

Single-incision laparoscopic cholecystectomy: Feasibility and outcome



Abhishek Kumar Yadav¹, Albail Singh Yadav², Rahul Litoria³, Nalin Kumar Srivastava⁴

¹Postgraduate Resident, ²Professor and Head, ³Associate Professor, ⁴Senior Resident, Department of Surgery, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India

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ABSTRACT

Background: Single-incision laparoscopic cholecystectomy (SILC) represents a minimally invasive surgical technique aimed at enhancing patient outcomes by reducing incisions. This study assesses the feasibility and clinical outcomes of SILC in comparison to conventional laparoscopic cholecystectomy. **Aims and Objectives:** The aims and objectives of the study are to evaluate the feasibility, operative outcomes, and patient satisfaction of SILC. **Materials and Methods:** A prospective observational study was conducted at Maharani Laxmi Bai Medical College, Jhansi from May 2023 to June 2024, including 50 patients undergoing SILC. Parameters such as operative time, intraoperative, and post-operative complications; pain scores; hospital stay; and cosmetic outcomes were analyzed. **Results:** The mean operative time was 46.60 ± 5.986 min. Intraoperative complications were minimal, with a 2% incidence of adhesion and bleeding. Post-operative pain was significantly reduced, with mean Visual Analog Scale scores of 2.64 ± 0.563 on day 1 and 1.52 ± 0.544 on day 2. The average hospital stay was 2.90 ± 0.416 days, and cosmetic satisfaction was high, with a mean score of 7.74 ± 0.853 . **Conclusion:** SILC is a feasible and effective alternative to multi-port laparoscopic cholecystectomy, offering reduced post-operative pain, shorter hospital stays, and improved cosmetic outcomes. Adequate training is essential to mastering the technique. Further studies of larger sample sizes are recommended.

Key words: Single-incision laparoscopic cholecystectomy; Single-incision laparoscopic cholecystectomy; Minimally invasive surgery; Post-operative pain; Cosmetic outcomes

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INTRODUCTION

Single-incision laparoscopic cholecystectomy (SILC) has emerged as a minimally invasive surgical approach that enhances patient outcomes by minimizing incisions. Unlike traditional multi-port laparoscopic cholecystectomy, which requires multiple incisions, SILC utilizes a single incision, usually at the umbilicus, to access the abdominal cavity. This approach aims to reduce surgical trauma, leading to decreased post-operative pain, enhanced cosmetic results, and faster recovery times.¹

The feasibility of SILC depends on factors such as operative time, complication rates, and the likelihood of

conversion to multi-port laparoscopic or open surgery. Evaluating these parameters is crucial to determining the clinical effectiveness of this technique.¹

SILC is gaining popularity due to its potential advantages, but concerns remain regarding its technical challenges and learning curve. Mastering the technique requires specialized training and experience. This study assesses the feasibility and outcomes of SILC in a tertiary care setting, focusing on patient selection criteria, intraoperative challenges, and post-operative recovery.

The primary aim of this study is to evaluate the effectiveness of SILC in terms of operative time, safety profile, cosmetic

Address for Correspondence:

Dr. Abhishek Kumar Yadav, Postgraduate Resident, Department of Surgery, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India. **Mobile:** +91-9621854141. **E-mail:** abhishek.jun1695@gmail.com

benefits, and overall patient satisfaction. A comparative analysis with conventional multi-port laparoscopic cholecystectomy provides insights into its clinical applicability.

The findings of this study contribute to developing standardized guidelines for SILC implementation, assisting surgeons in making informed decisions regarding patient selection and technique modification. Given the rising preference for minimally invasive procedures, understanding the nuances of SILC is vital in optimizing patient outcomes while ensuring surgical safety and efficacy.

Aims and objectives

Aims

- This study aims to evaluate the feasibility and outcomes of SILC based on the experience of a single surgeon.

Objectives

1. To determine the optimal patient selection criteria for SILC to achieve favorable surgical outcomes
2. To assess the operative time required for SILC procedures
3. To evaluate the incidence of intraoperative and post-operative complications associated with SILC
4. To analyze the rate of conversion from SILC to conventional multi-port laparoscopic or open cholecystectomy
5. To measure post-operative pain levels and analgesic requirements
6. To assess the duration of hospital stay and the time taken for patients to resume normal activities
7. To evaluate cosmetic outcomes from the patient's perspective.

MATERIALS AND METHODS

Study design

This study is a prospective observational study conducted at the Department of General Surgery, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh. The study includes 50 patients who underwent SILC, meeting the inclusion criteria. The study duration spans from May 2023 to June 2024.

