SYSTEMATIC REVIEW

Clinical Outcomes and Complication Rates in Fast-Track Versus Routine after Total Knee Arthroplasty: A Systematic Review and Meta-analysis

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Abstract

Objectives: Fast-track or enhanced recovery after surgery (ERAS) pathways have been increasingly adopted in total knee arthroplasty (TKA) to optimize perioperative care, yet their comparative effectiveness and safety relative to routine pathways remain incompletely defined. This systematic review and meta-analysis compared the effects of fast-track versus routine perioperative care on length of hospital stay (LOS), postoperative pain, complications, and readmissions in patients undergoing primary TKA.

Methods: A systematic search of PubMed, Embase, Cochrane Library, Scopus, and Web of Science was performed from inception to January 2025 using MeSH terms. Primary outcomes were LOS and postoperative pain, with complications and readmissions assessed as secondary outcomes. Risk of bias was assessed using Cochrane RoB 2 for RCTs and ROBINS-I for non-randomized studies. A random-effects meta-analysis was conducted due to anticipated heterogeneity.

Results: Nine studies (total 2607 patients) met inclusion criteria. Fast-track care significantly reduced LOS (WMD: -2.41 days, 95% CI: -3.18 to -1.64). Postoperative pain was slightly higher in the fast-track group at 24h (MD: 0.98, 95% CI: -0.1 to 2.05) and at 2 weeks (MD: 0.33, 95% CI: -0.04 to 0.7), neither reaching statistical significance. Methodological quality was limited, with moderate to serious risk of bias in non-randomized studies and high risk of bias in all randomized trials.

Conclusion: Overall, the available evidence suggests that fast-track rehabilitation following TKA substantially reduces hospitalization without clinically meaningful or sustained increases in postoperative pain. These findings support the use of fast-track pathways to enhance perioperative efficiency in TKA, while highlighting the need for higher-quality randomized studies to better define their effects on pain and safety outcomes.

Level of evidence: III

Keywords: Fast-track, Rehabilitation, Routine, TKA, Total knee arthroplasty

Introduction

Fast-track surgery was first introduced in the 1990s by the Danish surgeon Henrik Kehlet as a structured, evidence-based approach aimed at accelerating postoperative recovery and reducing complications following major surgery.[1,2] Kehlet proposed that postoperative "organ dysfunction" is primarily driven by the surgical stress response, metabolic and endocrine alterations, and prolonged immobilization.[1,3] Importantly, isolated improvements in surgical technique, anesthesia, or perioperative pharmacological management alone had limited impact; rather, a multimodal strategy was required to meaningfully reduce postoperative physiological stress and enhance rehabilitation.[2,4]

Over time, fast-track surgery evolved into a patient-

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centered, multidisciplinary perioperative care model tailored to specific surgical procedures and institutional settings, commonly referred to as enhanced recovery after surgery (ERAS).[5,6] The core principle of fast-track surgery involves the integration of minimally invasive surgical techniques with optimized perioperative management to reduce morbidity, shorten hospital stay, improve patient satisfaction, and decrease healthcare costs while maintaining patient safety.[5,7] Following its initial implementation in colorectal surgery, fast-track protocols have been successfully adopted across a broad range of surgical specialties, including hepatobiliary, gastric, breast, and reconstructive surgery.[6-8]

Total knee arthroplasty (TKA) is a well-established and highly effective treatment for end-stage knee osteoarthritis, providing reliable pain relief and significant functional improvement.[9,10] With an aging population and the increasing global prevalence of osteoarthritis, the number of TKAs performed worldwide continues to rise, frequently in elderly patients with multiple medical comorbidities.[11,12] This growing demand has intensified interest in perioperative strategies that enhance recovery while minimizing complications, length of hospital stay, and resource utilization. Consequently, the principles of fast-track surgery have been increasingly applied to total joint arthroplasty, particularly TKA.[13-15]

