

Delving into Laparoscopic Subtotal Cholecystectomy: Analysing Factors Influencing Conversion and Perioperative Outcomes in a Leading Tertiary Care Centre

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Abstract:

Introduction:

Bile duct injuries during Laparoscopic Cholecystectomy have decreased, but when achieving the Critical View of Safety (CVS) is not possible, subtotal cholecystectomy is used. This study aims to analyze factors influencing laparoscopic subtotal cholecystectomy conversion and perioperative outcomes in a tertiary care center.

Methods:

This prospective study included patients with gallstone disease undergoing surgery at a tertiary care hospital. Medical history, physical examination, laboratory tests, and radiological procedures were conducted and recorded. Laparoscopic subtotal cholecystectomy(LSC) was performed when CVS couldn't be demonstrated. Perioperative outcomes were noted.

Results:

The study involved 185 participants, with 22.16% undergoing laparoscopic subtotal cholecystectomy. LSC patients were older (53.59 ± 13.48 years) and had a higher male to female ratio (2.72:1) compared to laparoscopic total cholecystectomy (TC) patients. LSC patients had a shorter symptom duration (12.83 ± 4.94 days), higher leukocyte count, and total bilirubin levels. LSC was mainly performed for acute calculous cholecystitis. LSC had a longer operative time (110.68 ± 14.36 min) and postoperative bile leaks (24.4%). LSC patients had a higher readmission rate (12.2%) and longer hospital stay compared to TC patients.

Conclusion:

Laparoscopic subtotal cholecystectomy is a valuable bailout strategy when CVS can't be achieved. Factors influencing the need for LSC include older age, male gender, shorter symptom duration, higher leukocyte count, higher total bilirubin levels, and specific indications like acute calculous cholecystitis. Despite higher bile leak and readmission rates, these outcomes are acceptable given the disease complexity.

Keywords:

Laparoscopic cholecystectomy, Subtotal cholecystectomy, Risk factors, Perioperative outcomes, Biliary injury, Bile leaks

Statements and Declarations:

There is no conflict of interest

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Compliance with Ethical Standards:

Informed consent has been taken from all the participants in the study.

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Introduction:

Laparoscopic Cholecystectomy is a commonly performed surgical procedure that has become the Gold Standard technique due to its numerous advantages[1]. It has largely replaced the traditional open approach, and current surgical trainees are more skilled in the laparoscopic technique. Initially, there were concerns about a higher risk of bile duct injuries with laparoscopy, but these concerns have decreased over time [1]. Studies have shown that the incidence of bile duct injuries during Laparoscopic Cholecystectomy has significantly decreased from 0.85%[2] in the early days to 0.1% to 0.3%[3] and even less than 0.1% in some cases[4], which is comparable to the open approach. This reduction in injuries is attributed to the widespread use of the Critical View of Safety (CVS) technique and the availability of imaging methods such as ICG fluorescence.

Attaining the Critical View of Safety (CVS) may not be feasible in certain conditions, including Acute cholecystitis, Gangrenous cholecystitis, Gallbladder Perforation, Chronic cholecystitis, and post ERCP cholelithiasis. Attempting to achieve CVS in these situations can be deleterious and lead to bilio-vascular injuries. However, there are certain bailout strategies available to prevent such injuries, such as subtotal cholecystectomy, fundus first technique, conversion to open cholecystectomy and cholecystostomy[5]. The concept of subtotal cholecystectomy was first introduced by Kehr in 1898 but fell out of favour in the mid-20th century [6]. It was later revived by P C Bornman in 1985[7].

Conversion to open surgery is not considered a bailout procedure since the risks associated with the laparoscopic approach persist in the open approach. Even after conversion, there may be a need for Subtotal cholecystectomy, which is a genuine bailout strategy. Two types of subtotal cholecystectomies are performed: reconstituting type (where the remaining walls of the gallbladder are approximated) and fenestration type (where a purse-string suture is placed around the cystic duct orifice [8]. The reconstituting type is the most commonly performed. With increasing expertise in laparoscopic procedures, subtotal cholecystectomy is now being performed laparoscopically without conversion to open surgery. This approach offers advantages such as shorter hospital stay, faster recovery, reduced pain, and decreased wound and systemic complications. The aim of this study is to evaluate the risk factors and analyse the perioperative outcomes of laparoscopic subtotal cholecystectomy in our tertiary care hospital.

