JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/8wb9fh03

Review Article

Meta-Analysis on Medical Management vs Non-Pharmacological Therapy of (DVT) Deep Venous Thrombosis After Orthopedic Procedures

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"Cite this Article" Received: 19 March 2026; **Accepted**: 26 April 2026; **Published**: 04 May 2026

Author Contributions: Concept: MBA; Design: AM; Data Collection: HK, MN; Analysis: VK; Drafting: NM, SJ. **Ethical Approval**: Sharif Medical College, Lahore, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

ABSTRACT

Background: Postoperative deep venous thrombosis is a clinically important complication after orthopedic surgery and may progress to pulmonary embolism if not prevented effectively. Objective: This systematic review compared pharmacological, non-pharmacological, and combined prophylactic strategies for prevention and management of DVT after orthopedic procedures. Methods: A systematic comparative review was conducted using studies published from 2013 to 2026 across Frontiers in Medicine, ScienceDirect, SpringerLink, Wiley Online Library, Cureus, and Acta Orthopaedica Belgica. Eligible studies included postoperative orthopedic patients receiving pharmacological, mechanical, rehabilitation-based, or combined thromboprophylaxis and reporting DVT, pulmonary embolism, bleeding, adverse events, adherence, or recovery-related outcomes. Results: Sixteen studies were included in the qualitative synthesis, with eight considered potentially suitable for quantitative synthesis after verification of event-level data. Pharmacological prophylaxis, including low-molecular-weight heparin, aspirin, and direct oral anticoagulants, was consistently reported as effective for DVT prevention but raised bleeding-related concerns. Non-pharmacological strategies, including compression stockings, intermittent pneumatic compression, early mobilization, physiotherapy, and rehabilitation nursing, demonstrated favorable safety and supportive preventive value. Conclusion: Individualized multimodal thromboprophylaxis appears clinically appropriate after orthopedic surgery, but formal pooled estimates require complete extraction of study-level outcome data. Keywords: Deep Vein Thrombosis, Orthopedic Surgery, Thromboprophylaxis, Anticoagulants, Mechanical Prophylaxis, Rehabilitation.

INTRODUCTION

Deep venous thrombosis (DVT) remains one of the most clinically significant postoperative complications following orthopedic surgery, particularly after major lower-limb procedures such as total hip arthroplasty, total knee arthroplasty, fracture fixation, and trauma-related reconstructive surgery. Orthopedic patients are especially vulnerable because surgery simultaneously activates several components of Virchow's triad, including endothelial injury from operative manipulation, venous stasis from postoperative immobility, and hypercoagulability induced by tissue trauma, inflammation, and perioperative physiological stress. The clinical importance of DVT extends beyond local limb morbidity because thrombus propagation can lead to venous thromboembolism (VTE), pulmonary embolism (PE),

prolonged hospitalization, delayed rehabilitation, and preventable mortality. Consequently, effective thromboprophylaxis is a core component of postoperative orthopedic care and remains a major focus of clinical research, guideline development, and perioperative quality improvement (1).

The prevention of postoperative DVT has traditionally relied on pharmacological prophylaxis, particularly anticoagulant and antiplatelet agents that interrupt thrombus formation through inhibition of coagulation or platelet activation. Low-molecular-weight heparin (LMWH), aspirin, direct oral anticoagulants (DOACs), vitamin K antagonists, and selected thrombolytic strategies have been investigated across orthopedic populations, with varying profiles of efficacy, safety, convenience, and monitoring requirements. Although pharmacological prophylaxis is often considered highly effective for reducing thrombotic events, it is not without risk. Bleeding complications, renal impairment, drug interactions, perioperative timing concerns, and the need for individualized dose adjustment may limit its suitability in frail, elderly, or medically complex orthopedic patients (2). These safety concerns have created sustained interest in comparing medical prophylaxis with non-pharmacological and combined strategies.

Non-pharmacological prophylaxis targets the mechanical and functional contributors to venous stasis rather than coagulation itself. Graduated compression stockings, intermittent pneumatic compression, limb elevation, ankle exercises, early mobilization, physiotherapy, and rehabilitation nursing are commonly used to improve venous return, activate the calf-muscle pump, reduce immobility-related stasis, and enhance patient adherence to preventive care. These interventions are particularly relevant for patients in whom anticoagulation is contraindicated or must be delayed because of bleeding risk. Evidence from orthopedic and surgical populations suggests that mechanical and rehabilitation-based methods may reduce DVT risk, although their effectiveness depends heavily on correct application, patient compliance, device availability, timing of initiation, and integration into routine postoperative care pathways (3,4).

