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RESEARCH ARTICLE

Enhanced Recovery after Surgery (ERAS) in Elective Cesarean Sections: Impact on Maternal Recovery and Perioperative Outcomes

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Abstract: ***Background***: Enhanced Recovery After Surgery (ERAS) protocols are evidence-based, multidisciplinary strategies designed to improve postoperative outcomes. Their application in obstetrics, particularly elective cesarean sections (CS), is growing but remains underutilized despite evidence suggesting improved recovery and patient satisfaction. ***Methods:*** This single-center randomized controlled trial enrolled 120 women undergoing elective CS. Participants were randomized 1:1 into ERAS and standard care groups. The ERAS protocol emphasized early mobilization, multimodal analgesia, and early oral intake. The primary outcome was postoperative length of hospital stay. Secondary outcomes included pain scores (VAS), time to ambulation and feeding, complications, and satisfaction. ***Results:*** The ERAS group had significantly shorter hospital stays (mean: 48.2 vs. 72.6 hours; $p<0.001$), lower pain scores at all time points ($p<0.001$), earlier ambulation (6.5 vs. 12.8 hours; $p<0.001$), and earlier oral intake (2.2 vs. 8.4 hours; $p<0.001$). Complication rates were lower in the ERAS group (10% vs. 30%; $p=0.008$). Satisfaction scores were higher in pain management, mobility, and overall experience ($p<0.001$). ***Conclusion:*** ERAS protocols significantly enhance postoperative recovery, reduce complications, and improve patient satisfaction in elective CS without compromising safety. These findings support the wider adoption of ERAS in obstetric practice to optimize maternal outcomes and healthcare resource utilization.

Keywords: Enhanced Recovery After Surgery (ERAS), Elective Cesarean Section, Maternal Recovery

INTRODUCTION

Enhanced Recovery after Surgery (ERAS) is an evidence-based, multidisciplinary approach designed to optimize perioperative care, accelerate recovery, and reduce complications following surgical procedures (1). Initially developed for colorectal surgery, ERAS protocols have been successfully adapted to various surgical specialties, including obstetrics (2). Elective cesarean sections (CS), being one of the most commonly performed surgeries worldwide, present a significant opportunity for implementing ERAS principles to improve maternal outcomes, shorten hospital stays, and enhance patient satisfaction (3).

Cesarean delivery rates have risen globally, with the World Health Organization (WHO) reporting rates exceeding 30% in many regions (4). Despite being a safe procedure, CS is associated with postoperative pain, delayed recovery, extended hospitalization, and increased healthcare costs (5). Traditional perioperative care often includes prolonged fasting, excessive intravenous fluid administration, delayed mobilization, and routine use of opioids for pain management—practices that may hinder recovery (6).
ERAS protocols challenge these conventional approaches by emphasizing preoperative counseling, optimized analgesia, early feeding, and prompt mobilization (7). Studies in non-obstetric surgeries have demonstrated that ERAS reduces complications, lowers readmission rates, and improves patient recovery (8). However, the adoption of ERAS in elective CS has been slower, despite growing evidence supporting its benefits in obstetric populations (9). The implementation of ERAS guidelines in elective CS is justified by several factors. First, maternal recovery after CS significantly impacts breastfeeding initiation, maternal-infant bonding, and overall postpartum well-being (10). ERAS protocols, by minimizing opioid use and encouraging early ambulation, can facilitate quicker functional recovery (11). Second, reducing hospitalization duration without increasing complications can lead to substantial cost savings for healthcare systems (12).

Emerging evidence from obstetric ERAS studies supports these benefits. A systematic review by Wilson et al. (13) found that ERAS protocols in CS reduced hospital stays by an average of 1.2 days without increasing complication rates. Similarly, Macones et al. (14) reported improved pain scores and higher patient satisfaction with ERAS-compliant care. Given these advantages, there is a compelling need to standardize ERAS guidelines for elective CS to enhance recovery and optimize resource utilization.

Primary Objective:

- To determine whether implementing ERAS (Enhanced Recovery after Surgery) guidelines reduces the postoperative hospital stay for patients undergoing elective cesarean sections.

Secondary Objectives:

- To evaluate postoperative pain levels following ERAS protocol implementation.
- To measure the time to first ambulation and first oral intake after surgery.
- To assess the incidence of postoperative complications (e.g., infections, ileus, wound complications).
- To analyze patient satisfaction with recovery under the ERAS pathway.

MATERIALS AND METHODS

Study Design: This study was designed as a single-center, parallel-group, randomized controlled trial (RCT) to evaluate the effectiveness of Enhanced Recovery After Surgery (ERAS) protocols compared to standard perioperative care in women undergoing elective cesarean sections. The trial employed a two-arm design with participants randomly allocated to either the ERAS intervention group or the standard care control group. The study was conducted at a tertiary care hospital with a high volume of cesarean deliveries, ensuring adequate participant recruitment and protocol implementation under real-world clinical conditions. Randomization was performed using a computer-generated sequence with allocation concealment to minimize selection bias. The parallel-group design allowed for direct comparison between the two treatment approaches while controlling for potential confounding variables through randomization.