In the context of TKA, fast-track surgery typically incorporates multimodal, opioid-sparing analgesia—such as local infiltration analgesia (LIA) and peripheral nerve blocks—to facilitate early mobilization and functional rehabilitation within hours after surgery.[14,16] Additional commonly implemented components include avoidance or early removal of surgical drains and urinary catheters, routine administration of tranexamic acid to reduce perioperative blood loss, standardized antibiotic and thromboprophylaxis protocols, prevention of postoperative nausea and vomiting, avoidance of unnecessary bowel preparation (though less relevant in TKA, included per existing protocols), and structured preoperative patient education.[15-17] Collectively, these interventions aim to enhance postoperative recovery and reduce morbidity, with secondary benefits including reduced length of hospital stay (LOS), lower healthcare costs, and faster return to function.[14,18] However, existing evidence remains inconclusive regarding whether fast-track protocols yield superior complication profiles and functional outcomes compared to routine rehabilitation following TKA. Therefore, the aim of this systematic review is to compare clinical outcomes and complication rates between fast-track and routine rehabilitation after TKA.

Materials and Methods

The present systematic review and meta-analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[19] The systematic review and meta-analysis protocol was officially registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD420251109130; https://www.crd.york.ac.uk/PROSPERO/.

Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including PubMed/MEDLINE, Embase, the Cochrane Library, Scopus, and Web of Science from inception to April 2025. The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to total knee arthroplasty, fast-track or enhanced recovery protocols, routine perioperative care, length of hospital stay, postoperative pain, and complications. The PubMed search strategy was adapted appropriately for each database to account for differences in indexing and terminology. Filters were applied to limit results to human studies published in English and to clinical or comparative study designs.

Eligibility Criteria

Studies were considered eligible for inclusion if they investigated patients aged 18 years or older undergoing primary TKA and directly compared a fast-track or ERAS-based perioperative pathway with a routine care. Both randomized controlled trials and comparative observational studies, including retrospective and prospective cohort designs, were eligible. Fast-track pathways were defined as structured perioperative programs incorporating components such as patient education, multimodal analgesia, optimized fluid management, and early mobilization, with the aim of reducing hospital length of stay.

Included studies were required to report at least one relevant clinical outcome, specifically LOS and/or postoperative pain assessment using validated measures such as the visual analog scale or numerical rating scale. Reporting of postoperative complications, including infection, thromboembolic events, and hospital readmission, was also required. Only full-text, peer-reviewed articles published in English were considered.

Studies were excluded if they consisted of case reports, small case series with fewer than 10 patients per group, reviews, editorials, conference abstracts without complete data, or non-comparative designs. Investigations focusing exclusively on revision TKA, unicompartmental knee arthroplasty, or pediatric populations were also excluded. Articles that failed to clearly define the perioperative care pathway or did not report the primary outcomes of interest were not considered eligible.

Study selection process

All retrieved records were imported into a reference management software, and duplicate entries were removed. Study selection was performed in two stages. Two independent reviewers (A.Q.E and A.M) screened titles, abstracts, and full texts to assess eligibility. Only studies meeting all inclusion criteria and no exclusion criteria were included in the final analysis.

Data extraction

Data were extracted independently by two reviewers (M.Z.D and S.R) using a standardized data collection form to ensure consistency and accuracy. Extracted variables included study characteristics (first author, year, publication, country, study design), patient demographics (age, sex distribution, body mass index when reported), sample size, perioperative pathway characteristics, follow-up duration, length of hospital stay, postoperative pain scores, complication rates, readmission rates, and functional outcome measures. Discrepancies were resolved by consensus among the review team.

Quality assessment

In order to assess the risk of bias or methodologic quality of included RCTs, the Cochrane risk of bias (ROB) tool was used. The ROBINS-I (Risk of Bias in Non-Randomized Studies of Interventions) tool was also used to assess the risk of bias for non-RCTs. Two reviewers (M.S and M.S) assessed the quality of studies, and the third reviewer verified it.

