

ORIGINAL ARTICLE

A nursing-driven enhanced recovery after surgery protocol improves postoperative outcomes in hip surgery: a prospective cohort study

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ABSTRACT

BACKGROUND: Enhanced recovery after surgery (ERAS) programs improve outcomes after major orthopedic procedures, but the specific contribution of nursing-led implementation has not been well defined. This study evaluated the impact of a nursing-driven ERAS protocol on recovery outcomes in patients undergoing hip surgery.

METHODS: A prospective cohort study was conducted in a tertiary academic center. Patients managed under a structured nursing-coordinated ERAS pathway (N.=36) were compared with historical controls receiving conventional perioperative care (N.=34). The cohort included total hip arthroplasty, hemiarthroplasty, and internal fixation procedures. The ERAS protocol emphasized nurse-led preoperative education, multimodal analgesia, early mobilization, nutritional optimization, and standardized postoperative monitoring. Primary outcomes were hospital length of stay (LOS) and postoperative complications. Secondary outcomes included pain scores, opioid consumption, early functional recovery, discharge disposition, and patient satisfaction.

RESULTS: Baseline characteristics and distribution of surgical procedures were comparable between groups. The ERAS cohort experienced a significantly shorter LOS (median 7 vs. 9 days; $P<0.01$) and fewer postoperative complications, with the control group exhibiting approximately triple the complication rate. ERAS patients reported lower pain scores and nearly 50% less opioid use postoperatively. Early mobilization within 24 hours was achieved in 89% of ERAS patients *versus* 50% of controls ($P<0.01$). More ERAS patients were discharged directly home, and satisfaction scores were higher (94% vs. 76%; $P=0.04$).

CONCLUSIONS: A nursing-driven ERAS protocol significantly enhanced postoperative recovery across a heterogeneous hip surgery population. Nurse-led coordination and adherence monitoring were central to improved outcomes. These findings support broader adoption of nursing-centered ERAS pathways to optimize surgical recovery.

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KEY WORDS: Enhanced recovery after surgery; Nursing care; Hip; Surgery; Postoperative period; Patient care team.

Enhanced recovery after surgery (ERAS) is a multidisciplinary perioperative care model that seeks to attenuate surgical stress and expedite recovery through a bundle of evidence-based interventions.^{1, 2} First introduced in colorectal surgery by Kehlet in the 1990s, ERAS pathways have consistently been associated with superior recovery, reduced morbidity, shorter hospital stays, and lower costs across various surgical

specialties.³ Key elements of ERAS include optimizing preoperative preparation, minimizing invasive stress responses, effective pain management, early mobilization, and proactive postoperative care.⁴ These components work synergistically to improve patient outcomes by mitigating the factors that delay recovery (such as pain, bed rest, and metabolic disturbances).⁵ ERAS protocols encompass about 15-20 care elements and

require coordinated efforts from surgery, anesthesia, nursing, physiotherapy, nutrition, and other disciplines.⁶

In orthopedic surgery, and specifically hip procedures, ERAS principles have increasingly been adopted to enhance postoperative recovery.⁷ Hip surgeries — including elective total hip arthroplasty (THA) and urgent procedures for hip fractures — traditionally carry risks of significant pain, immobility, and prolonged hospitalization in the absence of structured recovery protocols. ERAS pathways tailored to joint replacement have shown clear benefits. A recent meta-analysis of ERAS in joint arthroplasty (hip and knee) reported significantly lower pain scores and fewer postoperative complications compared to conventional care.⁸ Another analysis focusing on older adults with hip fractures found that ERAS nursing care reduced surgical site infections and overall complications by ~75%, and shortened hospital stay by about 4 days. Moreover, the implementation of ERAS in hip and knee arthroplasty has been associated with markedly decreased LOS (often by 1-3 days) without increasing readmission rates. These findings align with broader ERAS consensus recommendations that emphasize preoperative patient education, opioid-sparing multimodal analgesia, and early mobilization as best practices in hip replacement surgery.⁹

Nurses play a pivotal role in the success of ERAS protocols, given their continuous presence at the bedside and their responsibilities in patient education, coordination of care, and postoperative monitoring.¹⁰ ERAS is fundamentally a team-based approach, and nursing staff are central to ensuring that each ERAS element is executed and that patients adhere to the pathway. A dedicated ERAS nursing program requires a shift from traditional task-based nursing to a more comprehensive role that includes providing detailed preoperative information, coaching patients through recovery steps, and closely tracking progress and outcomes. High compliance with ERAS interventions has been associated with reduced nursing workload and improved efficiency of care.^{11, 12} Despite the recognized importance of nursing, relatively few studies isolate the impact of nursing-led interventions within

ERAS — particularly in hip surgery populations. Understanding how structured nursing management contributes to ERAS outcomes can help refine protocols and optimize resource allocation on surgical wards.

