



RESEARCH ARTICLE

COMPARATIVE STUDY: ENHANCED RECOVERY AFTER SURGERY FOR ACUTE CHOLECYSTITIS UNDERGOING LAPAROSCOPIC CHOLECYSTECTOMY IN A TERTIARY CENTRE OF RURAL TRIBAL BELT OF WESTERN MAHARASHTRA

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ABSTRACT

Background & objectives: Enhanced Recovery After Surgery (ERAS) pathways aim to minimise surgical stress, promote faster return of function, shorten hospital stay. While ERAS has been studied extensively in high-resource centres, evidence from rural tribal tertiary care hospitals is limited. This study compared ERAS with conventional perioperative care in patients undergoing laparoscopic cholecystectomy (LC) for acute cholecystitis. **Methods:** A prospective comparative study was conducted at rural tertiary hospital in western Maharashtra between January 2024 and July 2025. Adults aged 18–60 years with ASA grade I–III and Tokyo Guidelines grade I–II acute cholecystitis were included. Patients received either ERAS-based care or conventional management. Outcomes assessed included postoperative length of stay (LOS), time to oral intake and mobilisation, pain scores, opioid use, complications ($\geq$ Clavien–Dindo II), 30-day readmissions. **Results:** Of 126 enrolled patients, 63 were assigned to each group. ERAS patients had a shorter LOS (median 3.0 d [IQR 2–3] vs. 4.0 d [IQR 4–5]; $p < 0.001$), earlier oral intake (8 h [IQR 7–8] vs. 24 h [IQR 20–26]; $p < 0.001$), quicker mobilisation (7 h [IQR 6–8] vs. 24 h [IQR 20–26]; $p < 0.001$). Pain scores and opioid requirements were lower in ERAS group ($p < 0.001$). Rates of complications and readmissions were comparable ($p = 0.47$). **Interpretation & conclusions:** ERAS-based perioperative management for LC in acute cholecystitis is feasible in rural and tribal settings. Enabling earlier recovery, reduces opioid use, maintains safety outcomes, supporting its wider adoption in resource-limited hospitals.

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INTRODUCTION

Laparoscopic cholecystectomy (LC) is widely accepted as the standard treatment for acute cholecystitis, one of the most frequently encountered surgical emergencies. The Tokyo Guidelines 2018 (TG18) provide structured recommendations for diagnosis, severity grading, and perioperative decision-making, and are now considered the benchmark for both elective and emergency settings (5). Enhanced Recovery After Surgery (ERAS) protocols represent a multimodal, evidence-based approach designed to limit surgical stress, support physiological stability, and hasten recovery. Implementation of ERAS protocols has repeatedly demonstrated benefits such as reduced hospitalisation, fewer complications, and enhanced recovery across different surgical specialties (2). Randomised trials and systematic reviews, including those focusing on acute cholecystitis, have shown that ERAS pathways enable earlier oral intake, faster ambulation, reduced pain scores, decreased opioid consumption, and shorter hospital stay compared with conventional perioperative care (3,4,6). These

outcomes, however, may be influenced by available resources, training, and adherence to the protocol, which often differ in resource-constrained centres. For uniform reporting of surgical morbidity, the Clavien–Dindo classification remains a validated tool, enabling standardised comparisons between studies (1). This study was conducted in a rural tertiary hospital in western Maharashtra, which serves a predominantly tribal population. The objective was to compare ERAS-based perioperative management with conventional care for LC in acute cholecystitis. We hypothesised that ERAS implementation would shorten hospital stay and accelerate recovery milestones without increasing postoperative complications or readmissions.

MATERIALS AND METHODS

Study design and setting: This prospective comparative study was conducted in the Department of General Surgery, Vedantaa Institute of Medical Sciences, western Maharashtra (January 2024–July 2025). Patients with acute cholecystitis undergoing laparoscopic

cholecystectomy (LC) were randomised to either Enhanced Recovery After Surgery (ERAS) or conventional perioperative care using sealed opaque chits. The Institutional Ethics Committee approved the study (EC/16/2023, dated 11/12/2023). Written informed consent was obtained from all participants.