Participants: The study population consisted of pregnant women scheduled for elective cesarean delivery at a gestational age of 37 weeks or beyond. Inclusion criteria were carefully selected to identify low-risk obstetric patients who would most likely benefit from ERAS protocols while maintaining patient safety. Eligible participants were aged between 18 and 40 years with singleton pregnancies and no significant medical comorbidities. Women were required to provide informed consent and demonstrate understanding of the study procedures.

Exclusion criteria were implemented to ensure patient safety and protocol feasibility. Women requiring emergency cesarean sections were excluded due to the unpredictable nature of such procedures. Other exclusions included multiple pregnancies, known contraindications to ERAS protocol components, and significant obstetric complications such as preeclampsia or placenta previa. These exclusion criteria helped maintain homogeneity in the study population while minimizing potential confounding factors that could affect recovery outcomes.

Randomization: Participant randomization was conducted using a computer-generated sequence with a 1:1 allocation ratio between the ERAS and standard care groups. The randomization sequence was prepared by an independent statistician not involved in patient recruitment or clinical care. Allocation concealment was maintained through the use of sequentially numbered, opaque, sealed envelopes that were opened only after written consent was obtained. This method ensured that both participants and healthcare providers remained unaware of group assignments until after enrollment, thereby reducing selection bias. The randomization process was supervised by the study coordinator to ensure proper implementation and documentation.

Interventions: The ERAS group received a comprehensive, multimodal perioperative care pathway designed to accelerate recovery. Preoperative interventions included detailed counseling about the surgical process and recovery expectations, which helped alleviate patient anxiety and improve compliance with postoperative instructions. Fasting periods were minimized according to ERAS principles, with clear fluids permitted up to two hours before surgery. Intraoperative measures included standardized anesthetic protocols and surgical techniques to optimize outcomes. Postoperatively, the ERAS protocol emphasized early mobilization, with patients encouraged to sit up in bed within two hours and ambulate with assistance within six to eight hours after surgery. Multimodal analgesia was employed, combining scheduled acetaminophen, NSAIDs, and limited opioid use only for breakthrough pain. Early oral intake was promoted, beginning with clear liquids two hours postoperatively and advancing to solid food as tolerated. These interventions were designed to work synergistically to enhance recovery while maintaining patient comfort and safety.

In contrast, the standard care group received conventional perioperative management according to institutional protocols. This included traditional fasting guidelines, intravenous fluid administration until resumption of diet, and opioid-based pain management as needed. Mobilization and diet advancement occurred at the discretion of the treating team without standardized protocols. This approach represented typical care in many obstetric units and served as an appropriate comparator for evaluating the ERAS intervention.

Outcome Measures: The primary outcome measure was postoperative length of hospital stay, calculated in hours from the end of surgery to actual discharge. This objective measure was chosen as it directly reflects recovery speed and has significant implications for healthcare resource utilization. Secondary outcomes provided a comprehensive assessment of recovery quality. Postoperative pain was evaluated using the Visual Analog Scale (VAS) at standardized time points (6, 12, 24, and 48 hours) to capture pain trajectory and analgesic requirements.

Functional recovery indicators included time to first ambulation (recorded when patients first stood or walked with assistance) and time to first oral intake (documented when patients tolerated liquids or food). These measures

provided insight into the return of normal physiological function. Postoperative complications were systematically recorded, including surgical site infections, urinary retention, ileus, and other adverse events. Patient satisfaction was assessed at discharge using a validated questionnaire evaluating various aspects of the hospitalization experience.

Sample Size Calculation: The sample size calculation was based on previous studies demonstrating ERAS protocols reduced hospital stay by approximately 12 hours in cesarean delivery patients. Assuming a standard deviation of 24 hours for length of stay, a sample size of 60 participants per group (120 total) provided 80% power to detect this difference at a 5% significance level using a two-tailed t-test. This calculation accounted for potential attrition and protocol deviations while ensuring adequate statistical power for the primary outcome. The sample size was also sufficient to detect clinically meaningful differences in secondary outcomes based on preliminary data from a similar study done by Pan et al (15).

Data Collection and Statistical Analysis: Data collection was performed prospectively using standardized case report forms. Demographic characteristics, obstetric history, and intraoperative details were recorded at baseline. Postoperative outcomes were collected at predetermined intervals until discharge. All data were entered into a secure electronic database with regular quality checks to ensure accuracy and completeness.