Statistical Analysis

The primary outcomes of this meta-analysis were pain score, and LOS. Mean, standard deviation, and sample size before and after the intervention were extracted from each included study. Forest plots were used to assess heterogeneity and calculate pooled weighted mean differences (WMD) and standardized Mean Difference (SMD) with corresponding 95% confidence intervals (95% CI) using Der-Simonian and Laird method.[20] To account for the heterogeneity of study populations, we conducted a random-effects meta-analysis. We assessed heterogeneity across studies using I^2 statistics, which values of $I^2=0\%$ indicated no observed heterogeneity and $I^2 \geq 50\%$ indicated substantial heterogeneity.[21] Cochran's Q statistic was used to analyze the statistical significance of heterogeneity.[22] We performed a sensitivity analysis to determine the impact of individual studies on heterogeneity and assess the robustness of pooled estimates.[21] Publication bias was not assessed using Egger's regression asymmetry test or Begg's adjusted rank correlation test because a small number of studies were included in the meta-analyses.[23,24] All statistical tests were two-tailed, and a significance level of less than 0.05 was set for all analyses. All statistical analyses were conducted using Stata version 17.0 (Stata Corp., College Station, TX, USA).

Results

Literature search

A total of 2610 potentially relevant citations were retrieved from five electronic databases. After reviewing titles and abstracts, 919 duplicate records and 1541 irrelevant citations were excluded, resulting in 11 full-text articles for further assessment. Ultimately, nine studies published between 2016 and 2024 met the inclusion criteria and were included in the systematic review. Four studies were excluded from the meta-analysis due to insufficient data. Consequently, five studies with sufficient data were included in the meta-analysis. The PRISMA flow diagram is shown in [Figure 1].

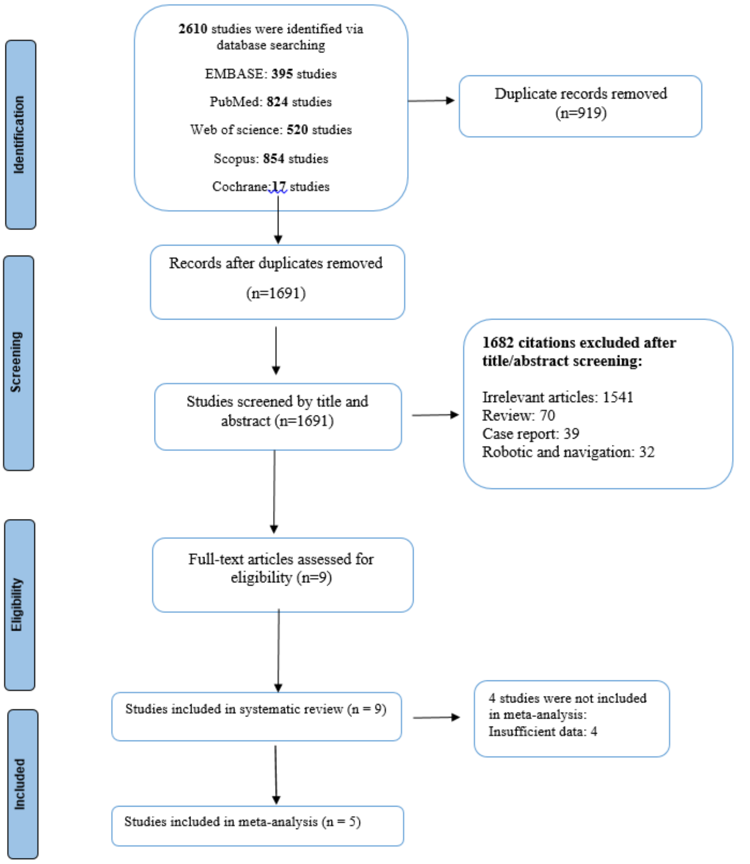


Figure 1. Flowchart of study selection (PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only)

Characteristics of included studies

A total of nine clinical trials involving 2607 participants (1629 females and 978 males) met the inclusion criteria, with 1020 patients in the fast-track group and 1587 in the routine care group. The mean age of patients ranged from 44 to 84 years. Of the nine eligible studies, five were conducted in the United States, three in Europe, and one in Asia. The study characteristics are detailed in [Table 1].