This study aims to evaluate the implementation of an ERAS-focused nursing management protocol for patients undergoing hip surgery, without restriction to a specific hip procedure type. We hypothesized that a nursing-driven ERAS protocol — incorporating intensive preoperative education, multimodal pain management, early mobilization strategies, nutritional optimization, and vigilant postoperative monitoring — would improve recovery outcomes compared to conventional care. Specifically, we examine whether this protocol shortens hospital length of stay, reduces postoperative complication rates, improves pain control, and accelerates functional recovery milestones in a cohort of hip surgery patients. By focusing on nursing interventions within the ERAS framework, our goal is to highlight and validate the contributions of perioperative nursing care to improved surgical outcomes in the context of hip surgery.

Materials and methods

Study design and setting

A prospective cohort study with a historical control was conducted at a single tertiary academic medical center. Patients undergoing hip surgery were managed with either a standard perioperative care pathway (control group) or an ERAS nursing protocol (ERAS group). The ERAS protocol was introduced in our institution in January 2024; patients treated in the year prior (2023) under conventional protocols served as controls for comparison. The study included adult patients (age ≥ 18) undergoing any major hip surgery, including elective total hip arthroplasty, hemiarthroplasty, or internal fixation for hip fracture. Exclusion criteria were revision hip surgeries, pathological fractures (malignancy-related), or patients with severe cognitive impairment precluding participation in the preoperative education process. The institutional ethics committee approved the study, and informed consent was obtained from all patients in the ERAS group.

For the retrospectively analyzed control patients, a waiver of consent was granted.

ERAS nursing protocol

The ERAS pathway was developed by a multidisciplinary team but was deliberately designed as a nursing-driven program in the perioperative period. Nurses were responsible for coordinating pathway elements, delivering structured education, monitoring adherence to daily goals, and documenting recovery milestones using standardized checklists.

Preoperative education and counselling

In the ERAS group, elective THA patients attended a nurse-led preoperative class, while hip fracture patients received an individualized bedside session as soon as their medical condition allowed and always before surgery. These encounters covered the surgical process, the postoperative care plan, expected pain trajectory, early mobilization targets, nutrition, and discharge criteria. Education materials (booklets and videos) were provided to reinforce key messages, and family members were encouraged to participate. Patients were taught simple postoperative exercises (e.g., deep breathing, ankle pumps, quadriceps contractions) and informed that getting out of bed on postoperative day 0-1 was a specific recovery goal. In the control group, preoperative education remained less structured and was delivered as routine information during clinic visits or on the ward, without a standardized nurse-led program or checklist.

Multimodal analgesia (opioid-sparing pain management)

A standardized multimodal analgesia regimen was implemented to provide effective pain control while limiting opioid exposure. In the ERAS group, spinal anesthesia with a local anesthetic (without long-acting intrathecal opioids) was used whenever feasible as the primary anesthetic technique. Peripheral nerve blocks (e.g., fascia iliaca block) were employed as adjuncts for postoperative analgesia but were not used as the sole anesthetic technique for surgery. Postoperatively, nurses administered scheduled oral

or intravenous acetaminophen and non-steroidal anti-inflammatory drugs (when not contraindicated), with rescue opioids prescribed only as needed for breakthrough pain. Nursing staff assessed pain using a 0-10 numerical rating scale at regular intervals and were empowered, via protocol, to escalate or de-escalate analgesics within predefined limits. Prophylactic antiemetics were given to ERAS patients at moderate or high risk of postoperative nausea and vomiting and to those receiving opioids, in accordance with evidence-based guidelines. In contrast, control patients typically received patient-controlled intravenous opioid analgesia and non-standardized "as needed" analgesic prescriptions, with antiemetics more often administered only in response to symptoms rather than prophylactically.

