

Impact of Stretching on Knee Joint Stability and Balance in Total Knee Replacement (TKR): A Review

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Abstract

Background: Total knee replacement (TKR), patients often experience deficits in balance, proprioception, and joint stability. Stretching is commonly included in rehabilitation, but its specific effects on stability and balance are not fully elucidated.

Objective: To review evidence on the impact of stretching interventions alone /combined on knee joint stability and balance following TKR.

Design: Narrative review to evaluate the impact of stretching on knee joint stability and balance after total knee replacement.

Methods: Relevant peer-reviewed literature (2020–2025) was identified via databases, examining stretching as part of postoperative physiotherapy for Total knee replacement. Key outcomes included postural control, balance measures, and range of motion (ROM).

Results: Evidence supports that stretching improves ROM and reduces stiffness. However, isolated stretching has limited direct impact on objective measures of balance and stability. Studies showing significant improvements in balance typically include combined programs such as strength, balance and task-specific training. Heterogeneity in dosing, timing, and outcome measures limits definitive conclusions.

Conclusion: Stretching is valuable for ROM recovery after Total knee replacement, but to meaningfully improve balance and joint stability, it should be integrated into a multimodal

rehabilitation regimen. Future research should focus on standardized balance outcome measures and better-defined stretching protocols.

Keywords: Total Knee Replacement, Stretching, Balance, Joint Stability, Rehabilitation

Introduction

Total knee replacement (TKR) is a widely performed surgical intervention to alleviate pain and restore function in patients with advanced knee osteoarthritis. Despite surgical improvements, many patients continue to experience impairments in muscle strength, proprioceptive function, and balance, which can contribute to reduced mobility and increased fall risk (Gauchard et al, 2010). Rehabilitation protocols commonly include stretching or flexibility exercises to improve range of motion (ROM) and reduce stiffness; however, the specific role of stretching in promoting knee joint stability and balance control is not fully understood. This review examines available evidence on whether stretching (static or dynamic) either alone or as part of combined rehabilitation interventions can improve balance and stability after total knee replacement (Domínguez, 2018).

Methodology

This narrative review synthesizes data from studies published between 2020 and 2025. Databases searched included PubMed, MEDLINE, Science Direct and Google Scholar. Priority was given to clinical trials, randomized protocols, and observational studies relating to stretching interventions, combined balance exercise programs, kinesio taping, core/knee stabilization exercises, and fall-prevention programs following TKR.

Results

Across acute and chronic TKR trials, stretching is most typically applied alongside strength, balance, and functional training. Stretching may be one complimentary component of more comprehensive neuromuscular retraining, according to An et al. (2024), who found that a combined balancing exercise program in the acute postoperative phase improved knee range of motion, balance scores, gait metrics, and functional outcomes. Core stability programs that incorporate stretching and trunk control exercises seem to improve proprioceptive acuity as well as patient-reported function and quality of life in chronic patients (Patel & Mishra, 2024).

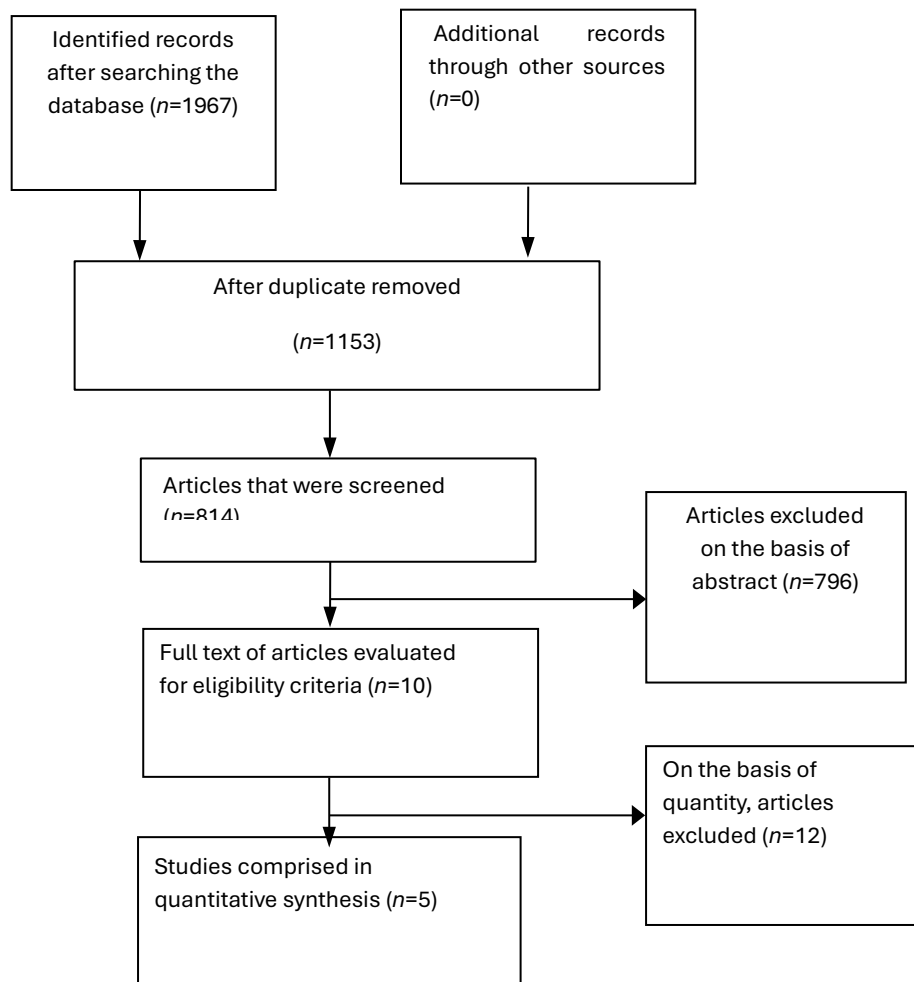
Moreover, Kinesio taping (Song et al., 2024) showed effects on joint ROM and balance in TKR patients, that additional modalities can transiently impact tissue mechanics and proprioceptive feedback. Stretching contributes primarily to ROM increases which, when accompanied with strength and balance work, translate to increased functional mobility (e.g., sit-to-stand, stair negotiation, walking endurance).