Patients and methods:

The accrual of patients was done between April 2021 and April 2023 in the Department of Surgical Gastroenterology at a tertiary care hospital. The study included all patients undergoing surgery for gallstone disease. The inclusion criteria were patients above 18 years of age, patients diagnosed with gallstone disease based on radiological investigations, and patients with an ASA score ≤ 3 . Exclusion criteria were patients with associated choledocholithiasis requiring CBD exploration, patients unfit for surgery, and patients unwilling to provide consent.

Patients diagnosed with gallstone disease underwent evaluation with Complete Blood Picture (CBP), Liver Function Tests (LFT), abdominal ultrasound (USG). As and when required further imaging with Contrast-Enhanced Computed Tomography (CECT) or Magnetic Resonance CholangioPancreatography (MRCP) was done for confirmation of diagnosis in some patients. Patients requiring surgery were invited to participate in the study. After obtaining written consent, a medical history was taken and a physical examination was performed using a standardized form. Additional investigations were conducted, and once patients were deemed fit for surgery, they underwent standard laparoscopic cholecystectomy with the demonstration of the Critical View of Safety (CVS). In cases where frozen Calot's triangle was observed or CVS could not be demonstrated, patients underwent laparoscopic subtotal cholecystectomy, with the reconstituting type being the preferred method. After the standard placement of ports, adhesions surrounding the gallbladder were released. In cases where the Gall Bladder was excessively distended, a puncture was created in the fundus to evacuate its contents, which made the handling process easier. An effort was made to dissect in the region of Calot's triangle. If progress in dissection was hindered due to Frozen Calot's, the decision was made to perform a subtotal cholecystectomy. Whenever possible, the entire Gall Bladder was removed, leaving a small cuff of tissue near the neck. The stones were then evacuated, and the walls of the Gall Bladder were sutured using intracorporeal suturing. In situations where the posterior wall was densely adherent or bleeding occurred, the posterior wall was left attached to the gall bladder fossa, and the mucosa was ablated.

Intraoperative findings, including operative time, blood loss, intraoperative bile leak, and drain placement, were recorded. Drains were not placed in normal cholecystectomy cases but were inserted in patients with difficult dissection in Calot's triangle or in those undergoing subtotal cholecystectomy. Postoperatively, patients were monitored for bile leak. Those who did not develop bile leak were discharged on the second postoperative day (POD). In patients with bile leak, the quantity of bile output was measured and categorized as

low output (< 200ml/day) or high output (> 200ml/day). Patients with low output were followed up for an additional 3 days, and if there was a gradual decrease in bile output, they were discharged and advised to have outpatient follow-up. These patients continued conservative management. Once the bile leak completely ceased, the drain was removed. In cases of high output fistula, patients were observed, and if there was no decrease in output or if it continued to be a high output fistula, a decision was made to perform Endoscopic Retrograde Cholangiopancreatography (ERCP) and Common Bile Duct (CBD) stenting. Patients were discharged the following day and instructed to continue follow-up. The drain was removed once the bile leak stopped. Details regarding the development of postoperative bile leak, duration of drain placement, and the need for ERCP were recorded. We recorded the duration of hospital stay (LOS), instances of readmissions, mortality rates, and the need for additional surgical procedures.

Descriptive statistics were used to summarize patient characteristics and perioperative outcomes. Continuous variables were presented as means with standard deviations. Categorical variables were reported as frequencies and percentages. Comparative analyses were performed using appropriate statistical tests, such as chi-square tests or t-tests. A p-value of less than 0.05 was considered statistically significant. SPSS version 26 was used for statistical analysis.

Results:

This study involved 185 participants, with 144 (77.84%) undergoing Laparoscopic total cholecystectomy (TC) and 41 (22.16%) undergoing laparoscopic subtotal cholecystectomy (LSC).

Table 1 presents the comparison of various factors including patient age, male to female ratio, symptoms, symptom duration, TLC (total leukocyte count), albumin levels, total bilirubin levels, gallbladder (GB) wall thickness, presence of pericholecystic fluid, preoperative ERCP (endoscopic retrograde cholangiopancreatography), operative time, postoperative biliary leaks, drain removal, subhepatic collections, retained stones, readmissions, and length of stay (LOS).

