RESEARCH PAPER

Efficacy of Enhanced Recovery after Surgery (ERAS) Protocols in Orthopedic Perioperative Care: A Systematic Review

Prof. Mrudula Phule[1] and Dr. Jasneet Kaur[2]

[1]Ph.D. Scholar, Symbiosis College of Nursing, Symbiosis International (Deemed University), Pune
[2]Professor, Symbiosis College of Nursing, Symbiosis International (Deemed University), Pune
[1]phulevaishali@gmail.com and [2]jasneetkaur@scon.edu.in

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ABSTRACT

Background: Orthopedic surgical procedures are frequently associated with postoperative complications, delayed convalescence, and substantial healthcare expenditure. Enhanced Recovery After Surgery (ERAS) protocols—structured multimodal perioperative care pathways—have been proposed as a mechanism for attenuating surgical stress and accelerating patient recovery. The magnitude and consistency of their efficacy within orthopedic settings have not been comprehensively established. Objectives: To critically appraise and synthesize available evidence regarding the effectiveness of ERAS protocols in improving perioperative outcomes among orthopedic surgical patients. Methods: A systematic literature search was conducted across PubMed, Scopus, CINAHL, Web of Science, and Google Scholar (2015–2024) following PRISMA guidelines. Eligible study designs included randomized controlled trials (RCTs) and observational studies. Results: Six studies met predefined eligibility criteria. ERAS implementation was associated with clinically meaningful reductions in hospital length of stay (LOS) by up to 4.7 days, lower postoperative complication rates, decreased blood transfusion requirements, enhanced analgesia, and facilitation of early mobilization. Conclusions: ERAS protocols confer significant perioperative benefits in orthopedic surgery. Broader standardized adoption is warranted. Future large-scale RCTs and implementation science research are needed to address persistent adoption barriers.

Index Terms—enhanced recovery after surgery; ERAS protocol; orthopedic surgery; perioperative care; postoperative recovery; systematic review; multimodal analgesia; early mobilization

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I. INTRODUCTION

Surgical interventions constitute an indispensable pillar of contemporary healthcare, addressing traumatic injuries, degenerative musculoskeletal diseases, neoplastic disorders, and congenital anomalies [1]. Globally, approximately 313 million surgical procedures are performed annually, with demand projected to increase alongside aging populations and expanding access to surgical services in low- and middle-income countries [2]. Despite advances in operative technique and anesthetic pharmacology, the perioperative period remains a clinically critical interval during which patients are highly susceptible to physiological stress and systemic complications [3]. Between 20% and 30% of surgical patients experience at least one postoperative complication, contributing to elevated morbidity, preventable mortality, and escalating healthcare costs [4].

Conventional perioperative management—characterized by extended preoperative fasting, opioid-centric analgesia, prolonged bed rest, and protracted hospitalization—has increasingly been recognized as suboptimal. The Enhanced Recovery After Surgery (ERAS) framework was developed in the late 1990s by Professor Henrik Kehlet to coordinate best perioperative practices from surgery, anesthesiology, nursing, and allied health into a cohesive, standardized care pathway [5]. Since its inception, ERAS has been progressively refined and expanded across colorectal, urological, gynecological, and cardiac surgery settings.

A. Orthopedic Surgery: Epidemiological Burden

Orthopedic surgery encompasses a heterogeneous range of procedures addressing osteoarthritis, rheumatoid arthritis, fractures, spinal disorders, and congenital skeletal abnormalities. Musculoskeletal diseases affect approximately 1.71 billion individuals worldwide, representing one of the foremost causes of years lived with disability. Total knee arthroplasty (TKA) and total hip arthroplasty (THA) rank among the most frequently performed elective procedures globally, with exponential growth driven by progressive demographic aging [6]. Patients undergoing these procedures face substantive

**Author for Correspondence: phulevaishali@gmail.com*

risks of postoperative pain, thromboembolic events, blood loss, and functional impairment.

B. ERAS in the Indian and Regional Healthcare Context

In India, the burden of musculoskeletal disorders has escalated sharply due to population aging, urbanization, sedentary lifestyles, and high rates of road traffic trauma. Over 200,000 knee arthroplasty procedures are performed annually, with adoption of evidence-based ERAS frameworks remaining heterogeneous across institutions [15]. Maharashtra, one of India's most populous states, operates a large orthopedic surgical network across metropolitan centers including Mumbai, Pune, Nagpur, and Nashik. Standardized perioperative optimization frameworks are critically needed to address the escalating volumetric burden of orthopedic procedures in this region.

