ORIGINAL RESEARCH

Comparative Study of Single Incision versus Conventional Four Ports Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) has become the gold standard for the surgical treatment of gallbladder diseases, particularly symptomatic cholelithiasis. To compare the outcomes of Single Incision Laparoscopic Cholecystectomy (SILC) and Conventional Four Ports Laparoscopic Cholecystectomy (C4PLC) in terms of intraoperative parameters, postoperative recovery, complications, and patient satisfaction.**Material and Methods:** This comparative study included 100 patients diagnosed with symptomatic cholelithiasis, randomly assigned into two groups: SILC (n=50) and C4PLC (n=50). Preoperative evaluations included clinical history, examination, routine blood investigations, liver function tests, and ultrasonography. SILC was performed using a single umbilical incision with a specialized port, while C4PLC followed the standard four-port technique. Operative time, blood loss, conversion to open surgery, postoperative pain (VAS score), analgesic requirements, hospital stay, complications, and patient satisfaction were assessed. Statistical analysis was performed using SPSS, considering $p<0.05$ as significant.**Results:** Baseline characteristics were comparable between the two groups. The SILC group had a significantly longer operative time (55.3 ± 12.6 min vs. 42.8 ± 9.4 min, $p<0.001$) and higher blood loss (45.2 ± 10.8 mL vs. 30.6 ± 8.9 mL, $p<0.001$). Pain scores were significantly lower in SILC at 6 hours (5.8 ± 1.2 vs. 6.5 ± 1.0, $p=0.03$) and 24 hours (3.2 ± 0.9 vs. 3.8 ± 1.0, $p=0.04$). The SILC group required fewer analgesic doses (3.5 ± 1.1 vs. 4.2 ± 1.3, $p=0.02$) and had a shorter hospital stay (2.1 ± 0.5 days vs. 2.5 ± 0.6 days, $p=0.01$). Postoperative complication rates were similar between both groups. SILC patients reported significantly higher satisfaction (8.5 ± 1.2 vs. 7.8 ± 1.4, $p=0.02$) and better cosmetic outcomes (9.2 ± 0.8 vs. 7.5 ± 1.1, $p<0.001$).**Conclusion:** SILC is associated with reduced postoperative pain, shorter hospital stays, and better cosmetic outcomes but has longer operative times and higher intraoperative blood loss compared to C4PLC. Both techniques have comparable safety profiles. SILC can be a preferred approach for patients prioritizing cosmesis and minimally invasive surgery.

Keywords: Laparoscopic cholecystectomy, Single Incision, Conventional Four Ports, Postoperative pain, Cosmetic outcome.

INTRODUCTION

Laparoscopic cholecystectomy (LC) has become the gold standard for the surgical treatment of gallbladder diseases, particularly symptomatic cholelithiasis. Since its introduction, it has largely replaced open cholecystectomy due to its minimally invasive nature, reduced postoperative pain, shorter hospital stays, and quicker recovery. Over the years, laparoscopic techniques have evolved, leading to modifications in the standard approach to further improve patient outcomes. Among these modifications, single-incision laparoscopic cholecystectomy (SILC) has emerged as an alternative to the conventional four-port laparoscopic cholecystectomy (C4PLC), aiming to minimize surgical trauma while maintaining the efficacy of the procedure.[1]

The conventional four-port technique, widely accepted and practiced, involves the insertion of four trocars through separate small incisions in the abdominal wall. This method provides a stable platform for surgical maneuverability, ensuring optimal visualization of the gallbladder and surrounding structures. The triangulation of instruments allows for precise dissection and safe removal of the gallbladder, reducing complications associated with bile duct injuries. Despite its advantages, concerns about postoperative pain, visible scarring, and potential wound-related complications have led to the exploration of alternative approaches.[2]

Single-incision laparoscopic cholecystectomy is an advancement that aims to improve cosmetic outcomes and reduce postoperative discomfort. In SILC, all instruments are introduced through a single incision, usually at the umbilicus, creating a scarless appearance after healing. The technique requires specialized instruments and enhanced surgical skills to overcome the challenges associated with reduced triangulation and instrument crowding. While SILC has been associated with improved patient satisfaction due to better cosmesis and potentially less postoperative pain, concerns remain regarding its technical difficulty, longer operative time, and increased risk of intraoperative complications.[3]

