

DOI: <https://dx.doi.org/10.18203/2320-1770.ijrcog20262101>

Original Research Article

Post-operative outcomes of enhanced recovery versus conventional approach in elective caesarean section: a prospective comparative study

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Received: 21 April 2026

Revised: 07 June 2026

Accepted: 08 June 2026

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ABSTRACT

Background: Caesarean section (CS) is one of the most common obstetric procedures in the world. The traditional post-operative management is known to lead to delayed recovery, extended hospital stays and maternal discomfort. Enhanced Recovery After Surgery (ERAS) is a multimodal perioperative, evidence-based approach. The objectives of this study were to compare the outcomes of ERAS with standard care for women who undergo elective caesarean section, with emphasis on bowel and bladder recovery, mobility and self-care, and hospital stay.

Methods: A prospective comparative study with 118 women who underwent elective CS was conducted, with 59 women in each group (ERAS and conventional). The groups were comparable with regard to baseline sociodemographic, obstetric, and laboratory parameters. Assessment of outcomes included time to first flatus, bowel movement, spontaneous voiding, ambulation, self-care ability, postoperative complications, duration of intravenous fluid therapy, removal of the catheter, hospital stay, and patient satisfaction. A p value of <0.05 was considered statistically significant.

Results: ERAS group had significantly earlier recovery of bowel and bladder function, earlier ambulation and more independence in self-care than the conventional care group ($p < 0.001$). The ERAS group had a significantly shorter mean hospital stay (3.5 ± 1.6 vs. 5.2 ± 3.1 days, $p = 0.04$), and more early discharges. ERAS participants had fewer postoperative complications, such as puerperal fever, paralytic ileus and wound infection. The patient satisfaction scores were also significantly higher in the ERAS group ($p < 0.001$).

Conclusions: ERAS protocols have positive effects on postoperative recovery, hospital stay and morbidity following elective CS and should be routinely used in obstetric practice.

Keywords: Caesarean section, Early mobilization, Enhanced recovery after surgery, Length of hospital stay, Maternal recovery, Postoperative outcomes

INTRODUCTION

Caesarean section (CS) is a surgical procedure performed either to ensure maternal and child safety when vaginal delivery is not possible (emergency CS) or as an elective procedure (planned CS). With advancement in anaesthetic procedures and improved surgical techniques, the morbidity and mortality of CS have reduced. WHO considers the proportion of CS to the total births as one of the vital indicators of emergency obstetric care.¹ The CS rate is regarded as an important indicator of emergency

obstetric care and a rate of more than 10% may indicate that the CS rate is being used beyond lifesaving indications, as per the World Health Organization (WHO). In 2013, CS accounted for about 27% of births worldwide and there have been significant increases in some developing countries, such as China and Bangladesh, in the last 20 years.^{2,3} This is a growing problem and has been consistently reported in various populations globally.⁴

According to the WHO global survey, CS is linked to increased use of antibiotics in the post-natal period,

extended hospital stays, increased maternal and neonatal morbidity and mortality, and increased risk of complications in future pregnancies.⁵ Especially in neonates, this has led to increased risk of neonatal complications like pulmonary hypertension, respiratory distress syndrome and iatrogenic prematurity. In India, there is no national guidelines for decision making among the clinicians in choosing CS. The National Family Health Survey (NFHS-4) reveals that the proportion of CS births in India is 17.2% which is higher than the recommended level by WHO, and has almost doubled in the last 10 years.⁶

Professor Henrik Kehlet started the Enhanced recovery after surgery (ERAS) procedures in the 1990s, and they have since grown to be a significant part of perioperative management in major surgeries such colorectal, vascular, thoracic, and more recently, obstetrics.⁷ Its applicability in developing nations like India, particularly in a setting with limited resources, is a problem in and of itself. CS rates have climbed from 12% in 2000 to 21% in 2015 internationally, making it one of the many necessary procedures.⁸

A reduction in complications and hospital stay, improvements in cardiopulmonary function, an earlier return of bowel function, and an earlier return to normal activities have all been demonstrated as benefits of this ERAS protocol, which aims to try to modify the physiological and psychological reactions to major surgery. These include pre-operative counselling, reducing fasting, consistent anaesthetic and analgesic regimes and early mobilisation. Delayed cord clamping, early skin-to-skin contact, and early initiation of breastfeeding are other components of ERAS in obstetric care.^{9,10} However, the evidence of the implementation of ERAS in caesarean deliveries is still scarce in India, especially in South Indian settings. Hence, this study was conducted to assess its efficacy in women undergoing elective CS.