C. Study Objectives

The present systematic review was conducted to critically appraise and synthesize published evidence on the effectiveness of ERAS protocols in improving perioperative outcomes among orthopedic surgical patients. By consolidating findings from RCTs and observational studies published between 2015 and 2024, this review provides an evidence-based foundation to inform clinical practice, guide institutional policy, and identify priority areas for future research.

II. MATERIALS AND METHODS

A. Study Design

The investigation was conducted as a systematic review adhering strictly to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [12], ensuring transparency, reproducibility, and methodological rigor in the identification, selection, critical appraisal, and synthesis of relevant evidence.

B. Literature Search Strategy

A comprehensive electronic search was conducted across five academic databases: PubMed, Scopus, CINAHL, Web of Science, and Google Scholar, covering publications from January 2015 to December 2024. Search terms combined free-text keywords and Medical Subject Headings (MeSH) terminology using Boolean operators. The primary search string comprised: ("Enhanced Recovery After Surgery" OR "ERAS protocol" OR "fast-track surgery") AND ("orthopedic surgery" OR "arthroplasty" OR "joint replacement") AND ("perioperative care" OR "postoperative recovery"). Reference lists of eligible articles were manually examined to identify additional studies. Records were imported into EndNote for deduplication and screening.

C. Eligibility Criteria

Inclusion criteria encompassed: (i) studies evaluating ERAS protocols in orthopedic surgical patients; (ii) RCTs, prospective/retrospective cohort studies, observational studies, and systematic reviews; (iii) studies reporting at least one perioperative outcome—hospital LOS, complication rate, pain intensity, mobilization time, transfusion requirements, or patient satisfaction; and (iv) English-language peer-reviewed publications from 2015 to 2024. Exclusion criteria comprised: non-orthopedic populations, absence of formal ERAS evaluation, case reports, letters, editorials, conference abstracts, duplicates, and inaccessible full-text articles.

D. PICO Framework

The study was structured using the PICO framework to ensure conceptual clarity and methodological coherence in research question formulation:

PICO Element	Description
Population	Patients undergoing orthopedic surgical procedures (TKA, THA, fracture fixation, spinal surgery)
Intervention	Structured ERAS protocol: preoperative education, nutritional optimization, multimodal analgesia, goal-directed fluid therapy, minimally invasive techniques, PONV prophylaxis, early oral feeding, early mobilization
Comparison	Conventional perioperative care without formal ERAS protocol
Outcome	Hospital LOS, postoperative complication rates, blood transfusion requirements, pain scores, mobilization timeline, functional recovery, patient satisfaction

E. Study Selection and Quality Assessment

Study selection was executed in a multi-stage PRISMA-compliant process. An initial 85 records were retrieved electronically and 5 via manual reference-list searching, totaling 90 records. Following removal of 20 duplicates, 70 unique records proceeded to title/abstract screening. Of these, 50 were excluded as irrelevant. Twenty full-text articles were assessed for eligibility; 14 were excluded (non-orthopedic focus, n=5; no ERAS evaluation, n=4; reviews/editorials without primary data, n=3; insufficient outcome data, n=2). Six articles satisfied all inclusion criteria and were incorporated into the final qualitative synthesis. Methodological quality was assessed using the Cochrane Risk of Bias Tool (RoB 2) for RCTs, the Newcastle–Ottawa Scale (NOS) for observational studies, and AMSTAR-2 for systematic reviews.

II. RESULTS

A. Study Characteristics

Six studies fulfilled the predefined eligibility criteria. Study designs included a multicenter prospective cohort

study, two systematic reviews with meta-analyses, a hospital-based clinical trial, and two observational studies. Study duration ranged from 3 months to 2 years. Collectively, the studies examined THA, TKA, intertrochanteric fracture fixation, and hip surgery across international settings. Table I presents the key characteristics and principal findings.

