

Effectiveness of Task-Oriented Balance Training Versus Perturbation-Based Training as Adjuncts to Conventional Physiotherapy in Stroke Rehabilitation

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Abstract:

➤ *Background:*

Balance impairment and reduced functional mobility are common consequences of stroke and can limit independence in activities of daily living. Conventional physiotherapy plays an important role in stroke rehabilitation; however, incorporating specific balance-training strategies may further improve postural control and mobility. Task-oriented balance training focuses on practising functional activities, whereas perturbation-based balance training aims to improve postural responses to balance disturbances. Comparative evidence regarding their effectiveness when combined with conventional physiotherapy remains an important area of investigation.

➤ *Objective:*

To compare the effects of Task-Oriented Balance Training and Perturbation-Based Balance Training, when combined with conventional physiotherapy, in improving balance and functional mobility among stroke patients.

➤ *Methods:*

A randomized controlled trial was conducted on 30 subacute stroke patients aged 40–70 years. Participants were randomly allocated into two groups: Group A (TOBT + conventional physiotherapy) and Group B (PBBT + conventional physiotherapy), with 15 patients in each group. Both groups received intervention for 4 weeks, three sessions per week. Outcome measures included the Berg Balance Scale (BBS) and Barthel Index (BI), assessed before and after the intervention period.

➤ *Results:*

Both groups demonstrated improvements in balance and functional mobility following treatment. Group A improved from a mean BBS score of 22.13 to 36.07 and a mean BI score of 42.67 to 66.60, whereas Group B improved from a mean BBS score of 23.73 to 45.53 and a mean BI score of 38.73 to 83.47. Post-treatment analysis revealed statistically significant differences favoring Group B for both BBS ($p = 0.0088$) and BI ($p = 0.0109$), indicating superior improvement in balance and ADL performance.

➤ *Conclusion:*

Both Task-Oriented Balance Training and Perturbation-Based Balance Training, when combined with conventional physiotherapy, were effective in improving balance and functional independence in stroke patients. However, Perturbation-Based Balance Training produced significantly greater improvements and may be considered a more effective rehabilitation strategy for enhancing postural control, mobility, and independence in activities of daily living following stroke.

Keywords: Stroke, Balance Training, Task-Oriented Balance Training, Perturbation-Based Balance Training, Berg Balance Scale, Barthel Index, Rehabilitation, Functional Independence.

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I. INTRODUCTION

Stroke is a major cause of long-term disability worldwide and can result in persistent neurological impairments that affect an individual's independence and quality of life. Depending on the location and extent of the brain lesion, stroke survivors may experience motor weakness, sensory disturbances, impaired coordination, altered postural control and limitations in functional activities. These impairments can interfere with the performance of everyday tasks, particularly those requiring standing, walking, transferring between positions and maintaining stability during movement. Consequently, improving balance and functional mobility remains an important objective of poststroke rehabilitation [1,2].

Balance is a complex motor function that depends on the integration of visual, somatosensory and vestibular information, together with appropriate neuromuscular responses. Following stroke, damage to the central nervous system may disrupt sensory processing, postural adjustments and the coordination of movements. Weakness on the affected side, asymmetrical weight distribution and reduced ability to control the body's centre of mass may further compromise postural stability. These difficulties can affect both anticipatory balance control during voluntary movements and reactive balance control following an unexpected disturbance. Impaired balance and mobility may consequently restrict participation in daily activities and increase vulnerability to falls [2,3].

Physiotherapy is an essential component of stroke rehabilitation and incorporates interventions intended to improve motor performance, postural stability, walking ability and functional independence. Among the available approaches, task-oriented training emphasises repetitive practice of meaningful activities that resemble the functional demands encountered in everyday life. Exercises may include sit-to-stand transfers, reaching, weight shifting, stepping, turning and walking-related activities. The difficulty of these tasks can be adjusted according to the individual's functional capacity, with progression introduced as performance improves. By integrating movement practice with specific functional goals, task-oriented training aims to facilitate motor relearning and the transfer of acquired skills to daily activities [3,4].

Evidence from clinical studies supports the potential benefits of task-oriented interventions for balance and mobility after stroke. Park and Won reported improvements in functional balance following task-oriented training incorporating altered somatosensory input in individuals with chronic stroke [3]. Similarly, Choi and Kang found improvements in balance, activities of daily living and self-efficacy following a patient-centred task-oriented training programme [4]. More recently, a systematic review and meta-

analysis of 17 randomised controlled trials involving 888 participants reported beneficial effects of task-oriented training on gait speed, walking endurance, Berg Balance Scale performance and Timed Up and Go test results [2]. Nevertheless, the magnitude of improvement may vary according to the characteristics of the participants, the tasks selected, the intensity of practice and the duration of the intervention.