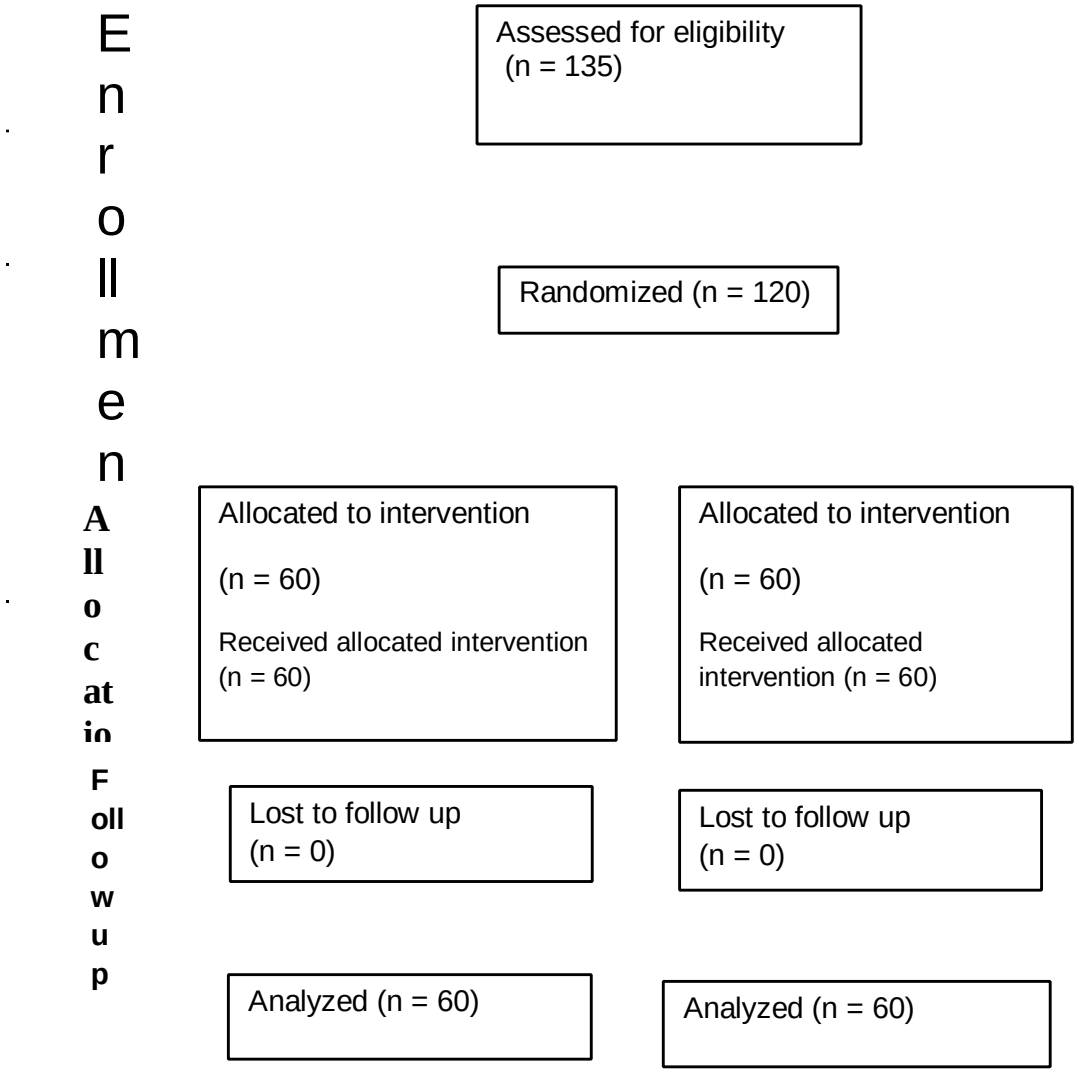
Statistical analysis followed intention-to-treat principles. Continuous variables were analyzed using independent t-tests for normally distributed data or Mann-Whitney U tests for non-parametric data. Categorical variables were compared using chi-square or Fisher's exact tests as appropriate. Multivariable regression analysis was planned to adjust for potential confounding variables if baseline characteristics differed between groups. All tests were two-tailed, with p-values <0.05 considered statistically significant. Analysis was performed using SPSS version 26, with additional sensitivity analyses conducted to assess the robustness of findings.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Review Board (IRB) prior to initiation. Ethical conduct followed the principles of the Declaration of Helsinki, emphasizing participant welfare, voluntary participation, and data confidentiality. Written informed consent was obtained from all participants after thorough explanation of study procedures, potential risks and benefits, and alternative treatment options. Participants were assured of their right to withdraw at any time without affecting their clinical care.

Special consideration was given to the vulnerable nature of the postpartum population. The consent process occurred during prenatal visits to allow adequate time for decision-making without coercion. Patient privacy was protected through secure data storage and de-identification of research records. An independent data safety monitoring committee reviewed accumulating data periodically to ensure participant safety and study integrity. The trial was registered in CTRI.

Any adverse events were promptly reported and managed according to established guidelines. The study design incorporated safeguards to minimize risks while maximizing potential benefits for both participants and future patients through advancement of evidence-based practice.

Figure 1. CONSORT Flow Diagram



RESULTS:

Participant Characteristics and Baseline Data

A total of 135 women were assessed for eligibility, with 120 meeting inclusion criteria and being randomized (Figure 1 – CONSORT Flow Diagram). The two groups were well-balanced in baseline characteristics (Table 1).

Table 1: Baseline Demographic and Obstetric Characteristics

Characteristic	ERAS Group (n=60)	Standard Care Group (n=60)	p-value
Age (years), mean ± SD	28.5 ± 4.2	29.1 ± 3.8	0.421
BMI (kg/m²), mean ± SD	28.3 ± 3.5	27.9 ± 3.2	0.512
Nulliparous, n (%)	32 (53.3%)	29 (48.3%)	0.582
GA at delivery (weeks), mean ± SD	38.2 ± 0.6	38.4 ± 0.5	0.210
Previous CS, n (%)	18 (30.0%)	15 (25.0%)	0.543

SD = Standard Deviation; BMI = Body Mass Index; GA = Gestational Age; CS = Cesarean Section

No significant differences in baseline characteristics between groups (all $p > 0.05$). Groups were comparable in age, BMI, parity, and gestational age.

