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Effect of Enhanced Recovery After Surgery on the Prognosis of Patients With Hip Fractures: A Systematic Review and Meta-Analysis

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BACKGROUND: Hip fractures, predominantly occurring in the elderly, are a significant public health concern due to associated morbidity, disability, and mortality. Prolonged bed rest following the fracture often leads to complications, further threatening patient health. Enhanced recovery after surgery, a modern approach to postoperative care, is being explored for its potential to improve outcomes and quality of life in hip fracture patients.

OBJECTIVE: This study investigates the impact of enhanced recovery after surgery on hip fracture patients.

METHODS: In this systematic review, we addressed the PICO question: Does the enhanced recovery after surgery program reduce 1-year mortality, readmissions, and postoperative pain and improve Harris Hip Score compared with traditional care in elderly hip fracture patients? We searched key databases and gray literature and analyzed outcomes through a meta-analysis using RevMan, Stata, and the Newcastle–Ottawa Scale for quality assessment.

RESULTS: Nine studies involving 10,359 patients were included. Compared with the control group, the enhanced recovery after surgery group showed significant reduction in length of stay (mean difference [MD] = –2.00; 95% confidence interval [CI] [–2.87, –1.14]; $p < .0001$) and overall complication rate (risk ratio [RR] = 0.76; 95% CI [0.67, 0.85]; $p < .0001$), with a lower delirium rate (RR = 0.42; 95% CI [0.26, 0.68]; $p = .004$). No significant differences were observed in Harris Hip Score, pain score, 1-year mortality, readmission rate, or incidences of urinary tract infection, respiratory tract infection, and deep vein thrombosis.

CONCLUSION: Enhanced recovery after surgery is associated with reduced length of stay, complication rate, and delirium rate in hip fracture patients.

KEY WORDS: Complication rate, Enhanced recovery after surgery, ERAS, Hip fracture, Length of stay

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Hip fractures, common in the older population, are serious injuries with high morbidity, disability, and mortality rates. The increasing trend in hip fracture incidences, coupled with population aging, highlights a global health concern. Hip fractures impact patients' daily life and independence (Alexiou et al., 2018), with global incidences exceeding 1.7 million annually and are projected to reach 6.3 million by 2050 (Anderson et al., 2009). Mortality rates are reported to vary between 6.1% to 8.7% within 30 days and 21% to 30% within a year of the fracture (Bai et al., 2020; Liu et al., 2021).

Surgery is the primary treatment, yet recovery is often slow for older patients due to underlying health conditions, causing anxiety and poor rehabilitation compliance (Balfour et al., 2022). Perioperative care is essential for maximizing surgical benefits and hastening recovery.

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KEY POINTS

- Hip fractures in older adults often lead to significant postoperative complications, with traditional care models often falling short in optimizing patient recovery.
- This study indicates that ERAS-based perioperative care can enhance patient prognosis, including shorter hospital stays, reduced postoperative pain, and lower complication rates.
- ERAS protocols can be incorporated into care strategies for older adults with hip fractures to improve surgical outcomes and patient experience.
- Despite promising results, the study highlights the need for more comprehensive, well-designed studies to further validate these findings, especially in developing countries.
- Study results should be interpreted cautiously due to limitations such as potential confounding factors and lack of exploration of subgroup interactions.

Enhanced recovery after surgery (ERAS), proposed by Kehlet (1997), is a comprehensive nursing approach comprising preoperative, intraoperative, and postoperative measures, including preoperative nutritional support, analgesia, fluid management, and early rehabilitation (Eriksson et al., 2012). ERAS has shown effectiveness in reducing postoperative mortality, shortening length of stay (LOS), and lowering complication rates (Gomez et al., 2019). However, the impact of ERAS on the prognosis of hip surgery patients lacks high-quality evidence. Research shows conflicting results: researchers have noted shortened LOS for total hip arthroplasty patients but not for hip fracture patients (Proudfoot et al., 2017), whereas other researchers found no significant difference in mortality and readmission rates between ERAS and standard care (Haugan et al., 2017).

High LOS in hip fractures represents a significant public health issue linked to increased complications, readmission rates, and mortality (Husted et al., 2010). The Harris Hip Score (HHS) is a widely used measure of joint function posthip fracture. Delirium, a common postoperative complication in older hip fracture patients, can increase medical costs and postoperative mortality (Jiang et al., 2021).

OBJECTIVE

The aim of this study was to systematically evaluate the effect of ERAS on patients with hip fractures, using outcome indicators such as HHS, LOS, pain score, 1-year mortality, readmission rate, and the incidence of complications.