Sample size: Length of stay (LOS) was the primary endpoint. The formula for two independent groups was applied:

$$n = 2(Z1 - \alpha/2 + Z1 - \beta)2\sigma^2\Delta^2n = \Delta^22(Z1 - \alpha/2 + Z1 - \beta)2\sigma^2$$

Assumptions: $\alpha=0.05$ (two-sided), power=80%, $\sigma=1.5$ days, $\Delta=0.75$ day. The required sample was 63 per arm (total 126).

Participants

Inclusion: adults 18–60 years; Tokyo Guidelines 2018 grade I–II acute cholecystitis; ASA I–III; complete records; treated entirely at the study centre.

Exclusion: elective LC for chronic cholecystitis/asymptomatic stones; ASA IV–V or unstable comorbidity; choledocholithiasis needing ERCP/bile duct exploration; pregnancy; incomplete data.

Interventions

ERAS group: pathway adapted from ERAS Society guidelines, including preoperative counselling, shortened fasting, avoidance of bowel prep, prophylactic antibiotics, risk-based VTE prophylaxis, short-acting anaesthesia, multimodal analgesia, low-pressure pneumoperitoneum, normothermia maintenance, avoidance of routine drains/tubes, early oral fluids (4–6 h), diet advancement from POD1, mobilisation within 6 h, early catheter removal, opioid-sparing analgesia, chest physiotherapy, and discharge once predefined criteria were met.

Conventional group: routine overnight fasting, delayed oral intake ($\geq$ POD1), regular use of drains and catheters, mobilisation from POD1, opioid-based analgesia, and discharge after 2–3 days irrespective of recovery milestones.

Outcomes

- **Primary:** LOS (surgery to discharge, days).
- **Secondary:** time to first oral intake, time to mobilisation, VAS pain scores (6 h, 24 h, POD1), total opioid use (morphine milligram equivalents), 30-day complications (Clavien–Dindo $\geq$ II), and 30-day readmissions. Conversions to open surgery were excluded from LOS analysis but retained for secondary outcomes.

Statistical analysis: Data were analysed using IBM SPSS v23. Continuous variables were expressed as mean $\pm$ SD or median (IQR) and compared with t-test/Welch's t-test or Mann–Whitney U as appropriate. Categorical variables were summarised as n (%) and analysed using Chi-square or Fisher's exact test. Effect sizes were reported as mean differences, odds ratios, or risk ratios with 95% confidence intervals. Multivariable regression adjusted for baseline covariates. Significance was set at $p < 0.05$. The study followed STROBE guidelines, and a patient flow diagram is presented.

RESULTS

Cohort and Flow: Between January 2024 and July 2025, 126 patients underwent laparoscopic cholecystectomy for acute cholecystitis (63 ERAS; 63 conventional). Eleven patients (8.7%) required conversion to open surgery—1 d (1.6%) in ERAS and 10 d (16.1%) in conventional care ($p = 0.004$; odds ratio 0.09, 95% CI: 0.01–0.74). Converted cases were excluded from primary analyses, leaving 62 ERAS and 53 conventional patients.