Although task-oriented training addresses functional performance, it may not specifically provide sufficient practice of rapid postural responses to unexpected balance disturbances. Perturbation-based balance training is an intervention designed to address this aspect of postural control. It involves the controlled introduction of balance disturbances that require the individual to generate appropriate compensatory responses, such as rapid stepping or grasping, to restore stability. Perturbations may be delivered manually by a trained therapist or through specialised equipment, depending on the intervention protocol and available resources. Repeated exposure to appropriately graded perturbations may facilitate the development of reactive balance strategies that are relevant to situations in which balance is unexpectedly challenged [5,6].

Research investigating perturbation-based balance training in stroke rehabilitation has reported promising but variable findings. In a randomised controlled trial involving individuals with subacute stroke, Handelzalts and colleagues found improvements in reactive balance responses and balance confidence following perturbation-based training compared with weight-shifting and gait training. However, significant between-group differences were not observed in several conventional clinical measures of balance and walking performance [6]. A systematic review and meta-analysis by Alayat and colleagues also reported a beneficial effect of perturbation-based training on balance, although the certainty of the available evidence was low or very low [5]. Furthermore, a systematic review examining fall prevention after stroke concluded that the available evidence was insufficient to establish whether perturbation-based training reduces fall risk [7]. These findings indicate the need for further comparative research using clearly defined interventions and appropriate clinical outcome measures.

Task-oriented balance training and perturbation-based balance training address related but distinct components of postural control. The former emphasises the practice of goal-directed functional activities, whereas the latter focuses on the ability to recover stability when balance is disturbed. Both approaches may be relevant to improving balance and mobility after stroke, but their effects may differ depending on the outcome being assessed. Improvements in functional balance scores, mobility performance and walking speed do not necessarily indicate equivalent changes in reactive postural responses or fall-related outcomes. Therefore,

selecting an appropriate rehabilitation strategy requires consideration of the specific functional deficits and treatment goals of the individual.

Although researchers have investigated both interventions in stroke rehabilitation, the available evidence does not conclusively show which approach yields greater improvements when combined with the same conventional physiotherapy programme. Direct comparisons using equivalent treatment duration, comparable intervention intensity and standardised outcome assessment are particularly important for interpreting the relative effects of these approaches. Such comparisons may help distinguish the contribution of task-specific functional practice from that of reactive balance training and provide useful information for clinical decision-making.

Therefore, the present study aims to compare the effectiveness of task-oriented balance training and perturbation-based balance training, both combined with conventional physiotherapy, in improving balance and functional mobility among individuals with stroke. The study will assess changes in balance and mobility following the intervention and determine whether the magnitude of improvement differs between the two groups. The findings may contribute to the evidence base for selecting and integrating balance-training strategies within individualised stroke rehabilitation programmes.

➤ *Aims and Objectives*

- **Aims:** To compare the effects of TOBT versus PBBT, along with conventional physiotherapy to improve balance and functional mobility in stroke patients.
- **Objectives**
 - ✓ To assess the effectiveness of TOBT along with conventional physiotherapy in improving balance and functional independence in stroke patients.
 - ✓ To assess the effectiveness of PBBT along with conventional physiotherapy in improving balance and functional independence in stroke patients.
 - ✓ To compare the effectiveness of TOBT versus PBBT along with conventional physiotherapy in improving balance and functional independence in stroke patients.

II. METHODOLOGY

➤ *Study Design:*

A two-group comparative intervention study was conducted to evaluate the effects of task-oriented balance training and perturbation-based balance training, with both approaches supplemented by conventional physiotherapy.

➤ *Sample Size and Group Allocation*

A total of 30 participants were included in the study and divided into two groups, comprising 15 participants in each group.

- **Group A (n = 15):** Task-oriented balance training combined with conventional physiotherapy.
- **Group B (n = 15):** Perturbation-based balance training combined with conventional physiotherapy.
- **Sampling Method:** Simple random sampling was reported as the sampling method. Participants were subsequently allocated to the two intervention groups. The specific randomisation and allocation procedures should be described separately in the final manuscript.
- **Study Duration:** The overall study period was six months.
- **Study Setting:** The study was conducted in the Outpatient Department of the Department of Physiotherapy, University of Science and Technology Meghalaya (USTM), and at a rehabilitation centre in Guwahati.
- **Intervention Duration and Frequency:** The intervention programme was delivered over four weeks, with three sessions per week. Each session lasted 45 minutes, comprising 30 minutes of the assigned balance-training intervention and 15 minutes of conventional physiotherapy.
- **Criteria for Participant Selection:** Patients for the study were selected based on the following criteria.