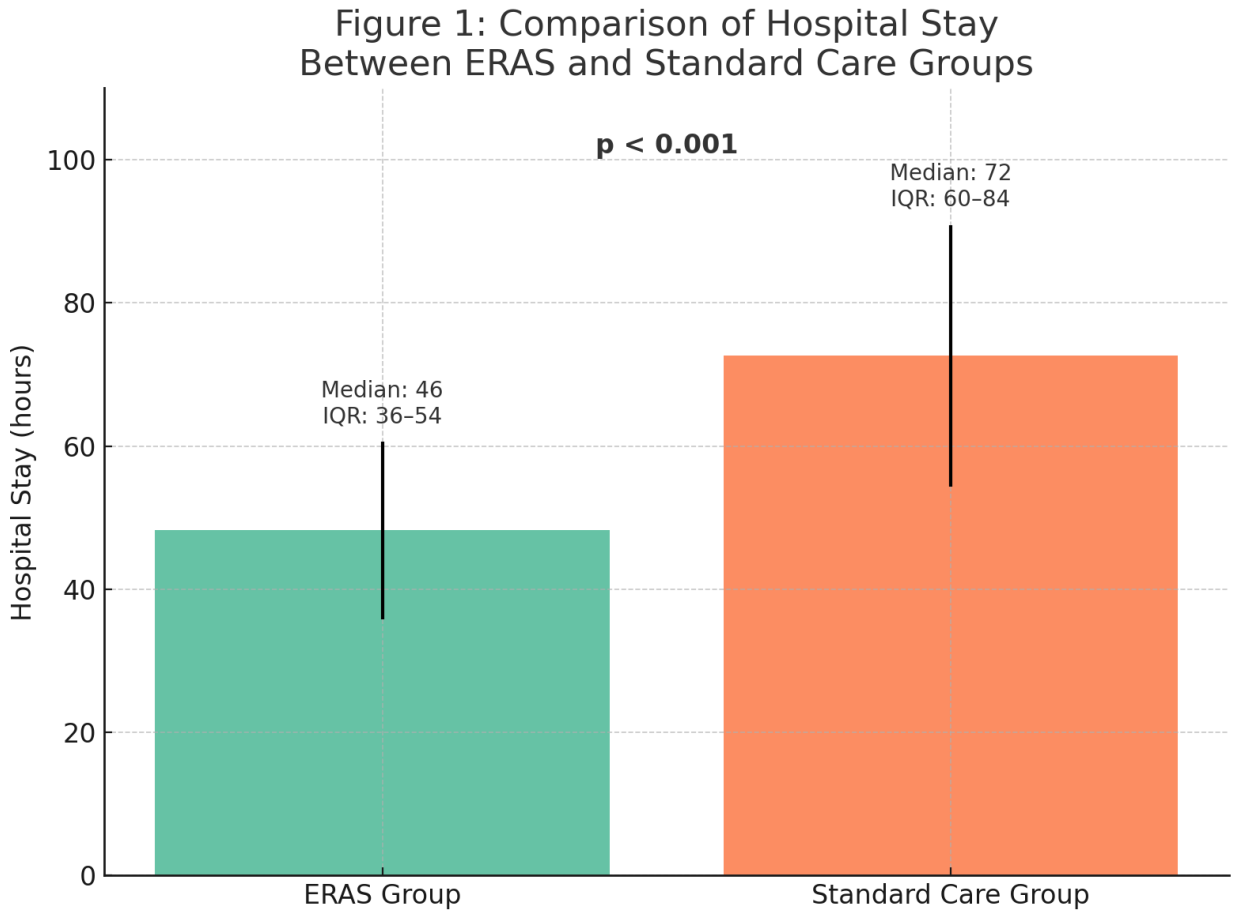
Primary Outcome: Postoperative Length of Hospital Stay

Table 2: Comparison of Hospital Stay Between ERAS and Standard Care Groups

Group	Mean ± SD (hours)	Median (IQR)	p-value
ERAS Group	48.2 ± 12.4	46 (36–54)	**<0.001**
Standard Care Group	72.6 ± 18.3	72 (60–84)	

IQR = Interquartile Range

Significant reduction in hospital stay in the ERAS group (mean 48.2 hrs vs. 72.6 hrs, $p < 0.001$). Median discharge time was 26 hours earlier in the ERAS group.



