swollen gallbladder, and it took some time to enlarge the incision during specimen extraction. The operative duration spent in SILC and 3ILC was comparable in most cases, for both simple and complicated gallbladder disease. Although we failed to reveal the difference in postoperative narcotic use between the two subgroups, it is too early to make a conclusion. In our clinical practice, a steady intramuscular pethidine dose is available, but the patients may feel pain in different degrees. To clarify the issue of postoperative pain related to the procedures, more detailed studies are necessary.

The outcome following a converted LC is worse than that following a successful LC[35,36]. A qualified laparoscopic surgeon should never hesitate to convert the procedure in an early stage if patient safety is questionable in difficult situations. The high conversion rate in our study (36% in the complicated group and 19% in the uncomplicated group) reflected our safety concerns (Table 5). Consistent with other studies, no procedure was converted to an OC[23,24]. The above-mentioned modified laparoscopic procedures for severe cholecystitis, such as gallbladder decompression, dissection with a suction irrigation device, retrograde cholecystectomy, subtotal cholecystectomy and intracorporeal suturing, might reduce the open conversion rates tremendously without increasing the complication rates.

In conclusion, SILC with conventional instruments is as safe and efficacious as traditional multi-incision LC for both complicated and uncomplicated acute cholecystitis in experienced hands. The complication rate is low, and the major benefit for patients is faster postoperative recovery. Before applying SILC in difficult gallbladders, a surgeon must be proficient in this novel technique for simple gallbladder disease and the modified laparoscopic techniques for severe cholecystitis. A low threshold for converting the procedure should be maintained for patient safety. Further prospective randomized trials are needed to verify our findings.

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COMMENTS

Background

Single-incision laparoscopic cholecystectomy (SILC) is a novel technique, with safety and efficacy profiles that are comparable to traditional multi-incision laparoscopic cholecystectomy (LC) for uncomplicated benign gallbladder diseases. For complicated gallbladder diseases, such as acute cholecystitis, the published studies regarding SILC have thus far been conducted with only a small number of patients. Studies comparing SILC and traditional LC for acute cholecystitis are rare, but necessary.

Research frontiers

Single-incision laparoscopic surgery (SILS; also known as laparoendoscopic single site surgery) is a novel minimally invasive technique, compared with the traditional multi-incision laparoscopic surgery. Besides the obvious cosmetic advantage (producing no visible scar), decreased post-operative pain and faster recovery are the potential benefits of SILS. However, the higher complication rate that accompanies a beginner operator's learning curve must be accounted for when choosing to apply this technique.

Innovations and breakthroughs

SILC with conventional instruments is as safe and efficacious as traditional multi-incision LC for both complicated and uncomplicated acute cholecystitis when performed by a physician with experienced hands. In particular, the patient benefits are low complication rate and faster postoperative recovery. Before applying SILC in difficult gallbladders, a surgeon must be proficient in this novel technique for simple gallbladder disease and the modified laparoscopic techniques for severe cholecystitis. A low threshold for converting the procedure should be maintained to help ensure patient safety.

Applications

This study suggests that SILC with conventional instruments can be applied to patients with acute cholecystitis safely and efficaciously, particularly when performed by physicians with experienced hands. Better cosmetic outcome and faster recovery time are major advantages.

Terminology

Single-incision laparoscopic surgery is a minimally invasive surgical procedure, in which the surgeon operates through a small single entry site - often the navel. As such, this procedure is considered a type of scarless surgery. The SILS procedure is a good alternative approach (compared to the traditional surgical cholecystectomy procedure) for treating acute cholecystitis, an acute inflammation of the gallbladder characterized by unendurable pain in the right upper abdominal quadrant and is closely correlated with gallbladder stones.

Peer review

This comprehensive comparative study of SILC and the traditional multi-incision LC treatment approach for acute cholecystitis represents the largest case series investigation of SILC in acute cholecystitis published to date. As well as better cosmetic outcome, SILC was shown to have a faster recovery time and less complications. The postoperative complication of fever remains to be fully understood and may be primarily related to the body's inflammatory response to the cholecystitis rather than the surgical procedure itself. Unfortunately, the well known difference in cost between the two procedures and the longer operating time required by SILC make it difficult to justify further prospective studies.

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