PICO QUESTION

- Population: Elderly patients with hip fractures
- Intervention: ERAS programs
- Comparator: Traditional perioperative care
- Outcomes: One-year mortality, readmission rate, HHS, postoperative pain score, LOS, incidence of postoperative complications

Among elderly patients presenting with hip fractures, should ERAS programs be implemented compared with traditional perioperative care to reduce 1-year mortality, readmission rates, postoperative pain scores, LOS and incidence of postoperative complications, and to improve HHS?

METHODS

Search Strategy

We performed a systematic review of related literature in accordance with the Preferred Reporting Items for Systematic Review and Meta-analysis guidelines (Page et al., 2021). To enhance the comprehensiveness and systematic nature of our search strategy, we conducted searches on various databases, including Embase, PubMed, Web of Science, CINAHL, and Cochrane libraries, from database inception to June 15, 2022, with the language limited to English. In addition, we searched MEDLINE via the Ovid platform, Scopus, PsycINFO, ClinicalTrials.gov, and China National Knowledge Infrastructure (CNKI), among others. The search limits and conditions of each database were adjusted to ensure the accuracy and consistency of the search results. Figure 1 contains the string used for the initial search. Reference lists of related articles were also searched manually. In our team, each author independently reviews all retrieved article titles and

("Hip Fractures"[MeSH] OR "hip fracture"[tiab] OR "fracture of hip"[tiab]) AND ("Enhanced Recovery After Surgery"[MeSH] OR "ERAS"[tiab] OR "fast-track surgery"[tiab] OR "accelerated recovery"[tiab]) AND ("Perioperative Care"[MeSH] OR "traditional care"[tiab] OR "usual care"[tiab]) AND ("Mortality"[MeSH] OR "readmission"[tiab] OR "Harris Hip Score"[tiab] OR "pain score"[tiab] OR "length of stay"[tiab] OR "postoperative complications"[tiab]) AND ("Aged"[MeSH] OR "elderly"[tiab] OR "older adults"[tiab]) AND ("Humans"[MeSH])

Figure 1. Search string with MeSH terms.

abstracts and filters them according to preset inclusion and exclusion criteria.

After the preliminary screening, the screening results were discussed by all the authors to confirm the final inclusion of studies. During the discussion stage, if there were differences in the inclusion or exclusion of a study, the following measures were taken to resolve the differences. First, the full text of the article was reviewed and carefully checked to determine whether it met the inclusion and exclusion criteria. After the full text review, a discussion was held to share views and reasons. If no consensus could be reached after the discussion, third-party experts were consulted to review the divergent articles independently. The third party made the final decision on whether to include the divergent study.

Inclusion and Exclusion Criteria

Design and Study

Studies published in English that examined the effect of ERAS on the prognosis of patients with hip fractures were included. The exclusion criteria included case reports, editorials, animal experiments, commentaries, reviews, and articles with insufficient data for quantitative analysis.

This review established specific criteria for inclusion and exclusion. The population under consideration is comprised individuals who have experienced a hip fracture without regard to demographic factors such as age, gender, race, or baseline characteristics. The intervention employed for treatment and rehabilitation was the ERAS regimen. Compared with the control group who received conventional perioperative nursing, the intervention group was given perioperative ERAS care. The study's findings included at least one outcome pertaining to the prognosis of patients, such as the duration of hospitalization, HHS, pain levels, 1-year mortality rates, rehospitalization rates, and the occurrence of complications. There was no time limit imposed on the inclusion of studies. Studies published in English that investigated the impact of ERAS on the prognosis of individuals who had sustained a hip fracture were eligible. The exclusion criteria for this study encompassed nonoriginal research works, including case reports, editorials, animal experiments, reviews, and meta-analyses.

Participants

Older patients (aged $>$ 60 years) of all genders who underwent hip fracture surgery and received ERAS were included. Those diagnosed with advanced malignancy, cachexia, and systemic organ metastases were excluded.

Exposure/Intervention

The exposed/intervention group was given perioperative ERAS care, including the following:

1. Preoperative patient education, psychological counseling;
2. Optimization of anesthesia;
3. Simplified preoperative routine bowel preparation;
4. Perioperative nutrition management;
5. Intraoperative nursing: In addition to routine care, rewarming blankets were used and intraoperative fluid infusion was maintained at 37 °C;
6. Rational use of drainage tubes and catheters;
7. Postoperative analgesia;
8. Early postoperative standard functional exercise;
9. Perioperative fluid therapy

Comparison

The nonexposed/control group received conventional perioperative nursing. The ERAS protocol is a collection of multidisciplinary strategies designed to optimize perioperative patient care and enhance patient rehabilitation. Although many ERAS strategies are regarded as standard practice in contemporary surgical nursing, these strategies may not be completely implemented or adhered to in conventional perioperative nursing. Traditional perioperative care includes prolonged fasting, excessive intravenous infusion, absence of early activity and rehabilitation, and more stringent postoperative pain management. In our study, the control group received conventional perioperative care, so they may not have reaped the full benefits of the ERAS-promoted strategies to enhance patient recovery. In contrast, the intervention group received care based on the ERAS, which included individualized perioperative care strategies such as early nutrition, reduced intravenous infusion, multimodal analgesia, and early rehabilitation.