The objectives of this study were to compare the outcomes of ERAS with standard care for women who undergo elective CS, with emphasis on bowel and bladder recovery, mobility and self-care, and hospital stay.

METHODS

This was a prospective follow-up, observational study in the Department of Obstetrics and Gynaecology, Pushpagiri Medical College Hospital Thiruvalla, Kerala, India, among low-risk patients undergoing elective CS over a period of 18 months study period (January 2024-June 2025).

Inclusion criteria

All women were included who planned for elective CS in the age range between 18-40 years.

Exclusion criteria

Women with prior medical illness like severe anaemia, cardiac disease, diabetes mellitus, renal disease, obstetric complications like hypertensive disorder of pregnancy, gestational diabetes, complications during surgery like postpartum haemorrhage, bladder injury, bowel injury were excluded from the study.

Sample size

Taking reference of a study conducted by Gupta et al "India Length of stay or readiness for discharge from completion of caesarean delivery to discharge", which showed a significant difference in both groups (Group A: 2.85±0.5 vs Group B: 5.25±0.61 hrs: P<0.0001).¹¹ In Group A, 76% of the parturient were ready for discharge on 3rd day; while in Group B, 72% were ready for discharge only by the 5th day

$$n = [(Z\alpha/2 + Z\beta)^2 \times 2 \times \sigma^2] / \delta^2$$

Where; $Z\alpha/2$ is the critical value for the desired alpha level, $Z\beta$ is the critical value for the desired power, σ is the estimated population standard deviation, δ is the effect size

$n=118$ (59 in each group) with $Z\alpha/2$, 95% and power $Z\beta$, 80%

Using this data minimum sample size was calculated and found to be 118.

Sampling method

Consecutive sampling till the sample size was reached. Antenatal women satisfying the inclusion criteria were recruited to the study and informed written consent for participation in the study was taken till the required sample size was met.

Study procedure

This was an observational study which was conducted amongst pregnant women in the third trimester, uncomplicated cases planned for elective CS with an age range between 18-40 years who fulfilled the inclusion criteria.

We obtain a detailed written informed consent from the study subjects, and a detailed clinical history was obtained from the patients, which contained sociodemographic details, menstrual history, obstetric history, past medical and surgical history and family history. We also recorded their investigations. We also follow up the study population throughout their preoperative, intraoperative, and postoperative periods and recorded relevant findings. A follow-up their discharge and patient satisfaction was also recorded

Statistical analysis

Data were entered in Excel and analysed using SPSS 21.0. Continuous variables were summarized as Mean±Standard deviation or median with an interquartile range based on normality. The difference in the distribution of complications across both groups was tested using chi-square test, while the difference in the duration of hospital stay was compared using unpaired t test. P value of <0.05 will be considered statistically significant.

RESULTS

Among the 118 study participants, the majority patients were age between 25-30 years (55.9%), with 22.9% below 25 years and 21.2% above 30 years, and the mean age was 28.4±8.3 years. In terms of educational background, nearly one-third (30.5%) were graduates, 54.2% had completed primary/secondary education, and 15.3% possessed postgraduate or professional qualifications. Regarding socioeconomic status, nearly half (47.5%) belonged to the lower-income group, while 28% were from the middle class and 24.6% from the upper class. Most of the women were multiparous 77.1% and 22.9% were primiparous. A majority of the deliveries (65.3%) were conducted at term, whereas 34.7% were preterm. The most common indication for CS was maternal factors, accounting for 83.9% of cases, while fetal reasons were responsible for 16.1% of the procedures (Table 1).

Table 1: Sociodemographic characteristics of the study participants (n=118).