➤ *Inclusion Criteria*

Participants were recruited based on the fulfilment of the following eligibility requirements which includes if they presented with a first-ever stroke, were between 40 and 70 years of age, and included individuals of either gender. Participants were required to be ambulatory, with or without the use of ambulatory aids, and to have experienced a stroke within 0–3 months before recruitment, corresponding to the subacute stage of stroke recovery. Participants were also required to be able to follow verbal commands and have a Mini-Mental State Examination (MMSE) score of ≥ 24 , indicating adequate cognitive function to participate in the study procedures.

➤ *Exclusion Criteria*

Participants were not considered eligible for the study if they had severe cognitive impairment, other neurological disorders that could affect balance, or severe musculoskeletal conditions that could limit participation in the study. Individuals with visual or vestibular disorders affecting balance, unstable cardiovascular conditions, or severe aphasia that prevented effective communication were also excluded. In addition, patients with significant sensory, proprioceptive, cognitive, or perceptual impairments that could independently influence balance or interfere with the assessment or intervention were deemed unsuitable for enrolment in the study.

➤ *Outcome Measures:*

- **Berg Balance Scale (BBS):** The Berg Balance Scale is a standardised clinical instrument used to assess functional balance in individuals with neurological and other

conditions affecting postural stability. It consists of 14 items covering activities such as sitting, standing, transferring, reaching and changing positions. Each item is scored on a five-point ordinal scale ranging from 0 to 4, giving a maximum possible score of 56. Higher scores indicate better functional balance performance.

The scale is commonly used in stroke rehabilitation to document balance performance and monitor changes following therapeutic interventions. Its administration generally requires approximately 15–20 minutes, depending on the participant's functional abilities [8,9].

- **Barthel Index:** The Barthel Index (BI) is used to measure the performance of daily life activities, mobility, and functional dependency of patients. It was developed to monitor performance in chronic pre- and post-treatment patients and to indicate when to move on to rehabilitation. The scale described 10 tasks and was scored according to amount of time or assistance required by the patient. Total score was from 0 to 100, with lower scores representing greater nursing dependency. First used in approximately 1955, Barthel's eponymous scale became popular in rehabilitation and was well-established by time of publication [10].

➤ Procedure

Participants were screened using a structured selection proforma to determine whether they met the predefined inclusion and exclusion criteria. Eligible individuals who agreed to participate were informed about the purpose, procedures and nature of the study. Written informed consent was obtained before enrolment, and relevant demographic information was recorded.

Following enrolment, the participants were divided into two groups of 15 participants each. Baseline assessments were performed using the Berg Balance Scale and the Barthel Index to document their initial balance performance and level of functional independence.

Group A received task-oriented balance training in addition to conventional physiotherapy, whereas Group B received perturbation-based balance training in addition to conventional physiotherapy. Both groups followed the intervention schedule of three sessions per week for four weeks. Each treatment session lasted 45 minutes, including 30 minutes of the assigned balance-training intervention and 15 minutes of conventional physiotherapy.

The prescribed interventions were delivered according to the respective group protocols. Appropriate precautions were taken during treatment, particularly during perturbation-based exercises, to minimise the risk of loss of balance and injury.

Post-intervention assessments were conducted using the same outcome measures to evaluate changes in balance and functional independence. The pre- and post-intervention findings were intended to establish the changes within each

group and facilitate comparison of outcomes between the two intervention groups.

➤ Experimental Protocols:

- **Group A (TOBT):** Participants will receive 30 minutes of task-oriented balance training focusing on functional activities such as sit-to-stand, reach outs, obstacle walking, brisk walking, and perturbation on swiss ball.[11] Followed by conventional physiotherapy to the 15 patients. Sessions will be conducted 3 days per week for 4 weeks.
- **Group B (PBBT):** Participants in Group B received 30 minutes of perturbation-based balance training followed by 15 minutes of conventional physiotherapy during each session.

The perturbation-based programme involved the application of controlled manual disturbances intended to challenge postural stability and encourage appropriate balance-recovery responses. Perturbations were applied in different postural positions, including sitting, kneeling and standing on a mattress. The prescribed protocol consisted of the following components:

Manual perturbations were administered in sitting, kneeling and standing positions. Each perturbation was followed by a 10-second holding period, as specified in the study protocol. Ten perturbations were administered in each position. Two sets were prescribed according to the intervention protocol. Training was conducted three times per week for four weeks [7]. Precautions were taken throughout the intervention to minimise the risk of falls or injury. Participants were closely supervised during the exercises, and the intensity of the perturbations was intended to remain appropriate to their functional capacity and safety. After the perturbation-based training component, participants received 15 minutes of conventional physiotherapy. The conventional programme included range-of-motion exercises, stretching and strengthening of the lower-limb muscles, trunk-control activities, transfer practice and gait training, as specified in the treatment protocol.[12]