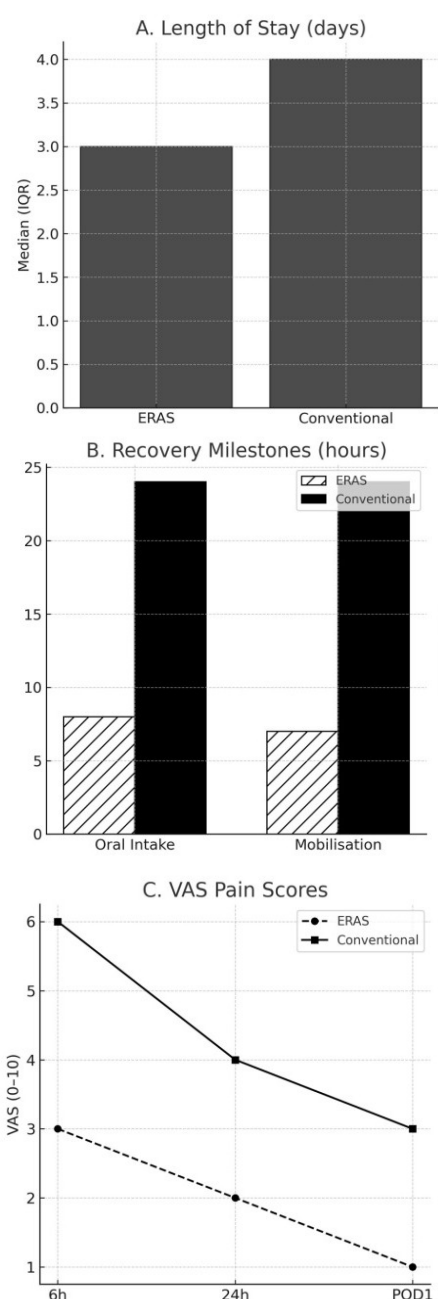


Figure 1. Comparison of perioperative outcomes between Enhanced Recovery After Surgery (ERAS) and conventional care in patients undergoing laparoscopic cholecystectomy for acute cholecystitis. (A) Median postoperative length of stay (LOS) in days, showing shorter hospitalisation in the ERAS group compared to conventional care. (B) Recovery milestones expressed in hours, demonstrating earlier resumption of oral intake and mobilisation in ERAS patients. (C) Postoperative pain assessment using Visual Analogue Scale (VAS, 0–10) at 6 hours, 24 hours, and postoperative day (POD) 1, with consistently lower pain scores in ERAS patients.

Baseline Characteristics: Groups were comparable for age, BMI, sex, comorbidities, ASA class, and Tokyo grade (Table 1). Median time to surgery was shorter in ERAS (14 h) than in conventional care (26 h, $p < 0.001$).

Outcomes

Significantly faster recovery: Was seen in patients managed using the ERAS protocol compared to that of patients managed with conventional care. Median length of stay was 3.0 d (IQR 2–3) in the ERAS group versus 4.0 d (IQR 3–5) in the control group ($p < 0.001$); mean difference – 1.1 d, 95% CI: –1.4 to –0.8.

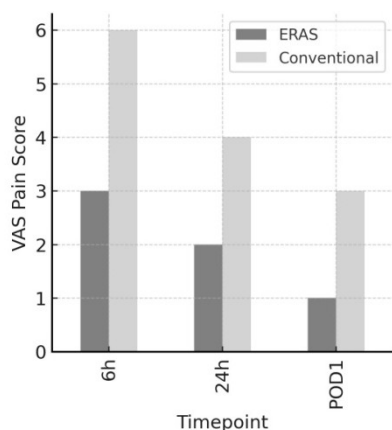


Figure 2. Comparison of postoperative pain scores (VAS) at 6 hours, 24 hours, and postoperative day 1 (POD1). VAS = Visual Analogue Scale; POD = postoperative day.

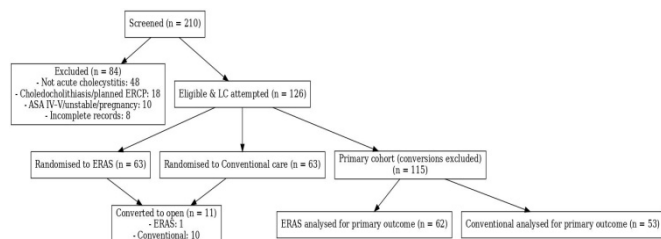


Figure 3. STROBE flow diagram showing patient screening, inclusion, randomisation, and analysis

Time to oral intake: Was reduced from 24 h (IQR 20-26] in controls to 8 h (IQR 7-8] with ERAS ($p < 0.001$); mean difference -15.7 h, 95% CI: -17.2 to -14.3

