RESEARCH PAPER

Effect of Progressive Sitting Balance Training on Trunk Control and Functional Outcomes in Acute Stroke Patients: A Randomized Controlled Trial

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ABSTRACT

Background: Impaired trunk control is a key contributor to balance dysfunction and reduced functional independence in acute stroke patients. Recent evidence emphasizes the importance of trunk-focused rehabilitation; however, structured progressive sitting balance training protocols remain underexplored.

Objective: To evaluate the effect of progressive sitting balance training on trunk control and functional outcomes in acute stroke patients.

Methods: A single-blinded randomized controlled trial was conducted on 30 acute stroke patients, who were randomly allocated into an experimental group (n = 15) and a control group (n = 15). The experimental group received progressive sitting balance training along with conventional physiotherapy, while the control group received conventional physiotherapy alone. The intervention was administered for 4 weeks (5 days/week). Outcome measures included the Trunk Impairment Scale (TIS) as the primary outcome, and Function in Sitting Test (FIST) and Modified Barthel Index (MBI) as secondary outcomes. Within-group analysis was performed using paired t-tests, and between-group comparisons were analyzed using independent t-tests.

Results: Both groups showed statistically significant improvements in all outcome measures ($p < 0.05$). However, the experimental group demonstrated significantly greater improvements compared to the control group in TIS, FIST, and MBI scores ($p < 0.001$). The mean change in TIS, FIST and MBI scores was higher in the experimental group, indicating superior improvement in trunk control, sitting balance, and functional independence.

Conclusion: Progressive sitting balance training is an effective intervention for enhancing trunk control and functional outcomes in acute stroke patients. Incorporating structured, task-specific trunk training into early rehabilitation programs may lead to improved recovery and independence.

Keywords: Stroke, Trunk Control, Sitting Balance, Physiotherapy, Functional Outcome, Randomized Controlled Trial.

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INTRODUCTION

Stroke remains one of the leading causes of long-term disability worldwide, resulting in significant impairments in motor control, balance, and functional independence. A large proportion of stroke survivors exhibit deficits in postural stability, with approximately 80% experiencing balance dysfunction during the acute and subacute stages of recovery[1]. These impairments are primarily attributed to deficits in neuromuscular coordination, proprioception, and motor control, particularly affecting the trunk musculature[2].

Trunk control is a fundamental component of postural stability and is essential for maintaining sitting and standing balance, facilitating coordinated limb movement, and performing functional activities such as transfers and ambulation[3]. Impaired trunk function has been shown to negatively impact sitting balance, gait, and activities of daily living (ADL), thereby delaying overall functional recovery following stroke[4].

Recent randomized controlled trials emphasize that trunk dysfunction is not merely a secondary impairment but a primary determinant of functional outcomes after stroke. A single-blinded RCT by Karaca et al. (2024) demonstrated that trunk-centered training significantly improved trunk control, proprioception, balance, and ADL performance in stroke patients[5]. Similarly, another RCT comparing virtual reality-based and conventional balance training reported significant improvements in trunk impairment and dynamic sitting balance, highlighting the importance of targeted trunk rehabilitation strategies[6].

Moreover, systematic reviews and meta-analyses of randomized controlled trials have consistently shown that balance training interventions produce significant improvements in trunk control (Trunk Impairment Scale), balance (Berg Balance Scale), and mobility outcomes compared to conventional therapy alone[7]. These findings reinforce the clinical importance of incorporating structured balance and trunk training into early stroke rehabilitation programs.

Progressive sitting balance training is a task-specific rehabilitation approach that involves graded challenges to postural control through controlled static and dynamic activities. This method enhances sensory-motor integration, promotes anticipatory and reactive postural adjustments, and improves trunk muscle activation patterns. Evidence suggests that task-specific and progressive training paradigms are more effective than traditional exercises in improving dynamic trunk control and functional outcomes[8].

Despite the growing body of evidence supporting trunk-focused rehabilitation, there remains a lack of well-structured protocols specifically targeting progressive sitting balance training in acute stroke populations. Therefore, this study aims to evaluate the effectiveness of progressive sitting balance training on trunk control and functional outcomes in acute stroke patients.

METHODOLOGY:

- **Study Design**:
  Randomized Controlled Trial (Single-blinded)
- **Participants:**
  Patients diagnosed with stroke
- **Sample Size:**
  Total sample = 30 participants
- **Sampling Method**
  Simple random sampling using computer-generated randomization

Inclusion Criteria

- Age between 40–75 years
- First-ever unilateral ischemic or hemorrhagic stroke confirmed by imaging (CT/MRI)
- Acute stage of stroke (≤ 4 weeks post-onset)

- Medically stable and cleared for physiotherapy intervention
- Mini-Mental State Examination (MMSE ≥ 24)
- Ability to follow simple verbal commands

Exclusion Criteria

- Recurrent stroke or bilateral involvement
- Severe visual, vestibular or perceptual deficits (e.g., neglect)
- Other neurological disorders (e.g., Parkinson's disease, multiple sclerosis)
- Severe musculoskeletal conditions affecting sitting balance (e.g., spinal deformity, fractures, severe arthritis)
- Unstable cardiovascular or medical conditions (e.g., uncontrolled hypertension, cardiac instability)

INTERVENTION PROTOCOL

GROUP A (EXPERIMENTAL GROUP) PROGRESSIVE SITTING BALANCE TRAINING + CONVENTIONAL THERAPY

Participants in the experimental group received progressive sitting balance training (30 minutes) in addition to conventional physiotherapy, 5 days per week for 4 weeks.

