pISSN: 2508-5778 • eISSN: 2508-5859
Ann Hepatobiliary Pancreat Surg 2024;28:214-219
https://doi.org/10.14701/ahbps.23-168

AHBPS
Annals of Hepato-Biliary-Pancreatic Surgery

Original Article

Laparoscopic subtotal cholecystectomy in difficult gallbladder: Our experience in a tertiary care center

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Backgrounds/Aims: Open cholecystectomy is becoming obsolete and laparoscopic cholecystectomy has become the treatment of choice in gallstone diseases. Difficult gallbladders are encountered whenever there is a frozen calot's triangle, obliterated cystic plate, or both. Rather than converting to open procedure, there has been a growing preference for laparoscopic subtotal cholecystectomy (LSC) during difficult gallbladders. This study aimed to assess the advantages, indications, and viability of LSC in difficult gallbladders.
Methods: The study included patients undergoing laparoscopic cholecystectomy in NIMS Hospital, Jaipur, from January 2021 to January 2023. Data of the patients who underwent LSC for difficult gallbladders included demographics, comorbidities, operative time, conversion to open cholecystectomy, length of hospital stay, and complications. LSC was classified into three types depending on the part of the gallbladder remnant.
Results: A total of 728 patients underwent laparoscopic cholecystectomy. Among them, 41 patients (5.6%) were attempted for LSC. However, one patient was converted to an open procedure and the rest 40 underwent LSC. LSC was divided into 3 types, 4 patients underwent LSC type I, 34 patients underwent type II, and 2 patients type III. The average operating time and postoperative length of hospital stay were 86.2 minutes and 2.1 days, respectively. Two patients had surgical site infection. No patient had a bile leak and none required intensive care unit care.
Conclusions: LSC is a safe and feasible option for use in difficult gallbladders.

Key Words: Gallbladder diseases; Laparoscopy; Cholecystectomy; Subtotal cholecystectomy; Difficult gallbladder

INTRODUCTION

Gallbladder disorders place a considerable burden on public health worldwide. The prevalence of gallstone disease, a prevalent gastrointestinal condition that usually necessitates hospitalization, has increased with the westernization of society. In Northern India, the prevalence is approximately 6.2% [1]. The preferred method of treating gallstones is cholecystectomy. Notably, globally, laparoscopic procedures have supplanted open cholecystectomy marking a paradigm shift [2].

However, even with laparoscopy, injury to the common bile duct (CBD) during operative procedures is still a serious challenge. Additionally, inflammation frequently accompanying difficult gallbladders changes the native anatomy and makes dissection difficult [3]. The difficult gallbladder poses a greater threat to surgical safety when compared with normal cholecystectomy [4,5]. Subtotal cholecystectomy removes a portion of the gallbladder when the structures of the Calot's triangle cannot be identified, dissection between the gallbladder wall and liver bed cannot be accomplished, or the critical view of safety cannot be achieved. In this laparoscopic era, laparoscopic subtotal cholecystectomy (LSC) is replacing open subtotal cholecystectomy, and has demonstrated reduced morbidity [6]. LSC is defined as a procedure where the cystic duct cannot be isolated and ligation is done to a part of the gallbladder rim around the duct [7].

A comprehensive literature search revealed a dearth of studies that compared the outcomes of laparoscopic cholecystectomy (LC) with LSC. To assess the advantages, indications, and viability of LSC in these difficult gallbladders, this study eval-

Received: December 8, 2023, **Revised:** January 25, 2024,
Accepted: January 30, 2024, **Published online:** February 27, 2024

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uated how LSC influences complication rate, safety, length of hospital stay, and mortality. The study aimed to bridge the evidence gap and help clinicians in making an informed decision.