A comparison between these two approaches is necessary to evaluate their relative benefits and limitations in terms of surgical feasibility, safety, efficacy, and patient outcomes. Factors such as operative time, intraoperative complications, conversion rates to open surgery, postoperative pain scores, analgesic requirements, hospital stay duration, cosmesis, and overall patient satisfaction play a crucial role in determining the superiority of one technique over the other. Additionally, cost-effectiveness and the learning curve associated with each method are important considerations, particularly in healthcare systems with limited resources.[4-6]

While some studies have suggested that SILC provides better cosmetic results and reduced postoperative pain, others argue that it does not offer significant advantages over the conventional approach and may even increase the risk of complications. The debate continues as more clinical evidence emerges, necessitating further research and analysis.

AIM AND OBJECTIVES

This study aims to provide a comprehensive comparison of single-incision versus conventional four-port laparoscopic cholecystectomy, evaluating their respective outcomes and determining which technique offers the best balance of safety, effectiveness, and patient satisfaction.

MATERIALS AND METHODS

Study Design

This study is a prospective, randomized comparative study evaluating the outcomes of Single Incision Laparoscopic Cholecystectomy (SILC) versus Conventional Four Ports Laparoscopic Cholecystectomy (C4PLC) in patients with symptomatic cholelithiasis.

Study Population

A total of 100 patients diagnosed with symptomatic cholelithiasis and scheduled for laparoscopic cholecystectomy were enrolled. Patients were randomly assigned into two groups:

- **SILC group**: 50 patients undergoing Single Incision Laparoscopic Cholecystectomy
- **C4PLC group**: 50 patients undergoing Conventional Four Ports Laparoscopic Cholecystectomy

Study Place

The study was conducted in the Department of General Surgery at Santosh Medical College & Hospital, Ghaziabad, NCR Delhi, India.

Study Period

The study was carried out over a period of one year and four months, from January 2015 to April 2016.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before the commencement of the study. Written informed consent was obtained from all patients after explaining the nature, benefits, and possible risks associated with the procedures.

Inclusion Criteria

- Patients aged between 18 to 65 years diagnosed with symptomatic cholelithiasis.
- Patients fit for general anesthesia.
- Patients providing informed consent for the study.

Exclusion Criteria

- Patients with acute cholecystitis, choledocholithiasis, or gallbladder malignancy.
- Patients with previous upper abdominal surgery.
- Patients with severe cardiopulmonary comorbidities contraindicating laparoscopic surgery.

- Patients requiring immediate conversion to open cholecystectomy due to intraoperative complications.

Methodology / Procedure

- **Preoperative Evaluation**:
  - Detailed clinical history and physical examination.
  - Routine blood investigations, liver function tests, and abdominal ultrasonography.
- **Surgical Procedure**:

All surgeries were performed under general anesthesia by experienced surgeons using standardized techniques.

- **SILC Group**: A single umbilical incision was made, and a specialized multiport device was used for laparoscopic instrument insertion.
- **C4PLC Group**: The standard four-port laparoscopic technique was employed.
- Operative parameters, including duration, intraoperative complications, blood loss, and conversion to open surgery, were recorded.

Outcome Measures

- **Intraoperative Parameters**:
  - Operative time (measured from skin incision to closure).
  - Blood loss (estimated from suction drain and surgical sponges).
  - Intraoperative complications.
  - Conversion to open cholecystectomy.
- **Postoperative Parameters**:
  - Pain assessment using the Visual Analog Scale (VAS) at 6, 12, and 24 hours post-surgery.
  - Analgesic requirements.
  - Duration of hospital stay.
  - Incidence of wound infection.
  - Cosmetic satisfaction, assessed using a standardized patient questionnaire.