➤ Conventional Physiotherapy

Conventional physiotherapy was provided to both groups as an adjunct to their assigned balance-training intervention. The programme comprised the following activities:

- **Mat exercises:** Stretching and strengthening exercises for the lower-limb muscles.
- **Swiss-ball activities:** Sitting on a Swiss ball with eyes open and closed, under appropriate supervision.
- **Sitting balance exercises:** Reaching activities performed from a sitting position.
- **Standing balance exercises:** Reaching activities performed while standing.
- **Range-of-motion exercises:** Exercises intended to maintain or improve joint mobility.

- Functional training: Trunk-control exercises, transfer practice and gait training, as indicated in the respective treatment protocols.

The conventional physiotherapy component lasted 15 minutes per session and was delivered three times per week for four weeks. The overall session duration was 45 minutes, consisting of 30 minutes of group-specific balance training and 15 minutes of conventional physiotherapy.

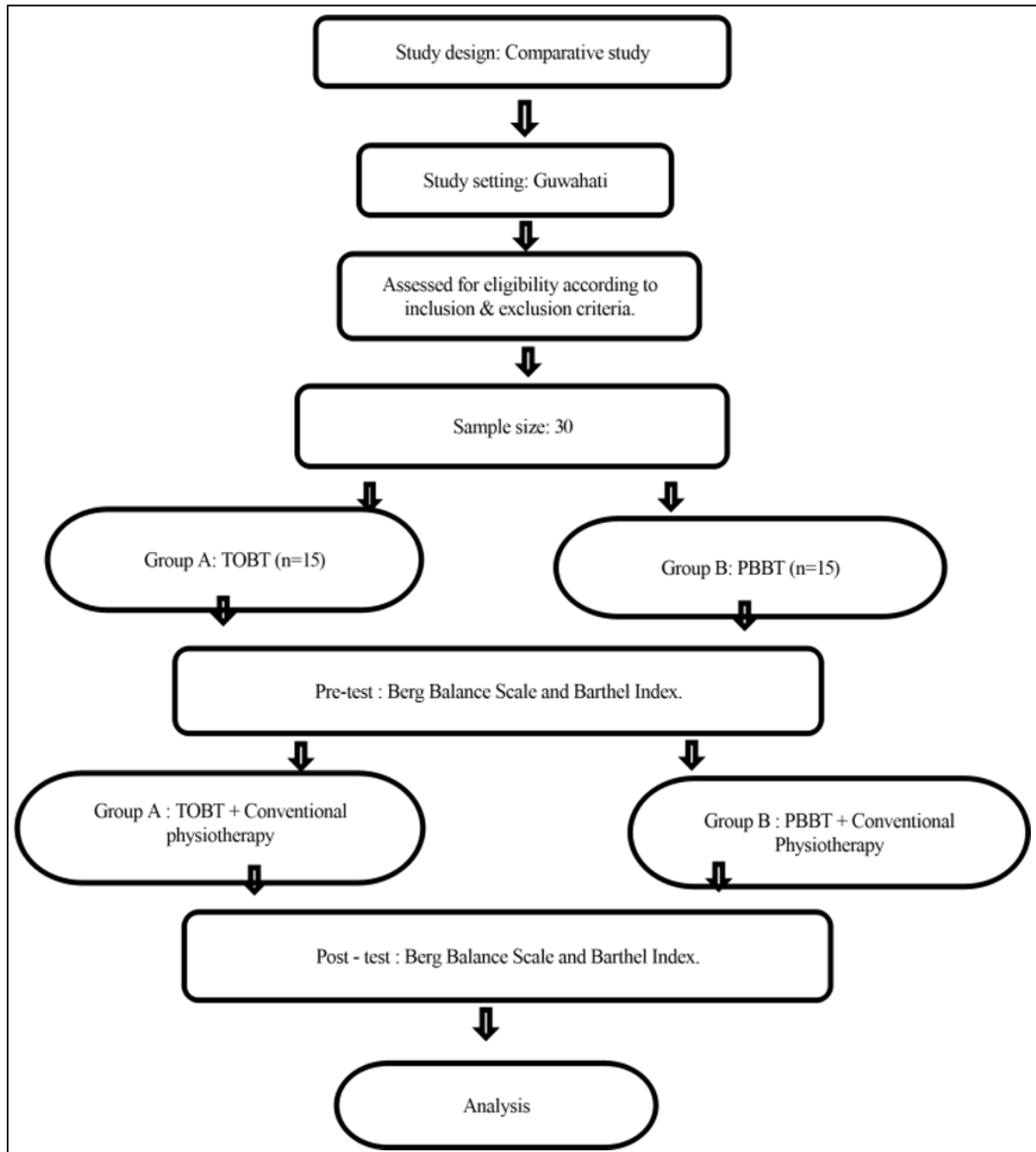


Fig 1 Consort Flowchart

➤ Statistical Analysis:

The collected data were organized in a master chart and analysed using IBM SPSS Statistics for Windows and Microsoft Excel 2007. Descriptive statistics, including mean and standard deviation, were used to summarize the data. An independent-samples **t*-test was used for intergroup comparisons of Berg Balance Scale (BBS) and Barthel Index (BI) scores between the Task-Oriented Balance Training (TOBT) and Perturbation-Based Balance Training (PBBT)

groups. A paired-samples **t*-test was used for intragroup comparisons of pre-intervention and post-intervention scores within each group. A paired-samples *t*-test was used for intragroup comparisons of pre-intervention and post-intervention scores within each group. The degrees of freedom, 95% confidence intervals, and *p*-values were calculated as appropriate. Statistical significance was set at *p* < 0.05.

III. RESULT

Total 39 patients were assessed and out of which 4 were excluded because they did not fulfill the inclusion criteria, 1 refused to participate in the study and 4 were not able to

complete the intervention of 4 weeks, so total 30 subjects divided in group A and group B 15 patients in each group. Total 23 males and 7 females participated in the study. In Group A, 12 were male and 3 were females whereas in Group B, 4 females and 11 males.

Table 1 Pre-Treatment Total Score Comparison of Both Groups.

	Group A	Group B	t-Value	p-Value
BBS	22.13333333	23.73333333	- 1.9623 97224	0.06 990601
BI	42.66666667	38.73333333	1.3284 68831	0.20527267

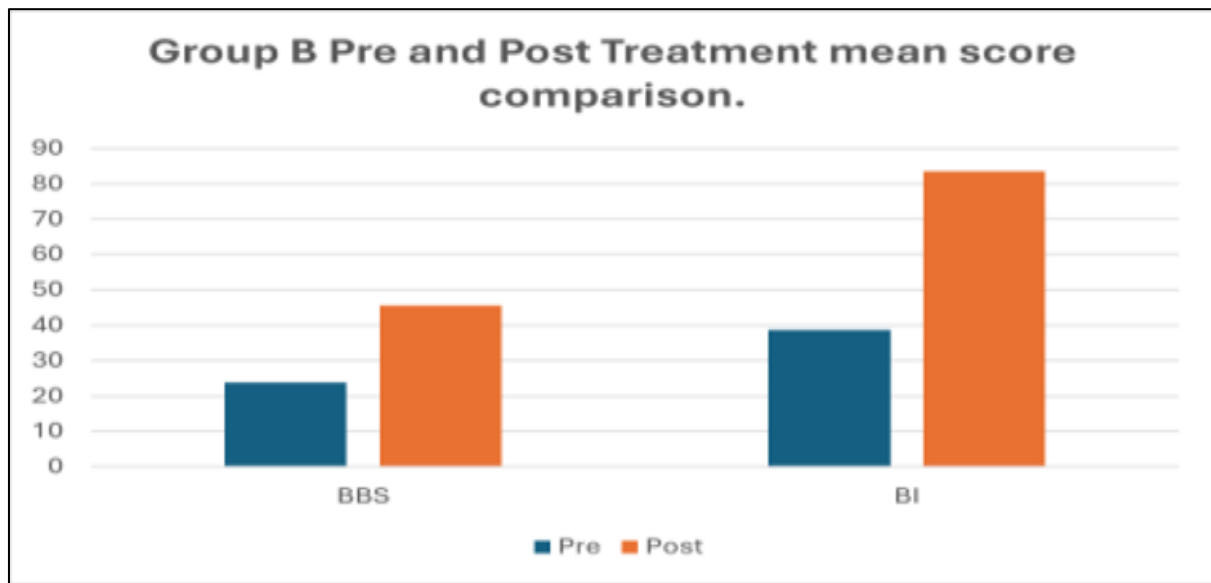


Fig 2 Comparison of BBS and BI at Pre-Treatment of Group A and B.

When comparison was done for the both groups (A and B) at Pre-Treatment for BBS and BI mean scores of the patients , it was found that there statistically significant improvement in values of BBS and BI (Table 1 and Figure 1),

which shows that conventional PT exercises are effective in improving Balance , Mobility and Functions in Stroke patients.

Table 2 Post-Treatment Total Score Comparison of Both Groups.