Table 1. Main characteristics of the included studies

ID	Author, Year	Country	Groups	Age	BMI	Sex(F/M)	Sample Size
1	Picart et al., 2021	France	Fast-tract	69.23 ± 7.80	30.15 ± 4.79	138/78	216
			Conventional	69.41 ± 9.86	30.86 ± 5.46	221/114	335
2	Plessl et al., 2020	New Orleans	Rapid recovery	68 ± 8.8	31.2 ± 5.1	135/59	194
			Standard recovery	65.7 ± 9.8	32.7 ± 5.9	82/47	129
3	Jiao et al., 2024	China	Quantitative	74.6±6.0	30.0±2.1	26/13	39
			Conventional	76.0±6.3	30.8±2.7	30/9	39
4	Fransen et al., 2018	Netherland	Fast-tract	64 ± 9	28.7 ± 3.5	14/11	25
			Regular	61 ± 7	30 ± 4.1	15/9	24
5	Arienti et al., 2020	Italy	Fast-tract	69 (60-77)	27.7 (25.4-29.4)	14/6	20
			Conventional	69 (65-73)	29.4 (26.2-32.5)	19/4	23
6	Rossman et al., 2016	Pennsylvania	LOS ≥ 3 days	66.51 ± 9.92	-	452/201	653
			LOS ≤ 2 days	62.94 ± 9.14	-	195/147	342
7	Littleton et al., 2020	Tennessee	Inpatient	57 (44-62)	35	13/28	41
			ASC	57 (46-71)	33.1	17/24	41
8	Gauthier Kwan et al., 2018	Ottawa	Inpatient	62.5 (51.2-74.0)	30.4 (23.5-41.6)	21/22	43
			Outpatient	62.5 (50.4-75.0)	28.6 (23.7-35.8)	14/29	43
9	Klemt et al., 2023	U.S.A.	Inpatient	62.6±11.4	30.8±6.4	168/132	300
			Same Day	62.5±10.5	30.3±7.2	55/45	100

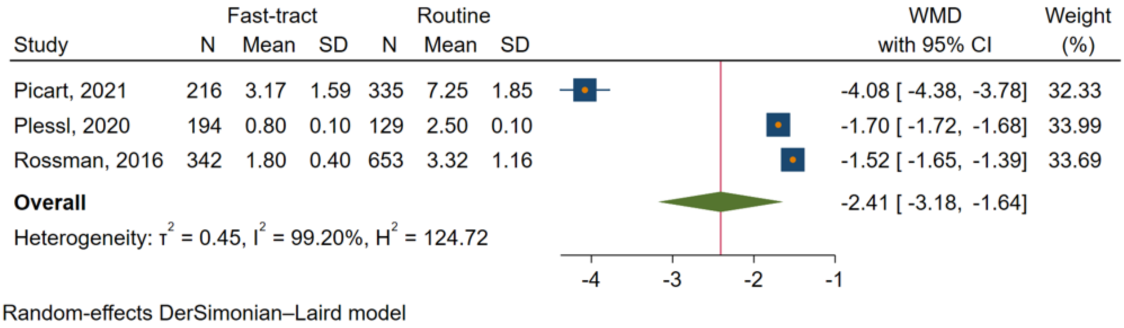
LOS: length of hospital stays, ASC: ambulatory surgery center

Meta-analysis findings

Length of stay (LOS):

Meta-analysis of three clinical trials showed that the LOS significantly decreased by -2.41 points (95% CI: -3.18 to -1.64) on average [Figure 2]. I-square showed high heterogeneity among reported data for LOS (I^2: 99.20%).

The sensitivity analysis revealed consistent mean changes in the LOS across iterative recalculations, with the range of pooled weighted means (WMs) from -2.89 to -1.62. This consistency supports the robustness and reliability of the meta-analysis model.