Training Protocol

Stage 1: Static Sitting Control

- Sitting with support gradually progress to unsupported sitting
- Maintenance of midline posture
- Emphasis on symmetrical weight-bearing

Stage 2: Dynamic Sitting Balance

- Weight shifting (anterior, posterior, lateral)
- Reaching activities within base of support
- Controlled trunk flexion/extension

Stage 3: Perturbation Training

- External manual perturbations
- Unstable surface sitting (e.g., therapy ball)
- Reactive balance training

Stage 4: Functional Task-Oriented Training

- Reaching outside base of support
- Dual-task activities
- Object manipulation tasks

GROUP B (CONTROL GROUP) CONVENTIONAL PHYSIOTHERAPY

- Range of motion exercises
- Strengthening exercises
- Bed mobility and transfer training
- Gait training

Total Session Duration: 30-45 minutes; 5 session/weekly, 4 weeks

OUTCOME MEASURES

Primary Outcome

Trunk Impairment Scale (TIS)

Secondary Outcomes

Function in Sitting Test (FIST)

Modified Barthel Index (MBI)

STATISTICAL ANALYSIS

Data were analysed using SPSS version 26.0. Normality of distribution was assessed using the Shapiro-Wilk test, which demonstrated normal distribution of all outcome variables ($p > 0.05$). For within-group comparisons, a paired t-test was used and for between-group comparisons, independent t-test was applied. The level of statistical significance was set at $p < 0.05$.

Table 1: Baseline Characteristics

Variable	Experimental Group	Control Group	p-value
Age (years)	57.8 ± 7.9	58.2 ± 8.1	0.88
Gender (M/F)	9/6	8/7	0.71
Stroke Duration (days)	12.1 ± 3.8	11.6 ± 4.0	0.69

TABLE 2: Within-Group Comparison - Experimental Group

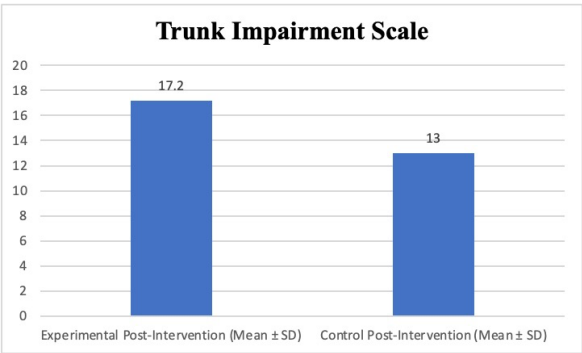
Outcome Measure	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	t-value	p-value
TIS	9.1 ± 2.0	17.2 ± 2.6	8.1	10.84	<0.001
FIST	20.0 ± 3.0	38.8 ± 3.9	18.8	14.27	<0.001
MBI	34.8 ± 5.9	69.2 ± 7.8	34.4	12.96	<0.001

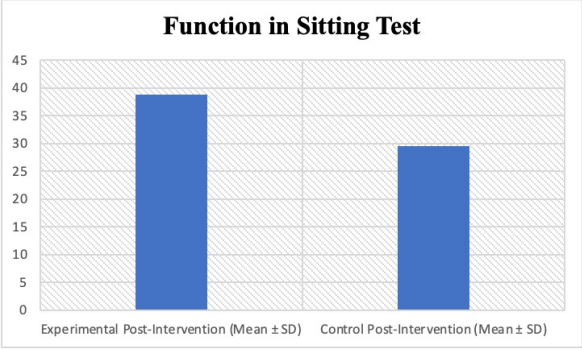
TABLE 3: Within-Group Comparison - control Group

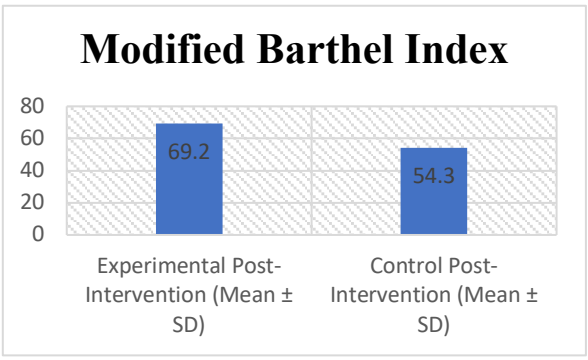
Outcome Measure	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	t-value	p-value
TIS	9.3 ± 2.2	13.0 ± 2.3	3.7	5.12	<0.05
FIST	20.8 ± 3.4	29.6 ± 3.5	8.8	6.45	<0.05
MBI	35.5 ± 5.6	54.3 ± 7.2	18.8	7.38	<0.05