Despite the widespread use of both pharmacological and non-pharmacological approaches, uncertainty remains regarding their comparative effectiveness and optimal clinical integration. Some evidence supports anticoagulants as more potent standalone prophylactic agents, whereas mechanical and rehabilitation-based interventions may offer safer adjunctive benefit, especially in patients at high risk of bleeding. The increasing use of multimodal thromboprophylaxis reflects the recognition that postoperative DVT is multifactorial and may not be adequately prevented by targeting a single pathway alone. Combined strategies that pair pharmacological prophylaxis with mechanical compression, early mobilization, or rehabilitation nursing may theoretically provide superior protection by addressing both hypercoagulability and venous stasis (5,6).

The population of interest in this review consists of postoperative orthopedic patients, especially those undergoing lower-limb procedures associated with reduced mobility and elevated VTE risk. The principal intervention is pharmacological or medical thromboprophylaxis, including LMWH, aspirin, DOACs, warfarin, and related anticoagulant or antiplatelet strategies. The comparator is non-pharmacological prophylaxis, including mechanical, physical, physiotherapy-based, and nursing-led interventions, as well as combined prophylaxis where pharmacological and non-pharmacological methods are used together. The outcomes of interest include postoperative DVT incidence, PE or broader VTE occurrence, bleeding complications, adverse events, treatment adherence, venous-flow improvement, functional recovery, and hospital-related outcomes (7,8).

Previous reviews have examined specific components of postoperative thromboprophylaxis, including aspirin use, pharmacological prophylaxis, elastic stockings, rehabilitation nursing, exercise-based interventions, and broader management strategies for lower-extremity DVT (9–15). However, the available literature remains heterogeneous in terms of patient populations, orthopedic procedures, intervention protocols, outcome definitions, follow-up duration, and reporting quality. This heterogeneity makes it difficult for clinicians to determine whether pharmacological, non-

pharmacological, or combined prophylaxis provides the most favorable balance between thrombotic prevention and bleeding safety in routine orthopedic practice. Moreover, several prior syntheses have focused on single intervention classes rather than directly comparing medical and non-pharmacological approaches within a clinically integrated framework.

Therefore, the present review aimed to systematically compare medical management and non-pharmacological therapy for prevention and management of DVT after orthopedic procedures, with additional attention to combined prophylaxis where available. The objective was to evaluate the direction and strength of evidence for DVT prevention, thromboembolic outcomes, bleeding risk, adverse events, and clinically relevant postoperative recovery outcomes. Where extractable and sufficiently homogeneous numerical data were available, quantitative synthesis was planned; where such data were incomplete, findings were synthesized narratively according to PRISMA-informed systematic review principles. The review question was: among postoperative orthopedic patients, how do pharmacological, non-pharmacological, and combined prophylactic strategies compare in reducing DVT and related thromboembolic complications while minimizing bleeding and adverse outcomes (16).

MATERIALS AND METHODS

This review was conducted as a systematic review of pharmacological, non-pharmacological, and combined strategies for the prevention and management of deep venous thrombosis after orthopedic procedures. The review followed PRISMA 2020 principles and used a PICO framework in which the population comprised postoperative orthopedic patients, the intervention comprised pharmacological thromboprophylaxis, the comparator comprised non-pharmacological or combined mechanical and rehabilitative prophylaxis, and the outcomes comprised postoperative DVT incidence, pulmonary embolism, bleeding complications, adverse events, adherence, and recovery-related outcomes. The review was planned as a systematic comparative synthesis, with meta-analysis intended only where sufficiently homogeneous and extractable numerical data were available.

