



Effects Of Proprioceptive Training To Improve Balance In Stroke Patients – An Evidence-Based Study

Study on Enhancing Balance Through Proprioceptive Training in Stroke Rehabilitation

¹Maan Dharmendrakumar Patel, ²Dr. Darshan Parmar, ³Kashish Dalshukhbhai Panchal

¹UG Student, ²Assistant Professor, ³UG Student

¹Department of Physiotherapy

¹KD Institute of Physiotherapy, Ahmedabad, Gujarat, India

ABSTRACT

Background: Balance impairment is a major concern in stroke rehabilitation. Loss of proprioception in the affected limb significantly impacts motor learning and balance re-education. While strength and functional training are commonly emphasized in rehabilitation, proprioception training may further enhance balance recovery. This study aims to explore the effectiveness of proprioceptive training in improving balance in stroke patients.

Objective: Numerous reports advocate that training of the proprioceptive system is a viable for improving Balance. However, there is little agreement of what constitutes proprioceptive training and how effective it is. We therefore conducted a systematic review of the available literature in order to provide clarity to the notion of training the proprioceptive system to improve balance in stroke patients.

Methodology: Major databases like PubMed, Google Scholar, and ResearchGate were used in a thorough search. We examined and analysed studies from 2015 to 2025 that focused on proprioception training for stroke patients. 6 studies out of 10 publications met all the requirements and were chosen for additional review.

Result: Stroke was the most common disorder studied for Proprioceptive training. However most of the articles showed improvement Balance after Proprioceptive training in Stroke patients.

Discussion: The findings of this systematic review suggest that proprioceptive training is a highly effective intervention for improving balance in stroke patients. These exercises enhance neuromuscular control, postural stability, and mobility by stimulating sensory feedback mechanisms and proprioceptors in muscles and joints. Techniques such as unstable surface training, mental imagery, weight-shifting drills, and integration with thermal therapy, kinesio taping, or motor imagery have shown strong outcomes in both subacute and chronic stroke populations. However, variations in training protocols highlight the need for standardization and long-term research to confirm sustained benefits.

Conclusion: The findings suggest that proprioception training plays a significant role in improving balance in stroke patients. Incorporating proprioception-based interventions into rehabilitation programs can enhance functional recovery and overall stability in this population.

Keywords: Proprioceptive Training, Balance Improvement, Stroke Rehabilitation.

INTRODUCTION

Stroke is one of the leading causes of long-term neurological disability worldwide, often leaving individuals with motor, sensory, and cognitive challenges. Among these, proprioceptive deficits are particularly important yet frequently overlooked. Proprioception, the body's ability to sense its position and movement, plays a vital role in maintaining balance, coordinating voluntary movement, and regulating muscle tone. Research suggests that approximately 65% of stroke survivors experience proprioceptive impairments, which directly contribute to balance problems and a higher risk of falls. Despite its significance, traditional rehabilitation programs tend to focus more on motor recovery, often neglecting sensory retraining. Proprioceptive training offers a promising approach by helping restore sensory feedback, improve joint stability, and enhance movement coordination. This study aims to evaluate the effects of proprioceptive training on balance, mobility, and overall rehabilitation outcomes in stroke patients, with the goal of promoting better independence and quality of life.

OBJECTIVE

This study explores how proprioceptive training, which improves body awareness, helps stroke patients recover their balance. It also focuses on understanding the role of proprioception in motor learning and balance re-education after a stroke.

MATERIALS & METHODS

1. Study Design:

This study is an evidence-based review of randomized controlled trials (RCTs) that investigate the effects of proprioceptive training on balance improvement in stroke patients. Although not a registered systematic review, it follows a structured and transparent methodology, referencing elements from the PRISMA framework for article identification, screening, and selection. The aim was to extract, analyze, and summarize high-quality evidence to guide clinical decision-making in stroke rehabilitation.