Table 4: Between-Group Comparison of Post-Intervention Scores Using Independent t-Test

Outcome Measure	Experimental Post-Intervention (Mean ± SD)	Control Post-Intervention (Mean ± SD)	Mean Difference	t-value	p-value
TIS	17.2 ± 2.6	13.0 ± 2.3	4.2	4.63	<0.001
FIST	38.8 ± 3.9	29.6 ± 3.5	9.2	6.78	<0.001
MBI	69.2 ± 7.8	54.3 ± 7.2	14.9	5.41	<0.001







RESULTS

Both the experimental and control groups demonstrated statistically significant improvements in trunk control, sitting balance and functional independence following the intervention period ($p < 0.05$). However, the experimental group showed significantly greater improvements compared to the control group. Within-group analysis using paired t-tests revealed a marked increase in Trunk Impairment Scale (TIS), Function in Sitting Test (FIST), and Modified Barthel Index (MBI) scores in the experimental group ($p < 0.001$), whereas the control group showed moderate improvements ($p < 0.05$). Between-group analysis using independent t-tests demonstrated highly significant differences in post-intervention scores for TIS, FIST and MBI ($p < 0.001$), favoring the experimental group. These findings indicate that progressive sitting balance training is more effective than conventional physiotherapy in improving functional outcomes in acute stroke patients.

DISCUSSION:

The present study investigated the effect of progressive sitting balance training on trunk control and functional outcomes in acute stroke patients and demonstrated that the experimental group showed significantly greater improvements in Trunk Impairment Scale (TIS), Function in Sitting Test (FIST), and Modified Barthel Index (MBI) scores compared to conventional physiotherapy. These findings suggest that structured, progressive trunk-focused interventions play a critical role in early stroke rehabilitation. The significant improvement in trunk control observed in the experimental group aligns with recent randomized controlled trials emphasizing the importance of targeted trunk rehabilitation. A

2023 RCT by Cabanas-Valdés et al. reported that task-specific trunk training significantly improved trunk impairment and postural control compared to standard therapy[1]. Similarly, a 2024 randomized trial demonstrated that core stability and trunk-specific exercises resulted in superior improvements in trunk coordination and balance, supporting the findings of the present study[2].

The observed enhancement in sitting balance (FIST scores) may be attributed to improved anticipatory and reactive postural adjustments. Progressive sitting balance training challenges the neuromuscular system through controlled weight shifts, reaching activities, and perturbations, thereby enhancing sensory-motor integration. A recent 2025 RCT investigating perturbation-based balance training found significant improvements in sitting and dynamic balance in stroke patients, highlighting the effectiveness of reactive postural control training[3].

Furthermore, the significant improvement in functional independence (MBI) in the experimental group indicates that gains in trunk control translate into meaningful functional outcomes. This is consistent with findings from a 2024 longitudinal study, which reported that early improvements in trunk control strongly predict ADL recovery and independence in stroke patients[4]. Another recent RCT demonstrated that trunk-focused rehabilitation leads to significantly higher functional independence scores compared to conventional therapy, reinforcing the clinical importance of targeting the trunk during early rehabilitation[5].

The superior outcomes observed in the experimental group can be explained by the principles of task-specific training and neuroplasticity. Progressive sitting balance training involves repetitive, goal-directed activities that stimulate cortical reorganization and improve motor learning. Evidence from neurorehabilitation research suggests that early, intensive, and task-oriented interventions enhance synaptic plasticity and functional recovery following stroke[6]. In contrast, although the control group showed improvements, these were comparatively smaller, likely due to the generalized nature of conventional physiotherapy, which may not sufficiently challenge trunk-specific control mechanisms. Recent systematic reviews have highlighted that conventional rehabilitation alone may be insufficient to optimize trunk recovery unless combined with targeted trunk interventions[7].

CONCLUSION

The findings of this study demonstrate that progressive sitting balance training is significantly more effective than conventional physiotherapy in improving trunk control, sitting balance, and functional independence in acute stroke patients. The experimental group showed superior improvements in Trunk Impairment Scale, Function in Sitting Test, and Modified Barthel Index scores, indicating that targeted, task-specific trunk rehabilitation enhances both postural control and activities of daily living. Incorporating progressive sitting balance training into early stroke rehabilitation programs may facilitate faster and more meaningful functional recovery. Further research with larger sample sizes and long-term follow-up is recommended to confirm the sustainability of these outcomes.

CONFLICT OF INTEREST:

None

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