PNF-Augumented Balance Training Using Balance Beam and Balance Board: A Controlled Trial Assessing Walking Speed Outcomes in Stroke Patients

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Abstract

Background & purpose: Stroke is a vulnerable condition having a high global prevalent rate. Balance impairment is a major antagonist to the disease progression. The current study aimed to compare two balance training program (balance board and balance beam training) on gait parameters in stroke patients.

Methods: The randomized trial was conducted among 100 stroke survivors. They were allocated in to two groups either the balance beam or the balance board training group. All the participants were undergone eight weeks of supervised training session. The gait velocity was assessed using the Time Up and Go (TUG) test at the baseline and post training.

Results: The result of the study revealed that both the group has showed significant improvements in the gait parameters ($p < 0.05$). However, the balance beam training group had statistically significant better gait velocity than the balance training group ($p < 0.05$).

Conclusion: The study concluded that balance training is an essential component in improving gait velocity during stroke rehabilitation. The clinicians can use either of the treatment options for gait velocity whereas, the balance training using balance beam devise has better results the other device.

Keywords: Walking Speed; Balance Training; Proprioceptive Neuromuscular Facilitation; Stoke Survivors

Abbreviations

PNF: Proprioceptive Neuro-Muscular Facilitation; COG: Centre of Gravity; BOS: Base of Support; TUG: Timed Up and Go.

Introduction

Stroke is a major cause of disability worldwide and which can result to development of significant impairment such as difficulty in standing balance and walking. Gait is

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Ann Physiother Occup Ther

important parameter for any subject for the ambulation purpose among survivors [1]. Gait speed is majorly affected due to the involvement of the central nervous system and the muscular system.

So thus literature has shown that balance training could be implemented to enhance the gait parameters among various populations. The balance board exercises are a form of physical training which helps to improve the lumbar pelvic stability. The motor coordination and the trunk and lower balance as well. This exercises usually given using various balance board devices in a flat platform that act as an axis [2,3].

The subjects can be instructed to engage their core and lower body muscles to maintain stability while getting trained using this devices. As per the evidences balance board exercises are found to be a useful method of training on neurological impaired subjects to improve the postal control mechanism and other motor tasks. The versatility of training using the balance board devices, activate the neuro-muscular system to promote the coordination during the regular activities [3].

The balance beam exercises are another form of balance training, which helps on announcing balance, coordination and body posture during different task performance. Traditionally, it has been proved that it can be used to improve the stability while performing various dynamic task of lower estimate. It is commonly used by the gymnastics and barriers, rehabilitation settings and during athletic. Rehabilitation literature has shown that certain neurological conditions can improve the balance parameter using this method of training [4,5].

The pro active neuro-muscular facilitation training is a form of rehabilitation, which encompasses promotion of recovery following any injury, surgical conditions, or due to neurological impairment such as stroke. It helps in restoration of various fundamental movement and activation of various kinetic chain patterns that is being used during routine activities. The principles of PNF allows to improve certain motor task by activating the kinetic chain and the muscular skeletal integration [6,7].

As the global prevalence of stroke is in rise, which puts a major challenge among rehabilitation professionals for the recovery. Thus, there are lot many balance training programs has been established to improve the balance and other motor task among patient. However, the best form of balance training to improve the gait parameter among the patients is still under research. The current existing research gap makes a need for these needs, which can lead to improved rehabilitation strategies and enhanced quality of life for stroke survivors [2-4,6].

Thus, the study aims to compare the effectiveness of balance board training versus balance beam training on gait velocity among stroke survivors.

Methodology

Participants were recruited from local rehabilitation centers, hospitals, and community health programs. Flyers and informational sessions were conducted to raise awareness about the study and its potential benefits. Interested individuals were screened based on the inclusion and exclusion criteria, and those who met the criteria were invited to participate in the study.

Participation Selection

The study requires participants to have a confirmed diagnosis of stroke, be aged 40-80, be ambulatory, have at least 6 months since stroke, and provide written informed consent. The focus is on adult stroke survivors, and participants must be able to walk independently or with minimal assistance. A total of 100 hemiplegic subjects were included in the study [4,5,8].

The study excluded individuals with severe cognitive impairment, other neurological conditions, severe comorbidity, or recent surgery to prevent complications during the study. Participants with cognitive deficits, other neurological disorders, severe cardiovascular, respiratory, or musculoskeletal conditions, or those who had undergone any surgical procedures within the last 3 months were excluded [6,8].

Procedure

Participants underwent an initial assessment to evaluate their baseline walking speed, balance, and overall functional mobility. This assessment was conducted using standardized measurement tools.

Participants were randomly assigned to one of two intervention groups:
Group A: Balance beam exercises with PNF techniques.
Group B: Balance board exercises with PNF techniques.

Both groups participated in the exercise sessions three times a week, for a duration of 8 weeks during January 2020 to February 2024. Each session lasted approximately 60 minutes, including warm-up, exercise, and cool-down phases. Participants performed a series of exercises on a balance beam [4-7].
• Static balance (holding positions).
• Dynamic balance (walking forward, backward, and sideways on the beam).

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- PNF techniques were integrated to enhance neuro-muscular activation and improve coordination.
- Participants engaged in exercises on a balance board, which included:
- Static balance (maintaining position on the board).
- Dynamic movements (shifting weight and performing controlled movements).

- PNF techniques were similarly applied to facilitate muscle engagement and improve balance [7].

All exercise sessions were supervised by trained physiotherapists to ensure safety and proper technique. Safety measures, such as the use of harnesses and mats, were implemented to prevent falls.

