ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 11, Issue – 4, August – 2026, Page No. : 79 – 87

A Prospective Observational Comparative Study of Postoperative Complications After Gallbladder Extraction Through the Epigastric Port Versus the Umbilical Port in Laparoscopic Cholecystectomy

[1]Suresh Chandra Singh, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
[2]Abhishek Gond, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
[3]Siddharth Singh, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
[4]Priyesh Shukla, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
[5]Yukteshwar Mishra, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
[6]Saurabh Agrawal, Department of General Medicine, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India
Corresponding Author: Suresh Chandra Singh, Department of General Surgery, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India

Citation this Article: Suresh Chandra Singh, Abhishek Gond, Siddharth Singh, Priyesh Shukla, Yukteshwar Mishra, Saurabh Agrawal, "A Prospective Observational Comparative Study of Postoperative Complications After Gallbladder Extraction Through the Epigastric Port Versus the Umbilical Port in Laparoscopic Cholecystectomy", IJMSIR – August – 2026, Vol – 11, Issue – 4, P. No. 79 – 87.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Laparoscopic cholecystectomy is the standard operative treatment for symptomatic gallstone disease. During standard four-port laparoscopic cholecystectomy, the gallbladder may be retrieved through either the epigastric or the umbilical port. The choice of extraction site may influence postoperative pain, fascial extension, surgical-site infection (SSI), and early port-site hernia (PSH).

Methods: This prospective, single-centre observational comparative study was conducted in the Department of General Surgery, G.S.V.M. Medical College and Associated LLR Hospital, Kanpur. Patient recruitment was performed from May 2025 to February 2026, with clinical follow-up continued for 6 months after surgery. Five hundred adults scheduled for elective laparoscopic cholecystectomy were included and classified according to the gallbladder retrieval port used during routine surgical care: Group A, epigastric retrieval (n = 250), and Group B, umbilical retrieval (n = 250). The operating surgeon selected the retrieval port as part of routine care, and the study did not dictate or alter this decision. Postoperative pain was assessed using a 10-point Visual Analog Scale (VAS) at 6, 12, 24, and 48 hours. Secondary outcomes included additional analgesic requirement, SSI, fascial extension, operative time, hospital stay, and clinically evident PSH during 6-month follow-up. Because no formal a priori sample-size calculation was documented, SSI and PSH were interpreted as exploratory secondary safety outcomes. Standardized operative, analgesic, and outcome-assessment protocols were used to reduce measurement and management variability; however, residual

confounding could not be excluded because of the observational design.

Results: Observed baseline demographic, clinical, and laboratory variables were broadly similar between groups. Umbilical retrieval was associated with significantly lower VAS pain scores at all-time points (all $p < 0.001$), with large effect sizes at 24 hours (Cohen's d = 1.23) and 48 hours (Cohen's d = 0.95). Additional analgesic use was observed less frequently in the umbilical group than in the epigastric group (14.0% vs. 41.6%; $p < 0.001$). Fascial extension was observed more frequently with umbilical retrieval (7.6% vs. 2.4%; $p = 0.012$). SSI was numerically higher in the umbilical group (6.8% vs. 2.8%; Fisher's exact $p = 0.058$), and PSH during 6-month follow-up was also numerically higher (2.8% vs. 1.6%; Fisher's exact $p = 0.544$), but these differences did not reach statistical significance.

Conclusion: Umbilical retrieval was associated with lower early postoperative pain and less additional analgesic use, together with a higher observed frequency of fascial extension and numerical, non-significant increases in SSI and PSH during 6-month follow-up. Because the study was observational, the comparisons were unadjusted, no a priori power calculation was documented, and SSI/PSH events were infrequent, these findings do not establish causality or equivalence. Retrieval-port selection should be individualized according to patient risk factors, intraoperative findings, wound contamination risk, and surgeon experience.

Keywords: Laparoscopic Cholecystectomy, Gallbladder Retrieval, Epigastric Port, Umbilical Port, Postoperative Pain, Surgical-Site Infection, Port-Site Hernia.