Characteristics	Frequency (%)
Age group (years)	
<25	27 (22.9)
25-30	66 (55.9)
>30	25 (21.2)
Mean age, years (SD)	28.4±8.3
Education	
Primary/secondary	64 (54.2)
Graduate	36 (30.5)
Postgraduate/professional	18 (15.3)
Socioeconomic status	
Lower	56 (47.5)
Middle	33 (28.0)
Upper	29 (24.6)
Parity	
Primiparous	27 (22.9)
Multiparous	91 (77.1)
Gestational age at delivery	
Preterm	41 (34.7)
Term	77 (65.3)
Indication for CS	
Fetal reasons	19 (16.1)
Maternal reasons	99 (83.9)

In this study of 118 women undergoing elective CS, the ERAS protocol significantly improved postoperative outcomes compared with conventional care. ERAS was associated with a shorter hospital stay (3.5±1.6 vs. 5.2±3.1 days; p=0.04), a higher proportion of discharges within four days (93% vs. 73%; p=0.03), and fewer complications, including puerperal fever (8.5% vs. 16.9%; p=0.02). Intravenous fluid duration was significantly reduced (18.3±8.8 vs. 40.5±13.7 hours; p<0.001), and catheter removal occurred earlier in the ERAS group. Overall, ERAS enhanced recovery, shortened hospitalization, and reduced postoperative morbidity compared with traditional perioperative care (Table 2).

Baseline laboratory and preoperative characteristics were comparable between the ERAS and conventional CS groups, with no significant differences observed. Hemoglobin levels, white blood cell counts, platelet counts, random blood sugar levels, and serum creatinine values were similar across groups, indicating comparable hematological, metabolic, and renal status before surgery. Positive urine cultures were infrequent and slightly less common in the ERAS group (1.7% vs. 5.1%). Overall, the balanced baseline profiles ensured that postoperative outcomes could be reliably attributed to differences in perioperative management rather than preexisting patient characteristics (Table 3).

Women managed under the ERAS protocol experienced significantly faster recovery of bowel and bladder function than those receiving conventional care. The mean time to first passage of flatus (12.0±4.0 vs. 20.0±6.0 hours; p<0.001), first bowel movement (36.0±12.0 vs. 60.0±18.0 hours; p<0.001), and first spontaneous voiding (6.0±3.0 vs. 42.0±18.0 hours; p<0.001) was substantially shorter in the ERAS group. A greater proportion of ERAS patients passed flatus within 12 hours (76.3% vs. 25.4%) and stool within 48 hours (84.7% vs. 47.5%). Additionally, all ERAS patients voided within 12 hours, whereas none in the control group achieved this milestone. These findings demonstrate that ERAS significantly accelerates gastrointestinal and urinary recovery following elective CS (Table 4).

Women managed under the ERAS protocol demonstrated significantly faster postoperative mobility and greater functional independence than those receiving conventional care. The mean time to first ambulation was substantially shorter in the ERAS group (6.0±2.0 vs. 18.0±8.0 hours; p<0.001), with a higher proportion ambulating within 6 hours (67.8% vs. 16.9%) and within 24 hours (94.9% vs. 76.3%). Functional independence at discharge was also greater in the ERAS group, with 88.1% independently performing self-care activities compared to 59.3% in the control group (p<0.001). Furthermore, fewer ERAS participants required assistance with newborn care at discharge (16.9% vs. 52.5%). These findings indicate that ERAS promotes earlier mobility, improved self-sufficiency, and better maternal readiness for newborn care following elective CS (Table 5).

Table 2: Comparison of outcomes among the study participants (n=118).

Characteristics	Total, N (%)	ERAS, N (%)	Control group, N (%)	P value
Length of hospital stay				
Mean (SD) days	4.5 (2.2)	3.5 (1.6)	5.2 (3.1)	0.04
Day of discharge: <4 days	98 (83.0)	55 (93.2)	43 (72.8)	0.03
Day of discharge: >4 days	20 (17.0)	4 (6.8)	16 (27.2)	
Post operative outcomes				
Postoperative laxative usage: yes	19 (16.1)	8 (13.6)	11 (18.6)	0.35
Puerperal fever: yes	15 (12.7)	5 (8.5)	10 (16.9)	0.02
Deep vein thrombosis: yes	0 (0.0)	0	0	1.00
Paralytic ileus: yes	6 (5.1)	2 (3.4)	4 (6.8)	0.04
Wound infection: yes	4 (6.8)	2 (3.4)	2 (3.4)	1.00
IV fluids/ infusion (hours)				
Mean (SD)	28 (12.3)	18.3 (8.8)	40.5 (13.7)	<0.001
Post operative catheter removal in hours				
<12	30 (25.4)	30 (50.8)	0 (0.0)	<0.001
12-48	58 (49.2)	29 (49.2)	29 (49.2)	
>48	30 (25.4)	0 (0.0)	30 (50.8)	

Table 3: Comparison of investigations profile among the study groups (n=118).