Exercise Type	Frequency	Intensity	Time	Type
Group A (Balance Beam Training)	3/ Week X 6 Weeks	Incremental Exercises Based On	20 Minutes	• Static Balance (Holding Positions).
		Challenging Tasks		• Dynamic Balance (Walking Forward, Backward, And Sideways On The Beam).
		Hold Time		• PNF Training
		Reduction Of BOS		
		Exercise Duration		
Group B (Balance Board Training)	3/ Week X 6 Weeks	Incremental Exercises Based On	20 Minutes	• Static Balance (Maintaining Position On The Board).
		Challenging Tasks		• Dynamic Movements (Shifting Weight And Performing Controlled Movements).
		Hold Time		• PNF Training
		Reduction Of BOS		
		Exercise Duration		

Table 1: Exercise Dosimetry.

At the end of the 8-week intervention period, participants underwent a follow-up assessment to measure changes in walking speed, balance, and functional mobility, using the same standardized tools as in the pre-intervention assessment.

Walking Speed Measurement
Timed Up and Go (TUG) Test:
Participants are instructed to stand up from a seated position, walk a distance of 3 meters (10 feet), turn around, walk back to the chair, and sit down. The time taken to complete this task is recorded in seconds. This test assesses mobility and walking speed [9-11].

Statistical Analysis

Means, standard deviations, and ranges were calculated for demographic variables (age, gender) and baseline measurements (walking speed and balance scores) for both intervention groups. The Shapiro-Wilk test was performed to assess the normality of the data distribution for walking speed and balance scores.
Independent t-tests: Used to compare the mean walking speed and balance scores between Group A (balance beam) and Group B (balance board) at baseline.

Paired t-tests: Conducted to compare pre and post-intervention walking speed and balance scores within each group, assuming normal distribution. A p-value of <0.05 was considered statistically significant for all analyses. Statistical analyses were performed using SPSS software version 26 for windows.

Result

Both groups (Group A: Balance Beam and Group B: Balance Board) were comparable in terms of demographic characteristics (age, gender) and baseline measurements of walking speed and balance.

Variables	Experimental	Control	P- Value
Number	50	50	> 0.05
Age	46.4 (5.3)	48.0 (6.5)	> 0.05
Gender (male/ female)	31/19	32/18	
HEIGHT (m)	1.56 (.98)	1.48 (1.2)	> 0.05
WEIGHT (kg)	62 (8.9)	65 (5.3)	> 0.05
Gait velocity	0.47s	0.45s	> 0.05

Table 2: Demographic details.

Groups	Pre	Post	P- Value
Group A (Balance Beam)	0.47	0.59	0.03
Group B (Balance Board)	0.45	0.52	0.04

Table 3: With In-Group Analysis of Gait Velocity.

Groups	Mean Difference	P-Value
Group A (Balance Beam)	0.64	< 0.05
Group B (Balance Board)		

Table 4: Between Group Analysis Gait Velocity

Walking Speed Improvements

There was a statistically significant increase in walking speed from pre-intervention to post-intervention (p < 0.05). Similarly, this group also showed a significant improvement in walking speed (p < 0.05).

Between-Group Comparison

Post-intervention, Group A demonstrated a greater improvement in walking speed compared to Group B (p < 0.05).

Discussion

The present study aimed to evaluate the effects of balance beam and balance board exercises combined with Proprioceptive neuro-muscular facilitation (PNF) techniques on walking speed in stroke patients.

The current study findings are also similar with the previously found literature like balance training in population [8-11]. Balance training helps to improve the postural control mechanism and stability that are vital for proper ambulation and motor control. Alongside the application of proactive neuro-muscular facilitation helps to gain the motor coordination and better functional outcomes by activating the neuro muscular skeletal integration.

According to previous studies it is been proved that balance training is more effective in gait velocity in older individuals.

In this current study the inclusion of dual task training may lead to improvement in neuromuscular control and thus the gait velocity. As all the training was done in standing position with an incremental challenging tasks the integration of anakle and hip strategy could impact on the gait velocity.

The incorporation of training stimuli using different surfaces and platforms could be the potential mechanism behind the change in gait velocity. Achieving significant postural control via bouncing, catching, throwing ball while standing also could a potential factor for the changes.

A study found that both balance training programs are helpful on the gait set. The authors propose that increasing the mobility and ability components could be the underline cause behind the outcomes received. Both of the balance training program enhance the lower body joint function, focusing on controlling posture during various task.5-7 Stroke survivor patients struggle with maintaining their centre of gravity (COG) within the base of support (BOS) due to various muscular weakness [4,5]. The balance training program could be potential mechanism behind regaining of the motor control. PNF techniques can facilitate specific movement patterns through application of the stretch and resistance. The hesitation in motor learning and motor re-learning program contributed to improvement in the walking and walking velocity [6,7]. Good walking speed is a central factor for getting the functional recovery. Supervised balance training increases mobility, function, independence, the quality of life. The combination of balance exercises and circuits makes a holistic rehabilitation by targeting the various parameters of motor parameters such as balance, postural control, strength, mobility, and Proprioceptive mechanism [8].

The possible mechanism behind the improvement would be the application of the customized balance training. Both balance training programs yielded improvement in gait parameters [6,12,13].

Limitation & Future Scope

The study several limitations, Firstly the duration of intervention and lack of follow-up show the future studies to be conducted with a large sample size and control group to draw a concrete conclusion regarding the effectiveness of barriers, balance problems on gait parameters.

Conclusion

The findings of this study support the inclusion of balance beam and balance board exercises with PNF techniques into rehabilitation programs for stroke survivor patients. While the results are good, advanced research is needed to explore the long-term effects to establish controlled comparisons, and account for variability in stroke severity. By focusing on these areas, future studies can contribute to the development of more resilient and individualized rehabilitation strategies for improving mobility in stroke survivors.

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