Introduction

Gallstone disease is one of the most common biliary disorders worldwide and remains a frequent cause of surgical admission[1]. Its epidemiology is influenced by age, sex, obesity, metabolic comorbidities, and regional dietary patterns. Patients with symptomatic cholelithiasis, recurrent biliary colic, cholecystitis, choledocholithiasis, or gallstone pancreatitis usually require definitive treatment. Laparoscopic cholecystectomy (LC) has become the preferred approach because it is associated with less postoperative pain, shorter hospital stay, and faster return to routine activities than open cholecystectomy[2,3]. In a standard four-port LC, a 10-mm umbilical port is used for the camera, a 10-mm epigastric port is commonly used for working instruments, and two 5-mm right subcostal ports are used for retraction[4]. After dissection, clipping, and division of the cystic duct and cystic artery, the gallbladder is detached from the liver bed and retrieved through either the umbilical or epigastric port. Although this step appears technically simple, extraction may require manipulation of the port site, fascial stretching, wound enlargement, and wound contamination, all of which may influence postoperative outcomes[5]. The umbilicus is frequently selected for extraction because it is centrally located, cosmetically concealed, and often sufficiently compliant to permit specimen retrieval with limited enlargement[6]. However, the umbilicus has limited muscular support and may harbour moisture and skin flora, which can increase the risk of wound infection and fascial weakness. By contrast, the epigastric port traverses the linea alba or rectus sheath and may provide stronger fascial support, but extraction through this site may produce more tissue stretching and early postoperative pain[7]. Current evidence remains heterogeneous with respect to study design, sample size, operative technique, use of retrieval bags, and follow-up duration[7,8]. Therefore, the present prospective observational comparative study was designed to evaluate the association of gallbladder retrieval through the epigastric versus umbilical port with

postoperative pain and port-site outcomes in a high-volume tertiary-care surgical unit in North India.

Materials and Methods

Study Design and Setting

This was a prospective, single-centre observational comparative study conducted in the Department of General Surgery, G.S.V.M. Medical College and Associated LLR Hospital, Kanpur, Uttar Pradesh, India. Patient recruitment was conducted from May 2025 to February 2026, and each participant was followed clinically for 6 months after surgery. Institutional Ethics Committee approval was obtained before study initiation, and written informed consent was obtained from every participant.

Participants

Adults aged 18-70 years with ultrasonography-confirmed symptomatic gallstone disease who were planned for elective LC were eligible. Patients with suspected or confirmed gallbladder malignancy, unfitness for laparoscopic surgery, pediatric age group, emergency open surgery, or conversion to open cholecystectomy were excluded. A total of 500 eligible patients were enrolled and classified according to the retrieval port used during routine care. The final analytic cohorts comprised Group A (epigastric port retrieval, n = 250) and Group B (umbilical port retrieval, n = 250).

Sample Size and Study Power

The study was conducted as a time-bound prospective study during the recruitment period from May 2025 to February 2026. All eligible consenting patients available during this period were included, resulting in a total sample size of 500 patients, with 250 patients in each group. A formal a priori sample-size or power calculation was not documented. The study was therefore powered mainly by available recruitment rather than by a predefined hypothesis for low-frequency endpoints. As a post hoc sensitivity consideration, 250 patients per group would generally be insufficient to rule out small absolute differences in uncommon outcomes such as SSI and PSH; hence, these outcomes were interpreted as secondary exploratory safety outcomes rather than as definitive equivalence endpoints.

Study Groups and Exposure Classification

Patients were classified into two cohorts according to the gallbladder retrieval port used during routine surgical care: Group A, epigastric port retrieval (n = 250), and Group B, umbilical port retrieval (n = 250). The retrieval-port choice was made by the operating surgeon as part of routine clinical and intraoperative decision-making, and the study did not dictate or alter that choice. Because the selected port could have been influenced by patient characteristics, gallbladder findings, technical considerations, or surgeon preference, selection bias and confounding by indication were considered possible.