Outcomes

Outcomes included at least one of the following measures: The primary outcomes HHS, LOS, pain score, 1-year mortality, and readmission rate; the secondary outcomes included overall complication rate and incidence of deep vein thrombosis (DVT), urinary tract infection, delirium, and respiratory tract infection.

Study Selection

According to the inclusion and exclusion criteria mentioned earlier, the study selection process was conducted independently by two reviewers (Z. R. Q. and Y. F. Q.), including screening titles, abstracts, and full texts.

Data Extraction

The two reviewers independently extracted data from the eligible studies, and any disagreement was discussed with a third reviewer to reach a consensus. The data extracted from the literature were as follows: first author, publication year, country, age, sex, study design, sample size, type of fractures, and outcome measures.

The longest follow-up data on outcome measures of each study were extracted.

Quality Assessment

The Newcastle–Ottawa Scale (NOS) (Stang, 2010) was used to assess the methodological quality of the included studies in terms of selection, comparability, and outcome, with a maximum score of nine. Scores seven or more showed a low risk of bias, scores from four to six demonstrated a medium risk of bias, and scores less than four indicated a high risk of bias.

Statistical Analysis

For continuous outcomes (LOS, HHS, and pain score), the mean difference (MD) with 95% confidence interval (CI) was calculated, whereas for dichotomous outcomes (the 1-year mortality, readmission rate, complication rate), the risk ratio (RR) was calculated. Heterogeneity was assessed by the Cochran's Q test and Higgins I^2 test; if the test results showed statistical homogeneity ($p > .100$, $I^2 < 50\%$), the fixed-effect model was used to merge data for analysis; on the contrary, if the test results showed statistical heterogeneity ($p \leq .100$, $I^2 \geq 50\%$), the random-effect model was used, and sensitivity analysis was conducted by eliminating individual studies one by one and observing the difference between the combined effect size and the total effect size of the remaining studies. Publication bias was evaluated by funnel plot analysis and Egger's linear regression test (only for the number of studies > 4). All tests were two-tailed, and statistical significance was defined as $p < .050$ (except for the heterogeneity test, which was considered statistically significant at $p < .100$). All analyses were performed in RevMan 5.3 and Stata 15.1.

RESULTS

Search Results and Study Characteristics

The initial literature search produced 7,131 records. After removing duplicates, 6,925 articles were screened by title and abstract and 6,885 were excluded. Following this step, full texts of 40 articles were read, of which nine (Gomez et al., 2019; Haugan et al., 2017; Kang et al., 2019; Li et al., 2020; Liu et al., 2017; Macfie et al., 2012; Pedersen et al., 2008; Pollmann et al., 2019; Sura-Amonrattana et al., 2021), involving 10,359 participants, met the inclusion criteria and were eventually included (Figure 2). The distributions of age, sex, and types of fractures were similar among the studies. Study types included prospective cohort studies, retrospective cohort studies, randomized controlled trials, and quasi-experimental studies. The studies were conducted in China ($n = 2$), France ($n = 1$), England ($n = 1$), Norway ($n = 2$), Thailand ($n = 1$), America ($n = 1$), and Denmark ($n = 1$) (Table 1).

Quality Assessment

After scoring the studies based on the NOS, a low risk of bias was observed in all studies. The minimum score was seven, and the maximum was nine (Table 2).

Primary Outcomes

Length of Stay

There were eight studies (Gomez et al., 2019; Haugan et al., 2017; Kang et al., 2019; Liu et al., 2017; Macfie et al., 2012; Pedersen et al., 2008; Pollmann et al., 2019; Sura-Amonrattana et al., 2021) with available LOS data (Figure 3A). A random-effects model was applied ($p < .0001$, $I^2 = 98\%$), and a significant reduction in the mean LOS was found for the ERAS patients compared with the control group (MD = −2.00; 95% CI [−2.87, −1.14]; $p < .0001$). The sensitivity analysis of the total effect was conducted by eliminating individual studies one by one. The results showed little difference from the original total effect, suggesting that the results of this study were stable.

Harris Hip Score

Two (Kang et al., 2019; Li et al., 2020) of the nine studies assessed the HHS ($n = 184$) (Figure 3B). Meta-analysis showed no significant difference in HHS between ERAS and control arms (MD = 4.20; 95% CI [−3.65, 12.05]; $p = .29$), with high heterogeneity ($I^2 = 95\%$, $p > .0001$). Because of the limited number of included studies (only two), although the heterogeneity was very high, we did not conduct a sensitivity analysis.