Table I. Summary of Included Studies: Design, Population, and Principal Findings

Reference	Sample / Setting	Study Design & Methods	Principal Findings
[6] Ripollés-Melchor et al. (2020)	6,146 patients; 131 hospitals (Spain); elective THA/TKA	Multicenter prospective cohort; 16 ERAS components; 30-day outcomes	Higher ERAS adherence → shorter LOS + fewer complications (dose-response relationship)
[7] Deng et al. (2018)	Meta-analysis; 25 studies; 16,699 patients; hip/knee arthroplasty	Comparative meta-analysis: RCTs + cohort studies; ERAS vs. conventional care	Significant reductions in LOS, complications, transfusion, perioperative mortality
[8] Kang et al. (2019)	Patients with intertrochanteric femoral fractures; single center	Hospital-based comparative study; ERAS vs. conventional care; recovery parameters	Shorter LOS without compromising functional recovery; safe accelerated discharge
[9] Frassanito et al. (2020)	Elective hip/knee replacement patients; orthopedic centers	Prospective observational; multidisciplinary ERAS pathway evaluation	Fewer complications, shorter LOS, improved care quality; multidisciplinary collaboration critical
[10] Sattler et al. (2025)	Systematic review; 5 RCTs; 710 patients; primary hip/knee arthroplasty	Systematic review of RCTs; ERAS vs. conventional; early functional outcomes	LOS reduced by ~4.7 days; improved functional recovery; no increase in complications
[11] Lee et al. (2025)	Meta-analysis; 21 studies; >2,000 patients; orthopedic hip surgery	Systematic review and meta-analysis; ERAS vs. conventional care	Reduced LOS, complications, transfusions; improved pain control across subgroups

B. Hospital Length of Stay

The most consistently reported benefit was a significant reduction in hospital LOS. Sattler et al. [10] demonstrated a mean LOS reduction of approximately 4.7 days in patients undergoing arthroplasty under ERAS pathways versus conventional care. Ripollés-Melchor et al. [6] identified a dose-response relationship between ERAS adherence and LOS reduction across 131 Spanish hospitals. Kang et al. [8] confirmed shorter hospital stays in fracture fixation patients without detriment to functional recovery. The LOS comparison is visualized in Fig. 2.

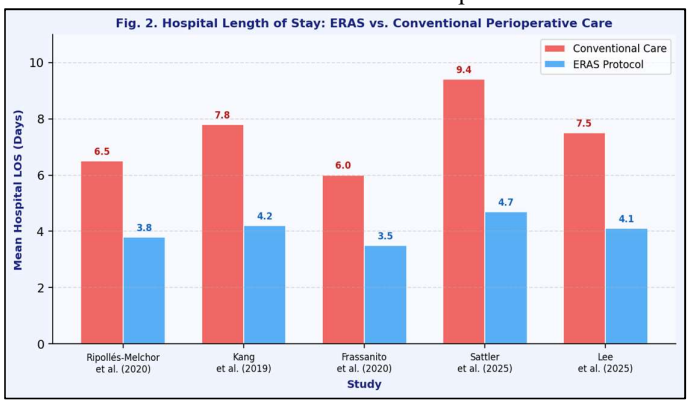

Fig. 1. Hospital Length of Stay (Days): ERAS Protocol vs. Conventional Perioperative Care

C. Postoperative Complication Rates

ERAS-compliant centers achieved significantly fewer 30-day surgical complications, with the magnitude of this effect scaling proportionally with degree of protocol adherence [6]. The meta-analytic data of Deng et al. [7] and Lee et al. [11] corroborated these findings across large pooled samples encompassing wound infections, thromboembolic events, cardiovascular incidents, and

respiratory complications. Frassanito et al. [9] similarly observed meaningful reductions following multidisciplinary ERAS implementation. Complication rates are compared in Fig. 3.

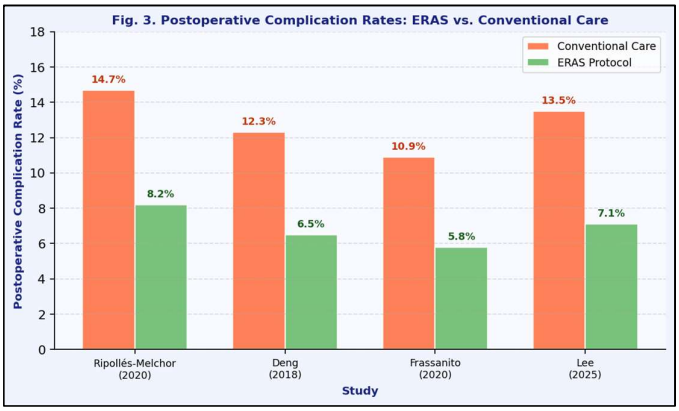

Fig. 2. Postoperative Complication Rates (%): ERAS vs. Conventional Care

D. Pain Management, Opioid Reduction, and Blood Transfusion

Lee et al. [11] provided explicit evidence that ERAS implementation substantially improved postoperative pain control in orthopedic hip surgery populations. Deliberate opioid reduction within ERAS frameworks yields multiple interdependent benefits: decreased incidence of nausea, vomiting, ileus, sedation, and respiratory depression, alongside improved physiotherapy engagement [22]. Deng et al. [7] identified significant reductions in blood transfusion requirements under ERAS management—particularly relevant in major orthopedic procedures associated with substantial intraoperative blood loss. These findings are illustrated in Fig. 5.