STATISTICAL ANALYSIS

- Data were analyse dusing Statistical Software, e.g., SPSS Version 16.
- Continuous variables were expressed as mean ± standard deviation and compared using the independent t-test or Mann-Whitney U test.
- Categorical variables were presented as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test.
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Preoperative Characteristics

Characteristic	SILC (n=50)	C4PLC (n=50)	p-value
Age (years, mean ± SD)	45.2 ± 10.5	46.5 ± 9.8	0.58
Gender (Male/Female)	22/28	24/26	0.75
BMI (kg/m², mean ± SD)	26.4 ± 3.2	27.1 ± 3.5	0.42
Comorbidities (%)	12 (24%)	10 (20%)	0.67

Table 1 shows that the baseline characteristics of the patients in both groups were comparable. The mean age of patients in the Single Incision Laparoscopic Cholecystectomy (SILC) group was 45.2 ± 10.5 years, while in the Conventional Four Ports Laparoscopic Cholecystectomy (C4PLC) group, it was 46.5 ± 9.8 years, with no statistically significant difference (p=0.58). The gender distribution was similar, with 22 males and 28 females in the SILC group and 24 males and 26 females in the C4PLC group (p=0.75). The mean body mass index (BMI) was 26.4 ± 3.2 kg/m² in the SILC group and 27.1 ± 3.5 kg/m² in the C4PLC group, showing no significant difference (p=0.42). The presence of comorbidities was observed in 24% of SILC patients and 20% of C4PLC patients (p=0.67), indicating that both groups were well-matched in terms of demographic and preoperative characteristics.

Table 2: Intraoperative Parameters

Parameter	SILC (n=50)	C4PLC (n=50)	p-value
Operative time (min, mean ± SD)	55.3 ± 12.6	42.8 ± 9.4	<0.001
Blood loss (mL, mean ± SD)	45.2 ± 10.8	30.6 ± 8.9	<0.001
Conversion to open surgery (%)	2 (4%)	1 (2%)	0.56

Table 2 shows that the intraoperative parameters revealed significant differences between the two techniques. The operative time was significantly longer in the SILC group (55.3 ± 12.6 minutes) compared to the C4PLC group (42.8 ± 9.4 minutes), with a p-value of <0.001, suggesting that single-incision surgery required more time, likely due to instrument crowding and limited maneuverability. Blood loss was also significantly higher in the SILC group (45.2 ± 10.8 mL) than in the C4PLC group (30.6 ± 8.9 mL) (p<0.001), possibly due to increased tissue handling and limited visualization. Conversion to open surgery was required in two cases (4%) in the SILC group and one case (2%) in the C4PLC group, but this difference was not statistically significant (p=0.56), indicating that both procedures had a low likelihood of conversion.

Table 3: Postoperative Pain and Recovery

Outcome	SILC (n=50)	C4PLC (n=50)	p-value
VAS score at 6h (mean ± SD)	5.8 ± 1.2	6.5 ± 1.0	0.03
VAS score at 24h (mean ± SD)	3.2 ± 0.9	3.8 ± 1.0	0.04
Total analgesic doses (mean ± SD)	3.5 ± 1.1	4.2 ± 1.3	0.02
Hospital stay (days, mean ± SD)	2.1 ± 0.5	2.5 ± 0.6	0.01

Table 3 shows that the Postoperative pain was assessed using the Visual Analog Scale (VAS), showing that pain scores at 6 hours were significantly lower in the SILC group (5.8 ± 1.2) compared to the C4PLC group (6.5 ± 1.0), with a p-value of 0.03. Similarly, pain scores at 24 hours were also lower in the SILC group (3.2 ± 0.9) than in the C4PLC group (3.8 ± 1.0) (p=0.04). This suggests that patients who underwent SILC experienced less postoperative pain, likely due to the reduced number of incisions. The total number of analgesic doses required postoperatively was lower in the SILC group (3.5 ± 1.1) compared to the C4PLC group (4.2 ± 1.3), with a significant difference (p=0.02). The duration of hospital stay was shorter in the SILC group (2.1 ± 0.5 days) than in the C4PLC group (2.5 ± 0.6 days), with a statistically significant p-value of 0.01, indicating that SILC patients had a faster recovery and could be discharged earlier.