Bias-Control Measures

Because this was an observational study, the investigators did not assign the retrieval port. Nevertheless, knowledge of the port used could influence perioperative management or postoperative assessment. To reduce measurement and management variability, all patients were managed with a standardized anaesthesia protocol, operative approach, postoperative analgesic regimen, VAS assessment schedule, SSI definition, and follow-up protocol. Pain scores were recorded on a predefined form by postoperative clinical staff. These measures improved consistency but could not eliminate residual confounding, selection bias, surgeon-related differences, or possible detection bias.

Operative Technique and Retrieval-Bag Policy

All procedures were performed under general anaesthesia using a standard four-port LC technique by experienced surgeons or supervised senior trainees.

Pneumoperitoneum was created through the umbilical port, and the critical view of safety was obtained before clipping and division of the cystic duct and artery whenever feasible. After detachment of the gallbladder from the liver bed, the specimen was retrieved through the port selected during routine surgical care. Fascial extension, if required for specimen extraction, was performed and recorded. Endoscopic retrieval bags were used selectively in contaminated or high-risk situations, including bile spillage, gallbladder perforation, empyema, gangrenous changes, friable gallbladder wall, or visibly infected specimen. Because retrieval-bag use was not governed by a uniform study protocol and was incompletely captured as a structured variable in some operative records, the present analysis did not perform a separate comparative subgroup analysis by bag use. This has been acknowledged as a reporting and confounding limitation.

Outcome Measures

The primary outcome was postoperative pain measured by the 10-point Visual Analog Scale (VAS; 0 = no pain and 10 = worst imaginable pain) at 6, 12, 24, and 48 hours after surgery. Secondary outcomes were additional analgesic requirement beyond the standard protocol, SSI according to predefined clinical criteria, fascial extension during specimen retrieval, gallbladder perforation, operative time, hospital stay, and clinically evident PSH assessed during clinical follow-up up to 6 months after surgery. The 6-month hernia assessment was included to improve detection of port-site hernia beyond the early 30-day postoperative period.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for distribution and reported as mean +/- standard deviation (SD). Intergroup comparisons for continuous variables were performed using the independent-samples Student's t-test or Mann-Whitney U test, as appropriate. Categorical variables were reported as frequency and percentage and compared using Pearson's chi-square test or Fisher's exact test for low-event outcomes. Fisher's exact test was used for SSI and PSH, and exact two-sided p-values were reported to avoid statistical inconsistency in low-count comparisons. Cohen's d was calculated to quantify the standardized difference in VAS pain scores. The reported comparisons were unadjusted; multivariable regression or propensity-score adjustment was not included in this analysis. Therefore, between-group findings were interpreted as associations rather than causal effects. A two-sided p-value < 0.05 was considered statistically significant; borderline p-values were described cautiously without claiming statistical significance.

Results

Baseline Characteristics

Observed baseline characteristics were broadly similar between the two groups (Table 1). Most patients were in the 41-50-year age group, and female predominance was observed, consistent with the epidemiology of gallstone disease. Approximately 80% of patients were overweight or obese (BMI >= 25 kg/m2). The observed distribution of diabetes mellitus, hypertension, dyslipidaemia, preoperative cholecystitis, stone size, baseline white blood cell count, and bilirubin levels did not differ significantly between groups. These comparisons do not exclude residual or unmeasured confounding.

Table 1: Baseline Characteristics of Study Groups

Parameter	Epigastric (n = 250)	Umbilical (n = 250)	p-value
Age: 41-50 yrs, n (%)	75 (30.0%)	75 (30.0%)	0.99
Female sex, n (%)	173 (69.2%)	188 (75.2%)	0.16

BMI >= 25 kg/m2, n (%)	199 (79.6%)	200 (80.0%)	0.99
Diabetes mellitus, n (%)	44 (17.6%)	35 (14.0%)	0.33
Hypertension, n (%)	36 (14.4%)	44 (17.6%)	0.39
Dyslipidaemia, n (%)	51 (20.4%)	47 (18.8%)	0.74
Preoperative cholecystitis, n (%)	71 (28.4%)	77 (30.8%)	0.62
Stones > 5 mm, n (%)	221 (88.4%)	213 (85.2%)	0.36

All comparisons by chi-square test unless otherwise specified. $p < 0.05$ was considered statistically significant.