2. Search Strategy:

A comprehensive literature search was performed across PubMed, Google Scholar, and ResearchGate for articles published between 2015 and 2025. The search terms included: "proprioceptive training," "balance improvement," "stroke rehabilitation," and "randomized controlled trial", combined using Boolean operators (AND, OR) to ensure relevance. Only peer-reviewed, full-text studies in English were included to maintain the quality and credibility of the review.

3. Inclusion Criteria

- Randomized controlled trials (RCTs) focusing on stroke patients undergoing proprioceptive training
- Use of validated outcome measures for balance (e.g., Berg Balance Scale, Timed Up and Go Test, Postural Assessment Scale for Stroke, Trunk Control Test)
- Minimum intervention duration of 4 weeks
- Studies involving adult stroke populations (both acute and chronic)
- Full-text availability and publication in English between 2015–2025

4. Exclusion Criteria

- Non-randomized trials, case reports, review articles, or expert opinions
- Studies involving non-stroke or pediatric participants
- Interventions shorter than four weeks or lacking a control/comparison group
- Research not using validated tools to measure balance outcomes
- Articles not accessible in full-text or published in languages other than English

5. Study Selection and Bias Minimization:

Articles were screened based on titles, abstracts, and full-text reviews. The final selection of studies was based strictly on the inclusion/exclusion criteria. To minimize selection bias, a consistent search strategy and predefined criteria were applied. Studies were excluded when they lacked methodological clarity, used inappropriate outcome measures, or presented incomplete data.

6. Quality Assessment:

The PEDro (Physiotherapy Evidence Database) scale was used to assess the methodological quality of included studies.

- Four studies scored 7/11 (Lee et al., Sangeetha and Kunduru, Kim et al. 2022, Mishra et al.), indicating high quality
 - Two studies scored 6/11 (Chae et al., Kim and Kim), representing moderate quality, primarily due to lack of blinding or incomplete follow-up details
- Studies scoring below 6 were excluded from this review.

7. Data Extraction and Review:

The selected studies were thoroughly examined to capture essential information, including publication details, research design, sample size, participant characteristics (acute or chronic stroke), intervention types, duration and frequency of training, outcome assessment tools, and overall results. The aim was to assess how proprioceptive training influenced balance recovery across different study settings.

However, due to notable variations in intervention protocols, participant demographics, and outcome measurement tools, conducting a quantitative meta-analysis was not appropriate. As a result, the evidence has been synthesized using a qualitative narrative approach, offering a clear and clinically relevant summary of findings.

REVIEW OF LITERATURE

Strong evidence from recent clinical trials highlights the effectiveness of proprioceptive training in improving balance among stroke patients. A total of six randomized controlled trials (RCTs), published between 2015 and 2025, were reviewed. These studies explored different approaches, patient populations (both subacute and chronic stroke), and outcome measures. Despite some variations in protocol, all studies focused on proprioceptive interventions aimed at improving balance and consistently reported positive outcomes.

1. Lee et al. (2015)

This study involved 36 hospitalized stroke patients who underwent proprioceptive training combined with motor imagery. Exercises on soft pads and balance boards were paired with guided mental visualization. Results showed significant improvement in postural control, symmetry, and overall mobility.

PEDro Score: 7/11 – High Quality ^[3]

2. Sangeetha and Kunduru (2022)

They worked with 30 subacute stroke patients, comparing proprioceptive training to progressive adaptive physical activity. Both groups improved, but the proprioceptive group showed greater gains in dynamic balance, particularly in Berg Balance Scale (BBS) and Timed Up and Go (TUG) scores.

PEDro Score: 7/11 – High Quality ^[1]

3. Chae et al. (2017)

This study involved 30 chronic stroke patients who received proprioceptive training on unstable surfaces. Participants in the experimental group experienced better outcomes in balance, trunk stability, and mobility compared to those undergoing conventional therapy.