MATERIALS AND METHODS

This prospective study was carried out in the Department of Surgical Gastroenterology and Hepato-Pancreato-Biliary (HPB) unit between January 2021 to January 2023. All patients who underwent LC were considered for the study. Patients under the age of 12, those who were contraindicated for general anesthesia, and those with suspected gallbladder cancer were excluded from the study. The study commenced after receiving institutional review board clearance (IRB no. IEC/P-2332023). Informed consent was confirmed by the IRB.

The primary outcome was the frequency of CBD injuries. Secondary outcomes were indications for LSC, surgical methods implemented, complications encountered during or after the procedure, number of patients that required a re-operation, and frequency of mortality in 30 days.

Patients' preoperative information, including demographics, symptom complexity, comorbidities, results of all routine laboratory tests, abdominal ultrasound results, and general anesthetic suitability, was collected. Additionally, previous examinations and techniques, such as endoscopic retrograde cholangiopancreatography (ERCP), were noted. Magnetic resonance cholangiopancreatography was performed only when necessary.

Intraoperative data included the type of anesthesia used, the American Society of Anesthesiologists (ASA) grade, the total duration of the operative procedure, the type of subtotal cholecystectomy performed and its indication, intraoperative blood transfusions, conversion to open cholecystectomy, and the insertion of additional laparoscopic ports.

Postoperative data included the length of hospital and intensive care unit (ICU) stays following surgery, postoperative complications, 30-day mortality, readmissions, and the necessity for further investigation.

Operative approach

Standard 4 ports for LC were used. Additional laparoscopic ports were used in selected cases mainly to lift the left lobe and to retract the stomach and duodenum. LSC was classified into three types (Table 1) [6].

In type I, the calot's triangle was dissected, cystic duct and artery were identified, clipped separately, and divided. The anterior wall of the gallbladder was removed and the mucosa of the posterior wall was ablated using diathermy. In type II, the fundus first approach was used. The gallbladder was opened at the infundibulum and neck region circumferentially. Stones and sludge from the gallbladder remnant were evacuated and the mucosa was cauterized. The leftover gallbladder was sutured. In type III, both the posterior wall and part of the gallbladder neck were left behind and the mucosa was ablated. Contents of the gallbladder and the specimen were procured into an endo bag and removed. Remnant gallbladder stump closure in type II and type III was accomplished by intracorporeal suturing. Abdominal drainage kits were used in a few cases only.

Statistical analysis

The data was compiled in Microsoft Excel version 16.7 and analyzed with the statistical software GraphPad InStat v3.0. Patient demographics and outcomes were compared between LC and LSC. Categorical variables were expressed as frequency and percentages and analyzed using the chi-square test (when the value of each cell was > 5) or Fischer's exact test (when the value of a cell was 5 and below). The continuous variables are presented as mean (standard deviation). Comparison between two groups was analyzed using the unpaired t-test while three groups were compared using analysis of variance (ANOVA). p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 728 patients underwent LC in this 2-year period. Out of which 41 patients (5.6%) were attempted for LSC. Only 1 patient was converted to an open procedure. Among the remaining 687,564 patients underwent conventional LC, 99 underwent cholecystectomy along with CBD exploration, and 24 underwent cholecystectomy along with other procedures. In this study, a comparison between LSC (40 patients) and conventional LC (564 patients) was done.

In patients who underwent LSC, a majority (32.5%) of patients belonged to the age group between 31 and 40 years. The age group between 61 to 70 years made up 25% of the population making it the second most prevalent. Fig. 1 depicts the

Table 1. Classification of laparoscopic subtotal cholecystectomy

Type	Definition
Type I	Difficult gallbladder bed where the posterior wall of gallbladder is left in situ
Type II	Difficult calot's triangle where part of gallbladder neck is left and sutured
Type III	Both difficult gallbladder bed and calot's triangle where part of the gallbladder neck and posterior wall left in situ. Gallbladder neck is sutured.

Cited from the article of Gode et al. (Int J Med Sci Public Health 2014;3:397-400) [6].