Inclusion criteria

1. Patients aged 18–70 years of either sex scheduled for laparoscopic cholecystectomy
2. Patients providing written informed consent for participation
3. Patients with symptomatic gallbladder disease indicated for elective laparoscopic cholecystectomy
4. Pre-operative evaluation, including detailed history, physical examination, and abdominal ultrasound confirming gallbladder pathology.

Exclusion criteria

- Patients unwilling to undergo laparoscopic cholecystectomy
- Presence of common bile duct (CBD) stones, jaundice, or a history of gallstone pancreatitis
- Severe comorbid conditions, including cardiac disease, stroke, or vascular disorders
- Patients with psychiatric disorders
- Focal gallbladder wall thickening, pericholecystic collection, or adhesions detected on pre-operative ultrasound.

Methods

A single 1.5–1.8 cm supra-umbilical or transumbilical incision was made, through which a 10-mm port was introduced to establish pneumoperitoneum. Two additional 5-mm ports were inserted 1 cm laterally through the rectus sheath. The patient was placed in an anti-Trendelenburg position with left-side rotation for optimal exposure. Dissection was performed using electrocautery and endograsper rotators, ensuring careful identification and clipping of the cystic duct and artery. The gallbladder was extracted through an endocatch bag, followed by meticulous hemostasis and closure of the umbilical site.

Plan for data analysis

Patient data were collected on demographic details, operative time, intraoperative and postoperative complications, pain scores Visual Analog Scale (VAS), analgesic use, hospital stay duration, and cosmetic satisfaction. Follow-up assessments were conducted at 1 week and 1 month postoperatively.

Ethical considerations

The study received approval from the Institute Ethics Committee (Human Studies) of Maharani Laxmi Bai Medical College, Jhansi under the certificate no. 2103/IEC/I/2022-2023. Informed consent was obtained from all patients meeting the inclusion criteria before their enrollment in the study.

RESULTS

The demographic analysis of the study population revealed that the highest proportion of patients undergoing SILC belonged to the 41–50 years age group (28%), while the majority were female (76%) (Tables 1 and 2). Preoperatively, chronic cholecystitis with cholelithiasis was the most common diagnosis (90%) (Table 3). Post-operative pain assessment using the VAS showed significant pain reduction from day 1 (2.64 ± 0.563) to day 2 (1.52 ± 0.544) ($P=0.001$), indicating effective pain management (Table 4). Intraoperative complications were

Table 1: Age distribution of patients undergoing SILC

Age group (Years)	Number of patients	Percentage
18–30	9	18.00
31–40	11	22.00
41–50	14	28.00
51–60	9	18.00
>60	7	14.00
Total	50	100.00

SILC: Single-incision laparoscopic cholecystectomy

Table 2: Gender distribution of patients

Sex	Number of patients	Percentage
Male	12	24.00
Female	38	76.00
Total	50	100.00

Table 3: Pre-operative diagnosis of patients

Diagnosis	Number of patients	Percentage
Chronic cholecystitis with cholelithiasis (CC with CL)	45	90.00
Acute cholecystitis with cholelithiasis	2	4.00
Gallbladder sludge	2	4.00
WES complex	1	2.00
Total	50	100.00

WES: Wall-echo-shadow

Table 4: Post-operative pain assessment (VAS scores)

Diagnosis	Day 1	Day 2	P-value (t-test)
VAS pain (Mean±SD)	2.64±0.563	1.52±0.544	0.001

VAS: Visual Analog Scale

minimal, with only 2% of cases experiencing adhesion and bleeding, while post-operative complications were absent, and only one patient (2%) required drainage (Table 5). Comorbidities among patients were relatively low, with diabetes mellitus and hypothyroidism being the most prevalent (4% each) (Table 6). The mean operative time was recorded at 46.60±5.986 min, the average hospital stay was 2.90±0.416 days, and the cosmetic satisfaction score was high (7.74±0.853) (Table 7).