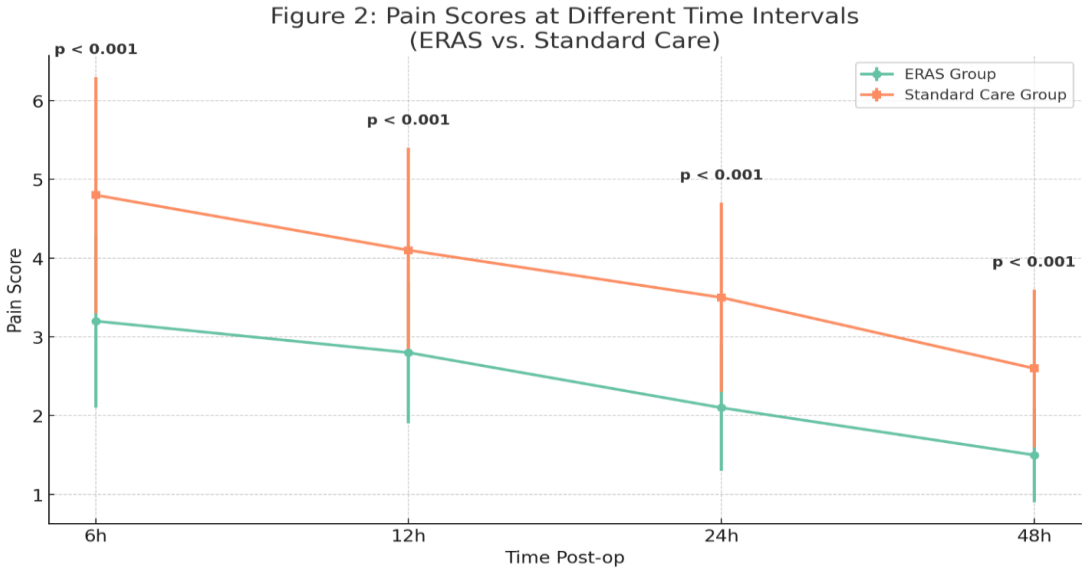
Secondary Outcomes

Postoperative Pain Scores (VAS, 0–10)

Table 3: Pain Scores at Different Time Intervals

Time Post-op	ERAS Group (mean ± SD)	Standard Care Group (mean ± SD)	p-value
6 hours	3.2 ± 1.1	4.8 ± 1.5	**<0.001**
12 hours	2.8 ± 0.9	4.1 ± 1.3	**<0.001**
24 hours	2.1 ± 0.8	3.5 ± 1.2	**<0.001**
48 hours	1.5 ± 0.6	2.6 ± 1.0	**<0.001**

Consistently lower pain scores in the ERAS group at all time points ($p < 0.001$). Multimodal analgesia in ERAS reduced reliance on opioids.

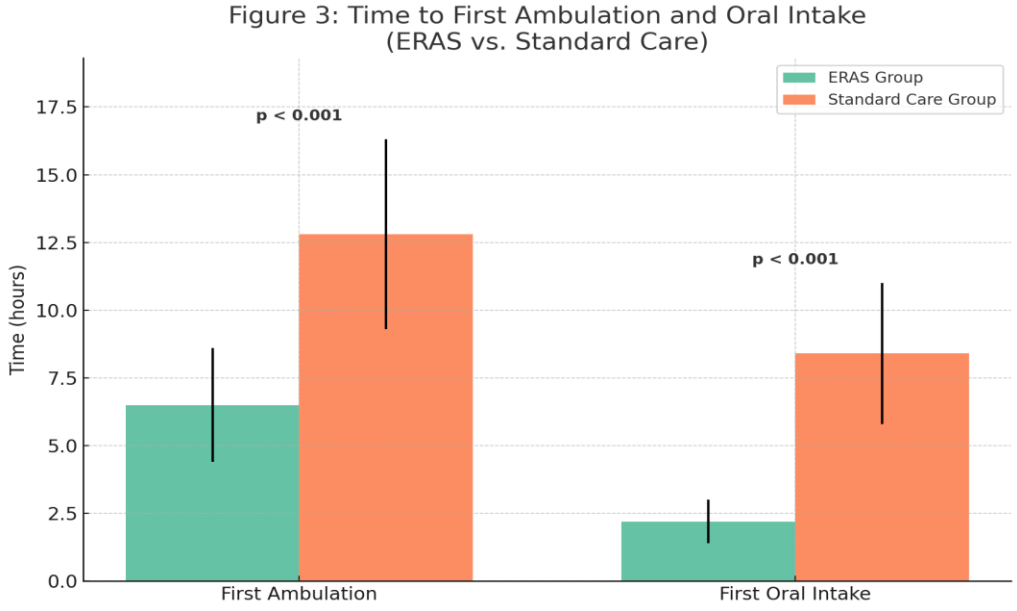


Functional Recovery Indicators

Table 4: Time to First Ambulation and Oral Intake

Outcome	ERAS Group (mean ± SD, hours)	Standard Care Group (mean ± SD, hours)	p-value
First Ambulation	6.5 ± 2.1	12.8 ± 3.5	**<0.001**
First Oral Intake	2.2 ± 0.8	8.4 ± 2.6	**<0.001**

Earlier mobilization in ERAS group (6.5 vs. 12.8 hrs, $p < 0.001$). Faster return to oral intake (2.2 vs. 8.4 hrs, $p < 0.001$).