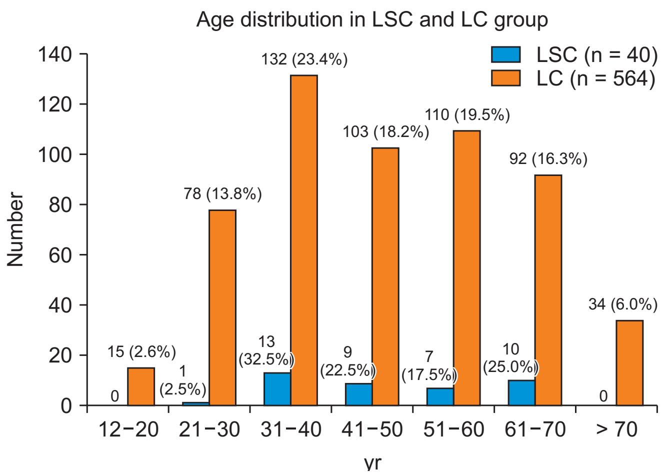

Fig. 1. Age distribution of patients who underwent laparoscopic subtotal cholecystectomy (LSC) and laparoscopic cholecystectomy (LC).

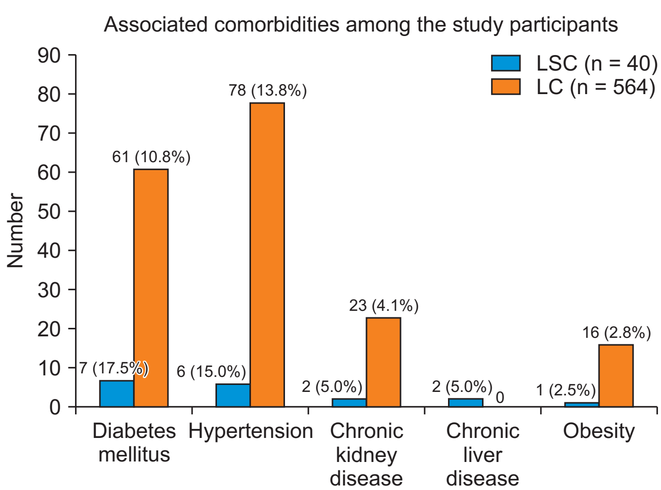

Fig. 2. Distribution of comorbidities among patients who underwent laparoscopic subtotal cholecystectomy (LSC) and laparoscopic cholecystectomy (LC).

Table 2. Indications for LSC and LC among the patients included in the study

	LSC (n = 40)	LC (n = 564)
Chronic calculous cholecystitis	18 (45.0)	27 (4.8)
Post ERCP for gall stone disease	20 (50.0)	27 (4.8)
Emphysematous cholecystitis	2 (5.0)	7 (1.2)
Symptomatic cholelithiasis	0 (0)	330 (58.5)
Acute calculous cholecystitis	0 (0)	129 (22.8)
Gallbladder perforation	0 (0)	5 (0.9)
Gallbladder polyp	0 (0)	25 (4.4)
Mirrizzi syndrome	0 (0)	14 (2.5)

Values are presented as number (%).
ERCP, endoscopic retrograde cholangiopancreatography; LC, laparoscopic cholecystectomy; LSC, laparoscopic subtotal cholecystectomy.

age distribution among the study population. In this research, a female preponderance of 29/40 (72.5%) patients in the LSC group and 405/564 (71.8%) patients in the LC group was also noted. However, no statistical difference was noted in gender distribution in comparison with the chi-square test ($p = 0.92$).

Among the 40 patients who underwent LSC, 30 patients (75%) were in ASA grade II, 6 patients (15%) in ASA grade I, and 4 patients (10%) in ASA grade III. Among the LC group, 439 patients (77.8%) were in ASA-II, while 86 (15.2%) and 39 (6.9%) were in ASA-I and ASA-III, respectively. Fig. 2 shows the distribution of comorbidities between the two study groups.

All the patients had severe inflammatory changes due to chronic calculus cholecystitis, ERCP for choledocholithiasis, emphysematous cholecystitis, etc. The study procedure has been described in Table 2.