PEDro Score: 6/11 – Moderate Quality ^[4]

4. Kim and Kim (2022)

They evaluated the combined use of ankle proprioceptive training with thermal therapy in stroke patients. Improvements were observed in trunk control, gait performance, and balance, indicating that sensory stimulation (heat/cold) alongside movement exercises enhances rehabilitation outcomes.

PEDro Score: 6/11 – Moderate Quality ^[5]

5. Kim et al. (2022)

In this single-blind RCT, 40 stroke patients were divided into two groups: one received proprioceptive training with kinesio taping on the knee, and the other received placebo taping. The taped group showed better improvements in proprioception, balance, and gait.

PEDro Score: 7/11 – High Quality ^[6]

6. Mishra et al. (2024)

This study focused on active lower limb proprioceptive exercises such as squats, static stances, and foot taps among 30 adult stroke patients. Compared to passive therapies, the experimental group showed significantly greater improvements in trunk control and balance (measured using the Trunk Control Test and BBS).

PEDro Score: 7/11 – High Quality ^[2]

PEDro Score Summary:

- studies scored 7/11 (Lee et al., Sangeetha & Kunduru, Kim et al. (2022), Mishra et al.), indicating high methodological quality.
- 2 studies scored 6/11 (Chae et al., Kim & Kim), representing moderate quality, mostly due to lack of blinding or incomplete follow-up reporting.

These findings collectively support the clinical value of proprioceptive training in stroke rehabilitation. Patients receiving such interventions showed better postural stability, neuromuscular control, and dynamic balance compared to conventional therapies. While further long-term studies are needed to establish standardized protocols, current literature strongly favors incorporating proprioceptive exercises into stroke recovery programs.

RESULT

1. Studies Identified:

After applying the inclusion and exclusion criteria, a total of 10 articles were initially found using keywords related to proprioceptive training, balance improvement, and stroke rehabilitation. Out of these, four articles were excluded because they either didn't have full-text access, didn't match the study objectives, or didn't meet the inclusion criteria. In the end, six studies were selected and moved forward for the quality assessment phase.

2. Quality Assessment:

The methodological quality of the included studies was assessed using the PEDro scale.

- Four studies (Lee et al., Sangeetha & Kunduru, Kim et al. 2022, and Mishra et al.) were rated as high quality with scores of 7 out of 11.
- Two studies (Chae et al., and Kim & Kim) received moderate quality ratings with scores of 6 out of 11, primarily due to limitations such as absence of blinding or incomplete follow-up data.
- Studies with scores below 6 were excluded to maintain the reliability of this review.

3. Overview of Interventions and Outcomes:

All six included studies involved stroke patients in either the subacute or chronic phase of recovery. The interventions applied proprioceptive training techniques such as unstable surface exercises, motor imagery, weight-shifting drills, thermal therapy, and kinesio taping. These programs were conducted over a span of 4 to 8 weeks, typically with three to five sessions per week, lasting between 30 and 60 minutes per session. The structured frequency and duration allowed participants to progressively engage in balance-focused rehabilitation.

4. Outcome Measures and Observed Benefits:

To assess improvements, commonly used balance assessment tools included the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), Postural Assessment Scale for Stroke (PASS), and Trunk Control Test (TCT). Across all studies, participants who received proprioceptive training demonstrated visible improvements in balance control, trunk stability, weight-bearing symmetry, and overall confidence during movement. These gains were consistently greater than those reported in comparison groups receiving conventional rehabilitation alone.

5. Synthesis of Evidence:

Given the variability in participant characteristics, intervention protocols, and outcome measures, a quantitative meta-analysis was not appropriate. Therefore, the findings have been synthesized narratively. Collectively, the evidence supports the use of proprioceptive training as a beneficial and targeted approach to enhance balance and postural control in stroke rehabilitation settings.