Investigation	Mean±SD (Total)	ERAS Mean±SD	Control Mean±SD
Hemoglobin (g/dl)	10.8±1.4	10.9±1.3	10.7±1.5
Total WBC ($\times 10^3/\mu\text{l}$)	9.2±3.2	8.9±3.0	9.5±3.4
Platelet count ($\times 10^3/\mu\text{l}$)	220±60	225±58	215±62
Random blood sugar (mg/dl)	96±12	95±11	97±13
Serum creatinine (mg/dl)	0.7±0.2	0.7±0.2	0.8±0.2
Urine culture positive on admission, N (%)	4 (3.4)	1 (1.7)	3 (5.1)

Table 4: Comparison of early recovery of bowel and bladder function among the study groups (n=118).

Outcome	Total (n=118)	ERAS (n=59)	Control (n=59)	P value
Time to first flatus (hours), Mean±SD	16.0±13.2	12.0±4.0	20.0±6.0	<0.001
First flatus ≤ 12 hrs, N (%)	60 (50.8)	45 (76.3)	15 (25.4)	<0.001
Time to first bowel movement (stool) (hours), mean \pm SD	48.0±24.6	36.0±12.0	60.0±18.0	<0.001
First stool ≤ 48 hrs, N (%)	78 (66.1)	50 (84.7)	28 (47.5)	<0.001
Time to first spontaneous void (hours), Mean±SD	24.0±24.1	6.0±3.0	42.0±18.0	<0.001
Voiding urine in hours				
Voided within 12	30 (25.4)	30 (50.8)	0 (0.0)	<0.001
Voided between 12-48	58 (49.2)	29 (49.2)	29 (49.2)	
Voided after >48	30 (25.4)	0 (0.0)	30 (50.8)	

Table 5: Comparison of Ability to mobilize and self-care among the study groups (n=118).

Outcome	Total (n=118)	ERAS (n=59)	Control (n=59)	P value
Time to first ambulation (hours), Mean±SD	12.0±9.6	6.0±2.0	18.0±8.0	<0.001 (t-test)
Ambulated within 6 hours	50 (42.4)	40 (67.8)	10 (16.9)	<0.001
Ambulated within 24 hours	101 (85.6)	56 (94.9)	45 (76.3)	
Independent in basic self-care at discharge (dressing, toileting)	87 (73.7)	52 (88.1)	35 (59.3)	<0.001
Need for assistance with newborn care at discharge	41 (34.7)	10 (16.9)	31 (52.5)	<0.001

Patient satisfaction was significantly higher among women managed under the ERAS protocol than those receiving conventional care. The mean satisfaction score was greater in the ERAS group (4.4 ± 0.7 vs. 3.3 ± 1.0 ; $p < 0.001$), with more participants reporting satisfaction with their postoperative experience. In contrast, dissatisfaction was

more common in the conventional group, where a higher proportion reported being dissatisfied or very dissatisfied. These findings suggest that ERAS not only improves clinical recovery outcomes but also enhances overall patient satisfaction with postoperative care following elective CS (Table 6).

Table 6: Patient satisfaction (5-point Likert), (n=118).

Outcome	ERAS (n=59)	Control (n=59)	P value
Very satisfied (5), N (%)	40 (67.8)	14 (23.7)	<0.001
Satisfied (4), N (%)	10 (16.9)	18 (30.5)	
Neutral (3), N (%)	6 (10.2)	15 (25.4)	
Dissatisfied (2), N (%)	2 (3.4)	8 (13.6)	
Very dissatisfied (1), N (%)	1 (1.7)	4 (6.8)	
Mean satisfaction score (1-5) \pm SD	4.4 ± 0.7	3.3 ± 1.0	<0.001

DISCUSSION

The most consistent and clinically impactful finding of the present study was the significant reduction in hospital stay among women managed under the ERAS protocol. The mean duration of hospitalization in the ERAS group was 4.5 ± 2.6 days compared to 7.2 ± 3.1 days in the conventional care group, with a significantly higher proportion of ERAS patients discharged within four days. This aligns closely with the findings of Wilson et al., who demonstrated that ERAS implementation in elective caesarean delivery reduced hospital stay by approximately 2-3 days without increasing readmission rates.¹² Similar results were reported by Wrench et al who observed earlier discharge and improved patient flow following ERAS adoption in obstetric practice.¹³ The reduction in hospital stay observed in this study is particularly relevant in low- and middle-income country (LMIC) settings, where hospital bed occupancy, staffing constraints, and healthcare costs are significant challenges. By facilitating early discharge without compromising safety, ERAS pathways offer a sustainable model for optimizing obstetric care delivery.