Outcome Measures	Group A	Group B	t-Value	p-Value
BBS	36.06666667	45.53333333	-3.040508968	0.00881424
BI	66.6	83.46666667	-2.933627353	0.01089316

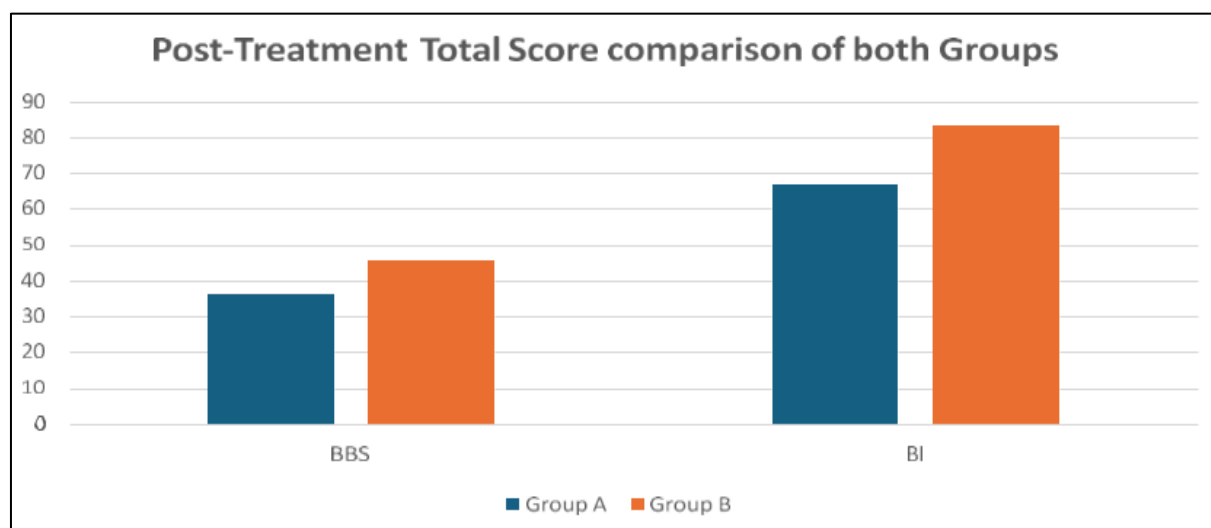


Fig 3 Comparison of BBS and BI at Post-Treatment of Group A and B.

Table 3 Group A Pre and Post Treatment Mean Score Comparison.

Outcome Measures	Pre	Post
BBS	22.13333333	36.06666667
BI	42.66666667	66.6

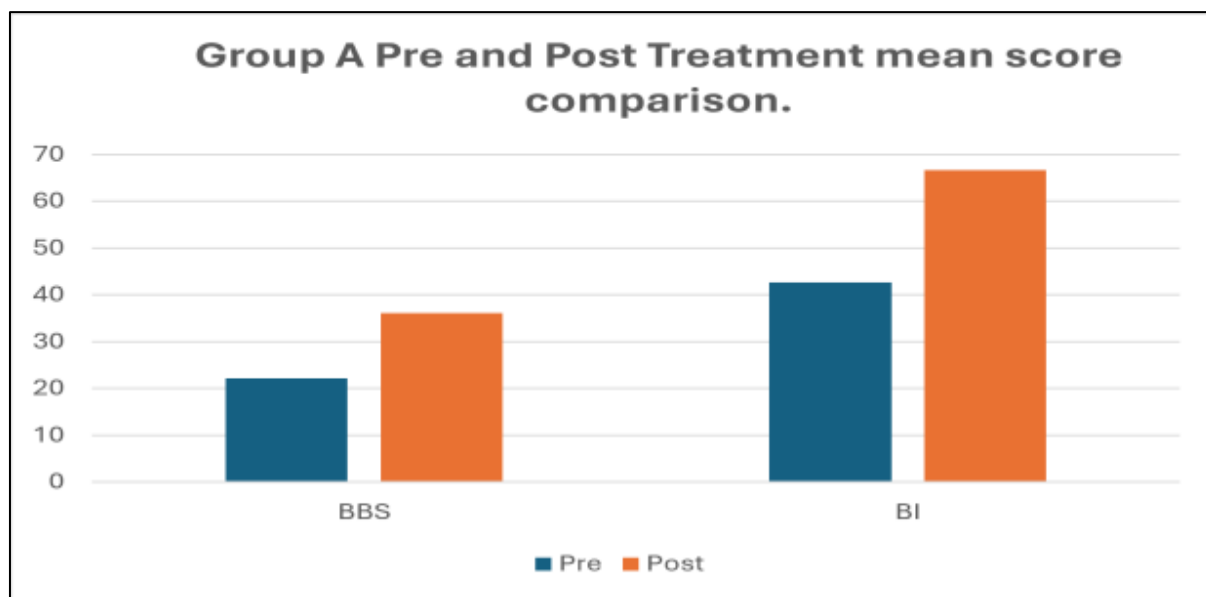


Fig 4 Comparison of BBS and BI at Pre and Post-Treatment of Group A .