Pain Score

Two (Kang et al., 2019; Li et al., 2020) of the nine studies ($n = 184$) had assessed pain scores (Figure 3C). Meta-analysis showed a significant difference in pain scores between the two studies (MD = −0.95; 95% CI [−1.34, −0.57]; $p < .00001$) with low heterogeneity ($p = .73$, $I^2 = 0$).

One-Year Mortality

Five of the nine studies ($n = 4,941$) had assessed 1-year mortality (Gomez et al., 2019; Haugan et al., 2017; Pedersen et al., 2008; Pollmann et al., 2019; Sura-Amonrattana et al., 2021) (Figure 3D). Meta-analysis showed no significant difference in 1-year mortality across all five studies (RR = 0.99; 95% CI [0.90, 1.10]; $p = .91$) with low heterogeneity ($I^2 = 27\%$, $p = .24$).

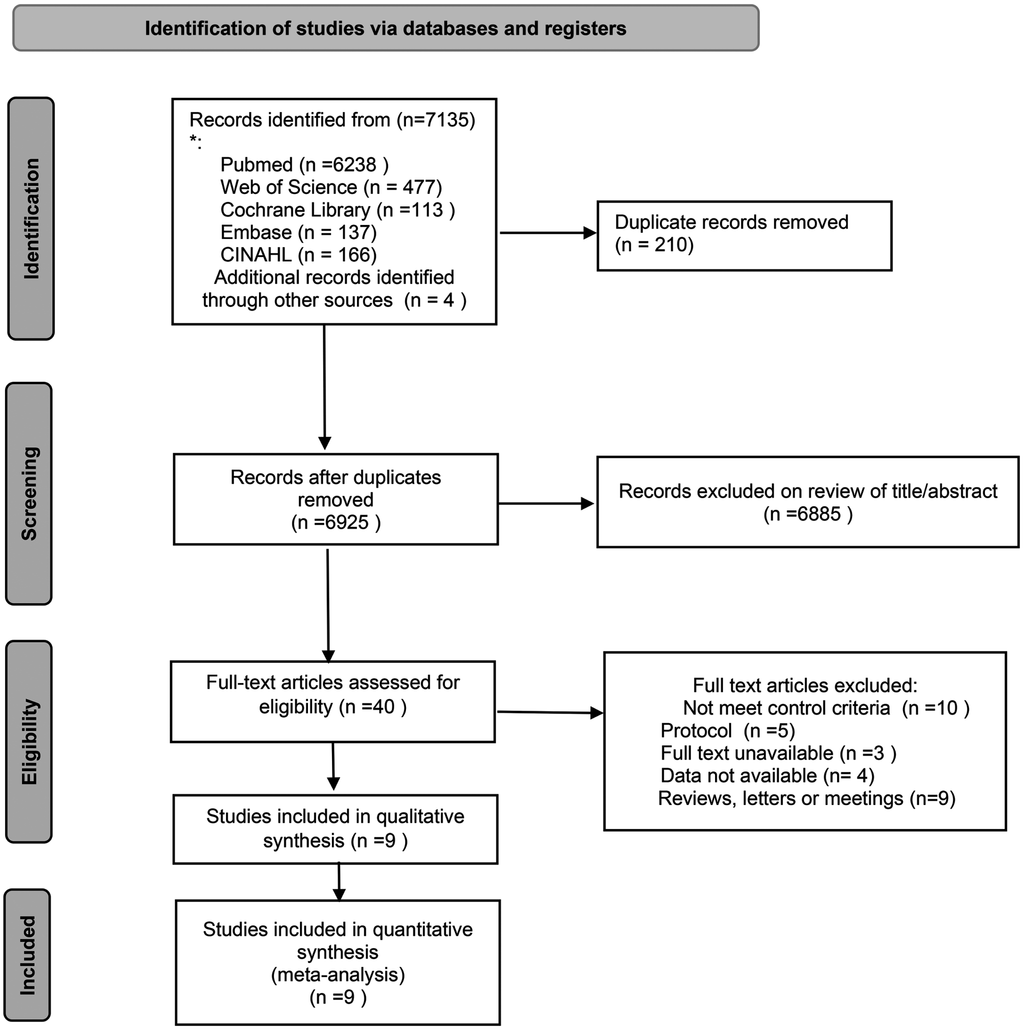

Figure 2. Flow diagram of study selection.

Readmission Rate

There were six studies (Gomez et al., 2019; Haugan et al., 2017; Kang et al., 2019; Liu et al., 2017; Pollmann et al., 2019; Sura-Amonrattana et al., 2021) with available data on readmission rate (Figure 3E). A fixed-effects model was applied, as the heterogeneity was not significant (p = .31, I^2 = 16%). A significant reduction in the mean readmission rate was not found in the ERAS patients compared with the control group (RR = 1.02; 95% CI [0.94, 1.11]; p = .66).