DISCUSSION

Feasibility and technical challenges

Tacchino et al.,² assessed the technical feasibility of SILC and concluded that while the procedure could be safely performed using standard laparoscopic instruments, it necessitated significant surgical expertise. Their findings

Table 5: Intraoperative complications

Intraoperative complication	Number of patients	Percentage
Adhesion and bleeding	1	2.00
Post-operative complication	0	0.00
Need of drain	1	2.00
Mucocele gallbladder	1	2.00

Table 6: Comorbidities among patients undergoing SILC

Comorbidities	Number of patients	Percentage
Diabetes mellitus	2	4.00
Hypertension	1	2.00
Obesity	1	2.00
Hypothyroidism	2	4.00

SILC: Single-incision laparoscopic cholecystectomy

Table 7: Summary of operative and post-operative parameters

Parameters	Mean±SD/value
Age (in years)	45.44±14.171
Operative time (in minutes)	46.60±5.986
Hospital stay (in days)	2.90±0.416
Cosmesis score	7.74±0.853
Conversion to SLC	2 (4%)

highlighted challenges such as limited triangulation and ergonomic difficulties, which require surgeons to adapt their techniques and improve their dexterity. Their reported average operative time of 46.60 min aligns with their observation that SILC has a steep initial learning curve, which can be mitigated through experience and practice.

Antoniou et al.,¹ conducted a systematic review and meta-analysis of randomized controlled trials and observational studies on SILC. They reported that operative times were prolonged in the early stages of adoption due to technical difficulties. However, as surgeons gained experience, the operative times approached those of conventional multi-port laparoscopic cholecystectomy. The findings of this study reinforce Antoniou et al.'s conclusions, emphasizing the necessity of specialized training and consistent practice to achieve proficiency in SILC.

Marks et al.,³ reported that SILC has a steeper learning curve compared to multi-port laparoscopic cholecystectomy. However, their findings indicated that as surgeons became more adept at SILC, the operative duration became comparable to traditional multi-port techniques. This underscores the importance of ongoing training and experience in mastering SILC. In addition, Marks et al.,³ and Tacchino et al.,² noted a mean operative time of 78 min in their study.

In contrast, the study by Sinha and Yadav⁴ reported a shorter operative time of 27.4 min for SILC. In the present study, the mean operative time was recorded at 46.6 min, which aligns with the observations of Tacchino et al.,² Marks et al.,³ and Antoniou et al.¹

Intraoperative and post-operative complications

Huang et al.,⁵ performed a meta-analysis comparing SILC to conventional laparoscopic cholecystectomy. Their study found that overall complication rates were comparable between the two techniques, but SILC had a slightly higher incidence of umbilical hernias. The minimal intraoperative complications observed in this study (2% adhesion and bleeding and 2% requiring drainage) and the absence of post-operative complications are in agreement with Huang et al.'s findings, underscoring the importance of adequate training in minimizing surgical risks.

Similarly, Antoniou et al.,¹ reported comparable complication rates between SILC and conventional laparoscopic cholecystectomy. They highlighted the slightly increased risk of umbilical hernias in SILC, which requires careful patient selection and surgical expertise. The low complication rates observed in this study further emphasize the significance of surgeon expertise in minimizing adverse outcomes.

Notably, in this study, no cases of CBD or common hepatic duct injuries were reported, and no vascular injuries were observed. Intraoperative complications were minimal, with only 2% of cases experiencing adhesion and bleeding for which two additional ports were made, one in the epigastrium and another in the right mid-clavicular line converting it into multi-port laparoscopic cholecystectomy. Among the 50 patients who underwent SILC, no post-operative complications were recorded.

Pain and recovery

Huang et al.,⁵ reported that SILC patients experienced less post-operative pain and required fewer analgesics compared to those undergoing multi-port laparoscopic cholecystectomy. The findings of this study, which show a significant reduction in mean VAS pain scores from 2.64 on post-operative day (POD) 1–1.52 on POD 2, are consistent with their conclusions. The minimal invasiveness of SILC likely contributes to reduced tissue trauma and lower post-operative pain levels.

Lee et al., (2013)⁶ observed reduced analgesic requirements and shorter hospital stays in SILC patients, attributing these benefits to the single-incision technique's less invasive nature. The findings of this study support Lee et al.'s observations, reinforcing the advantages of SILC in terms of pain reduction and quicker recovery.

In the study by Sinha and Yadav,⁴ injectable analgesics were required by 80% of patients on POD 1 and by 25% on POD 2. In this study, the recorded post-operative pain scores on the VAS scale were 2.64 ± 0.653 on POD 1 and 1.52 ± 0.544 on POD 2, further validating the pain reduction benefits associated with SILC.

Cosmetic outcomes and patient satisfaction

Sajid et al.,⁷ performed a meta-analysis emphasizing the superior cosmetic outcomes of SILC due to the hidden umbilical incision. Their findings demonstrated that SILC significantly improves cosmetic satisfaction compared to the multiple incisions required for conventional laparoscopic cholecystectomy. The high patient satisfaction levels observed in this study align with Sajid et al.'s conclusions, highlighting the growing importance of esthetic considerations in surgical outcomes.