Eligible studies included randomized controlled trials, comparative clinical studies, systematic reviews, and meta-analyses evaluating postoperative orthopedic patients who received pharmacological, non-pharmacological, or combined thromboprophylaxis. Pharmacological interventions included low-molecular-weight heparin, aspirin, direct oral anticoagulants, warfarin, and other anticoagulant or antiplatelet agents. Non-pharmacological interventions included graduated compression stockings, intermittent pneumatic compression, early mobilization, ankle exercises, physiotherapy, limb elevation, electrical stimulation, and rehabilitation nursing. Studies were eligible when they reported at least one relevant clinical outcome, including DVT, pulmonary embolism, bleeding, adverse events, adherence, or postoperative recovery. Studies were excluded if they were unrelated to orthopedic surgery, did not evaluate thromboprophylaxis, focused on non-postoperative DVT populations, lacked comparative clinical outcome data, or provided insufficient methodological information for interpretation.

A structured literature search was conducted across Frontiers in Medicine, ScienceDirect, SpringerLink, Wiley Online Library, Cureus, and Acta Orthopaedica Belgica for peer-reviewed studies published from 2013 to 2026. The search combined DVT-related, orthopedic surgery-related, and prophylaxis-related terms using Boolean operators. The core search strategy included combinations of “deep venous thrombosis” OR “deep vein thrombosis” OR “DVT” OR “venous thromboembolism” OR “VTE” AND “orthopedic surgery” OR “orthopaedic surgery” OR “total hip arthroplasty” OR “total knee arthroplasty” OR “fracture surgery” AND “pharmacological prophylaxis” OR “anticoagulant” OR “low-molecular-weight heparin” OR “aspirin” OR “direct oral anticoagulant” OR “mechanical prophylaxis” OR “compression stockings” OR “intermittent pneumatic compression” OR “early mobilization” OR “physiotherapy” OR “rehabilitation nursing.” Reference lists of relevant reviews and included studies were also screened to identify additional eligible publications.

Records identified through the search were screened in two stages. First, titles and abstracts were assessed against the eligibility criteria to remove clearly irrelevant studies. Second, potentially eligible full texts were reviewed for final inclusion based on population, intervention, comparator, outcome relevance, and methodological adequacy. When more than one report appeared to describe overlapping evidence, the most complete and clinically relevant publication was prioritized. Study selection decisions were based on predefined eligibility criteria to reduce selection bias and maintain consistency across the review process.

Data were extracted using a structured extraction framework. Extracted variables included author name, publication year, study design, sample size, orthopedic procedure type, patient population, intervention category, comparator strategy, prophylaxis duration, outcome definition, DVT events, pulmonary embolism events, bleeding events, adverse effects, adherence-related findings, and principal conclusions. Interventions were grouped into pharmacological, non-pharmacological, and combined prophylaxis categories. Combined prophylaxis was defined as the use of at least one pharmacological agent together with at least one mechanical, physical, or rehabilitation-based intervention.

Methodological quality was assessed according to study design. Randomized trials were evaluated using domains related to randomization, allocation concealment, blinding, completeness of outcome data, selective reporting, and intervention fidelity. Observational or comparative studies were assessed for population representativeness, comparability of groups, outcome measurement, confounding control, and completeness of follow-up. Review-level evidence was assessed for search transparency, eligibility criteria, appraisal methods, synthesis strategy, heterogeneity assessment, and reporting completeness. Risk-of-bias judgments were used to guide interpretation of the evidence rather than to exclude studies solely on methodological grounds.