Table 4: Postoperative Complications

Complication	SILC (n=50)	C4PLC (n=50)	p-value
Wound infection (%)	3 (6%)	4 (8%)	0.67
Bile leak (%)	1 (2%)	2 (4%)	0.56
Hematoma (%)	1 (2%)	2 (4%)	0.43

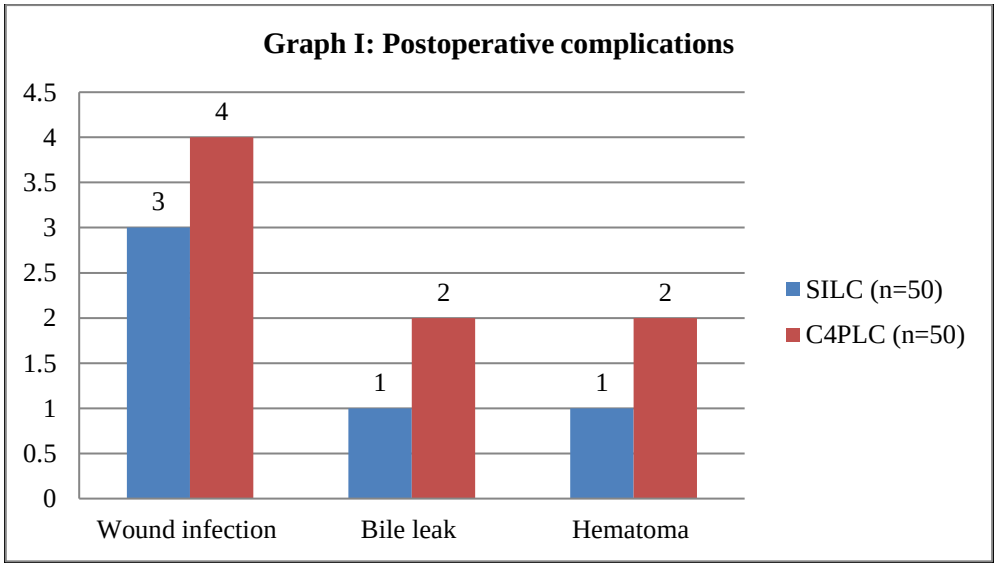

Table 4 shows that the incidence of postoperative complications was similar between the two groups. Wound infection occurred in 6% of SILC patients and 8% of C4PLC patients, with no

significant difference (p=0.67). Bile leak was observed in 2% of SILC cases and 4% of C4PLC cases (p=0.56), while hematoma was noted in 2% of SILC patients and 4% of C4PLC patients (p=0.43). None of these differences were statistically significant, indicating that the complication rates were comparable between the two surgical techniques.

Table 5: Patient Satisfaction and Cosmetic Outcome

Parameter	SILC (n=50)	C4PLC (n=50)	p-value
Patient satisfaction (mean ± SD)	8.5 ± 1.2	7.8 ± 1.4	0.02
Cosmetic score (mean ± SD)	9.2 ± 0.8	7.5 ± 1.1	<0.001

Table 5 shows that the Patient satisfaction was higher in the SILC group, with a mean satisfaction score of 8.5 ± 1.2 compared to 7.8 ± 1.4 in the C4PLC group, with a statistically significant p-value of 0.02. The cosmetic outcome, as assessed by a cosmetic score, was significantly better in the SILC group (9.2 ± 0.8) compared to the C4PLC group (7.5 ± 1.1), with a highly significant p-value of <0.001. This suggests that the reduced number of incisions in SILC led to improved cosmetic results, making it a preferred choice for patients concerned about postoperative scarring.

DISCUSSION

In our study, the demographic and preoperative characteristics, including age, gender distribution, BMI, and comorbidities, were comparable between the Single Incision Laparoscopic Cholecystectomy (SILC) and Conventional Four Ports Laparoscopic Cholecystectomy (C4PLC) groups. This uniformity aligns with the findings of Bucher et al. (2011), who reported no significant differences in baseline characteristics between patients undergoing SILC and those undergoing conventional laparoscopic cholecystectomy. Such consistency in patient selection criteria ensures that outcome comparisons between the two surgical techniques are reliable and not influenced by demographic disparities.7

Our results indicated that the operative time was significantly longer in the SILC group (55.3 ± 12.6 minutes) compared to the C4PLC group (42.8 ± 9.4 minutes), with a p-value of <0.001. This finding is consistent with the study by Ma et al. (2011), who observed a longer operative time for SILC (69 ± 4.00 minutes) versus conventional laparoscopic cholecystectomy (38.53 ± 4.00 minutes), attributing the increased duration to the limited instrumentation and challenging ergonomics associated with the single-port technique.[8] Additionally, our study found that blood loss was significantly higher in the SILC group (45.2 ± 10.8 mL) than in the C4PLC group (30.6 ± 8.9 mL) (p<0.001). This observation aligns with the meta-analysis by Trastulli et al. (2013), which reported that SILC is associated with more blood loss and takes longer than conventional laparoscopic cholecystectomy.[9] The conversion rates to open surgery in our study were low and comparable between groups, similar to the findings of Allemann et al. (2014), who reported no increased incidence of bile duct injury in either group.[10]