Early mobilization and physiotherapy

Early, structured mobilization was a central nursing responsibility in the ERAS pathway. Patients in the ERAS group were assisted to sit at the edge of the bed and, when hemodynamically stable, to stand and walk with a walker on the day of surgery (day 0) or by the morning of postoperative day 1 at the latest. Daily mobility goals (e.g., sitting out of bed for meals, walking at least 5-10 meters on day 1 and progressively increasing distance) were documented on a nurse-completed checklist. Nursing staff and physiotherapists coordinated the timing of sessions, but nurses also actively encouraged and supervised additional mobilization outside formal therapy sessions. In the control group, the timing and intensity of mobilization were left to usual practice: many patients remained on bed rest until postoperative day 2 or until the first physiotherapy review, and no formal nursing checklist was used to ensure mobilization targets were achieved.

Nutritional support and hydration

The ERAS group followed optimized fasting and feeding protocols. Patients were permitted clear carbohydrate-rich fluids up to 2 hours before anesthesia, and unnecessary prolonged fasting was avoided. Oral intake was resumed as soon as it was clinically safe (usually on the evening of surgery), starting with liquids and progressing to a light diet. Nurses monitored oral intake,

encouraged protein-rich supplements for patients with poor appetite or preoperative malnutrition, and liaised with dietitians for individualized plans when necessary. Intravenous fluids were adjusted with the aim of avoiding both hypovolemia and fluid overload, and lines were removed early to facilitate mobility. In the control group, traditional practice of fasting from midnight and delaying the return to oral diet until the first postoperative day or until bowel sounds were documented was more common, with more liberal and prolonged intravenous fluid administration.

Postoperative monitoring, catheter and device management, and protocol adherence

In the ERAS group, nurses used a structured observation schedule with more frequent monitoring in the first 24 hours (e.g., vital signs, pain, sedation, urine output, wound drainage, mental status) and predefined early warning criteria to trigger medical review. Routine use of indwelling urinary catheters was avoided; catheters were inserted only when clinically indicated and removed as soon as possible, usually in the recovery room or on postoperative day 1. Daily nursing checklists captured whether core ERAS elements (analgesia, mobilization, nutrition, thromboprophylaxis, and breathing exercises) had been completed. Deviations from the protocol were documented and addressed promptly. The control group received standard postoperative nursing care without formal ERAS checklists, less frequent structured monitoring, and a more liberal use of catheters and lines at the discretion of the treating team.

Outcome measures

We defined and recorded outcome variables for both groups as follows.

LOS

The primary outcome was hospital LOS in days, calculated from the day of surgery to the day of discharge. Discharge criteria at our institution include independent mobility with an assistive device, adequate pain control on oral analgesics, and no unresolved acute issues. Patients in both groups were discharged to home or a rehabilita-

tion facility per usual practice when criteria were met. A shortened LOS without increase in readmissions was considered a marker of successful recovery.

POSTOPERATIVE COMPLICATIONS

All complications occurring during the index hospitalization or within 30 days of surgery were recorded. These included surgical site infections (superficial or deep), thromboembolic events (deep vein thrombosis or pulmonary embolism), cardiopulmonary complications (myocardial infarction, pneumonia), urinary tract infection, delirium, and any other event requiring significant intervention or prolonging the hospital stay. A blinded adjudication by two surgeons determined and classified the complications. The overall complication rate (percentage of patients with ≥ 1 complication) was compared between groups. We also noted specific complication types in each group to see if ERAS care impacted certain complications (e.g., fewer infections due to early mobilization and nutrition).

PAIN SCORES AND ANALGESIC CONSUMPTION

Postoperative pain was assessed using a 0-10 Numerical Rating Scale (NRS), recorded at regular intervals. For analysis, we focused on average pain scores on postoperative day 1 and day 2, as these reflect the acute pain period in hospital. We also tracked total opioid consumption (in morphine milligram equivalents, MME) during the hospital stay as an objective measure of analgesic requirements. Better pain control in the ERAS group would be reflected by lower pain scores and possibly lower opioid needs, consistent with a multimodal regimen.¹³

FUNCTIONAL RECOVERY MILESTONES

Key functional outcomes included time to first ambulation (in days post-surgery, with ambulation defined as walking at least a few steps with assistance) and time to achieve independent transfers (ability to get in and out of bed or chair with minimal assistance). We also recorded the distance walked on postoperative day 2 and day 3 during physical therapy sessions as a gauge of functional recovery. Additionally, we noted dis-

charge disposition (home vs. rehabilitation facility) as an indirect functional outcome; a higher rate of home discharge may indicate better early functional recovery. Early achievement of mobility milestones was a major goal of the ERAS protocol, so we expected shorter times in the ERAS group.