Intraoperative Findings

Mean operative time did not differ significantly between the epigastric and umbilical groups (90.96 +/- 35.82 minutes vs. 88.72 +/- 37.09 minutes; p = 0.49). Gallbladder perforation occurred in 30 patients (12.0%) in the epigastric group and 28 patients (11.2%) in the umbilical group (p = 0.889). Fascial extension was observed significantly more often during umbilical retrieval than during epigastric retrieval (19/250 [7.6%] vs. 6/250 [2.4%]; p = 0.012). Retrieval-bag use was selective and primarily employed in contaminated or high-risk extraction scenarios; because it was not governed by a standardized study protocol and was not uniformly documented as a structured outcome, no formal comparative analysis by bag use was performed.

Postoperative Pain Trajectory

Umbilical retrieval was associated with significantly lower VAS pain scores at all postoperative time points (Table 2 and Figure 1). At 6 hours, mean VAS score was 6.12 +/- 1.36 in the epigastric group compared with 5.18 +/- 1.21 in the umbilical group ($p < 0.001$). The difference persisted at 12, 24, and 48 hours. The standardized differences were medium at 6 and 12 hours and large at 24 and 48 hours. Because the analysis was observational and unadjusted, these effect sizes describe the magnitude of the observed between-group differences and should not be interpreted as causal effects.

Table 2: VAS Pain Scores by Retrieval Port at Each Postoperative Time Point

Time Point	Epigastric Mean +/- SD	Umbilical Mean +/- SD	p-value	Cohen's d
6 Hours	6.12 +/- 1.36	5.18 +/- 1.21	< 0.001	0.73 (Medium)
12 Hours	5.96 +/- 1.48	5.01 +/- 1.24	< 0.001	0.69 (Medium)
24 Hours	5.85 +/- 1.61	4.11 +/- 1.20	< 0.001	1.23 (Large)
48 Hours	4.73 +/- 1.45	3.40 +/- 1.36	< 0.001	0.95 (Large)

Independent-samples t-test. SD = standard deviation; VAS = Visual Analog Scale.

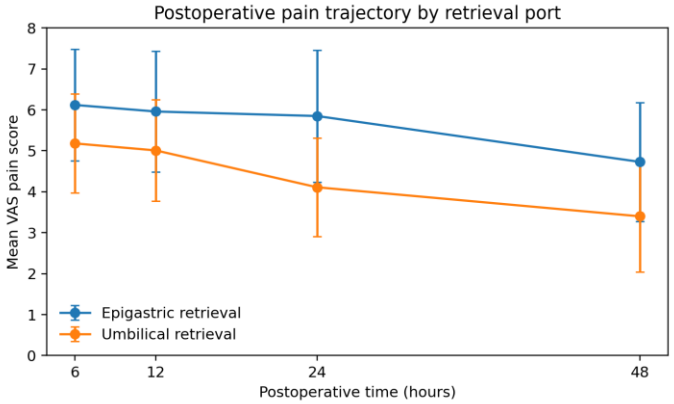

Figure 1: Mean VAS postoperative pain scores by retrieval port at 6, 12, 24, and 48 hours. Error bars represent standard deviation. All intergroup differences were statistically significant ($p < 0.001$).

Secondary Outcomes: Analgesic Requirement and Complications

Additional analgesic use beyond the standard postoperative protocol was observed significantly less often in the umbilical group than in the epigastric group (35/250 [14.0%] vs. 104/250 [41.6%]; p < 0.001). Mean

hospital stay did not differ significantly between groups (2.41 +/- 1.74 days vs. 2.59 +/- 1.57 days; p = 0.226).

SSI was observed in 17 patients (6.8%) in the umbilical group and 7 patients (2.8%) in the epigastric group. Although this numerical difference suggested a higher observed infection frequency in the umbilical group, Fisher's exact test did not cross the prespecified threshold for statistical significance (exact two-sided p = 0.058). Clinically evident PSH during 6-month follow-up was identified in 7 patients (2.8%) in the umbilical group and 4 patients (1.6%) in the epigastric group (Fisher's exact p = 0.544). Six of the 11 patients with PSH also had SSI. This co-occurrence may be clinically relevant; however, the small number of events, observational design, unadjusted analysis, and absence of an a priori power calculation preclude definitive inference.