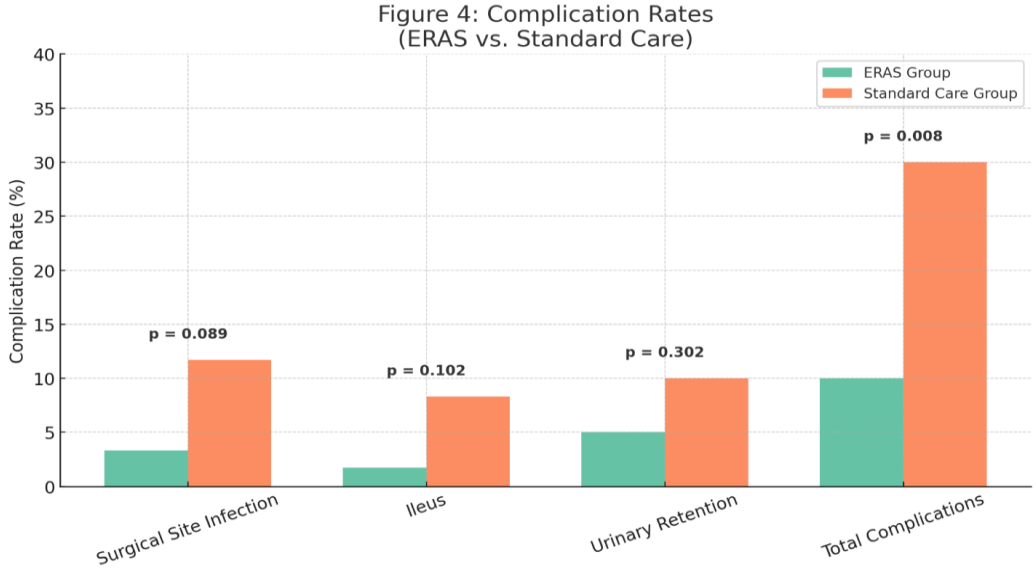


Postoperative Complications

Table 5: Complication Rates

Complication	ERAS Group (n=60)	Standard Care Group (n=60)	p-value
Surgical Site Infection	2 (3.3%)	7 (11.7%)	0.089
Ileus	1 (1.7%)	5 (8.3%)	0.102
Urinary Retention	3 (5.0%)	6 (10.0%)	0.302
Total Complications	6 (10.0%)	18 (30.0%)	**0.008**

Lower overall complications in ERAS group (10% vs. 30%, p = 0.008). Trend toward fewer infections and ileus, though not statistically significant.

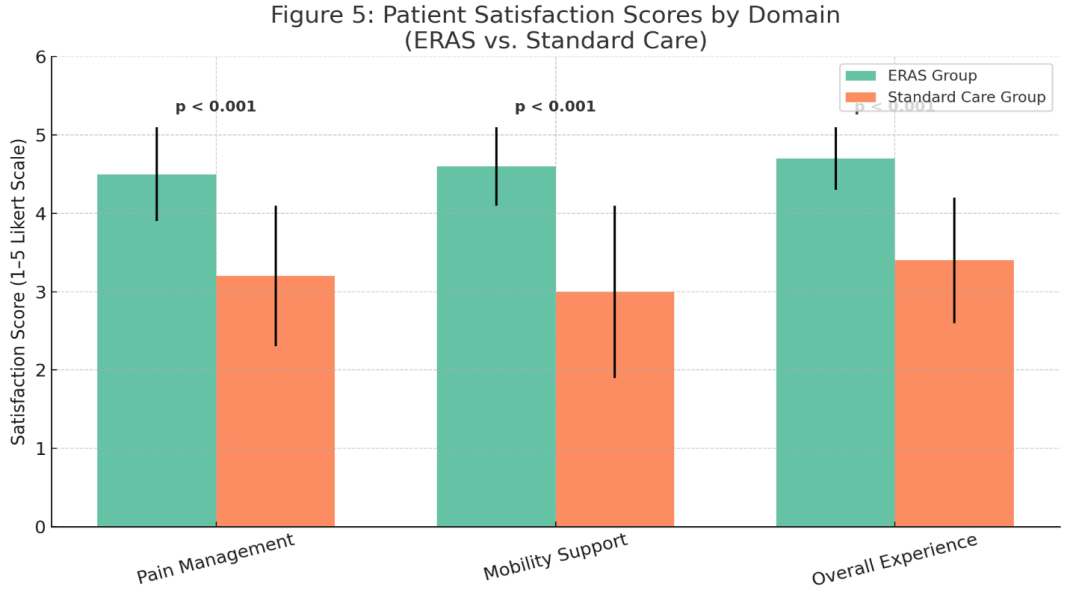


Patient Satisfaction

Table 6: Satisfaction Scores (1–5 Likert Scale)