E. Early Mobilization and Functional Recovery

Mobilization within the first 24 hours postoperatively—a standard ERAS target—is associated with significant reductions in the risk of deep vein thrombosis, pulmonary embolism, hospital-acquired pneumonia, and skeletal muscle deconditioning [19]. Sattler et al. [10] demonstrated that ERAS patients achieved superior early functional recovery milestones without any increase in complication rates. Kang et al. [8] confirmed that ERAS-facilitated early mobilization in fracture fixation patients did not impair postoperative functional outcomes. The multi-domain ERAS efficacy profile is depicted in Fig. 4.

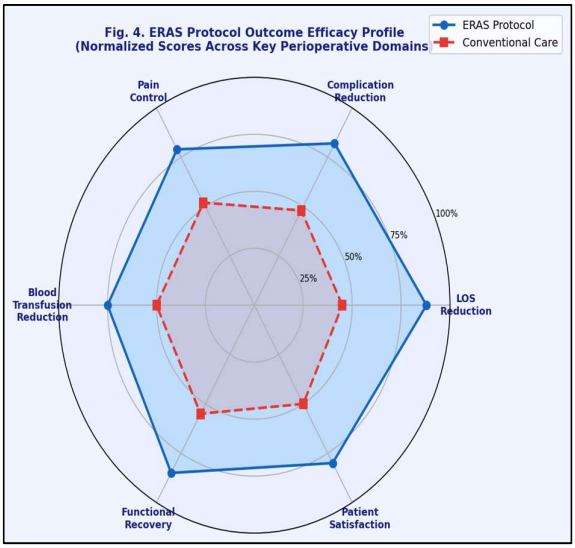

Fig. 3. Radar Chart: ERAS Protocol Efficacy Across Key Perioperative Outcome Domains (Normalized Scores)

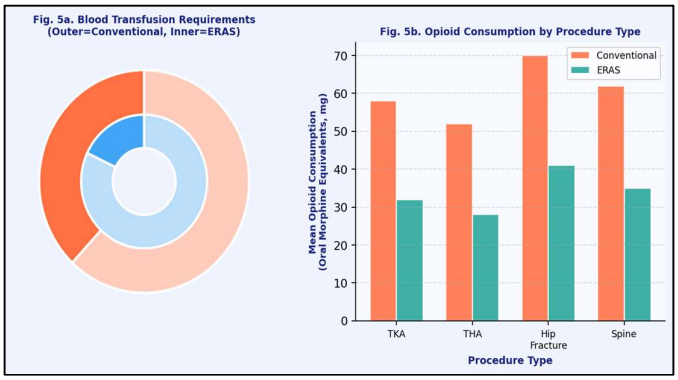

Fig. 4. Blood Transfusion Requirements and Opioid Consumption: ERAS vs. Conventional Care

IV. DISCUSSION

A. Overview of Findings

The findings of this systematic review provide consistent and convergent evidence supporting the clinical effectiveness of ERAS protocols in improving perioperative outcomes across a range of orthopedic surgical procedures. Despite variability in study design, patient population, and procedure type, the included studies collectively demonstrate that ERAS implementation is associated with clinically meaningful benefits across multiple perioperative outcome domains, aligning with the broader ERAS literature spanning other surgical specialties [13].

B. Multidisciplinary Implementation and Nursing Roles

A recurring and clinically important theme was the recognition that effective ERAS implementation is contingent upon coordinated multidisciplinary engagement. Frassanito et al. [9] explicitly identified integrated collaboration—encompassing surgeons, anesthesiologists, nurses, physiotherapists, and dietitians—as a prerequisite for successful outcomes. Nurses occupy a pivotal role within ERAS pathways, assuming responsibility for preoperative patient education, intraoperative monitoring, postoperative assessment, early mobilization facilitation, pain management coordination, and discharge planning [24]. High-quality nursing care directly influences patient adherence to ERAS components and represents an independent determinant of pathway outcomes.