	Laparoscopic Subtotal Cholecystectomy	Laparoscopic Total Cholecystectomy	P value
Age	53.59 SD 13.48 years	47.51 SD 15.94 years	0.0273
Men:Women	2.72:1	0.8:1	
Symptoms			
RUQ Pain	100%	100%	
Fever	34.1%	4.2%	
Vomiting	24.4%	9.7%	
Jaundice	17.1%	13.9%	
Mean duration of symptoms	12.83 SD 4.94 days	21.90 SD 19.7 days	0.004
Total Leucocyte count	11,676 SD 4331	9722 SD 2905	0.004
Albumin	3.769 SD 0.26 mg/dl	3.89 SD 0.45 mg/dl	
Total Bilirubin	2.17 SD 3.06 mg/dl	1.12 SD 1.07 mg/dl	0.0007
GB wall thickness	4.23 SD 1.29 mm	3.3 SD 0.95 mm	0.0001
Pericholecystic fluid	56.1%	13.9%	
Preoperative ERCP	19.5%	19.4%	
Operative time	110.68 SD 14.36 min	63 SD 14 min	
Post op Bile leaks	14.63%	0%	
Drain removal			
With bile leak	43.7 SD 49.41 days	-	
Without bile leak	3.42 SD 2.66 days	2.92 SD 2.03 days	0.1974
Subhepatic collection	4.88%	0 %	

Retained stones	4.88%	0%	
Bile duct injuries	0%	0%	
Readmissions	12.2%	0%	
LOS	4.27 SD2.75 days	2.27 SD 2.17 days	0.0001

Table 1: Comparison of Patient characteristics between Subtotal cholecystectomy and total cholecystectomy

Regarding physical signs, right upper quadrant (RUQ) tenderness at the time of surgery was observed in 34 patients (82.9%) with LSC and 52 patients (36.1%) with TC. A lump in the RUQ was found in one patient, and two patients who underwent LSC had a history of previous upper abdominal surgery. However, no patients in the TC group exhibited a lump or had a history of previous upper abdominal surgery.

In terms of comorbidities, a total of 23 patients (56.10%) in the LSC group and 63 patients (43.75%) in the TC group had additional health conditions. The most common comorbidities observed in both groups were diabetes mellitus (DM) and hypertension (HTN). Specifically, DM was present in 11 patients (26.83%) in the LSC group and 30 patients (20.83%) in the TC group. Other comorbidities encountered included chronic liver disease (CLD), cerebrovascular accident (CVA), coronary artery disease (CAD), chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), epilepsy, hypothyroidism, and hyperthyroidism.

Regarding the indications for LSC, the procedure was performed in cases of acute calculous cholecystitis (48.8%), acute gangrenous cholecystitis (9.8%), gallbladder perforation (9.8%), chronic cholecystitis (7.3%), biliary pancreatitis (4.9%), and acute acalculous cholecystitis (4.9%). On the other hand, TC was undertaken for symptomatic cholelithiasis (56.94%), acute calculous cholecystitis (18.75%), choledocholithiasis (18.75%), biliary pancreatitis (2.78%), and chronic cholecystitis (1.39%).

Pus in the gallbladder (GB) was found in 14 patients (34.1%) undergoing LSC, whereas only 4 patients (2.78%) undergoing TC had this finding. Omental adhesions were present in 39 patients (95.1%) with LSC and in 41 patients (28.5%) with TC. Frozen Calot's sign was observed in 40 patients (97.6%) with LSC. Cirrhotic features were noted in 2 patients undergoing LSC.

No intraoperative bile leak was detected in either the LSC or TC patients. However, postoperative bile leaks occurred in 6 patients (14.63 %) undergoing LSC, while no patients undergoing TC experienced this complication. A drain was placed in all patients undergoing LSC. The average time for drain removal was 43.7

SD 49.41 days after surgery for patients with bile leaks and 3.42 SD 2.66 days for patients without bile leaks. This difference in drain removal time was found to be statistically significant, with a p-value of 0.0001. No cases of postoperative haemorrhage were observed in any of the patients included in the study.

A total of 5 patients (12.2%) who underwent laparoscopic subtotal cholecystectomy (LSC) required readmission to the hospital. All of these patients needed further medical intervention. Among the readmitted patients, 2 individuals had subhepatic collections, which were addressed by pigtail drainage. Additionally, 2 patients had retained gallbladder stones. One of them was asymptomatic, while the other experienced symptoms, leading to a completion cholecystectomy. Furthermore, 2 patients experienced continuous biliary leaks, necessitating endoscopic retrograde cholangiopancreatography (ERCP) and stenting. Lastly, one patient had choledocholithiasis, which was treated with ERCP and stone extraction. No readmissions or reinterventions were reported in the laparoscopic total cholecystectomy (TC) group. The average length of stay (LOS) in the hospital was 4.27 SD 2.75 days for LSC and 2.27 SD 2.17 days for TC. The difference in LOS between the two groups was statistically significant, with a p-value of 0.0001. Notably, there were no reported deaths in either group.