Secondary Outcomes

Overall Complication Rate

Four of the nine studies (n = 3,154) assessed the overall complication rate (Kang et al., 2019; Liu et al., 2017; Macfie et al., 2012; Pedersen et al., 2008) (see Supplemental Digital Content Figure 4a, available at: http://links.lww.com/JTN/A116). Meta-analysis showed a significant difference in overall complication rate across all four studies (RR = 0.76; 95% CI [0.67, 0.85]; $p < .0001$) with low heterogeneity (p = .21, I^2 = 33%).

Urinary Tract Infection Rate

Five of the nine studies assessed urinary tract infection rate (Gomez et al., 2019; Kang et al., 2019; Macfie et al., 2012; Pedersen et al., 2008; Sura-Amonrattana et al., 2021) (see Supplemental Digital Content Figure 4b, available at: http://links.lww.com/JTN/A116). Meta-analysis showed no significant difference in urinary tract infection rate across all five studies (RR = 0.81; 95% CI [0.38, 1.75]; p = .60) with high heterogeneity (p = .008, I^2 = 75%). The sensitivity analysis of the total effect was conducted by eliminating individual studies one by one. The results showed little difference from the original total effect, suggesting that the results of this study were stable.

Respiratory Tract Infection Rate

Five of the nine studies assessed respiratory tract infection rate (Gomez et al., 2019; Kang et al.,

Table 1. Characteristics of the Included Studies[a]

Author, Publication Year	Country	Characteristics of Study Population: Sample Size (N)		Age (Years)		Male/Female		Follow-up	Type of Fracture	ERAS Measures	Study Design	Outcomes
Gomez et al., 2019	France	27	27	84.5 (8.7)	85.0 (8.5)	7 M/20 F	7 M/20 F	1 year	Peritrochanteric fracture	2, 4	Prospective cohort study	LOS, readmission rates, 1-year mortality, overall complication rate, specific complication rate, DVT, delirium rate
Haugan et al., 2017	Norway	1,032	788	83.1	83.1	298 M/734 F	214 M/574 F	1 year	Hip fracture	4, 7, 9	Retrospective cohort studies	Mortality, readmission rates, LOS
Kang et al., 2019	China	50	50	77.81 (8.14)	78.32 (8.24)	15 M/35 F	16 M/34 F	30 days	Intertrochanteric fracture	1, 2, 7, 8	Non-RCT	LOS, pain score, HHS, readmission rates, and mortality, DVT, delirium rate
Li et al., 2020	China	42	42	65.0 (5.3)	64.4 (5.2)	20 M/22 F	24 M/18 F	/	Hip fracture	1, 3, 4, 5, 8, 9	RCT	Pain score, HHS
Macfie et al., 2012	Danmark	117	115	82.5 (9.2)	82.7 (8.7)	28 M/89 F	24 M/91 F	6 months	Proximal femoral fractures	2, 3, 4, 8, 9	Retrospective cohort studies	LOS, complication rate, 1-year mortality, DVT
Pedersen et al., 2008	England	178	357	Male 76.9; female 83.9	Male 77.5; female 84.2	42 M/136 F	85 M/272 F	1 year	Hip fracture	2, 3, 4, 7, 8, 9	Retrospective cohort studies	Complication rate (delirium rate, pneumonia, and urinary tract infection), LOS, mortality, DVT
Pollmann et al., 2019	Norway	1,140	1,090	79.6 (0.3)	79.7 (0.3)	351 M/789 F	350 M/740 F	1 year	Proximal femoral fractures	2, 4, 7, 8, 9	Retrospective cohort studies	Mortality, readmission, LOS
Sura-amonrattana et al., 2021	Thailand	151	151	79.7 (7.85)	80.7 (7.51)	38 M/113 F	34 M/107 F	1 year	Hip fracture	1, 2, 4, 7, 8	Retrospective cohort studies	Incidence of medical complications, mortality, DVT
Liu et al., 2017	America	2,514	2,488	79.7 (11.7)	79.3 (11.9)	/	/	30 days	Hip fracture	1, 3, 4, 7, 8	Prospective cohort study	LOS, readmission rates, and complication rates

Note. DVT = deep vein thrombosis; ERAS = enhanced recovery after surgery; HHS = Harris Hip Score; LOS = length of stay; RCT = randomized controlled trial.

[a]Enhanced recovery of surgery, not applicable. ERAS measures: (1) preoperative propaganda and education/psychological counseling, (2) optimizing anesthesia, (3) simplification of routine intestinal preparation before operation, (4) perioperative nutrition management, (5) perioperative heat preservation, (6) rational use of drainage tube and catheter, (7) postoperative analgesia, and (8) early postoperative standard functional exercise.