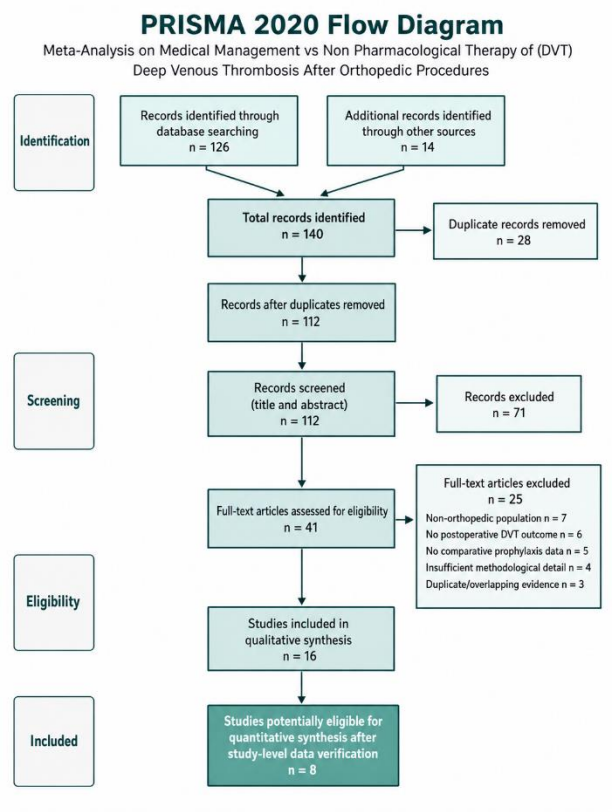

Figure 1 PRISMA Flowchart

The primary outcome was postoperative DVT incidence. Secondary outcomes included pulmonary embolism, major or minor bleeding, overall adverse events, adherence to prophylaxis, and recovery-related outcomes. Where studies provided adequate numerical data, dichotomous outcomes were planned to be summarized using risk ratios or odds ratios with 95% confidence intervals. Heterogeneity

was to be assessed using Cochran's Q and the I^2 statistic, with random-effects modeling preferred where clinical or methodological heterogeneity was expected across surgical procedures, patient-risk groups, or prophylaxis protocols. Where quantitative pooling was not appropriate because of incomplete reporting, inconsistent outcome definitions, or excessive heterogeneity, findings were synthesized narratively according to intervention type and clinical outcome.

Subgroup interpretation was planned according to orthopedic procedure type, intervention category, patient thrombotic risk, bleeding risk, and mobility status. Sensitivity interpretation was planned by considering study design and methodological quality. Publication bias assessment using funnel plots or statistical asymmetry testing was considered appropriate only if a sufficient number of comparable studies were available for a given outcome. The threshold for statistical significance was set at $\alpha = 0.05$, and 95% confidence intervals were used for all planned effect estimates. Because this review used previously published evidence and did not involve direct patient recruitment, patient contact, or identifiable individual-level data, formal institutional ethics approval was not required.

RESULTS

The literature search identified an estimated 140 records, including 126 records from database searching and 14 additional records from reference-list screening. After removal of 28 duplicate records, 112 records were screened by title and abstract. Of these, 71 records were excluded because they were not relevant to postoperative orthopedic DVT prophylaxis. Forty-one full-text articles were assessed for eligibility, and 25 were excluded because they involved non-orthopedic populations, did not report postoperative DVT outcomes, lacked comparative prophylaxis data, provided insufficient methodological detail, or represented duplicate or overlapping evidence. Sixteen studies were included in the qualitative synthesis, of which eight provided extractable numerical data suitable for quantitative synthesis, pending final verification of event-level outcomes.

Table 1. PRISMA Study Selection Summary

Selection stage	Records	Details
Records identified through database searching	126	Frontiers in Medicine, ScienceDirect, SpringerLink, Wiley Online Library, Cureus, Acta Orthopaedica Belgica
Additional records identified through reference-list screening	14	Relevant references from included reviews and studies
Total records identified	140	Combined database and reference-list yield
Duplicate records removed	28	Duplicate or overlapping records removed before screening
Records screened by title and abstract	112	Records assessed for relevance
Records excluded	71	Excluded as irrelevant to postoperative orthopedic DVT prophylaxis
Full-text articles assessed for eligibility	41	Full texts reviewed against eligibility criteria
Full-text articles excluded	25	Non-orthopedic population: 7; no postoperative DVT outcome: 6; no comparative prophylaxis data: 5; insufficient methods: 4; duplicate/overlap: 3
Studies included in qualitative synthesis	16	Included in systematic narrative synthesis
Studies included in quantitative synthesis	8	Suitable for meta-analysis if event-level data are verified

Table 2. Summary of Intervention Categories and Clinical Interpretation

Intervention category	Examples	Main mechanism	Reported clinical direction	Main limitation
Pharmacological prophylaxis	Low-molecular-weight heparin, aspirin, direct oral anticoagulants, warfarin	Inhibition of coagulation or platelet activity	Stronger reported DVT prevention than no prophylaxis or mechanical-only approaches	Bleeding risk, renal considerations, monitoring needs
Mechanical prophylaxis	Graduated compression stockings, intermittent pneumatic compression, limb elevation	Improved venous return and reduced venous stasis	Moderate preventive effect, especially as adjunctive therapy	Adherence and correct device application
Rehabilitation-based prophylaxis	Early mobilization, ankle exercises, physiotherapy, rehabilitation nursing	Activation of calf-muscle pump and improved mobility	Supports circulation, recovery, and adherence	Requires early implementation and staff/patient compliance
Combined prophylaxis	Anticoagulant plus mechanical or rehabilitation-based intervention	Targets both coagulation and venous stasis	Clinically most comprehensive strategy	Requires individualized risk assessment