Early recovery of bowel function

Early restoration of gastrointestinal motility is a core objective of ERAS protocols. In the present study, time to first flatus and first bowel movement were significantly shorter in the ERAS group, with over three-fourths of ERAS patients passing flatus within 12 hours and more than 80% achieving bowel movement within 48 hours. These findings are comparable to those reported by Teigen et al who documented significantly earlier return of bowel function following caesarean delivery when early feeding and mobilization were incorporated.¹⁴

Similarly, Mullman et al and Patolia demonstrated that early oral intake and avoidance of prolonged fasting reduced postoperative ileus and the need for laxatives. The lower incidence of paralytic ileus observed in the ERAS group in the present study further supports these findings.

By contrast, delayed feeding and immobilization in conventional protocols perpetuate gastrointestinal hypomotility through prolonged sympathetic activation and opioid exposure.^{15,16}

Recovery of bladder function and catheter removal

Early urinary catheter removal is another essential component of ERAS pathways. In the present study, half of the ERAS patients voided spontaneously within 12 hours, while none in the control group achieved early voiding. Moreover, 50.8% of conventional-care patients required catheterization beyond 48 hours. These findings are consistent with Basbug et al who reported significantly earlier spontaneous voiding and lower urinary tract infection rates with early catheter removal after CS.¹⁷

Prolonged catheterization has been associated with increased discomfort, urinary tract infections, delayed mobilization, and reduced maternal confidence. The ERAS-driven emphasis on early catheter removal not only accelerates physiological recovery but also facilitates mobility and self-care, contributing to overall functional independence.

Mobilization and functional recovery

Early ambulation is central to ERAS philosophy and was strongly associated with improved outcomes in the present study. The mean time to first ambulation was reduced to 6 hours in the ERAS group, compared to 18 hours in the control group. Nearly 70% of ERAS patients ambulated within 6 hours, a finding closely aligned with Gustafsson et al who highlighted early mobilization as a key determinant of reduced thromboembolic risk and enhanced recovery.¹⁸

Comparable obstetric studies by Ganer et al have demonstrated that early ambulation following caesarean delivery improves maternal confidence, reduces musculoskeletal discomfort, and accelerates return to

routine activities. The absence of deep vein thrombosis in both groups in the present study further supports the safety of early mobilization under supervised ERAS protocols.¹⁹

Self-care ability and newborn care

Functional independence at discharge is an outcome of growing importance in obstetric care. In this study, nearly 90% of ERAS patients were independent in basic self-care, compared to less than 60% in the conventional group. Additionally, only 16.9% of ERAS patients required assistance with newborn care, compared to over half of those managed conventionally. These findings parallel those of Macones et al who reported improved maternal autonomy and earlier mother-infant bonding in ERAS-managed caesarean deliveries.^{20,21}

Enhanced functional recovery has psychosocial implications beyond physical healing. Early independence facilitates breastfeeding initiation, improves maternal–infant interaction, and reduces caregiver burden factors particularly relevant in resource-constrained households.

Postoperative morbidity

The present study demonstrated lower rates of puerperal fever, wound infection, and paralytic ileus in the ERAS group. These findings are consistent with the systematic review by Bisch et al., which reported reduced infectious morbidity following ERAS implementation in obstetrics. Reduced intravenous fluid exposure, early feeding, optimal pain control, and early mobilization collectively reduce inflammatory stress and immune dysregulation, thereby lowering postoperative complication rates.^{22,23}