Table 4 Group B Pre and Post Treatment Mean Score Comparison.

Outcome Measures	Pre	Post
BBS	23.73333333	45.53333333
BI	38.73333333	83.46666667

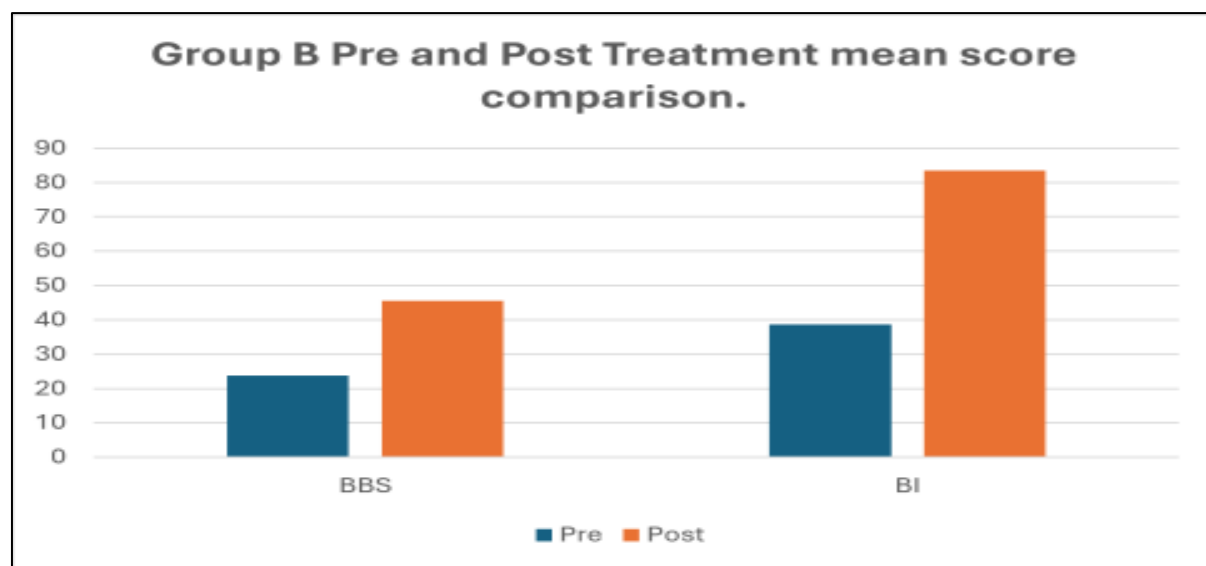


Fig 5 Comparison of BBS and BI at Pre and Post-Treatment of Group B

IV. DISCUSSION

The present study was conducted to compare the effects of two rehabilitation interventions in improving balance and functional independence among stroke patients. Balance impairment and reduced ability to perform activities of daily living are common consequences of stroke and significantly affect quality of life. Therefore, interventions that can

enhance postural control, mobility, and functional independence are of great clinical importance. The findings of the present study demonstrated that both Group A and Group B showed improvement following the treatment period. The improvement observed in both groups suggests that rehabilitation interventions play a vital role in restoring functional abilities after stroke. However, the magnitude of improvement was greater in Group B, indicating that the

intervention administered to Group B was more effective than the intervention received by Group A. The pre-treatment comparison revealed no statistically significant differences between the groups. The mean BBS scores of Group A and Group B were 22.13 and 23.73 respectively, while the mean BI scores were 42.67 and 38.73. The absence of significant baseline differences indicates that both groups were comparable before intervention and that the observed posttreatment changes were likely attributable to the interventions rather than pre-existing differences. Following treatment, Group A improved from a mean BBS score of 22.13 to 36.07 and from a mean BI score of 42.67 to 66.60. Group B improved from a mean BBS score of 23.73 to 45.53 and from a mean BI score of 38.73 to 83.47. These improvements indicate enhanced balance, mobility, and independence in activities of daily living. The post-treatment analysis demonstrated statistically significant differences between the groups. Group B achieved higher scores on both BBS and BI compared with Group A. These findings suggest that the intervention administered to Group B may have promoted greater neuromuscular adaptation, motor relearning, postural stability, and functional recovery. Improved balance contributes directly to enhanced mobility and confidence during movement, which subsequently improves performance of daily activities. The findings of the present study are consistent with the principles of contemporary stroke rehabilitation, which emphasize task-specific training, repetition, motor learning, and functional practice. Improvements in balance and functional independence observed in this study support the growing evidence that targeted rehabilitation strategies can significantly enhance recovery outcomes in stroke survivors.