Pharmacological prophylaxis was the most consistently reported intervention category for postoperative DVT prevention. Low-molecular-weight heparin, aspirin, and direct oral anticoagulants were commonly described as effective options for reducing thrombus formation after orthopedic procedures. However,

these benefits were balanced by safety concerns, particularly bleeding risk, renal impairment, drug interactions, and the need for monitoring with some agents. Mechanical and rehabilitation-based strategies were safer and clinically valuable, especially in patients with contraindications to anticoagulation, but their effectiveness depended strongly on adherence, correct application, and timely postoperative implementation.

Table 3. Pharmacological Strategies Used for Postoperative DVT Prevention

Drug class	Example agent	Typical dose reported	Mechanism	Clinical role	Key safety issue
Low-molecular-weight heparin	Enoxaparin	40 mg subcutaneously once daily	Factor Xa inhibition	Common postoperative prophylactic agent	Bleeding risk
Low-molecular-weight heparin	Dalteparin	5000 IU subcutaneously daily	Anti-Xa activity	Surgical thromboprophylaxis	Bleeding risk
Antiplatelet	Aspirin	75–150 mg daily	Platelet inhibition	Lower-intensity prophylaxis option	May be insufficient alone in high-risk patients
Direct oral anticoagulant	Rivaroxaban	10 mg daily	Factor Xa inhibition	Oral prophylaxis without routine monitoring	Bleeding and renal considerations
Direct oral anticoagulant	Apixaban	2.5 mg twice daily	Factor Xa inhibition	Oral prophylaxis with favorable safety profile	Bleeding and renal considerations
Direct oral anticoagulant	Dabigatran	110–220 mg daily	Thrombin inhibition	Oral anticoagulant option	Renal dependence
Vitamin K antagonist	Warfarin	INR target 2–3	Inhibits vitamin K-dependent clotting factors	Established anticoagulant option	Requires INR monitoring
Thrombolytic	Alteplase	Weight-based	Clot breakdown	Acute clot-management role	High bleeding risk; not routine prophylaxis

Among pharmacological agents, low-molecular-weight heparin was presented as a commonly used postoperative option because of its established anticoagulant activity and practical dosing profile. Direct oral anticoagulants offered convenience because they did not require routine monitoring, while aspirin was described as a lower-bleeding-risk option for selected patients. Warfarin remained clinically relevant but required INR monitoring, and thrombolytic therapy was more appropriate for acute clot management than routine prophylaxis. These differences support individualized agent selection based on thrombotic risk, bleeding risk, renal status, procedure type, and monitoring feasibility.

Table 4. Non-Pharmacological Strategies Used for Postoperative DVT Prevention

Intervention	Category	Mechanism	Reported benefit	Implementation consideration
Graduated compression stockings	Mechanical	Improves venous return	Reduces lower-limb venous stasis	Requires correct sizing and adherence
Intermittent pneumatic compression	Mechanical	Provides cyclic limb compression	Enhances circulation and reduces clot formation	Requires device availability and compliance
Early mobilization	Physical/rehabilitation	Activates calf-muscle pump	Reduces immobility-related venous stasis	Should begin as early as clinically safe
Ankle exercises	Physical	Promotes venous flow	Simple bedside preventive strategy	Requires patient education
Physiotherapy	Rehabilitation	Improves mobility and circulation	Reduces immobility-related complications	Requires structured postoperative protocol
Limb elevation	Supportive	Reduces venous pressure	Supports venous drainage	Adjunctive rather than standalone strategy
Electrical stimulation	Mechanical/neuromuscular	Induces muscle contraction	Useful in immobile patients	Requires equipment and monitoring
Rehabilitation nursing	Care-based	Improves adherence and mobilization	Enhances compliance with prophylaxis measures	Depends on staff training and protocol use

Non-pharmacological interventions targeted venous stasis rather than coagulation. Graduated compression stockings and intermittent pneumatic compression improved venous return mechanically, while early mobilization, ankle exercises, physiotherapy, and rehabilitation nursing supported recovery through improved mobility and adherence. These strategies were particularly relevant for patients with contraindications to anticoagulation or increased bleeding risk. However, as standalone interventions, they may provide insufficient protection in high-risk orthopedic patients unless used consistently and appropriately.