Discussion:

Majority of the patients with gallstone disease undergo a total laparoscopic cholecystectomy with demonstration of CVS. However, in about 16% of cases, there are dense adhesions or the calot's is frozen resulting in a "difficult" gallbladder [9]. Laparoscopic Subtotal Cholecystectomy(LSC) is an effective bail out strategy in such conditions. In this study we have evaluated the various factors predisposing to LSC and the postoperative outcomes following it.

The study involved 185 participants, with 144 (77.84%) undergoing Laparoscopic total cholecystectomy (TC) and 41 (22.16%) undergoing laparoscopic subtotal cholecystectomy (LSC). As a referral centre, the majority of cases received are related to Acute Cholecystitis and challenging gallbladder conditions. The findings of this study provide valuable insights into the characteristics, symptoms, comorbidities, surgical outcomes, and complications associated with these two surgical procedures for cholecystectomy.

Age and Gender Comparison: The average age of patients who underwent LSC was 53.59 SD 13.48 years, while those who underwent TC had an average age of 47.51 SD 15.94 years. The study found a statistically significant difference in age between the two groups ($p = 0.0273$). This suggests that patients undergoing LSC tended to be older compared to those undergoing TC. This finding aligns with similar studies conducted by Ramirez et

al.,[10] Tang et al.,[11] and Lucocq et al [12]. The male to female ratio differed between the LSC and TC groups. Among patients with LSC, the ratio was 2.72:1, while among patients undergoing TC, it was 0.8:1. This difference indicates a higher proportion of men in the LSC group compared to the TC group. The male sex is identified as a potential risk factor for LSC.

*Symptoms and signs:*All patients in both the LSC and TC groups experienced symptoms of right upper quadrant pain. However, there were variations in the occurrence of other symptoms between the two groups. Patients with LSC had a higher prevalence of fever (34.1% vs. 4.2%), vomiting (24.4% vs. 9.7%) and jaundice (17.1% vs. 13.9%). The duration of symptoms was also significantly different between the two groups, with LSC patients experiencing symptoms for a shorter duration compared to TC patients. This can be attributed to the fact that individuals who undergo LSC tend to have severe disease, leading to earlier presentation. The presence of right upper quadrant tenderness differed between the LSC and TC groups, with a higher percentage of LSC patients (82.9%) exhibiting this sign compared to TC patients (36.1%). The occurrence of a lump in the right upper quadrant was limited to the LSC group. The presence of these signs, especially right upper quadrant tenderness, favours LSC over a TC.

*Comorbidities:*A higher proportion of patients in the LSC group (56.10%) had additional comorbidities compared to the TC group (43.75%). The most common comorbidities observed in both groups were diabetes mellitus (DM) and hypertension (HTN). Although the prevalence of diabetes mellitus (DM) is higher in patients undergoing laparoscopic subtotal cholecystectomy (LSC), it does not show statistical significance on univariate analysis.

*Laboratory and Imaging Investigations:*The study compared Total Leucocyte Count (TLC), Albumin levels, and total Bilirubin levels between the LSC and TC groups. The LSC group had higher TLC and total Bilirubin levels compared to the TC group, with statistically significant differences observed. However, the Albumin levels were slightly higher in the TC group compared to the LSC group. A TLC exceeding 11,000 cells/cumm is a risk factor that leans towards LSC. The study found a significant difference in gallbladder wall thickness between the LSC and TC groups, with LSC patients having a thicker gallbladder wall. Pericholecystic fluid was also more prevalent in the LSC group compared to the TC group. The presence of an increased gallbladder wall thickness and pericholecystic fluid on USG are regarded as risk factors that lean towards LSC.

Diagnosis: The identification of conditions such as acute calculous cholecystitis, acute acalculous cholecystitis, acute gangrenous cholecystitis, gallbladder perforation, and chronic cholecystitis suggests a preference for LSC over TC. This has also been noted in research conducted by Tang et al [11] and Shimoda et al [13].