The greater improvement observed in the PBBT group is in agreement with the findings of Alison Schinkel-Ivy et al. (2019), who reported that perturbation-based balance training improved reactive stepping and postural responses in individuals with chronic stroke. Repeated exposure to external perturbations may enhance the ability to generate rapid corrective responses, thereby improving balance recovery and reducing fall risk.[13]

The findings of the present study are further consistent with previous research. Chandan Kumar and Nawaj Pathan (2016) reported that manual perturbation exercises combined with conventional physiotherapy produced greater improvements in balance, function, and mobility compared to conventional physiotherapy alone.[12]

The superior outcomes observed in the PBBT group may be explained by its emphasis on reactive balance control. Unlike task-oriented training, which primarily targets anticipatory postural adjustments during functional activities, perturbation-based training challenges patients with unexpected balance disturbances. This promotes rapid neuromuscular responses, enhances sensory integration, and improves the ability to maintain stability during real-life situations. Consequently, patients may develop better postural control, confidence, and functional mobility. The significant improvements in Barthel Index scores in both groups indicate enhanced independence in activities of daily

living. These findings are supported by Choi and Kang, who reported that patient-centered task-oriented training improved balance, self-efficacy, and activities of daily living following stroke. Improved balance performance likely contributed to better functional independence and mobility.[4]

Task-Oriented Balance Training also produced significant improvements in balance and functional performance. This can be explained by the repetitive practice of meaningful functional tasks such as sit-to-stand transfers, reaching activities, obstacle negotiation, and walking tasks. Task-specific training promotes motor relearning, neuroplasticity, and improved performance of activities of daily living. Previous studies by Min-Hee Park and Jong-Im Won (2017) and Aye Aye Thant et al. (2019) similarly reported positive effects of task-oriented training on balance and functional outcomes in stroke patients.[3,4]

Overall, the results of the present study suggest that both TOBT and PBBT are effective rehabilitation approaches for stroke patients. However, PBBT appears to provide additional benefits in improving balance and functional independence, possibly due to its greater emphasis on reactive postural control and fall prevention strategies. Therefore, incorporating perturbation-based balance training into conventional physiotherapy programs may lead to superior rehabilitation outcomes in individuals with subacute stroke.

➤ *Limitations of Current Evidence:*

Despite the positive findings, several limitations should be considered while interpreting the results. First, the study included a relatively small sample size, which limits the generalizability of the findings. Larger studies are needed to confirm the effectiveness of the intervention across diverse patient populations. Second, the duration of intervention was limited. Stroke rehabilitation outcomes may continue to evolve over longer periods, and the current study may not fully capture long-term benefits. Third, participants were recruited from a single clinical setting. Multicenter studies would provide stronger evidence and improve external validity. Fourth, no follow-up assessment was conducted after completion of treatment. Therefore, the long-term retention of improvements remains unknown. Fifth, only two outcome measures, BBS and Bi, were used. Additional measures, such as gait speed, functional reach, quality of life, muscle strength, and motor recovery scales, could provide a more comprehensive evaluation of treatment effectiveness. Finally, individual factors such as stroke severity, lesion location, patient motivation, cognitive status, and adherence to therapy may have influenced treatment outcomes and were not fully controlled.

V. CONCLUSION

A comparative analysis of the study findings demonstrates clear differences in treatment outcomes between the two groups. At baseline, both groups exhibited similar levels of impairment, as reflected by non-significant differences in BBS and BI scores. This comparability

strengthens the internal validity of the study and allows meaningful comparison of treatment outcomes. Both interventions resulted in measurable improvements. Group A demonstrated moderate gains in balance and functional independence. However, Group B achieved substantially greater improvements across both outcome measures. The increase in BBS scores indicates superior enhancement of postural control and balance performance, while the increase in BI scores reflects greater independence in activities of daily living. The post-treatment statistical analysis revealed significant differences favoring Group B. These findings indicate that although conventional rehabilitation approaches are beneficial, the intervention used in Group B provides additional therapeutic advantages. The greater improvement observed in Group B may be attributed to increased sensory-motor integration, improved weight shifting, better postural responses, enhanced muscle activation patterns, and greater functional carryover into daily activities. Clinically, these results suggest that incorporating the Group B intervention into stroke rehabilitation programs may help maximize patient recovery, reduce disability, and improve overall quality of life.

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