C. Barriers to ERAS Implementation

Despite compelling evidence, barriers to widespread ERAS adoption persist, particularly in developing healthcare systems. These include resource heterogeneity, absence of standardized protocol frameworks, inadequate multidisciplinary coordination, low clinician awareness, resistance to practice change, and insufficient training [15]. In resource-constrained settings such as India, the logistical demands of implementing multicomponent pathways present additional challenges [18]. Addressing these barriers requires targeted educational initiatives, institutional policy mandates, structured implementation programs with fidelity monitoring, and dedicated quality improvement infrastructure.

V. RISK OF BIAS ASSESSMENT

A formal risk of bias assessment was conducted using design-appropriate validated instruments. Included studies exhibited generally acceptable methodological quality; however, several limitations warrant acknowledgment. The majority employed observational or cohort designs inherently susceptible to selection bias and confounding by indication. Variations in ERAS protocol components across institutions introduced heterogeneity in both intervention and outcome measurement, complicating direct cross-study comparisons. Several studies provided incomplete reporting of blinding procedures and randomization methodology. Publication bias is a plausible concern, as studies reporting positive ERAS outcomes are more likely to be published. Notwithstanding these limitations, the consistency of directional findings across heterogeneous designs, diverse settings, and large aggregate samples supports the overall reliability of the evidence synthesis.

VI. STRENGTHS AND LIMITATIONS

This review offers several methodological strengths, including a comprehensive multi-database search strategy, PRISMA adherence, predefined eligibility criteria, and validated quality appraisal instruments. The inclusion of diverse study designs facilitated examination of ERAS effects across a broad range of orthopedic procedures and clinical settings. The explicit PICO framework ensured conceptual precision.

Limitations include the small final synthesis of six primary studies, which may constrain generalizability. Heterogeneity in ERAS protocol composition, demographics, procedure types, and outcome measurement instruments precluded formal meta-analytic pooling. Restriction to English-language publications may have introduced language bias [12]. The observational design of several included studies limits causal inference. Future systematic reviews incorporating standardized outcome reporting and high-quality RCTs are necessary to address these limitations.

VII. IMPLICATIONS FOR CLINICAL PRACTICE

The consistent evidence for ERAS-related reductions in hospital LOS, postoperative complications, opioid requirements, and recovery time supports the formal

integration of standardized ERAS pathways into routine orthopedic perioperative management. Healthcare organizations should prioritize ERAS adoption supported by dedicated implementation teams, clinician education programs, and audit mechanisms to monitor protocol adherence [16]. From a nursing practice perspective, nursing-specific ERAS competency frameworks and structured training programs should be formally developed and institutionalized. Embedding ERAS principles into undergraduate and postgraduate nursing curricula will be essential to building a workforce equipped to sustain evidence-based perioperative care.

VIII. RECOMMENDATIONS FOR FUTURE RESEARCH

Large-scale multicenter RCTs with standardized ERAS protocols and harmonized outcome instruments are needed to generate high-certainty evidence across diverse orthopedic procedures including spinal surgery, complex fracture fixation, and revision arthroplasty [17]. Comparative effectiveness studies evaluating specific ERAS components individually would facilitate identification of the key active elements driving outcome improvement. Longitudinal studies examining long-term consequences of ERAS adoption—including 12-month quality of life and functional rehabilitation trajectories—are notably lacking. Health economic evaluations quantifying the cost-effectiveness of ERAS programs across diverse healthcare systems would support institutional investment decisions. Implementation science research characterizing barriers and facilitators to ERAS adoption in low- and middle-income settings—particularly India and Maharashtra—is urgently required.

IX. CONCLUSION

This systematic review provides compelling and convergent evidence that ERAS protocols confer clinically meaningful perioperative benefits for patients undergoing orthopedic surgical procedures. Across diverse study designs, procedure types, and clinical settings, ERAS implementation was consistently associated with reductions in hospital LOS (by up to 4.7 days), lower postoperative complication rates, decreased blood transfusion requirements, improved postoperative pain management, and facilitation of early mobilization—without adverse effects on functional recovery. The multidisciplinary, patient-centered architecture of ERAS pathways positions them as a paradigm-shifting framework for perioperative care applicable to the full spectrum of orthopedic procedures. Broader adoption, supported by targeted implementation strategies, clinician education, and sustained quality improvement, is strongly warranted. Nursing professionals represent an indispensable component of successful ERAS delivery and must be formally empowered to fulfill their critical roles within these multidisciplinary pathways.

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