Our assessment of postoperative pain using the Visual Analog Scale (VAS) revealed that pain scores at 6 hours were significantly lower in the SILC group (5.8 ± 1.2) compared to the C4PLC group (6.5 ± 1.0) (p=0.03). At 24 hours, the SILC group continued to report lower pain scores (3.2 ± 0.9) than the C4PLC group (3.8 ± 1.0) (p=0.04). These findings are in line with the study by Joseph et al. (2011), which demonstrated reduced postoperative pain in SILC patients, likely due to the single incision resulting in less tissue trauma.[11] Furthermore, our study found that the total number of analgesic doses required postoperatively was lower in the SILC group (3.5 ± 1.1) compared to the C4PLC group (4.2 ± 1.3) (p=0.02), and the duration of hospital stay was shorter for SILC patients (2.1 ± 0.5 days) versus C4PLC patients (2.5 ± 0.6 days) (p=0.01). These outcomes are consistent with the findings of Chang et al. (2011), who reported that SILC patients experienced less postoperative pain and had a shorter hospital stay compared to those undergoing conventional laparoscopic cholecystectomy.[12]

The incidence of postoperative complications in our study was similar between the two groups. Wound infection rates were 6% in the SILC group and 8% in the C4PLC group (p=0.67). Bile leaks occurred in 2% of SILC cases and 4% of C4PLC cases (p=0.56), while hematomas were noted in 2% of SILC patients and 4% of C4PLC patients (p=0.43). These differences were not statistically significant, indicating comparable

safety profiles for both surgical techniques. Our findings are corroborated by the meta-analysis conducted by Arezzo et al. (2013), which concluded that SILC is a safe procedure with complication rates comparable to those of conventional laparoscopic cholecystectomy.[13]

Patient satisfaction in our study was higher in the SILC group, with a mean satisfaction score of 8.5 ± 1.2 compared to 7.8 ± 1.4 in the C4PLC group (p=0.02). The cosmetic outcome, assessed by a cosmetic score, was significantly better in the SILC group (9.2 ± 0.8) versus the C4PLC group (7.5 ± 1.1) (p<0.001). These results suggest that the reduced number of incisions in SILC leads to improved cosmetic results, making it a preferred choice for patients concerned about postoperative scarring. This observation is supported by the study of Marks et al. (2013), who reported that SILC is associated with improved cosmetic satisfaction compared to the conventional four-port technique.[14]

LIMITATIONS OF THE STUDY

1. **Single-Center Study** – The study was conducted at a single tertiary care hospital, which may limit the generalizability of the findings to other healthcare settings.
2. **Small Sample Size** – The study included only 100 patients, which may not be sufficient to detect rare complications or subtle differences in outcomes between the two surgical techniques.
3. **Short-Term Follow-Up** – The study primarily focused on short-term postoperative outcomes. Long-term complications, such as incisional hernia or delayed cosmetic dissatisfaction, were not assessed.
4. **Exclusion of Complex Cases** – Patients with complicated gallstone disease (e.g., acute cholecystitis, choledocholithiasis) were excluded, limiting the applicability of the results to more complex surgical scenarios.
5. **Lack of Cost Analysis**
6. **Potential Selection Bias**

CONCLUSION

This comparative study demonstrates that Single Incision Laparoscopic Cholecystectomy (SILC) offers advantages over Conventional Four Ports Laparoscopic Cholecystectomy (C4PLC) in terms of reduced postoperative pain, lower analgesic requirements, shorter hospital stays, and superior cosmetic outcomes. However, SILC is associated with longer operative times and increased intraoperative blood loss. Both techniques have comparable safety profiles, with no significant differences in complication rates. Given its benefits, SILC can be considered a viable alternative for patients prioritizing minimal scarring and improved cosmesis.

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