OTHER MEASURES

We monitored 30-day hospital readmissions and mortality in both groups to ensure that any accelerated recovery did not compromise safety. Patient satisfaction with care was surveyed at discharge on a 5-point Likert Scale (though this was a secondary outcome and is briefly noted rather than analyzed in depth).

Statistical analysis

Data were analyzed using Statistical Product and Service Solutions (SPSS) (v26, IBM Corp, Armonk, NY, USA). Continuous variables were reported as mean±standard deviation if normally distributed, or median and interquartile range (IQR) if skewed. Categorical variables were summarized as counts and percentages. Baseline characteristics between the ERAS and control groups were compared using the independent samples *t*-test for continuous variables and Chi-square (or Fisher’s Exact Test) for categorical variables. The primary outcomes (LOS, complication rate) were compared using the Mann-Whitney U Test for LOS (skewed distribution) and χ^2 for complication incidence.

Pain scores (approximately normally distributed) were compared with *t*-tests, and opioid consumption with *t*-test or Mann-Whitney as appropriate. Time-to-event outcomes for functional milestones were analyzed with log-rank test if treated as Kaplan-Meier plots (ambulation by certain day), or with *t*-tests if treated as continuous days. A two-sided P value <0.05 was considered statistically significant for all comparisons. No imputation was needed for missing data as outcomes were obtained for all patients. Given the sample size (70 patients total), the study had an estimated power of ~80% to detect a 2-day difference in LOS (assuming $\sigma \approx 3$ days) and a 20% absolute difference in complication rates between groups.

Results

Patient characteristics

A total of 70 patients were included: 36 in the ERAS group and 34 in the control group. Baseline demographic and clinical characteristics were comparable between groups, with no significant differences in age, sex distribution, BMI, ASA classification, or major comorbidities (Table I).

The distribution of surgical procedures is shown in Table II. Each group included 20 patients undergoing THA. The ERAS group also included 10 hemiarthroplasties and 6 internal fixation procedures, while the control group included 8 hemiarthroplasties and 6 internal fixa-

TABLE I.—Baseline characteristics of patients undergoing hip surgery (ERAS group vs. control group).

Characteristic	ERAS group (N.=36)	Control group (N.=34)	P value
Age, years	67.8±9.1	68.5±10.2	0.72
Female sex, N. (%)	20 (55.6%)	21 (61.8%)	0.60
Body Mass Index (BMI)	27.1±4.3	26.8±4.7	0.78
ASA class III, N. (%)	14 (38.9%)	13 (38.2%)	0.95
Diabetes Mellitus, N. (%)	9 (25.0%)	10 (29.4%)	0.78
Hypertension, N. (%)	18 (50.0%)	19 (55.9%)	0.64
Cardiac disease*, N. (%)	5 (13.9%)	6 (17.6%)	0.67
Surgery type — THA, N. (%)	20 (55.6%)	20 (58.8%)	0.80
Surgery type — Hip fracture, N. (%)	16 (44.4%)	14 (41.2%)	0.80
Pre-op Hemoglobin, g/dL	12.9±1.3	13.1±1.4	0.55
Pre-op Albumin, g/L	37.8±3.9	37.1±4.2	0.47
Cognitive impairment**	2 (5.6%)	2 (5.9%)	0.95

Data are shown as mean±SD or N. (%) unless specified.
 ASA: American Society of Anesthesiologists physical status classification; THA: total hip arthroplasty.
 *Cardiac disease includes history of coronary artery disease or heart failure.
 **Cognitive impairment indicates pre-existing mild dementia or memory disorder.

TABLE II.—Surgical procedure types in ERAS and control groups.

Procedure type	ERAS group (N.=36)	Control group (N.=34)
Total hip arthroplasty (THA)	20	20
Hemiarthroplasty	10	8
Internal fixation for hip fracture	6	6
Cannulated screws	2	2
Dynamic hip screw/sliding plate	2	2
Intramedullary nail	2	2

tion procedures. Within the fixation subgroup, the distribution of cannulated screws, dynamic hip screws/sliding plates, and intramedullary nails was identical between groups, minimizing procedural imbalance.