Table 2. Quality Assessment of Included Studies

	Selection				Comparability	Outcome			
Study Source	**Representativeness of the Exposed Cohort**	**Selection of the Nonexposed Cohort**	**Ascertainment of Exposure**	**Demonstration That Outcome of Interest was not Present at Start of Study**	**Comparability of Cohorts on the Basis of the Design or Analysis**	**Assessment of Outcome**	**Was Follow-up Long Enough for Outcomes to Occur**	**Adequacy of Follow Up of Cohorts**	**Total Score**
Gomez et al., 2019	1	1	1	1	2	1	1	1	9
Haugan et al., 2017	1	1	1	1	2	0	1	1	8
Kang et al., 2019	1	1	1	1	2	0	1	1	8
Li et al., 2020	1	1	1	1	2	0	0	1	7
Macfie et al., 2012	1	1	1	1	2	0	1	1	8
Pedersen et al., 2008	1	1	1	1	1	1	1	1	8
Pollmann et al., 2019	1	1	1	1	2	0	1	1	8
Sura-amonrattana et al., 2021	1	1	1	1	1	0	1	1	7
Liu et al. 2017	1	1	1	1	1	1	0	1	7

2019; Macfie et al., 2012; Pedersen et al., 2008; Sura-Amonrattana et al., 2021) (see Supplemental Digital Content Figure 4c, available at: http://links.lww.com/JTN/A116). Meta-analysis showed no significant difference in respiratory tract infection rate across all five studies (RR = 0.76; 95% CI [0.50, 1.14]; $p = .19$) with low heterogeneity ($p = .62$, $I^2 = 0\%$).

DVT Rate

There were four studies (Gomez et al., 2019; Kang et al., 2019; Li et al., 2020; Sura-Amonrattana et al., 2021) with available data on DVT rate (see Supplemental Digital Content Figure 4d, available at: http://links.lww.com/JTN/A116). A fixed-effects model was applied, as the heterogeneity was not significant ($p = .23$, $I^2 = 31\%$). A significant reduction in DVT rate was not found in the ERAS patients compared with the control group (RR = 0.41; 95% CI [0.12, 1.40]; $p = .16$).

Delirium Rate

There were three studies (Gomez et al., 2019; Kang et al., 2019; Pedersen et al., 2008) with available data on delirium rate (see Supplemental Digital Content Figure 4e, available at: http://links.lww.com/JTN/A116). A random-effects model was applied as the heterogeneity was moderate ($I^2 = 65\%$). No significant reduction in the delirium rate was found in the ERAS patients compared with the conventional nursing group (RR = 0.61; 95% CI [0.16, 2.37]; $p = .47$).

Publication Bias

The funnel plot and Egger's test were used to examine for publication bias. Egger's test showed no publication bias in LOS, 1-year mortality, readmissions, urinary tract infections, or respiratory tract infections (p = .26, .77, .87, .98, .60; see Supplemental Digital Content Figure 5, available at: http://links.lww.com/JTN/A117). Egger's test showed there was publication bias in the DVT rate ($p = .001$).

DISCUSSION

Hip fractures, a common osteoporotic injury in the elderly, cause pain and mobility issues, leading to long-term bed rest and a heightened risk of complications, sometimes life-threatening (de Bot et al., 2020). Early mobilization can enhance patients' quality of life and lower complications and mortality. ERAS, a multidisciplinary approach, aims to minimize perioperative trauma and stress, thus improving postoperative recovery and safety (Kehlet, 1997). It was introduced in China in 2007 by professor Li Jieshou of Nanjing Military Region General Hospital. Despite its widespread use in orthopedics (Ping et al., 2021; Yin et al., 2020), ERAS's efficacy in hip fracture prognosis is debated. Nurses are