Furthermore, Core stability and knee stabilization exercises reveal persistent favorable benefits on proprioception and dynamic joint stability. A mechanism by which trunk control and soft tissue flexibility contribute to increased sensory-motor integration and knee joint awareness is supported by Patel & Mishra's (2024) report of improvements in knee proprioception measurements in chronic TKR patients following a customized core stability protocol. Similar improvements in balance and walking ability with knee stabilization exercises were reported by Park et al. (2021), emphasizing that targeted neuromuscular training supports stability more directly than isolated passive stretching.

Randomized trials that integrate balance exercises with strength training and functional tasks demonstrate significant improvements in both static and dynamic balance outcomes. Stretching when combined with balance-specific training usually results in better balance. The Al-Saleh et al. (2025) protocol highlights the clinical consensus that fall risk is best addressed through combined strategies (strength, balance, functional task practice, and flexibility) and stresses fall prevention through

practical, multi-component interventions. The protocol is awaiting trial results. An et al. (2024) discovered that a mixed balance program improves acute-phase balance and gait, indicating that early multimodal rehab deployment may lessen short-term instability and enhance recovery trajectories. Measures such as single-leg stance duration, timed up-and-go (TUG), and postural sway showed notable enhancement when patients engage in combined programs. Strength training, particularly of the quadriceps, hamstrings, and hip abductors, is strongly correlated with improvements in postural control and overall functional mobility. Evidence suggests that early initiation of combined balance and strength training in the acute postoperative phase accelerates recovery of gait symmetry, dynamic postural control, and independence in activities of daily living.

Figure 1: Prisma Chart



Despite the positive findings, there is considerable variability among studies regarding intervention timing, frequency, intensity, and outcome measures. Some trials initiate exercises within the first week post-surgery, while others begin several weeks later. Exercise dose and progression also vary, making direct comparison challenging. Furthermore, balance and stability are assessed using diverse tools, including clinical scales, computerized posturography, and functional mobility tests, which limit the ability to perform meta-analytic synthesis. Few studies isolate stretching as a single variable affecting balance, and follow-up durations are often short, generally ranging from 4 to 12 weeks. Consequently, while combined interventions consistently demonstrate improvements, the independent contribution of stretching remains unclear (Chen et al, 2024).

Some studies have explored adjunctive interventions, such as virtual reality-based balance training, aquatic therapy, and neuromuscular electrical stimulation, in conjunction with standard rehabilitation. These approaches show mixed results; in several cases, no additional benefits in postural control were observed beyond what was achieved with conventional multimodal training. This reinforces the notion that strengthening, balance exercises, and functional task practice are the core determinants of balance recovery after TKR, whereas stretching plays a supporting role.

Discussion

This review highlights the role of stretching within postoperative rehabilitation for patients undergoing total knee replacement (TKR) and its relationship to knee joint stability and balance. Stretching exercises are consistently shown to improve knee range of motion (ROM) and reduce joint stiffness, which are critical for facilitating early functional mobility. Improved ROM allows patients to perform daily activities such as walking, climbing stairs, and sit-to-stand tasks more efficiently, indirectly supporting balance and reducing compensatory movement patterns that may predispose to falls. However, evidence indicates that stretching alone has limited direct impact on balance or postural stability, emphasizing the need for additional interventions.

Randomized trials demonstrate that combined programs incorporating balance exercises, strength training, and functional tasks yield the most meaningful improvements in static and dynamic balance measures. Functional task practice, such as sit-to-stand repetitions, stair negotiation, and gait training with obstacles, reinforces neuromuscular coordination and promotes real-world functional stability. Strengthening exercises targeting the quadriceps, hamstrings, and hip musculature are strongly correlated with gains in postural control, proprioception, and dynamic postural adjustments. Early initiation of such combined programs in the acute postoperative phase accelerates recovery of gait symmetry, improves confidence during daily activities, and reduces fall risk, highlighting the importance of integrating multimodal rehabilitation strategies.

The heterogeneity of existing studies limits definitive conclusions regarding the independent contribution of stretching to balance outcomes. Variations in intervention timing, intensity, frequency, and outcome measures, along with short follow-up durations, make comparisons challenging. From a mechanistic perspective, stretching likely supports balance recovery indirectly by enhancing ROM, which facilitates effective muscle activation and joint alignment during functional tasks. Clinically, physiotherapists should continue to emphasize stretching in early rehabilitation while prioritizing strength, balance, and functional task training for comprehensive recovery. Future research should focus on standardized, long-term outcome measures and well-designed trials comparing stretch-only versus multimodal programs to clarify the specific benefits of stretching for postural stability after TKR.

Conclusion

Stretching is a crucial feature of postoperative TKR therapy for improving ROM and encouraging participation in strength and balance training. However, meaningful improvements in knee proprioception, stability, balance, gait, and quality of life are most consistently achieved when stretching is integrated into multimodal rehabilitation programs that emphasize core stability and knee-specific neuromuscular training. Future randomized studies should isolate stretching parameters (type, intensity, frequency) and examine long-term functional and fall-related outcomes to better inform clinical guidelines.

Conflict of Interest

The authors declare no conflicts of interest.

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