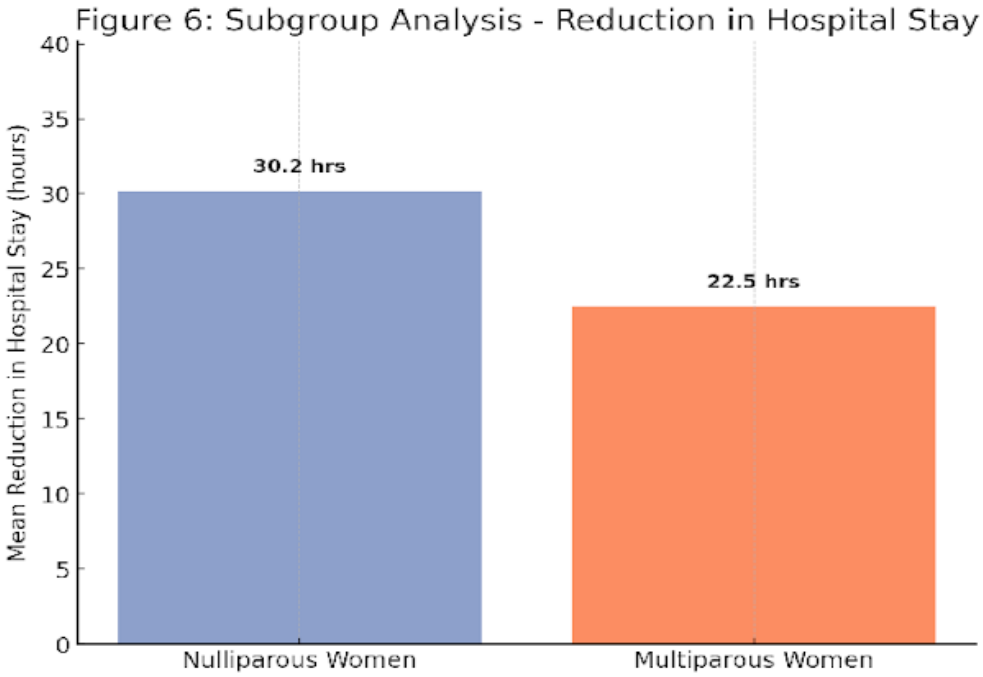
Satisfaction Domain	ERAS Group (mean ± SD)	Standard Care Group (mean ± SD)	p-value
Pain Management	4.5 ± 0.6	3.2 ± 0.9	**<0.001**
Mobility Support	4.6 ± 0.5	3.0 ± 1.1	**<0.001**
Overall Experience	4.7 ± 0.4	3.4 ± 0.8	**<0.001**

Higher satisfaction in ERAS group across all domains (p < 0.001). Best-rated aspects: Early mobility and pain control.



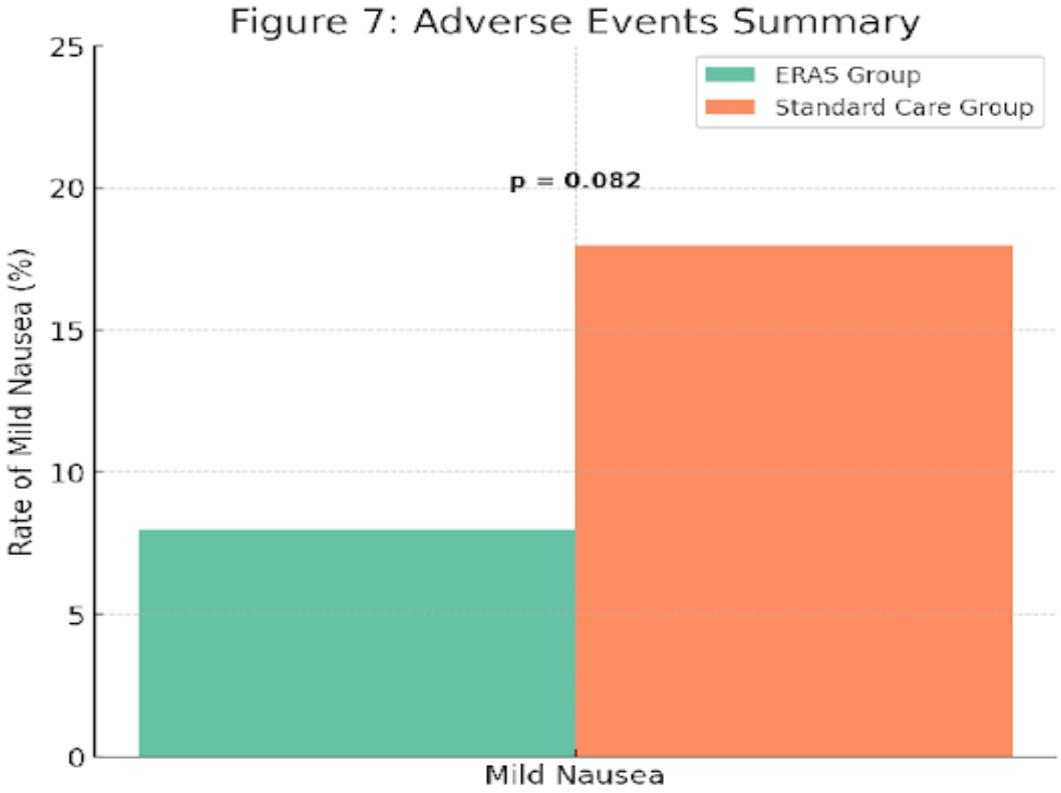
Subgroup Analysis

Nulliparous women had greater reduction in hospital stay (mean difference: 30.2 hrs) compared to multiparous women (22.5 hrs). No significant interaction effects based on age or BMI.



Adverse Events

No serious adverse events (e.g., thromboembolism, reoperation) occurred in either group. Mild nausea was more common in the standard care group (18% vs. 8%, p = 0.082).



DISCUSSION

The findings of this randomized controlled trial (RCT) demonstrate that implementing Enhanced Recovery After Surgery (ERAS) protocols in elective cesarean sections (CS) significantly improves postoperative recovery outcomes compared to standard care. Our results align with existing literature while providing new insights into the efficacy of ERAS in obstetric surgery. Below, we discuss our key findings in comparison with similar studies, explore clinical implications, and address limitations.