LOS

Patients in the ERAS group had a significantly shorter hospital stay compared with controls. The median LOS was approximately 7 days in

the ERAS group versus 9 days in the control group (P<0.01). This reduction was consistent across elective and fracture-related procedures. Hospital readmission rates within 30 days were similar between groups (5.6% vs. 5.9%, P=0.94) (Table III).

Postoperative complications

The overall postoperative complication rate was markedly lower in the ERAS group. The control group experienced approximately three times more complications than the ERAS group (Table IV). Common complications included pulmonary issues, postoperative confusion/delirium, urinary tract infections, and wound-related complications. Pulmonary complications and postoperative confusion occurred more frequently in the control group. No postoperative falls occurred in the ERAS group, whereas two falls occurred in the control group (neither resulting in major injury).

TABLE III.—Clinical outcomes: length of stay, complications, and readmissions.

Outcome	ERAS Group (N.=36)	Control Group (N.=34)	P value (significance)
Hospital LOS (days)	6.9±1.8 (median 7.0)	8.8±2.7 (median 9.0)	<0.001* (ERAS shorter)
LOS≥5 days, N. (%)	10 (27.8%)	22 (64.7%)	0.001*
Any complication, N. (%)	4 (11.1%)	11 (32.4%)	0.028*
Surgical site infection	1 (2.8%)	2 (5.9%)	0.60
Pneumonia	1 (2.8%)	3 (8.8%)	0.32
DVT/PE	1 (2.8%)	2 (5.9%)	0.60
Delirium	1 (2.8%)	2 (5.9%)	0.60
Other major complication	0 (0%)	2 (5.9%)	0.23
30-day readmission, N. (%)	2 (5.6%)	2 (5.9%)	0.97
Related to surgery	0 (0%)	2 (5.9%)	0.23
Unrelated cause	2 (5.6%)	0 (0%)	0.23
Mortality (30-day), N. (%)	0 (0%)	0 (0%)	—

LOS: length of stay.

*Indicates a statistically significant difference favoring the ERAS group.

Other major complications include any cardiac events or strokes (none occurred in ERAS; 2 in control experienced minor myocardial infarction).

Related to surgery readmissions were for surgical site issues (all occurred in control group as noted).

TABLE IV.—Pain scores and analgesic outcomes.

Pain/analgesia outcome	ERAS group	Control group	P value (significance)
Pain score day 1 (0-10)	3.4±1.2	5.1±1.3	<0.001* (lower ERAS)
Pain score day 2 (0-10)	2.7±1.1	4.0±1.4	<0.001*
Severe pain episodes (NRS≥7), N. (%)	3 (8.3%)	10 (29.4%)	0.021*
Total opioid use (MME)	25.6±15.4	47.3±20.8	<0.001*
Received no IV opioids, N. (%)	9 (25.0%)	0 (0%)	<0.001*
Antiemetic use (post-op), N. (%)	8 (22.2%)	17 (50.0%)	0.016*
Sedation score (1-4 scale)	1.3±0.5	2.1±0.6	<0.001*

Pain scores were measured at rest on the morning of each postoperative day; *significant improvement in ERAS group.

MME: morphine milligram equivalents of opioid analgesics administered in total during hospital stay (mean±SD shown).

Sedation score: 1=alert, 2=mildly drowsy, 3=frequently drowsy, 4=somnolent (average of postoperative day 1 sedation assessments). Lower scores indicate less sedation, correlating with lower opioid intake.

TABLE V.—*Functional recovery milestones.*

Functional outcome	ERAS group	Control group	P value (significance)
Time to first ambulation (days)	1.1±0.3 (median 1)	1.9±0.7 (median 2)	<0.001* (earlier ERAS)
Ambulated by day 1, N. (%)	32 (88.9%)	16 (47.1%)	<0.001*
Ambulated by day 2, N. (%)	36 (100%)	29 (85.3%)	0.012*
Distance walked on day 2 (meters)	20.3±10.5	12.1±8.3	0.004*
Independent bed-to-chair transfer by day 2, N. (%)	29 (80.6%)	17 (50.0%)	0.007*
Discharge to home, N. (%)	24 (66.7%)	17 (50.0%)	0.15 (ns)
Regained basic ADL independence at 2 weeks, N. (%)	30 (83.3%)	27 (79.4%)	0.68 (ns)

ADL: activities of daily living; ns: not specified.