The average operating time was 86.2 ± 12.8 minutes in LSC compared to 50.3 ± 7.5 minutes in LC. A statistical decrease in operating time was seen in LC with $p < 0.001$ using unpaired t-test. The average postoperative length of hospital stay was 2.5 ± 0.7 days and 1.1 ± 0.3 days in LSC and LC, respectively, with a statistical increase in hospital stay in the LSC group ($p <$

Table 3. Comparison between LSC and LC

Variable	LSC (n = 40)	LC (n = 564)	*p*-value
Operative time (min)	86.2 ± 12.8	50.3 ± 7.5	< 0.001 (unpaired t test)
Additional laparoscopic ports used	3 (7.5)	21 (3.7)	0.237 (Fischer exact test)
Abdominal drain	28 (70.0)	39 (6.9)	< 0.001 (chi-square test)
Postoperative complication			
Surgical site infection	2 (5.0)	10 (1.8)	0.15 (Fischer exact test)
Bilioma	0 (0)	2 (0.4)	> 0.999 (Fischer exact test)
Bile duct injury	0 (0)	2 (0.4)	> 0.999 (Fischer exact test)
Postoperative length of hospital stay (day)	2.5 ± 0.7	1.1 ± 0.3	< 0.001 (unpaired t test)

Values are presented as mean ± standard deviation or number (%).
LC, laparoscopic cholecystectomy; LSC, laparoscopic subtotal cholecystectomy.

Table 4. Comparison between types of LSC

	LSC type I (n = 4)	LSC type II (n = 34)	LSC type III (n = 2)
Sex			
Male	2 (50.0)	9 (26.5)	0 (0)
Female	2 (50.0)	25 (73.5)	2 (100)
Comorbidity			
Diabetes mellitus	1 (25.0)	6 (17.6)	0 (0)
Hypertension	0 (0)	6 (17.6)	0 (0)
Chronic kidney disease	0 (0)	2 (5.9)	0 (0)
Chronic liver disease	2 (50.0)	0 (0)	0 (0)
Obesity	0 (0)	0 (0)	1 (50.0)
ASA			
I	1 (25.0)	5 (14.7)	0 (0)
II	3 (75.0)	25 (73.5)	2 (100)
III	0 (0)	4 (11.8)	0 (0)
Indications			
Chronic calculous cholecystitis	2 (50.0)	15 (44.1)	1 (50.0)
Post ERCP for gall stone disease	2 (50.0)	17 (50.0)	1 (50.0)
Emphysematous cholecystitis	0 (0)	2 (5.9)	0 (0)

Values are presented as number (%).
ASA, American society of Anesthesiologists; ERCP, endoscopic retrograde cholangiopancreatography; LSC, laparoscopic subtotal cholecystectomy.

0.001 using unpaired t-test). No patient required ICU care. Overall, these results suggest that LSC procedures resulted in statistically significantly longer operating times and postoperative hospital stays than those of LC (Table 3). Postoperative complications occurred in 2/40 (5.0%) patients in the LSC group, and both patients had wound infection, versus 14/564 (2.5%) in the LC group. There was no statistically significant increased complications rate in the LSC group compared to conventional LC. Table 3 compares the two study procedures. The minimum follow-up period was 180 days with the average follow-up period being 284 days. No patients developed biliary stricture, readmission, or reinterventions during the follow-up period. Also, during the follow-up period, no patients developed problems associated with remnant gallbladder like cholecystitis or gallstone disease.

The study team conducted a further investigation by further comparing the different types of LSC that were performed. We observed that LSC type II was most frequently conducted (34/40 patients [85.0%]). Out of 40 patients, 4 (10.0%) underwent type I LSC, while 2/40 (5.0%) patients underwent type III LSC. Table 4 presents the demographic details of the three types of LSC carried out.