DISCUSSION

The findings of this systematic review suggest that proprioceptive training is a highly effective intervention for improving balance in stroke patients. Balance issues after a stroke are often caused by a combination of motor weakness, sensory loss, and postural instability. These challenges significantly increase the risk of falls and reduce a patient's ability to perform daily tasks independently. The reviewed randomized controlled trials

consistently demonstrate that specific proprioceptive exercises enhance neuromuscular control, postural stability, and mobility during stroke rehabilitation.

One of the key reasons proprioceptive training is so effective is its ability to boost sensory feedback and improve coordination between the brain and body. These exercises stimulate proprioceptors located in muscles, joints, and tendons, helping patients adjust posture and weight distribution more effectively. Techniques such as balance board training, exercises on unstable surfaces, and weight-shifting drills were especially effective in building confidence and control in movement. This highlights the importance of targeting the body's position sense for better recovery.

Multiple studies reported improvements in balance using standardized tools like the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and the Postural Assessment Scale for Stroke. For instance, Lee et al. studied hospitalized stroke patients and found that combining proprioceptive training with mental imagery improved balance, mobility, and weight-bearing symmetry. Similarly, Sangeetha and Kunduru compared proprioceptive training with adaptive physical activity in subacute stroke patients. While both groups showed gains, proprioceptive training demonstrated stronger improvements, especially in dynamic balance.

In patients recovering from chronic stroke, Chae et al. conducted a study using unstable surface training, showing positive effects on mobility and confidence. Another study by Kim and Kim included post-stroke patients and combined proprioceptive training with thermal therapy, leading to enhanced trunk stability and gait performance. Their approach included one-hour sessions held five days a week and was assessed using tools such as the Trunk Impairment Scale (TIS), BBS, and the 10-Meter Walk Test.

Further, Kim et al. explored the impact of combining proprioceptive exercises with kinesio taping. In this study involving stroke patients, the group with kinesio taping showed greater improvements in balance, proprioception, and gait compared to the control group. The training included frequent sessions, and measurements were recorded using tools like electrogoniometers and pressure plates.

Mishra et al. also evaluated proprioceptive training among adult stroke patients and found that active techniques such as squats, foot tapping, and stabilization exercises significantly improved trunk control and overall balance compared to passive therapies.

Taken together, these studies show that proprioceptive training yields better outcomes when adjusted to each patient's stage of recovery and when combined with complementary therapies such as kinesio taping, motor imagery, or thermal interventions. Such approaches help patients regain trunk stability, postural control, and movement coordination, which are key components for achieving functional independence.

1. Research Gaps and Future Directions:

- 1.1. Although the benefits are evident, the reviewed studies present certain limitations. Most trials included relatively small sample sizes, short durations of intervention, and lacked long-term follow-up, making it difficult to assess sustained outcomes. There was also inconsistency in training protocols, exercise intensity, and outcome measurement tools across studies. These factors limit the generalizability of findings and highlight the need for standardized approaches.
- 1.2. Future research should focus on conducting large-scale, multicenter randomized controlled trials with consistent training protocols and extended follow-up periods. The inclusion of technology-based interventions such as sensor-assisted proprioceptive devices or virtual reality platforms could provide objective feedback and enhance engagement. Moreover, assessing real-world functional improvements such as fall reduction, independence in daily living, and patient-reported outcomes will further clarify the clinical value of proprioceptive training in stroke rehabilitation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research. All contributions were made independently, and no financial, professional, or personal relationships influenced the outcome of this study.

CONCLUSION

The findings of this evidence-based study suggest that proprioceptive training is a helpful and effective approach for improving balance in stroke patients. The reviewed randomized controlled trials consistently show that adding proprioceptive exercises to rehabilitation programs boosts neuromuscular coordination, postural stability, and overall mobility. Techniques like weight-shifting exercises, balance board training, and unstable surface activities have all shown strong results in helping patients regain balance. Based on these positive outcomes, proprioceptive training should be seen as a key part of stroke rehabilitation to support

balance recovery and lower the risk of falls. However, more research is needed to fine-tune training protocols and understand the long-term impact of these interventions.

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