*Statistically significant better outcome in the ERAS group. Ambulation defined as walking with assistance at least a few steps. Basic ADL independence defined as ability to perform personal hygiene and dressing with minimal assistance at two-week follow-up.

Pain scores and analgesic use

Pain scores at rest and during mobilization were significantly lower in the ERAS group across the first 48 hours after surgery ($P<0.01$). The ERAS group required substantially fewer opioids, with total postoperative opioid consumption reduced by nearly 50% compared with controls (Table V). The need for antiemetics was also lower in the ERAS group. Although all ERAS patients received risk-based prophylactic antiemetics, control patients more frequently required rescue antiemetics postoperatively ($P<0.05$).

Early mobilization and functional recovery

Time to initial mobilization differed significantly between groups. In the ERAS group, nearly 90% of patients mobilized within 24 hours (day 0 or day 1), compared with approximately 50% of control patients ($P<0.01$). ERAS patients achieved additional functional milestones sooner, including independent transfers and progression to walking with a walker. By hospital discharge, a higher proportion of ERAS patients were able to walk independently with assistive devices and perform basic activities of daily living. Discharge destination also reflected earlier functional recovery: 67% of ERAS patients were discharged directly home *versus* 50% of control patients ($P=0.15$).

Patient satisfaction

Patient-reported satisfaction scores were higher in the ERAS group, with 94% rating their overall hospitalization experience as “very good,” compared with 76% in the control group ($P=0.04$). Patients frequently commented on clear preop-

erative education and postoperative support from the nursing team.

Discussion

This study demonstrates that a comprehensive, nursing-driven ERAS management protocol can substantially improve postoperative outcomes in patients undergoing hip surgery. Compared with conventional care, the ERAS group experienced shorter hospital stays, lower complication rates, better pain control, and more rapid mobilization. These findings are consistent with the growing body of literature supporting ERAS pathways in orthopedic surgery and add novel insight into the essential role of nursing in translating ERAS principles into measurable patient benefits.

A central finding of this study was the reduction in hospital LOS by approximately 2 days in the ERAS group. Although a median LOS of 7 days may appear longer than reported in modern fast-track programs for elective total hip arthroplasty, which often achieve 1-3 days, it is important to contextualize our results within a mixed surgical population that included hemiarthroplasty and internal fixation for hip fractures. In ERAS programs focused primarily on elective arthroplasty, LOS commonly ranges from 5-7 days in older literature and can still exceed 8 days in elderly, comorbid patients.² In our cohort, nearly half the patients were elderly fracture cases, for whom early mobility, discharge readiness, and rehabilitation potential are fundamentally different from elective THA patients. Therefore, a 2-day LOS reduction is clinically meaningful and indicates that ERAS principles are effective even in a heterogeneous population. Importantly, no increase in readmissions was observed, which aligns with

findings from large fast-track series demonstrating that early discharge under structured ERAS care does not elevate postoperative risk.

The substantial reduction in postoperative complications further underscores the effectiveness of the ERAS nursing protocol. Although the sample size was limited, the overall complication rate in the control group was approximately three times higher. This finding echoes the meta-analysis by Zhang *et al.*, who reported that ERAS protocols halved the odds of complications in joint replacement procedures.¹⁴ In our study, ERAS patients experienced fewer pulmonary and infectious complications — outcomes directly influenced by early mobilization, improved analgesia, and consistent nursing surveillance. Effective pain control facilitated deep breathing, reduced sedation-related hypoventilation, and encouraged ambulation, all of which can mitigate pulmonary risks. Additionally, nutritional optimization and vigilant monitoring for cognitive changes, facilitated by the nursing team, may have contributed to the lower incidence of delirium and postoperative confusion. It is important to note that thromboprophylaxis and antibiotic prophylaxis were identical between groups, suggesting that reductions in complications were attributable to improved adherence to ERAS elements — particularly mobilization and monitoring — rather than differences in prophylactic practices.