Among the patients who underwent type I LSC, 2/34 (5.9%) patients had chronic liver disease (CLD), and hence dissection along the cystic plate was not contemplated and the posterior wall of the gallbladder was left in situ with mucosa ablated. The other two cases had obliterated cystic plates. Additional laparoscopic ports were used in three cases, in one case to retract the redundant left lobe of the liver and in two cases of a cholecysto-duodenal fistula to retract the stomach and duodenum. In all three cases, one extra port was used in the left upper abdomen, just left of midline, mid-way between the standard umbilical and epigastric port. An abdominal drainage kit was used in 28 (70.0%) patients only which was removed after 48 hours when drainage was minimal and nonbilious. The operative parameters are depicted in Fig. 3. On analyzing the total operative time, no statistical difference was noted among the three groups (LSC-I: 80.4 ± 10.2 minutes vs. LSC-II: 90 ± 12.8 minutes vs. LSC-III: 88.2 ± 9.2 minutes) with p = 0.35 on ANOVA test. However, there was a statistical reduction

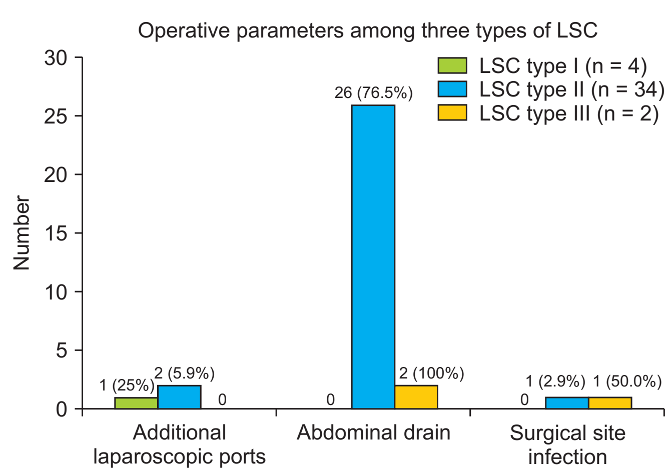

Fig. 3. Comparison of the operative parameters among the three types of laparoscopic subtotal cholecystectomy (LSC).

in postoperative length of hospital stay in LSC-I compared to those in LSC-II and LSC-III with $p = 0.018$ on the ANOVA test. The postoperative length of hospital stay was 1.5 ± 0.5 days, 2 ± 0.5 days, and 2.8 ± 0.6 days in LSC-I, LSC-II, and LSC-III, respectively.

DISCUSSION

Since open subtotal cholecystectomy is considered a bailout procedure during difficult cholecystectomy, this study aimed to determine the advantages, indications, and viability of LSC as the open procedure is associated with its morbidity. This study was done to determine indications, conversion rate, operating time, perioperative blood loss, complications, and duration of postoperative hospital stay in LSC.

Only 1 patient was converted to open subtotal cholecystectomy among the 41 patients who underwent subtotal cholecystectomy, the rest 40 patients underwent LSC who were included in this study.

The indication for LSC in our study was inflammatory changes in the form of frozen calot's triangle and obliterated cystic plate. Frozen calot's triangle refers to severe inflammation present in the calot's triangle. Structures present in the calots triangle, i.e., the cystic artery and cystic duct could not be visualized separately or could not be identified at all. Hence the calot's triangle is said to be frozen. The cystic plate is a thin fibrofatty layer between the liver bed and gallbladder in the gallbladder fossa region. Due to the severe inflammation, there are chances that this layer may be wiped out, which is referred to as an obliterated cystic plate. In such cases, dissection in this plane will cause bleeding from the liver surface. The frozen calot's triangle and obliterated cystic plate are purely intraoperative findings. The reasons for these changes in our study were chronic calculous cholecystitis in 45% of the cases and ERCP done for choledocholithiasis in 50% of the cases. All these patients who had undergone LSC post-ERCP underwent interval cholecystectomy rather than early cholecystectomy, which might be the reason for such changes. The other indication for LSC was emphysematous cholecystitis. The average period of surgery for index cholecystitis episodes was more than 6 weeks in all cases. No patient had undergone percutaneous transhepatic gallbladder drainage in our study. Compared with the conventional LC group, chronic calculous cholecystitis and ERCP done for choledocholithiasis constituted 4.8% of cases each. These two indications showed a significant number of cases going in for LSC compared to LC.