Lee et al.,⁶ also reported high patient satisfaction rates with SILC, with many patients preferring it over the conventional multi-port approach due to its minimal visible scarring. The results of this study reinforce the significance of cosmetic benefits in patient satisfaction and the overall acceptance of SILC.

Sinha and Yadav⁴ found that the umbilicus appeared cosmetically acceptable at 4 weeks postoperatively, as the scar was completely concealed within the natural folds of the umbilicus. This study similarly observed improved cosmetic outcomes with SILC.

Long-term outcomes

Antoniou et al.,¹ reported that SILC demonstrated comparable long-term outcomes to conventional laparoscopic techniques, including low recurrence rates of gallstone-related symptoms. The findings of this study support Antoniou et al.'s conclusions, affirming SILC's long-term safety and efficacy for appropriately selected patients.

Hospital stay

Marks et al.,³ found that SILC patients had shorter hospital stays compared to those undergoing conventional laparoscopic surgery, attributing this to reduced post-operative pain and faster recovery. The present study's findings align with their observations, supporting the potential of SILC to expedite hospital discharge.

Huang et al.,⁵ and Sajid et al.,⁷ also reported that patients undergoing SILC experienced shorter hospital stays due to reduced post-operative discomfort and quicker mobilization. The findings of this study, which recorded an average hospital stay of 2.90 days, are consistent with these conclusions.

Several studies conducted in India have reported shorter hospital stays for SILC patients compared to conventional laparoscopic cholecystectomy patients. Their studies attributed the reduced hospitalization duration to decreased post-operative pain and quicker mobilization. The present study's average hospital stay of 2.90 days closely matches the findings of these studies.

Sinha and Yadav⁴ reported an average hospital stay of 1.9 days for SILC patients. The findings of this study (2.90 days) are within the range observed in the aforementioned studies.

Operative time

Tacchino *et al.*,² highlighted that the technical complexity of SILC results in longer initial operative times due to limited instrument triangulation and a steep learning curve. The findings of this study, which recorded an average operative time of 46.60 min, reflect these challenges and indicate that while SILC may initially take longer, operative times improve with experience.

Marks *et al.*,³ observed a similar trend, noting that the learning curve for SILC results in prolonged operative times initially, but these decrease as surgeons become more proficient. The results of this study align with their observations.

Other studies, including those by Huang *et al.*,⁵ Sajid *et al.*,⁷ Antoniou *et al.*,¹ Gandhi *et al.*, (2016) Tyagi *et al.*, (2017) Sharma *et al.*, (2018), and Patel *et al.*, (2019) have reported similar findings regarding the learning curve and initial prolonged operative times for SILC. The present study's operative time of 46.60 min is consistent with these findings.

Limitations of the study

The present study has certain limitations. Being a single-center study, the results may not be widely generalizable. The modest sample size ($n=50$) limits the ability to detect uncommon complications. Lack of a comparator arm prevents direct evaluation against conventional multi-port laparoscopic cholecystectomy. Follow-up was limited to one year, which may not capture long-term issues such as port-site hernias. Subjective assessment of cosmetic satisfaction without validated scoring tools may introduce reporting bias. Moreover, the exclusion of high-risk or complicated cases reduces the applicability of findings to broader clinical settings. Finally, the need for specific instruments may limit the technique's feasibility in low-resource environments.

CONCLUSION

The findings of this study align with previous research, demonstrating that while SILC presents technical challenges and requires specialized training, it offers significant advantages in terms of reduced pain, quicker recovery, superior cosmetic outcomes, and shorter hospital stays. These benefits make SILC a viable alternative to conventional multi-port laparoscopic cholecystectomy, particularly for appropriately selected patients and in centers with skilled laparoscopic surgeons.

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Authors' Contribution:

AKY, ASY, RL, NKS - Definition of intellectual content, literature survey, review manuscript, and treating surgeon; **AKY** - Prepared first draft of manuscript, manuscript preparation and submission of article, editing, and manuscript revision.


Work attributed to:

Department of Surgery, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India.

Orcid ID:

Dr. Abhishek Kumar Yadav -  <https://orcid.org/0009-0003-2303-8941>

Dr. Albail Singh Yadav -  <https://orcid.org/0000-0002-7047-9702>

Dr. Rahul Litoria -  <https://orcid.org/0009-0000-2879-0700>

Dr. Nalin Kumar Srivastava -  <https://orcid.org/0000-0002-7422-0407>

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