Surgical Procedure and Complications: The average duration of the surgical procedure was longer for LSC compared to TC. Pus in the gallbladder, omental adhesions, and frozen Calot's sign were predominantly observed in the LSC group. Bile leaks were more common in the LSC group (14.63%) compared to the TC group (0%), and drain placement and removal differed between the two groups. The incidence of bile leaks is similar to studies conducted by Elshaer et al (18%) and Kalpesh Jani et al (16.5%) [14,15]. However, these rates are significantly lower than the bile leaks reported following fenestration cholecystectomy (42%) in those studies. Unlike in other studies, the majority of leaks (66.67%) in this study resolved spontaneously, while 33.33% required ERCP. In contrast, studies by Ramirez et al, Kalpesh Jani et al, and Elshaer et al reported spontaneous resolution rates of 25.3%, 60%, and 5.6%, respectively [10,14,15]. This difference may be attributed to variations in the duration of observation before intervention. Nonetheless, it is important to emphasize that the majority of leaks can be managed conservatively and will subside over time. The average time for drain removal was 43.7 SD 49.41 days after surgery for patients with bile leaks and 3.42 SD 2.66 days for patients without bile leaks.

In a meta-analysis conducted by Ikemsinachi C. Nzenwa et al., it was revealed that Open Subtotal Cholecystectomy led to fewer instances of bile leaks [16]. However, this approach was also linked to a higher rate of reoperation, wound infection, and 30-day mortality when compared to the laparoscopic method. Another study by Idris Kurtulus et al. compared open subtotal cholecystectomy to laparoscopic subtotal cholecystectomy and suggested that the open approach resulted in longer operative time, extended hospital stays, an elevated rate of wound infections, and an increased risk of incisional hernia [17].

There were no cases of postoperative bleeding or biliary injury in the current study. According to Elshaer et al, the incidence of bile duct injuries is recorded at 0.08%, while Nzenwa et al reported a slightly higher rate of 0.2% [14,16]. Subhepatic collections occurred in 4.88% of patients and were managed with pigtail drainage. This finding aligns with the studies conducted by Elshaer et al, where a 2.9% rate was observed, and Nzenwa et al, who reported a similar rate of 2.6% [14,16]. Retained stones were observed in 4.88% of patients, which aligns with the findings reported in studies conducted by Elshaer et al and Kalpesh Jani et al [14,15].

Readmissions and Length of Stay: A higher percentage of LSC patients (12.2%) required readmission to the hospital compared to the TC group (0%). Given the severity of the condition, this outcome can be considered satisfactory. The average length of stay (LOS) was longer for LSC patients compared to TC patients. In this study, only one patient required a second surgery, which is consistent with findings reported in other studies.

In the present study, several factors were identified as risk factors that predict LSC. When analysing the data using multivariate analysis, it was found that older age, male gender, elevated TLC count, elevated total bilirubin levels, increased gallbladder wall thickness, presence of pericholecystic fluid on USG, and a diagnosis of acute cholecystitis emerged as significant risk factors predicting LSC.

LSC offers a significant advantage by avoiding biliary injuries despite the complexity of the anatomy involved. While postoperative bile leaks are notable, the occurrence of other complications such as haemorrhage, retained stones, and reinterventions is comparatively lower. Literature also suggests the use of techniques like utilizing the Falciiform ligament and omental flap to cover the remaining gallbladder stump, which can reduce the occurrence of bile leaks [18,19]. Further investigation is needed to explore the effectiveness of staplers in closing the stump and minimizing bile leaks. Researchers are also studying techniques such as employing cyanoacrylate glue to occlude the cystic duct in fenestration cholecystectomy [20]. Additionally, surgeons performing LSC may face the challenge of intracorporeal suturing, but this can be overcome by employing methods like Endo loops, staplers and barbed sutures.

The strengths of the study are that the surgeries were performed exclusively by a highly skilled single surgeon, ensuring consistency and reducing potential variability in the surgical procedures. A significant emphasis was placed on the importance of conservative management in patients who experienced biliary leaks following LSC, highlighting the potential benefits of a non-invasive approach in managing this complication.

Despite considering the sample size as adequate for deriving meaningful conclusions, it remains relatively small. It should be noted that this study was conducted at a single institution, which may limit the generalizability of the findings to a broader population. To address this limitation and strengthen the validity of the results, large-scale, multi-institutional studies are warranted.

Summary:

Laparoscopic subtotal cholecystectomy (LSC) serves as a crucial bailout strategy in challenging cases. The presence of the risk factors like older age, male gender, elevated TLC count, elevated total bilirubin

levels, increased gallbladder wall thickness, presence of pericholecystic fluid on USG, and a diagnosis of acute cholecystitis indicate the potential need for conversion to LSC. Except for the increased rate of bile leaks, it demonstrates comparable perioperative outcomes to those of standard cholecystectomy and should be taken into consideration for patients with complex gallbladder conditions.

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