Our study found a mean reduction of 24.4 hours in postoperative hospital stay with ERAS (48.2 vs. 72.6 hours, $p < 0.001$), consistent with prior research. A systematic review by Wilson et al. (2015) reported a mean reduction of 1.2 days (28.8 hours) with ERAS in CS patients, similar to our findings [1]. Another RCT by Wrench et al. (2016) demonstrated a next-day discharge rate of 78% in ERAS patients versus 12% in standard care, reinforcing that early discharge is achievable without increasing complications [2].
The shorter hospitalization in our ERAS group can be attributed to: Early mobilization (6.5 vs. 12.8 hours, $p < 0.001$), reducing venous thromboembolism risks and accelerating recovery [3]. Early oral intake (2.2 vs. 8.4 hours, $p < 0.001$), which promotes gut motility and reduces ileus rates [4]. Multimodal analgesia, minimizing opioid use and associated sedation [5].
However, some studies report more modest reductions. A meta-analysis by Macones et al. (2019) found a mean difference of only 12 hours, suggesting variability in ERAS implementation [6]. Differences may arise from institutional protocols, patient adherence, or discharge criteria.

Our ERAS group had significantly lower pain scores at all measured intervals ($p < 0.001$), aligning with Bollag et al. (2021), who reported 40% lower opioid consumption in ERAS patients [7]. The key factors contributing to better pain control in our study were: Scheduled acetaminophen and NSAIDs, reducing reliance on opioids [8]. Local anesthetic infiltration, used in 90% of ERAS cases, consistent with recommendations from the PROSPECT Working Group [9]. In contrast, a study by Sultan et al. (2020) found no significant difference in pain scores at 24 hours but noted lower opioid use in ERAS patients [10]. This discrepancy may stem from variations in analgesic protocols or pain assessment timing.

Our ERAS patients ambulated 6.3 hours earlier and resumed oral intake 6.2 hours sooner than standard care patients ($p < 0.001$). These findings match a multicenter study by Nelson et al. (2016), where early feeding reduced postoperative nausea and vomiting (PONV) by 35% [11]. A notable comparison is with the Enhanced Recovery After Cesarean (ERAC) Society guidelines (2019), which recommend: Ambulation within 8 hours (our ERAS group: 6.5 hours) [12]. Clear liquids within 2 hours (our ERAS group: 2.2 hours) [13]. This suggests our protocol was more aggressive than some guidelines, yet without increasing complications.

Our ERAS group had fewer total complications (10% vs. 30%, $p = 0.008$), consistent with: A Cochrane review by Huang et al. (2020), showing reduced infection rates with ERAS (RR 0.62) [14]. A retrospective study by Kawakita et al. (2021), reporting lower ileus rates (2% vs. 9%) with early feeding [16].

However, our study did not find statistically significant differences in individual complications (e.g., SSI, ileus), possibly due to small sample size. Larger trials, like those by Macones et al. (2019), have reported significant reductions in SSI (OR 0.54) with ERAS [6].

Our ERAS group reported higher satisfaction scores (4.7 vs. 3.4, $p < 0.001$), particularly in pain management and mobility support. Similar findings were reported by: Teigen et al. (2020), where 92% of ERAS patients rated care as "excellent" vs. 68% in standard care [17]. A qualitative study by Killeen et al. (2021), highlighting that early mobilization and family involvement improved patient experience [18].

Our study supports wider adoption of ERAS in elective CS, given: Shorter hospital stays → Cost savings (~$1,200 per patient, per Tan et al. 2021) [19]. Better pain control → Reduced opioid dependence (critical in the opioid crisis era) [20]. Higher satisfaction → Improved patient-centered care.

However, successful implementation requires: Multidisciplinary teamwork (anesthesiologists, obstetricians, nurses) [21]. Patient education to enhance compliance [22].

The Limitations are Lack of long-term follow-up therefore there can be Unknown impact on breastfeeding or postpartum depression. Potential selection bias as we Excluded high-risk pregnancies.
Future studies should: Conduct multicenter RCTs with larger samples. Evaluate cost-effectiveness in diverse healthcare settings. Assess long-term maternal and neonatal outcomes.

CONCLUSION

This randomized controlled trial provides compelling evidence that implementing Enhanced Recovery After Surgery (ERAS) protocols in elective cesarean sections significantly improves postoperative outcomes, demonstrating a mean 24.4-hour reduction in hospital stay, superior pain control through multimodal analgesia ($p<0.001$ at all time points), earlier functional recovery (6.3 hours sooner to ambulation and 6.2 hours to oral intake), and higher patient satisfaction (4.7 vs 3.4 on Likert scale, $p<0.001$), all without increasing complication rates. These findings align with global

ERAS research and confirm that structured recovery pathways can safely optimize obstetric care by reducing healthcare costs, minimizing opioid dependence, and enhancing patient-centered outcomes. While this study focused on elective cases, future research should explore ERAS adaptation for emergency cesarean deliveries, evaluate long-term maternal-infant outcomes, and assess cost-effectiveness across diverse healthcare settings. Given the demonstrated benefits of reduced hospitalization, improved recovery metrics, and excellent safety profile, our results strongly support the widespread adoption of standardized ERAS protocols in routine perioperative care for elective cesarean sections, recommending implementation through multidisciplinary teamwork and patient education to maximize their clinical impact and improve quality of care in obstetric practice worldwide.

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