Table 3: Intraoperative and Postoperative Complication Summary

Outcome	Epigastric (n = 250)	Umbilical (n = 250)	p-value	Interpretation
Gallbladder perforation	30 (12.0%)	28 (11.2%)	0.889	Not significant
Fascial extension required	6 (2.4%)	19 (7.6%)	0.012	Significant
Surgical-site infection	7 (2.8%)	17 (6.8%)	0.058	Borderline; not significant
Port-site hernia up to 6 months	4 (1.6%)	7 (2.8%)	0.544	Not significant; underpowered safety outcome
Additional analgesic use	104 (41.6%)	35 (14.0%)	< 0.001	Statistically significant
Hospital stay (days, mean +/- SD)	2.59 +/- 1.57	2.41 +/- 1.74	0.226	Not significant

Categorical variables were compared using Fisher's exact test for low-event outcomes; hospital stay was compared using an independent-samples t-test. Exact two-sided Fisher's p-values are reported for SSI and PSH. $p < 0.05$ was considered statistically significant.

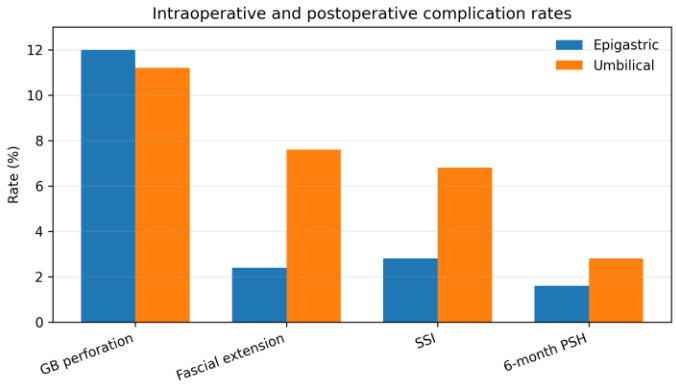

Figure 2: Intraoperative and postoperative complication rates according to retrieval port. SSI = surgical-site infection; GB = gallbladder; PSH = port-site hernia assessed up to 6 months.

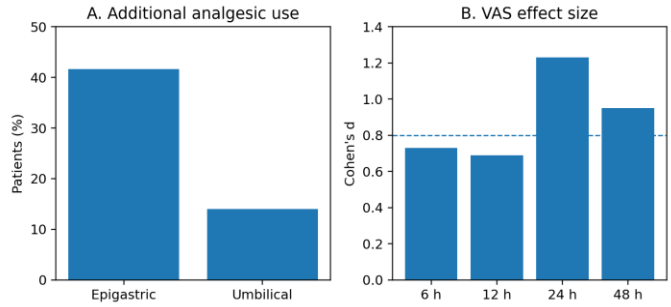

Figure 3: Panel A shows the proportion of patients requiring additional analgesia beyond the standard protocol ($p < 0.001$). Panel B shows Cohen's d effect sizes for VAS pain-score differences at each time point; the dashed line represents the conventional threshold for a large effect (d = 0.80).

Discussion

This prospective observational comparative study evaluated 500 patients undergoing elective LC and compared outcomes according to whether the gallbladder was retrieved through the epigastric or umbilical port during routine surgical care. The principal finding was that umbilical retrieval was associated with lower early postoperative pain and less additional analgesic use.