Study	Fast-tract N	Fast-tract Mean	Fast-tract SD	Routine N	Routine Mean	Routine SD	WMD with 95% CI	Weight (%)
Picart, 2021	216	3.17	1.59	335	7.25	1.85	-4.08 [-4.38, -3.78]	32.33
Plessl, 2020	194	0.80	0.10	129	2.50	0.10	-1.70 [-1.72, -1.68]	33.99
Rossman, 2016	342	1.80	0.40	653	3.32	1.16	-1.52 [-1.65, -1.39]	33.69
Overall							-2.41 [-3.18, -1.64]	

Heterogeneity: $\tau^2 = 0.45$, $I^2 = 99.20\%$, $H^2 = 124.72$

Random-effects DerSimonian–Laird model

Figure 2. Forest plot of the weighted mean difference (WMD) on length of stay (LOS) in patients in the fast-tract rehabilitation groups and routine rehabilitation groups. Diamond represents the summary standard mean difference (pooled SMD) estimate and its width shows corresponding 95% CI with random effects estimate. I-square test was used to assessing the statistical heterogeneity (P < 0.10) across studies

Pain score:

Pooled analysis of two studies showed that the pain score at 2 weeks post-operatively increased by a mean of 0.33 points (range, -0.04 to 0.69), in the fast-tract group [Figure 3]. The I-square showed low heterogeneity among reported data for pain score (I^2: 0.0%).

Pooled analysis of two studies, pain score at 24 hours post-operatively increased a mean of 0.98 scores (range, -0.1 to 2.05), in the fast-tract group [Figure. 4]. The I-square showed high heterogeneity among reported data for pain score (I^2: 77.45%).

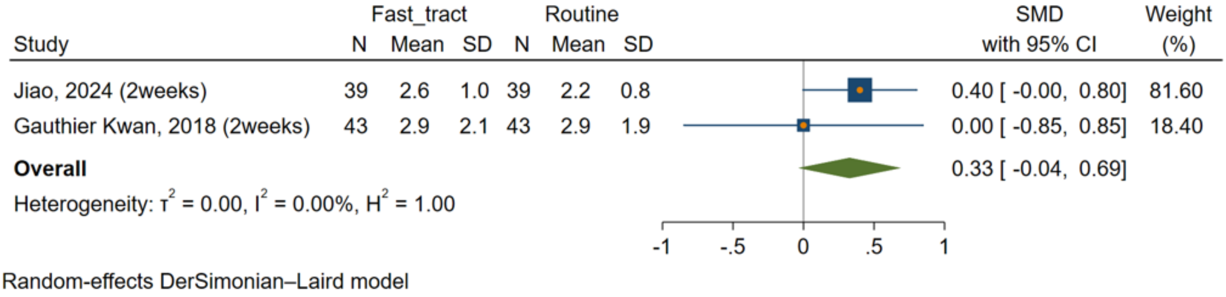


Figure 3. Forest plot of the Standard mean difference (SMD) on Pain score in patients in the fast-tract rehabilitation groups and routine rehabilitation groups 2 weeks after surgery. Diamond represents the summary standard mean difference (pooled SMD) estimate and its width shows corresponding 95% CI with random effects estimate. I-square test was used to assessing the statistical heterogeneity (P < 0.10) across studies