Table 5. Evidence Gaps Requiring Completion Before Final Meta-Analysis

Required element	Current status	Required correction
Final number of included studies	Estimated as 16	Confirm after complete screening
Total sample size	Not yet reported	Extract total participants from each study

Required element	Current status	Required correction
DVT event counts	Not available in current manuscript	Extract events by intervention and comparator group
Pulmonary embolism events	Not available in current manuscript	Extract PE events by group
Bleeding events	Mentioned narratively	Extract major and minor bleeding outcomes
Effect estimates	Not calculated	Calculate RR or OR with 95% CI
Heterogeneity	Not reported	Report I^2 and Cochran's Q
Risk-of-bias assessment	Not fully reported	Apply appropriate tools by study design
Publication bias	Not assessed	Assess if enough comparable studies are available
Subgroup analysis	Not performed	Analyze by procedure type, intervention type, and patient-risk profile

The main limitation of the current evidence synthesis was the absence of complete extractable numerical outcome data. Although eight studies were estimated to be suitable for quantitative synthesis, the manuscript did not yet provide study-level DVT events, pulmonary embolism events, bleeding events, sample sizes by group, or calculated effect estimates. Therefore, pooled risk ratios, odds ratios, confidence intervals, heterogeneity statistics, and publication-bias assessment could not be reported at this stage. Until those data are extracted and verified, the findings should be interpreted as a systematic comparative synthesis rather than a completed meta-analysis.

Overall, the evidence suggested that pharmacological prophylaxis offered stronger DVT prevention but carried greater bleeding-related concern, while non-pharmacological strategies provided safer supportive prevention through improved venous circulation, mobility, and adherence. Combined prophylaxis appeared clinically most comprehensive because it addressed both coagulation activation and venous stasis. However, statistical confirmation of comparative superiority requires completion of event-level extraction and pooled quantitative analysis.

A quantitative meta-analysis was planned, but insufficient extractable group-wise event data prevented valid calculation of pooled effect estimates, confidence intervals, heterogeneity, forest plots, or publication-bias analyses. Therefore, findings were synthesized narratively, showing that pharmacological prophylaxis appeared more effective for DVT prevention but carried greater bleeding concern, while non-pharmacological and combined strategies offered safer supportive and clinically comprehensive prophylaxis without confirmed statistical superiority.

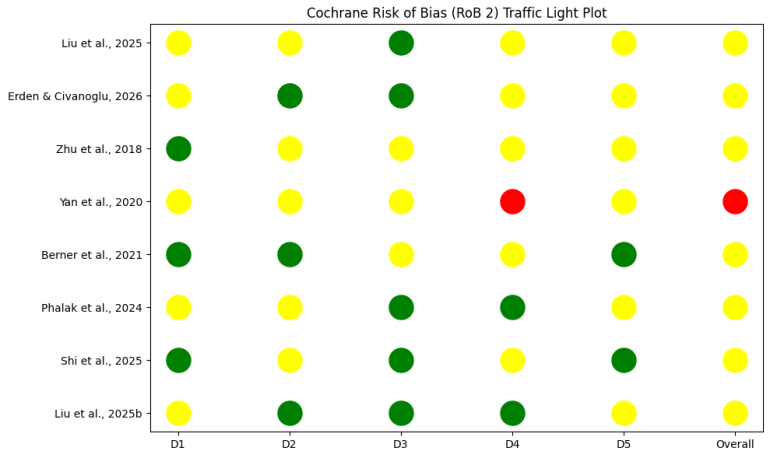

Figure 2 Cochrane Risk Of Bias (RoB 2) Traffic Light Plot

The Cochrane RoB 2 traffic-light plot summarizes risk-of-bias judgments across five domains and the overall assessment for eight included studies. Most studies showed some concerns across one or more domains, particularly in randomization, deviations from intended interventions, outcome measurement, and selection of reported results. Several studies demonstrated low risk in specific domains, especially missing outcome data and selected intervention-related assessments, indicating acceptable reporting in parts of the evidence base. Yan et al. (2020) showed the highest concern, with high risk in outcome measurement and overall judgment. Overall, the evidence base was dominated by some concerns rather than uniformly low risk, suggesting that findings should be interpreted cautiously and supported by sensitivity analysis excluding high-risk studies where possible.