These unadjusted differences were statistically significant at all prespecified time points and were largest at 24 and 48 hours. An anatomical explanation is plausible: the epigastric port passes through the linea alba or rectus sheath, and extraction through this port may stretch fascia and adjacent soft tissue, increasing nociceptive input in the early postoperative period. The umbilical port, by contrast, passes through a relatively compliant and naturally concealed region, which may permit specimen retrieval with less acute pain in uncomplicated cases[5,7]. These findings are consistent with previously published comparative studies and meta-analyses reporting lower early pain scores after umbilical retrieval in selected patients[7,8]. However, because retrieval-port selection occurred during routine care and was not controlled by the study investigators, the observed associations may also reflect differences in patient selection, gallbladder characteristics, operative difficulty, or surgeon preference. The lower observed frequency of rescue analgesia provides a clinical correlate to the VAS findings and could be relevant to short-stay and day-care laparoscopic surgery pathways, but causal benefit cannot be established from this study.

A major accompanying finding was the higher observed frequency of fascial extension in the umbilical group. Although the umbilical ring may be compliant, extraction may become difficult in patients with large stones, thick-walled or oedematous gallbladder, high BMI, or inflammation. Fascial extension did not significantly prolong operative time in this study, but it may increase tissue trauma and may also influence later wound outcomes. SSI was observed more frequently in the umbilical group in absolute terms (6.8% vs. 2.8%). The Fisher's exact p-value was 0.058, indicating a borderline but statistically non-significant difference. This finding should be interpreted cautiously: the direction of the association is biologically plausible because the umbilicus is prone to bacterial colonization and moisture retention, and specimen extraction can lead to bile contamination[6]. Careful umbilical preparation, wound protection, selective or routine retrieval-bag use in contaminated cases, and meticulous closure remain important preventive measures. PSH during 6-month follow-up was numerically more frequent in the umbilical group but did not differ significantly between groups. Extending follow-up from the early 30-day period to 6 months improves hernia surveillance, but the low event count and absence of an a priori power calculation mean that the non-significant PSH result should not be interpreted as proof of long-term equivalence. The co-occurrence of SSI in several PSH cases suggests a possible relationship, but longer follow-up, larger event numbers, and adjusted analyses are needed to examine this hypothesis.

Selection and surgeon-related bias are important considerations in this observational study. Because the retrieval port was chosen during routine care rather than assigned by the investigators, clinical factors such as obesity, inflammation, stone burden, gallbladder wall thickness, contamination risk, technical difficulty, and surgeon preference may have influenced both cohort membership and postoperative outcomes. Standardized operative technique, supervision, analgesia, outcome definitions, and follow-up were used to reduce variability, but they cannot eliminate confounding by indication or unmeasured differences between groups. Accordingly, the present results should not be interpreted as demonstrating the causal superiority of either retrieval port. They support further adjusted observational analyses and, where feasible, adequately powered randomized studies. In clinical practice, retrieval-port choice should remain individualized according to patient

risk factors, operative findings, wound contamination risk, and surgeon judgment.

Limitations

This study has several limitations. First, its observational design permits selection bias, confounding by indication, and residual confounding because the retrieval port was selected during routine care rather than assigned by the investigators. Second, the analysis was based on unadjusted between-group comparisons; no multivariable regression or propensity-score method was used to account for measured differences or surgeon preference. Similarity in the recorded baseline variables does not exclude imbalance in unmeasured factors such as operative difficulty, gallbladder wall thickness, degree of inflammation, contamination, traction requirements, or reasons for port selection. Third, the study was conducted at a single tertiary-care centre, which may limit generalizability. Fourth, outcome assessors were not consistently blinded to the retrieval port, creating a possibility of detection bias. Fifth, a formal a priori sample-size or power calculation was not documented; therefore, uncommon outcomes such as SSI and PSH should be interpreted as exploratory safety outcomes rather than definitive equivalence outcomes. Sixth, PSH assessment was limited to 6 months, and some port-site hernias may present later. Seventh, retrieval-bag use was selective, not governed by a uniform protocol, and incompletely recorded as a structured variable, preventing reliable subgroup analysis. Future multicentre studies should prospectively document the reasons for port selection, surgeon-level factors, retrieval-bag use, contamination, and operative difficulty; apply appropriate multivariable or propensity-score adjustment; use blinded wound assessment where feasible; and include a priori power calculations and longer hernia surveillance. Adequately powered randomized studies may be required to establish causal comparative effectiveness.