Time to mobilisation: Decreased from 24 h (IQR 20-26] to 7 h (IQR 7-8] ($p < 0.001$); mean difference -16.2 h, 95% CI: -17.8 to -14.7

VAS pain scores were consistently lower in the ERAS group at all measured intervals- 6 h (3 vs 6), $p < 0.001$; mean difference -3.0, 95% CI: -3.6 to -2.4 24 h (2 vs 4), $p < 0.001$; mean difference -2.0, 95% CI: -2.6 to -1.5 Postoperative day POD1 (1 vs 3), $p < 0.001$; mean difference -2.0, 95% CI: -2.5 to -1.4 Opioid use was reduced (median 6 mg morphine equivalents vs. 16 mg morphine equivalents; $p < 0.001$; mean difference -9.8 mg morphine equivalents, 95% CI: -11.3 to -8.3).

Safety Outcomes: Complications $\geq$ Clavien–Dindo II were not significantly different (6.3% vs. 0%; $p = 0.470$; risk difference 0.06, 95% CI: -0.02 to 0.14). Thirty-day readmissions were similarly low (3.2% vs. 0%; $p = 0.320$; risk difference 0.03, 95% CI: -0.03 to 0.09).

DISCUSSION

Principal Findings: In this study, patients on the ERAS pathway for laparoscopic cholecystectomy generally recovered sooner than those receiving conventional perioperative care. Their hospital stay was shorter by about a day, and most were eating and walking nearly 16–17 hours earlier. During the first two postoperative days, pain scores were consistently lower, and the need for opioids was noticeably reduced. Safety outcomes—including complications of Clavien–Dindo grade II or higher and 30-day readmissions—were infrequent and showed no increase with ERAS implementation.

Interpretation: Emphasise that opioid-sparing multimodal analgesia, early resumption of oral intake, and prompt postoperative mobilisation are consistent with the findings of the core principles of the ERAS protocol. Our study results of the reduction in LOS and time-to-recovery milestones are in line with prior studies evaluating ERAS pathways in LC cohorts [3,4]. Also, supporting the premise that pathway-level changes are better than the isolated interventions that drive the recovery benefits, reinforcing the value of ERAS as a bundled approach

External Validity: The improvements observed in this study were achieved in a rural tertiary hospital serving a predominantly tribal population, demonstrating the feasibility of ERAS adoption beyond high-resource centres. The protocol elements—standardised analgesia, early feeding and mobilisation, minimisation of drains, and criteria-based discharge—are adaptable to typical resource constraints, enhancing the generalisability of the findings to similar healthcare settings.

Limitations: This study has certain limitations. It was conducted at a single rural tertiary care centre with a modest sample size, which may restrict generalisability beyond similar resource-limited settings. Although randomisation was applied, blinding was not feasible, introducing potential performance bias. While ERAS adherence was high, each component was not independently audited in all patients, which could affect reproducibility. Additionally, outcomes were measured up to 30 days postoperatively, and long-term quality-of-life measures were not included. Future multicentric studies with larger cohorts and longer follow-up are warranted to confirm these findings and refine ERAS implementation in low-resource environments. These limitations should be considered while interpreting the findings.

Implications

Even in resource-limited rural tertiary settings, the present findings suggest that ERAS implementation for LC in acute cholecystitis can safely shorten hospital stay, reduce opioid use, and accelerate recovery. Implementation should be coupled with ongoing audits that monitor adherence to ERAS components and ensure consistent, high-quality documentation—particularly for outcomes such as PONV for sustained benefit. Expanding the use of ERAS may streamline surgical recovery and maintain the same level of patient safety.

CONCLUSION

At our rural, tribal tertiary hospital, introducing the ERAS pathway for laparoscopic cholecystectomy in patients with acute cholecystitis led to quicker recovery after surgery. Patients reached key functional milestones sooner and required fewer opioids, and this was achieved without an increase in complications. Consistently accurate documentation and sticking to the pathway steps were important in making this possible, and the findings suggest that similar hospitals could benefit from adopting ERAS.

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