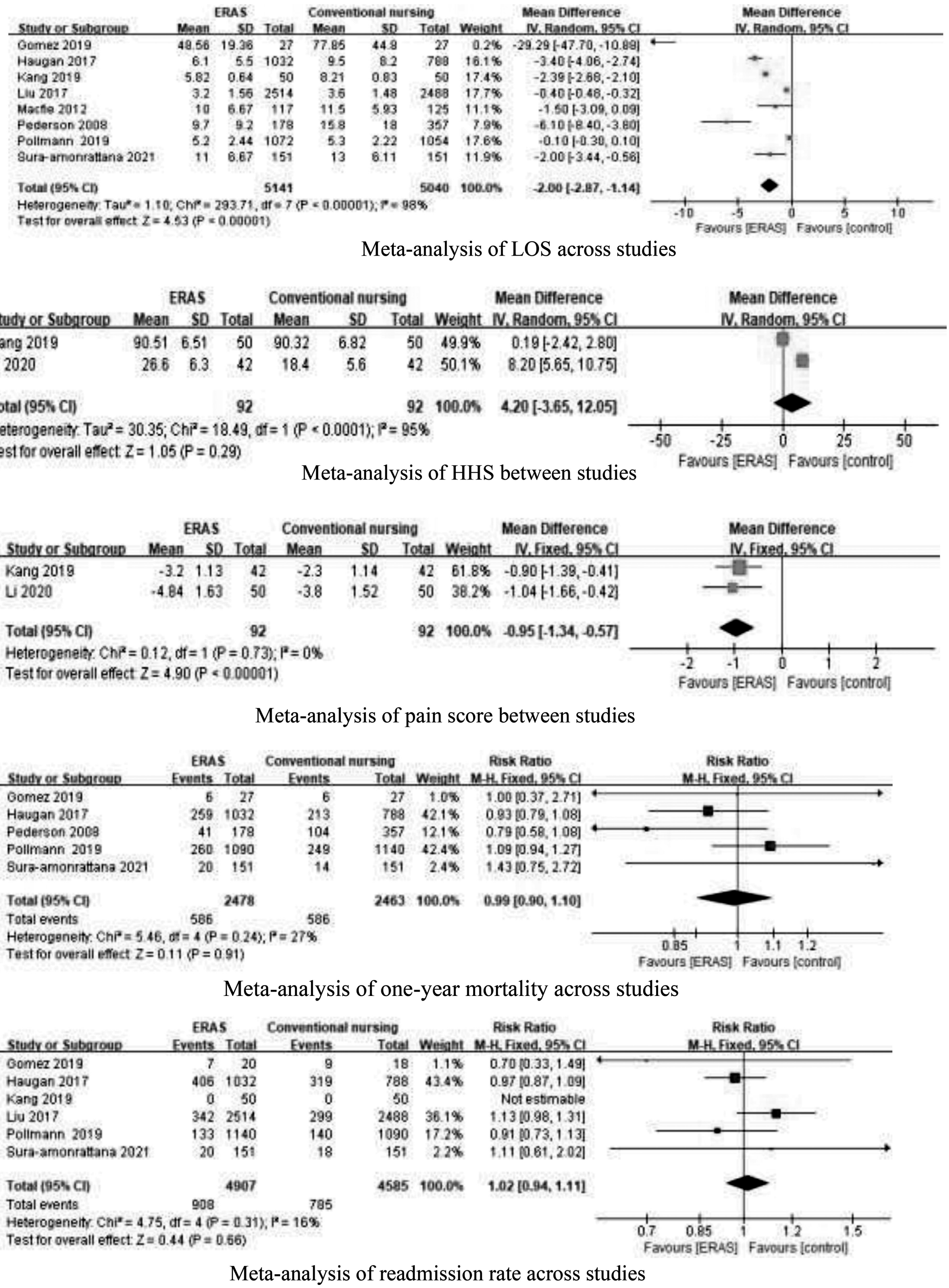

Figure 3. Forest plots for primary outcomes. (A) Meta-analysis of length of stay across studies. (B) Meta-analysis of Harris Hip Score between studies. (C) Meta-analysis of pain score between studies. (D) Meta-analysis of 1-year mortality across studies. (E) Meta-analysis of readmission rate across studies. ERAS = enhanced recovery after surgery.

key in identifying frail patients and coordinating preoperative patient education, functional training, and nutritional support (Eriksson et al., 2012).

Moreover, nurses are at the forefront of providing postoperative care, such as pain management, early mobilization, and fluid restriction, essential components of the ERAS pathway. Future research should focus on the specific nursing interventions that can be optimized within the ERAS framework to improve the care and outcomes of hip fracture patients, particularly those with varying levels of frailty.

In the present meta-analysis, nine studies were reviewed, in which 10,359 older patients with hip fractures were included to determine the effect of ERAS on prognosis (1-year mortality, readmission rate, HHS, pain score, LOS, and incidence of complications). The baseline frailty status of older patients is an important factor to consider in our study, as frailty is known to impact the recovery of hip fracture patients significantly. Although the included studies in our meta-analysis did not uniformly report the frailty status of their participants, it is essential to acknowledge that frailty could have contributed to the observed differences in outcomes between the ERAS and control groups. Frailty reflects biological aging and can influence various aspects of the patient's recovery, including the length of hospital stay, overall complication rate, and functional outcomes such as the HHS. In future studies, it would be beneficial to assess the frailty status of patients at baseline and stratify the results accordingly, allowing for a more comprehensive understanding of the effects of ERAS programs on different subgroups of older patients and facilitating personalized care for hip fracture patients with varying frailty levels.