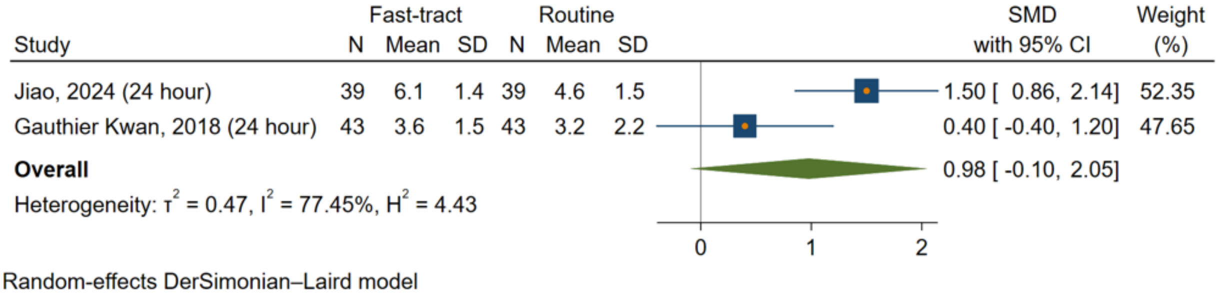
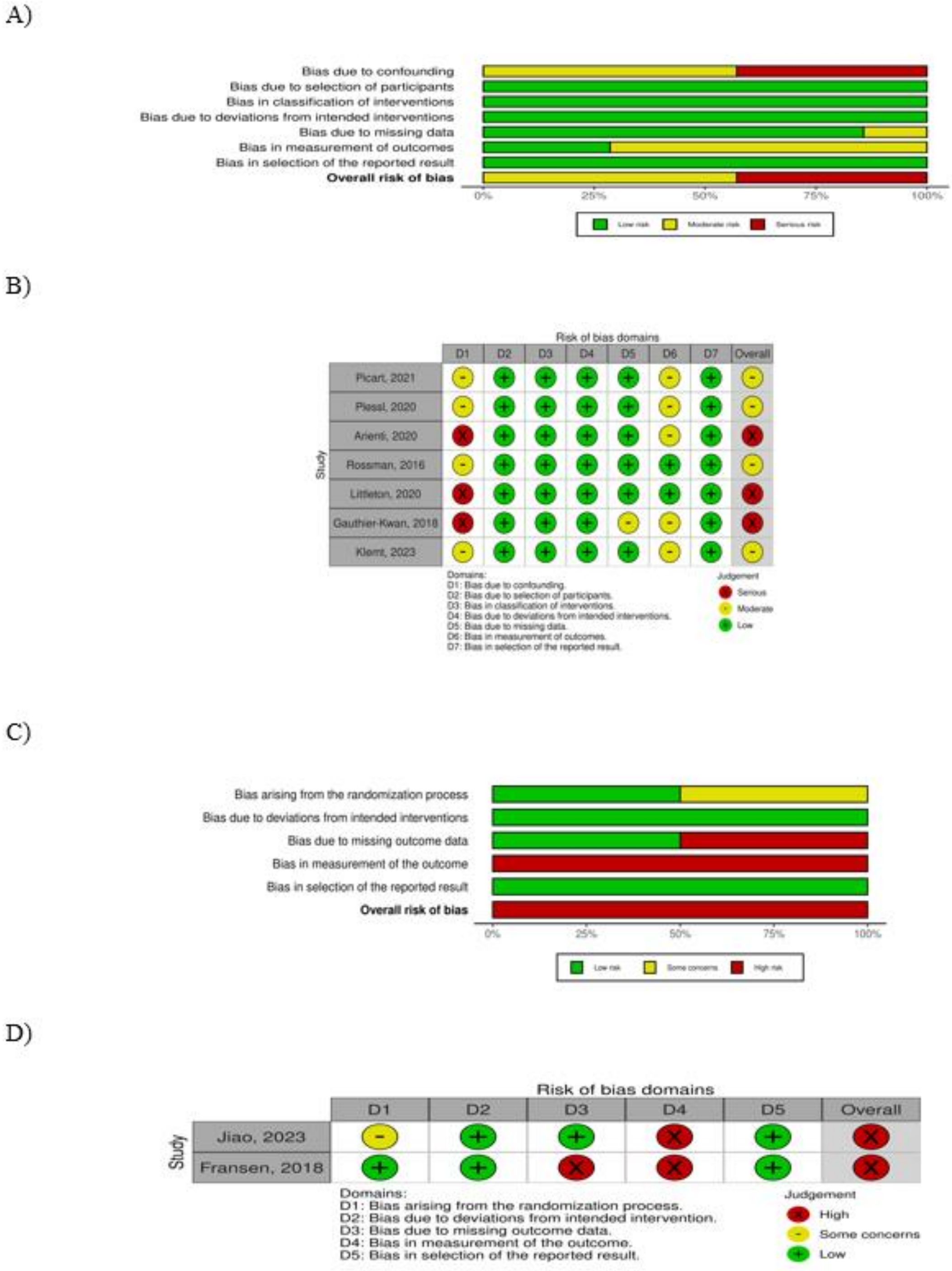


Figure 4. Forest plot of the Standard mean difference (SMD) on Pain score in patients in the fast-tract rehabilitation groups and routine rehabilitation groups 24 hour after surgery. Diamond represents the summary standard mean difference (pooled SMD) estimate and its width shows corresponding 95% CI with random effects estimate. I-square test was used to assessing the statistical heterogeneity (P < 0.10) across studies

Quality Assessment Findings:

The methodological rigor of all included studies was carefully examined using validated tools tailored to the design of each study. For non-randomized studies, the ROBINS-I tool was employed. Within this group (seven studies), four studies (57%) were rated as moderate risk of bias, and three as serious risk of bias (43%). There were strengths in domains 2, 3, 4, 5, and 7, while weaknesses were noted in domain 1 (bias due to confounding; 7 studies, 100%) and domain 6 (bias in measurement of outcomes; 5 studies, 72%) [Figure 5 A and B]. For the randomized controlled trials (RCTs), the methodological quality of the two included studies was assessed using the RoB 2 tool. Overall, two trials (100%) were determined to be at high risk. When examined across specific domains, all studies were deemed low risk for deviations from intended interventions and selective reporting. In the domains concerning outcome measurement, two studies were rated as high risk [Figure 5 C and D].



Study	D1	D2	D3	D4	D5	D6	D7	Overall
Picart, 2021	-	+	+	+	+	-	+	-
Piessl, 2020	-	+	+	+	+	-	+	-
Arienti, 2020	X	+	+	+	+	-	+	X
Rossman, 2016	-	+	+	+	+	+	+	-
Littleton, 2020	X	+	+	+	+	+	+	X
Gauthier-Kwan, 2018	X	+	+	+	-	-	+	X
Klemt, 2023	-	+	+	+	+	-	+	-

Study	D1	D2	D3	D4	D5	Overall
Jiao, 2023	-	+	+	X	+	X
Fransen, 2018	+	+	X	X	+	X

Figure 5. (A) Risk of bias summary (ROBINS-I). (B) Risk of bias graph (ROBINS-I). (C) Risk of bias summary (ROB tool). ROBINS-I, Risk of Bias in Non-Randomized Studies of Interventions; ROB tool, Cochrane risk of bias tool

Discussion

Several previous systematic reviews and meta-analyses have examined fast-track or ERAS pathways in joint arthroplasty. Zhu et al. [25] and Zhang et al. [26] demonstrated that ERAS protocols significantly reduce LOS following hip and knee arthroplasty, consistent with our findings. Ishaku et al. [27] similarly reported LOS reductions in elective total joint arthroplasty. However, the present study offers three distinct contributions to the existing literature. First, unlike prior reviews that combined hip and knee arthroplasty data, we focused exclusively on TKA, eliminating potential confounding from procedure-specific differences in rehabilitation trajectories, pain patterns, and discharge criteria. Second, previous meta-analyses did not separately examine pain outcomes at multiple postoperative time points; our time-stratified analysis reveals that the numerically higher pain scores observed at 24 hours are not statistically significant and return to near-baseline by 2 weeks postoperatively, a finding that has not been previously quantified. Third, while prior reviews acknowledged methodological limitations, we systematically applied ROBINS-I and ROB2 tools and explicitly discuss how the certainty of evidence differs between objective outcomes (LOS) and subjective outcomes (pain). In contrast to Ishaku et al.[27], we additionally performed a leave-one-out sensitivity analysis, which confirmed that no single study disproportionately influenced the pooled LOS estimate. Collectively, these distinctions clarify that our study does not merely replicate prior work but rather provides a more focused, time-specific, and methodologically rigorous synthesis for TKA.

The present meta-analysis demonstrates that fast-track rehabilitation after TKA leads to a substantial reduction in hospital LOS, while its effect on postoperative pain is modest, time-dependent, and variable. Quantitatively, fast-track rehabilitation reduced LOS by a mean of 2.41 days (95% CI: −3.18 to −1.64) compared with routine rehabilitation, whereas early postoperative pain showed numerically higher scores of 0.98 points at 24 hours and 0.33 points at 2 weeks, neither of which reached statistical significance. These findings are consistent with prior ERAS meta-analyses and fast-track cohort studies.[25-27]