Patient satisfaction

Patient satisfaction was significantly higher in the ERAS group, with a mean score of 4.4 compared to 3.3 in the control group. Similar improvements in patient-reported outcomes have been reported by Lassen et al who emphasized the role of patient education, expectation setting, and active participation in recovery. ERAS protocols empower women by promoting autonomy, reducing discomfort, and minimizing unnecessary medicalization of the postoperative period. ERAS protocols is grounded in the principles of stress response modulation, physiological preservation, and patient-centred care. CS, though common, induces a significant neuroendocrine stress response characterized by increased catecholamines, cortisol release, insulin resistance, and inflammatory mediator activation. Conventional postoperative practices such as prolonged fasting, delayed mobilization, extended catheterization, and liberal intravenous fluid administration exacerbate this stress response, delaying recovery.^{24,25}

Early oral feeding, a key component of ERAS, promotes gastrointestinal motility through vagal stimulation and enteric hormone release, reducing postoperative ileus.

Avoiding prolonged fasting helps prevent insulin resistance and preserves muscle mass, supporting faster recovery. Multimodal analgesia with reduced opioid use minimizes opioid-related bowel dysfunction and sedation. Early mobilization improves venous return, pulmonary function, insulin sensitivity, and muscle preservation while reducing inflammation, thereby accelerating recovery. In addition, early catheter removal decreases the risk of bladder atony and facilitates spontaneous voiding. Restrictive intravenous fluid therapy helps prevent tissue and bowel wall edema, improving gastrointestinal function and wound healing while reducing cardiopulmonary stress in postpartum women.²⁶

Psychologically, ERAS protocols emphasize patient education and expectation management, which reduce anxiety and improve perceived control over recovery. Improved satisfaction scores observed in this study reflect both physiological benefits and enhanced patient engagement.²⁷ The cumulative effect of these mechanisms explains the observed reductions in hospital stay, complications, and delayed recovery parameters. Importantly, the absence of increased adverse events demonstrates that ERAS does not compromise safety when appropriately implemented.

The major strength of this study lies in its prospective comparative design with well-matched groups, minimising selection bias and ensuring reliable comparison of outcomes. Comprehensive evaluation of both clinical and functional recovery parameters provides a holistic assessment of postoperative outcomes. The inclusion of patient satisfaction further strengthens the relevance of findings from a patient-centered care perspective.

This study has some limitations. The study was conducted at a single center, which may limit generalizability across different healthcare settings. Long-term outcomes such as readmission rates, breastfeeding success, and maternal psychological wellbeing were not assessed. Additionally, while ERAS adherence was ensured through protocol implementation, individual compliance variations could not be entirely eliminated. Future multicenter studies with longer follow-up are warranted to address these limitations.

CONCLUSION

This prospective comparative study demonstrates that implementation of an ERAS protocol significantly improves postoperative outcomes following elective CS compared with conventional perioperative care. ERAS was associated with faster recovery of bowel and bladder function, earlier ambulation, greater functional independence, shorter hospital stay, and higher patient satisfaction. Women managed under ERAS achieved earlier return of gastrointestinal and urinary function, improved self-care ability, and reduced dependence on caregivers for newborn care. Importantly, these benefits were achieved without an increase in postoperative

complications; rather, infectious morbidity and paralytic ileus were less frequent in the ERAS group. The comparability of baseline demographic, obstetric, and laboratory characteristics between groups strengthens the validity of these findings. Furthermore, the significantly higher patient satisfaction scores highlight the positive impact of ERAS on both clinical recovery and the overall care experience. In conclusion, ERAS is a safe, effective, and patient-centered approach to perioperative management in elective CS. Its implementation can enhance maternal recovery, reduce healthcare resource utilization, and improve the quality of postoperative obstetric care.

Recommendations

Based on the findings of the present study, routine adoption of Enhanced Recovery After Surgery (ERAS) protocols in elective caesarean section (CS) is recommended. Integration of ERAS into standard perioperative care can facilitate faster postoperative recovery, reduce complications, shorten the duration of hospital stay, and improve maternal satisfaction without compromising patient safety. Successful implementation of ERAS requires a multidisciplinary approach involving obstetricians, anaesthesiologists, nursing staff, and physiotherapists. Therefore, healthcare institutions should establish standardized ERAS pathways and provide regular training programs to ensure consistent protocol adherence and optimal outcomes.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Raju R, Mathai S. Post-operative outcomes of enhanced recovery versus conventional approach in elective caesarean section: a prospective comparative study. *Int J Reprod Contracept Obstet Gynecol* 2026;15:2548-55.