The results of this study revealed that ERAS had potential benefits for patients with hip fractures, such as reducing the overall complication rate, shortening LOS, and relieving postoperative pain. However, there was no significant difference in HHS between the ERAS and control groups. The severity of hip fractures may affect the postoperative recovery of patients. Most of the included studies did not assess and compare the hip fractures severity, which may lead to the bias of research results to a certain extent. Significant differences were found in the overall complication rate among four of the nine included studies. Still, the heterogeneity among studies was high, possibly related to overlapping CIs of study results.

However, there was no significant difference in urinary tract infection rate, respiratory tract infection rate, incidence of delirium, and DVT rate. This study's results differed from those of previous studies (Liu et al., 2021), which may be because this review incorporated more studies than previous studies, and the types of included studies consisted of not only cohort studies but also interventional studies. In ERAS, pain management is one of the most important constituents.

This meta-analysis showed a remarkable reduction in pain scores between the two groups, consistent with the study by Kang et al. (2019). To the best of our knowledge, traditional pain management involves administering proper measures when the patient complains of unbearable pain. As for managing postoperative pain, ERAS was to administer Cyclooxygenase-2 inhibitor analgesia before the complete extinction of anesthesia, emphasizing advanced and multi-mode analgesia. This may reduce the influence of adverse factors on the body's stress response, alleviate pain, and promote rapid recovery.

Postoperatively, ERAS focuses on postoperative analgesia, early feeding, early activity, and fluid restriction. A significant reduction of LOS between the two groups was discovered in our study, which was consistent with the study by Gomez et al. (2019). Postoperative analgesia can effectively improve patients' mood, help them to ambulate early, eat early and thus promote the recovery of various organ functions in the body, thereby reducing LOS. In addition, limiting the amount of fluid can reduce gastrointestinal mucosa edema, promote the recovery of gastrointestinal function and thus reduce LOS. However, there was no significant difference in readmission rate and 1-year mortality between the two groups, which may be related to the short follow-up time of each study and regional differences.

According to our results, ERAS has worked well in perioperative patients with hip fractures for the following reasons: preoperative patient education, functional training, shortened water fasting, removal of unnecessary bowel preparation, and nutritional support. It can effectively reduce patients' anxiety and fear and reduce the incidence of surgical stress response and postoperative complications. Active preoperative functional exercise helps improve the patient's body function, increase body tolerance, and promote postoperative physical recovery (Jiang et al., 2021).

Shortening patients' water fasting and removing unnecessary bowel preparation can, to some extent, relieve the patient's psychological stress and reduce their discomfort. Eating carbohydrates 2 hr before surgery can effectively promote insulin secretion in the body, increase insulin sensitivity, improve the body's tolerance, and does not increase the risk of aspiration during anesthesia (Peng & Li, 2021). During surgery, ERAS strategies focus on temperature control, fluid input control, central venous pressure control, anesthesia selection, and drainage tube placement. Controlling central venous pressure can reduce the amount of intraoperative blood loss and control the patient's body temperature and fluid input, effectively reducing the risk of hemodynamic instability and ultimately reducing the incidence of postoperative complications (Kang et al., 2019). Anesthesia focuses on general anesthesia and epidural anesthesia, which can reduce the use of general anesthesia drugs and have a good anesthetic effect, thereby reducing the load of each organ in the body and promoting the recovery of each organ function in the patient's body. Postoperative stimulation of drainage tubes to patients may cause psychological and physiological discomfort to a certain extent. Without the placement of a gravity tube, patients can get out of bed as soon as possible and further reduce the incidence of complications (Proudfoot et al., 2017).

LIMITATIONS

The limitations of this study are as follows: First, the majority of older patients with hip fractures had risk factors for poor incisional healing, such as advanced age, smoking, underlying diseases (such as diabetes and hypertension), or a history of medication use. Failure to control for these baseline factors may lead to a mixing bias. Second, this study could not explore the interactions between subgroup factors due to the limitations of the data reported in the included studies. In other words, although most included studies adjusted for confounding variables, our study failed to eliminate the impact of individual confounding factors, which may have affected the consistency of results. Despite the aforementioned limitations, which might have affected the conclusions and implications derived from our meta-analysis, the findings of this study are of referential value to medical professionals and may serve as a foundation for the development of ERAS care strategies in the future.

CONCLUSION

Perioperative care based on ERAS has potential benefits for the prognosis of patients after hip fractures, such as reduced LOS, relief of postoperative pain, and lower incidence of postoperative complications. However, due to the limitations, the results must be cautiously generalized. In future research, well-designed studies with larger sample sizes and longer follow-ups can be conducted worldwide, especially in developing countries, to validate this study's findings further.

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