Conclusion

In this prospective observational comparative study involving 500 patients undergoing elective laparoscopic cholecystectomy, umbilical gallbladder retrieval was associated with lower postoperative pain at 6, 12, 24, and 48 hours and less additional analgesic use than epigastric retrieval. Umbilical retrieval was also associated with a higher observed frequency of fascial extension and numerical, non-significant increases in SSI and PSH during 6-month follow-up. Because retrieval-port selection occurred during routine care and was not controlled by the study investigators, the comparisons were unadjusted, no formal a priori power calculation was documented, and SSI/PSH event counts were small, these findings do not establish causality or definitive equivalence. Retrieval-port selection should therefore be individualized according to patient risk factors, intraoperative contamination, gallbladder characteristics, and surgeon expertise, with careful wound protection and secure fascial closure regardless of the port selected.

Declarations

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical standards of the Institutional Ethics Committee of G.S.V.M. Medical College, Kanpur, and with the 1964 Declaration of Helsinki and its later amendments. Institutional Ethics Committee approval was obtained before study initiation. Written voluntary informed consent was obtained from every participant before enrolment.

Authors' Contributions

SCS: study conception, data collection, and manuscript preparation. YM: supervision and critical revision. SS: co-supervision and statistical guidance. PS: data

interpretation and manuscript review. AG: data collection assistance. SA: manuscript review and approval. All authors reviewed and approved the final manuscript.

Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Shabanzadeh DM. The symptomatic outcomes of cholecystectomy for gallstones. J Clin Med. 2023;12(5):1897.
2. Gutt C, Schlafer S, Lammert F. The treatment of gallstone disease. Dtsch Arztebl Int. 2020;117(9):148-158.
3. Madhok B, Nanayakkara K, Mahawar K. Safety considerations in laparoscopic surgery: a narrative review. World J Gastrointest Endosc. 2022;14(1):1-15.
4. Lin H, Zhang J, Li X, et al. Comparative outcomes of single-incision, mini-laparoscopic, four-port, three-port, and robotic cholecystectomy: a systematic review and network meta-analysis. Updates Surg. 2023;75(1):41-51.
5. Nemi CJ, Saran MS, Sushila C, et al. Insights into laparoscopic port site complications: a comprehensive review. Cureus. 2024;16(6):e61989.
6. Comajuncosas J, Hermoso J, Jimeno J, et al. Effect of bag extraction to prevent wound infection on umbilical port-site wound on elective laparoscopic cholecystectomy: a prospective randomized clinical trial. Surg Endosc. 2017;31(1):249-254.
7. Kulkarni AA, Sharma G, Deo KB, Jain T. Umbilical port versus epigastric port for gallbladder extraction in laparoscopic cholecystectomy: a systematic review and meta-analysis of randomized controlled trials with trial sequential analysis. Surgeon. 2022;20(3):e26-e35.
8. Sood S, Imsirovic A, Sains P, et al. Epigastric port retrieval of the gallbladder following laparoscopic cholecystectomy is associated with reduced risk of port-site infection and port-site incisional hernia: an updated meta-analysis of randomized controlled trials. Ann Med Surg. 2020; 55:244-251.
9. Pattanshetti VM, Shankar M, Metgud SC. Retrieval of gallbladder through umbilical versus epigastric port-site during laparoscopic cholecystectomy: a 1-year randomized controlled trial. J Sci Soc. 2025;52(1):25-29.
10. Buckley F III, Vassaur H, Jupiter D, et al. Influencing factors for port-site hernias after single-incision laparoscopy. Hernia. 2016;20(5):729-733.
11. Mohamed HK, Albendary M, Wuheb AA, et al. A systematic review and meta-analysis of bag extraction versus direct extraction for retrieval of gallbladder after laparoscopic cholecystectomy. Cureus. 2023;15(2):e34716.
12. Brunt LM, Deziel DJ, Telem DA, et al. Safe cholecystectomy multi-society practice guideline and state-of-the-art consensus conference on prevention of bile duct injury during cholecystectomy. Surg Endosc. 2020;34(7):2827-2855.