The reduction in LOS observed in this analysis is clinically meaningful. A decrease of 2.41 days represents approximately a 40%–60% reduction in hospitalization time compared with routine postoperative TKA pathways. However, the very high heterogeneity (I^2 = 99.2%) substantially lowers confidence in the pooled estimate, consistent with prior systematic reviews and prospective studies.[25,27,28] This high statistical heterogeneity likely reflects substantial clinical heterogeneity across the included studies. Potential sources include differences in healthcare systems (USA vs. Europe vs. Asia), varying definitions of 'discharge readiness,' different fast-track components (e.g., some protocols included local infiltration analgesia while others did not), and variability in routine care pathways across institutions. Importantly, despite this heterogeneity, the direction of effect was uniformly favorable to fast-track rehabilitation across all included studies, which strengthens confidence in the overall conclusion. Sensitivity analyses have confirmed the robustness of this effect, indicating that LOS reduction is not driven by single-study influence.[25,26]

Mechanistically, this reduction in LOS is best explained by earlier functional readiness for discharge rather than accelerated biological healing. Fast-track rehabilitation emphasizes early mobilization—often within the first 24 hours postoperatively—facilitating earlier achievement of basic functional milestones such as independent transfers, ambulation, and stair negotiation. In addition, standardized discharge criteria embedded in fast-track pathways reduce inter-clinician variability and subjective discharge decision-making.[29,30]

Pain outcomes demonstrated smaller effect sizes and greater variability compared with LOS. At 24 hours postoperatively, pain scores in the fast-track group were modestly higher (mean difference: 0.98 points; 95% CI: -0.10 to 2.05), and at 2 weeks postoperatively, the difference was 0.33 points (95% CI: -0.04 to 0.69). There was no statistically significant increase in pain at either time point. The numerically higher scores at 24 hours returned to near-baseline by 2 weeks, suggesting no sustained clinically important difference. This finding is consistent with prior ERAS studies.[25,31] The transient numerical increase is mechanistically consistent with early mobilization during the peak postoperative inflammatory phase and the use of opioid-sparing multimodal analgesic strategies.[31,32] By 2 weeks postoperatively, pain differences between the fast-track and conventional rehabilitation groups were negligible, indicating no sustained adverse effect on pain outcomes.[18] The moderate-to-high heterogeneity observed for pain scores at 24 hours (I^2 = 77.45%) may be explained by clinical differences in analgesic protocols across studies, including the type and timing of multimodal analgesia, the use of peripheral nerve blocks versus local infiltration analgesia, and varying opioid-sparing strategies.

Limitations

The methodological quality of the included studies limits the certainty of our findings. Among the seven non-randomized studies, three (43%) had serious risk of bias as assessed using ROBINS-I, primarily due to confounding and lack of blinding for pain assessment. While the large LOS reduction (2.41 days) is robust to these biases given its objective measurement and effect size, the non-significant pain differences should be interpreted cautiously. Both RCTs were also at high risk of bias. Therefore, LOS findings are clinically actionable, but pain-related findings require confirmation in future high-quality RCTs with blinded outcome assessment. Given the small number of included studies ($n \leq 3$ per outcome), publication bias cannot be ruled out. The observed effect sizes may therefore overestimate the true treatment effect.

Despite numerically higher (but not statistically significant) early pain scores, fast-track rehabilitation resulted in substantially shorter LOS, highlighting a dissociation between pain intensity and discharge readiness. Large cohort and fast-track pathway studies have demonstrated that early functional recovery and attainment of discharge criteria, rather than pain control alone, primarily determine discharge timing in modern fast-track TKA programs.[29,30] Although the overall quality of evidence was limited by methodological heterogeneity and risk of bias—particularly for subjective outcomes such as pain—the consistency of LOS reduction across randomized and non-randomized studies supports the clinical effectiveness of fast-track rehabilitation.[25-27] Clinicians should be aware that early pain scores may be numerically higher in fast-track protocols, but this difference is not statistically significant and resolves by 2 weeks postoperatively.

Conclusion

Fast-track rehabilitation after TKA significantly reduces hospital length of stay without causing sustained or statistically significant increases in postoperative pain. These findings support fast-track rehabilitation as a functionally driven strategy to improve perioperative efficiency and resource utilization after TKA. However, the high heterogeneity for LOS and the limited number of studies for pain outcomes warrant cautious interpretation and confirm the need for future high-quality randomized controlled trials with blinded outcome assessment.

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