Gode et al. [6] classified a new variant of LSC type I and classified it as LSC type III which was adopted in our study. Two patients underwent type III LSC, which appeared as a feasible option in the setting of both frozen calots triangle and obliterated cystic duct. In cases of CLD where bleeding from the liver during cystic plate dissection is a possible complication, LSC type I is the safest option with reduced morbidity. Two CLD patients in our study underwent type I LSC without increasing intraoperative bleeding or operative time. Additional ports were used in three cases. Two in LSC type II and 1 in LSC type I. We believe additional ports help in facilitating surgery and decreasing operative time.

Abdominal drains were selectively used in our patients. No drains were used in LSC type I. In type LSC II, drains were used in 26 patients, and all patients undergoing type III LSC had abdominal drains. Almost 70% of patients in LSC had abdominal drains compared to 6.9% in conventional LC. Drains were used very liberally in the LSC group because of the subtotal nature of the surgery.

No intraoperative complications occurred. Only two patients developed postoperative surgical site infections, Claven-Dindo grade 2, and were treated with antibiotics. The frequency of bile duct injury in LC is 0.6% [8,9]. Tornqvist et al. [10] observed a twofold surge in the bile duct injury rate when comparing patients with severe cholecystitis to those with normal gallbladders. A review of 15 retrospective studies and case series with 625 patients revealed only a single case of biliary injury in patients who underwent LSC [11]. We did not observe any biliary injuries or altered liver function tests in the LSC in the average follow-up of 284 days. Similarly, in our LC group, the incidence of bile duct injury was 0.35%, which is well within the accepted standards. After the surgery, none of the patients who underwent LSC needed ICU care.

The average postoperative length of hospital stays for patients who underwent LSC was 2.1 ± 0.7 days, while for those who underwent LC, it was 1.1 ± 0.3 days. Although there was a statistically significant increase in the hospital stay duration for LSC patients, the increase was only one day, and there was no significant increase in complications. Considering the complexity of the condition, this slight increase in hospital stay is deemed acceptable rather than opting for an open surgery.

A retrospective analysis was carried out by Boyd et al. [12] over the past 10 years to examine the practices of LC. The study showed a decrease in conversion to open surgery in recent years and an increase in the number of patients undergoing LSC for difficult gallbladders without an increase in morbidity. The study also reported only one case of remnant gallbladder disease out of 114 LSC surgeries performed. During our follow-up period, we did not observe any cases of remnant gallbladder disease.

Due to increased proficiency in laparoscopic operations and improved laparoscopic visualization of the changed anatomy, the conversion rate in our study is low. Also, in the current minimal-invasive era open cholecystectomy has lost its credibility for challenging gallbladder surgery. The threshold for open conversion should be low, nonetheless, anytime a difficulty in LSC emerges. Here, we've aimed to provide a thorough overview of LSC, including its subtypes indications, and safety profile.

Our study has limitations, including a small sample size, a

https://doi.org/10.14701/ahbps.23-168

single institutional study, and the need for long-term follow-up to identify potential complications.

Conclusion

In difficultgallbladders, LSC can significantly lower complication and conversion rates without causing more intraoperative or postoperative morbidity. The current study demonstrated that LSC is a feasible and safe surgical option.

FUNDING

None.

CONFLICT OF INTEREST

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

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AUTHOR CONTRIBUTIONS

Conceptualization: KH. Data curation: KSR, PKS. Methodology: KH, AR. Visualization: KH, KSR. Writing - original draft: KSR. Writing - review & editing: KH, AR, PKS.

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