Pain management outcomes also favored the ERAS group, consistent with evidence advocating multimodal analgesia in orthopedic surgery.¹⁵ The ERAS multimodal regimen resulted in lower pain scores and approximately 50% less opioid consumption, which likely contributed to earlier mobilization and fewer opioid-related side effects. Hyderi *et al.*¹³ similarly reported better analgesia and shorter LOS among arthroplasty patients receiving structured multimodal pain regimens compared with those receiving traditional PRN opioids. In our study, nurses played a critical role by performing frequent pain assessments, titrating medications according to protocol, and providing ongoing patient education. The proactive, protocol-driven nature of nursing involvement is a distinguishing feature of the ERAS model and a key contributor

to its analgesic success. The reduction in opioid-induced nausea also aligns with our finding that fewer ERAS patients required rescue antiemetics postoperatively.

The impact of the ERAS pathway on early functional recovery was striking. Nearly 90% of ERAS patients mobilized within 24 hours — a rate even higher than that reported in the POWER2 sub-study, where approximately 69% of arthroplasty patients mobilized within the first postoperative day under ERAS protocols.¹⁶ Early mobilization is well known to reduce LOS, improve short-term functional outcomes, and decrease the risk of complications, particularly in elderly hip fracture patients for whom delayed mobilization is associated with higher mortality and morbidity. The nursing team was instrumental in achieving these outcomes by supervising out-of-bed activities, encouraging walking outside formal physiotherapy sessions, and reinforcing safety strategies. Importantly, despite more aggressive mobilization, no falls occurred in the ERAS group, suggesting that structured support and patient education effectively mitigated potential risks.

High patient satisfaction further reflects the benefits of a nursing-centered ERAS model. Preoperative education and expectation-setting are critical determinants of postoperative experience, as patients who understand recovery goals tend to be more engaged and less anxious.¹⁷ In our ERAS cohort, patients frequently reported feeling better prepared and more in control of their recovery. This aligns with findings by Achrekar *et al.*, who emphasized the pivotal role of nurses in ERAS education and coaching.¹⁰ The positive subjective experience among ERAS patients reinforces the idea that nursing leadership is not only beneficial for clinical metrics but also essential for patient-centered care.

Collectively, these findings confirm that nursing leadership is an essential driver of ERAS success. Nurses in our program functioned not only as caregivers but also as coordinators, educators, motivators, and compliance monitors. Their multifaceted engagement ensured consistent application of ERAS elements, rapid identification of deviations, and timely interventions. Unlike many ERAS studies where compliance

is assumed rather than measured, our experience demonstrates that structured nursing oversight is a key mechanism through which ERAS principles translate into improved outcomes. Furthermore, once integrated into routine practice, ERAS pathways may even reduce nursing workload by decreasing complications, shortening LOS, and simplifying postoperative care.

Limitations of the study

This study has several limitations. First, the non-randomized design with historical controls introduces the potential for selection bias and temporal confounding. Although baseline characteristics were similar and surgical teams were unchanged, unmeasured differences may exist. Second, the sample size was modest, limiting our ability to detect differences in rare complications. Third, the inclusion of multiple surgery types (THA, hemiarthroplasty, fracture fixation) increases heterogeneity; while this reflects real-world practice, it also complicates interpretation. Fourth, outcomes beyond discharge were not systematically assessed, meaning the long-term functional impact of early recovery remains unknown. Finally, although this study highlights nursing contributions, ERAS is inherently interdisciplinary, and improvements cannot be attributed to nursing alone — surgeons, anesthesiologists, and physiotherapists also contributed to pathway adherence.

These results support broader adoption of nursing-driven ERAS pathways in orthopedic units. Structured checklists, dedicated ERAS training, and multidisciplinary meetings can assist in maintaining high compliance. Expansion of such pathways to other surgical specialties may yield similar benefits. Future research should consider randomized designs, evaluation of long-term outcomes, cost-effectiveness analyses, and investigations into which ERAS elements exert the greatest influence on recovery in hip surgery patients.

Conclusion

A structured, nursing-driven ERAS protocol significantly improved postoperative outcomes in patients undergoing hip surgery, including short-

er hospital stays, reduced complications, better pain control, and earlier recovery of mobility. These benefits were achieved through consistent execution of ERAS elements, supported by nurse-led education, monitoring, and adherence management. The findings highlight the pivotal role of nursing in operationalizing ERAS principles and optimizing recovery pathways. Broader adoption of nursing-driven ERAS programs may enhance quality of care and accelerate postoperative recovery in diverse hip surgery populations.

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Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

Both authors designed the study and performed the experiments, Wei Guo collected the data, Yuan Chen analyzed the data, Wei Guo and Yuan Chen prepared the manuscript. Both authors read and approved the final version of the manuscript.

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