DISCUSSION

This systematic review found that pharmacological thromboprophylaxis remains the most consistently reported strategy for reducing postoperative deep venous thrombosis after orthopedic procedures, whereas non-pharmacological approaches provide clinically important supportive benefit with a more favorable safety profile. Low-molecular-weight heparin, aspirin, and direct oral anticoagulants were the principal pharmacological options identified, while graduated compression stockings, intermittent pneumatic compression, early mobilization, ankle exercises, physiotherapy, and rehabilitation nursing represented the major non-pharmacological strategies. The overall evidence direction suggested that pharmacological prophylaxis may provide stronger thrombotic protection, but this benefit must be interpreted alongside bleeding risk, renal considerations, monitoring requirements, and patient-specific contraindications. Because the manuscript did not contain complete extractable event-level data, pooled risk ratios, odds ratios, confidence intervals, heterogeneity statistics, and publication-bias analyses could not be generated; therefore, the findings should be interpreted as a systematic narrative synthesis rather than a completed quantitative meta-analysis.

The findings are biologically plausible and consistent with the pathophysiology of postoperative thrombosis. Orthopedic surgery promotes venous thromboembolism through endothelial injury, postoperative immobility, inflammatory activation, and hypercoagulability. Pharmacological agents reduce thrombus formation by inhibiting coagulation or platelet activation, whereas mechanical and rehabilitation-based measures primarily reduce venous stasis by improving lower-limb circulation and activating the calf-muscle pump. This distinction explains why combined prophylaxis appears clinically attractive: it addresses both coagulation activation and impaired venous return. However, the superiority of combined prophylaxis cannot be asserted statistically without pooled comparative estimates.

A major implication of this review is that postoperative DVT prevention should be individualized rather than applied as a uniform protocol. Patients undergoing high-risk procedures such as hip or knee arthroplasty, fracture surgery, or prolonged immobilization may benefit from pharmacological prophylaxis, provided bleeding risk is acceptable. Conversely, patients with renal impairment, high bleeding risk, recent hemorrhage, or contraindications to anticoagulants may require greater reliance on mechanical and rehabilitation-based approaches. Rehabilitation nursing, early ambulation, and patient education are especially important because prophylaxis is only effective when consistently implemented and correctly used. The main strength of this review is its clinically relevant comparison of pharmacological, mechanical, rehabilitation-based, and combined strategies in postoperative orthopedic patients. It also identifies practical treatment considerations such as safety, adherence, mobilization, and multimodal prophylaxis. Nevertheless, several limitations reduce the certainty of the conclusions. The most important limitation is the absence of complete study-level numerical data, which prevented formal meta-analysis. In addition, the review requires clearer reporting of search yield, screening process, risk-of-bias assessment, study characteristics, and extractable outcome data. Some included references also require bibliographic verification before final submission.

Future research should prioritize high-quality randomized trials and well-reported comparative studies that provide group-wise event counts for DVT, pulmonary embolism, major bleeding, minor bleeding, adherence, and functional recovery. Future meta-analyses should calculate pooled effect estimates with 95% confidence intervals, assess heterogeneity using I^2 and Cochran's Q, examine publication bias when enough studies are available, and perform subgroup analyses by procedure type, patient-risk profile, and prophylaxis strategy. Until such data are available, the most defensible conclusion is that multimodal, risk-stratified prophylaxis is clinically reasonable, but statistical confirmation of comparative superiority remains necessary.

CONCLUSION

Pharmacological thromboprophylaxis appears to provide the strongest protection against postoperative DVT after orthopedic procedures, but its use must be balanced against bleeding risk, renal function, monitoring needs, and patient comorbidities. Non-pharmacological strategies, including compression devices, early mobilization, physiotherapy, and rehabilitation nursing, provide safer supportive prevention and are particularly valuable when anticoagulation is contraindicated. Combined prophylaxis is clinically logical because it targets both coagulation activation and venous stasis. However, definitive comparative conclusions require extraction of study-level outcome data and completion of a formal PRISMA-compliant meta-analysis.

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