

# Comparison of Pelvic Proprioceptive Neuromuscular Facilitation versus Core Training on Sit to Stand Performance and Fall Risk in Stroke Patients

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## ABSTRACT

**Background:** Stroke is one of the leading causes of long-term disability, affecting millions worldwide each year. It commonly results in impairments of balance, trunk stability, mobility, and independence. Sit-to-stand (STS) performance is an essential indicator of functional ability, and deficits in this task are strongly linked to fall risk. The present study compares pelvic Proprioceptive Neuromuscular Facilitation (PNF) with core training interventions, both in conjunction with lower limb strengthening, to assess their effects on STS performance and fall risk in stroke patients.

**Methodology:** A comparative experimental design was used. Thirty-six stroke patients (age 40–60) were randomly assigned to Group A (pelvic PNF + strengthening) or Group B (core training + strengthening). Interventions lasted four weeks, five sessions per week. Outcomes were assessed with the Five-Repetition Sit-to-Stand (5STS) and Timed Up and Go (TUG) test.

**Results:** Both groups showed significant improvements within groups for STS transition times and fall risk reduction. However, between-group comparisons revealed no significant differences, suggesting both strategies are equally effective.

**Conclusion:** Pelvic PNF and core training are both effective rehabilitation approaches for improving sit-to-stand performance and reducing fall risk in stroke patients. Clinicians may choose either intervention depending on patient needs and resources.

**Keywords:** Stroke, Rehabilitation, Pelvic PNF, Core Training, Fall Risk, Sit to stand

## INTRODUCTION

A stroke is characterized by the sudden loss of neurological function resulting from a disturbance or reduction in blood flow to a portion of the brain, thereby depriving brain tissue of oxygen and essential nutrients. This deprivation can impair brain function, leading to various clinical manifestations such as paralysis, aphasia or visual disturbances.<sup>1</sup>

Stroke is arise from a diverse range of risk factors, pathological processes, and mechanisms. Hypertension is the most critical modifiable risk factor for stroke, though its impact varies across different stroke subtypes.<sup>2</sup>

The majority (85%) of strokes are ischemic in nature, primarily attributable to small vessel arteriosclerosis, cardio embolism, and large artery thromboembolism. A smaller proportion (approximately 20%) of intracerebral hemorrhages are caused by

macrovascular lesions, including vascular malformations, aneurysms, cavernomas, venous sinus thrombosis, or other rarer etiologies.<sup>3</sup>

Symptoms of a stroke include difficulty speaking and comprehending others, numbness, weakness, or paralysis in the face, arm, or leg, vision problems in one or both eyes, headache, and difficulty walking. Different regions of the brain govern various functions, so the symptoms of a stroke depend on the specific area affected.<sup>4</sup>

Many people experience some physical impacts after a stroke, such as muscle weakness, fatigue, balance issues, foot drop, spasticity, contractures, and changes in sensation.<sup>5</sup>

Physiotherapy is integral to stroke rehabilitation, aiding in the improvement of movement, the reduction of pain, and the enhancement of independence. Techniques such as manual therapy and personalized treatment plans enable stroke patients to regain strength and aspire to better outcomes.<sup>6</sup> Early incorporation of balance-focused rehabilitation can lead to more positive results, facilitate functional independency, and ultimately improve the quality of life for stroke patients.<sup>7</sup> Engaging in programs that optimize balance and muscle-strengthening exercises significantly facilitates an individual's recovery trajectory. providing a rehabilitation program featuring exercises that enhance balance is crucial, as maintaining good balance is fundamental for restoring walking ability independently and perform routine tasks effectively.<sup>8</sup>

Pelvic PNF is a physiotherapy technique that improves pelvic alignment, stability, and coordination of surrounding muscles. It facilitates neuromuscular responses, enhancing sit-to-stand performance, posture, and balanced weight distribution. In stroke patients, it supports gait symmetry, proprioception, and safer ambulation, reducing fall risk and promoting independence.

Core training strengthens the abdominal, back, pelvic, and hip muscles that provide

stability for functional movement. Strong core control improves sit-to-stand ability, trunk balance, and gait, while also helping individuals recover from postural changes. These lowers fall risk and increase confidence in mobility.

The 5STS is a simple tool to assess lower limb strength, balance, and mobility. Performance depends on quadriceps, hamstrings, and gluteal strength, with completion time serving as a reliable indicator of lower body function.

The TUG test measures functional mobility and fall risk by timing the task of rising, walking, turning, and sitting. In stroke survivors with weakness and poor trunk control, it provides a quick assessment of gait efficiency, balance, and safety.

## **MATERIALS AND METHODS**

**STUDY DESIGN:** Comparison Study

**POPULATION:** Stroke patients

**DURATION OF STUDY:** 1 year

**SAMPLE SIZE:** 36 (18 in each group)

**SAMPLING DESIGN:** Simple random method

**TREATMENT DURATION:** 5 days per week for 4 weeks<sup>9</sup>

### **Materials Used:**

Ball, standard chair, plinth, stopwatch, measure tape, marking cone, pen and pencil, paper

### **Inclusion Criteria**

- Patients who are willing to participate
- Age: 40-60 years
- Both Male & Female
- Ischemic Stroke which is diagnosed based on MRI and CT scan of brain
- MMSE: 23
- MAS SCORE: 0-2
- VCG: 2,3,4

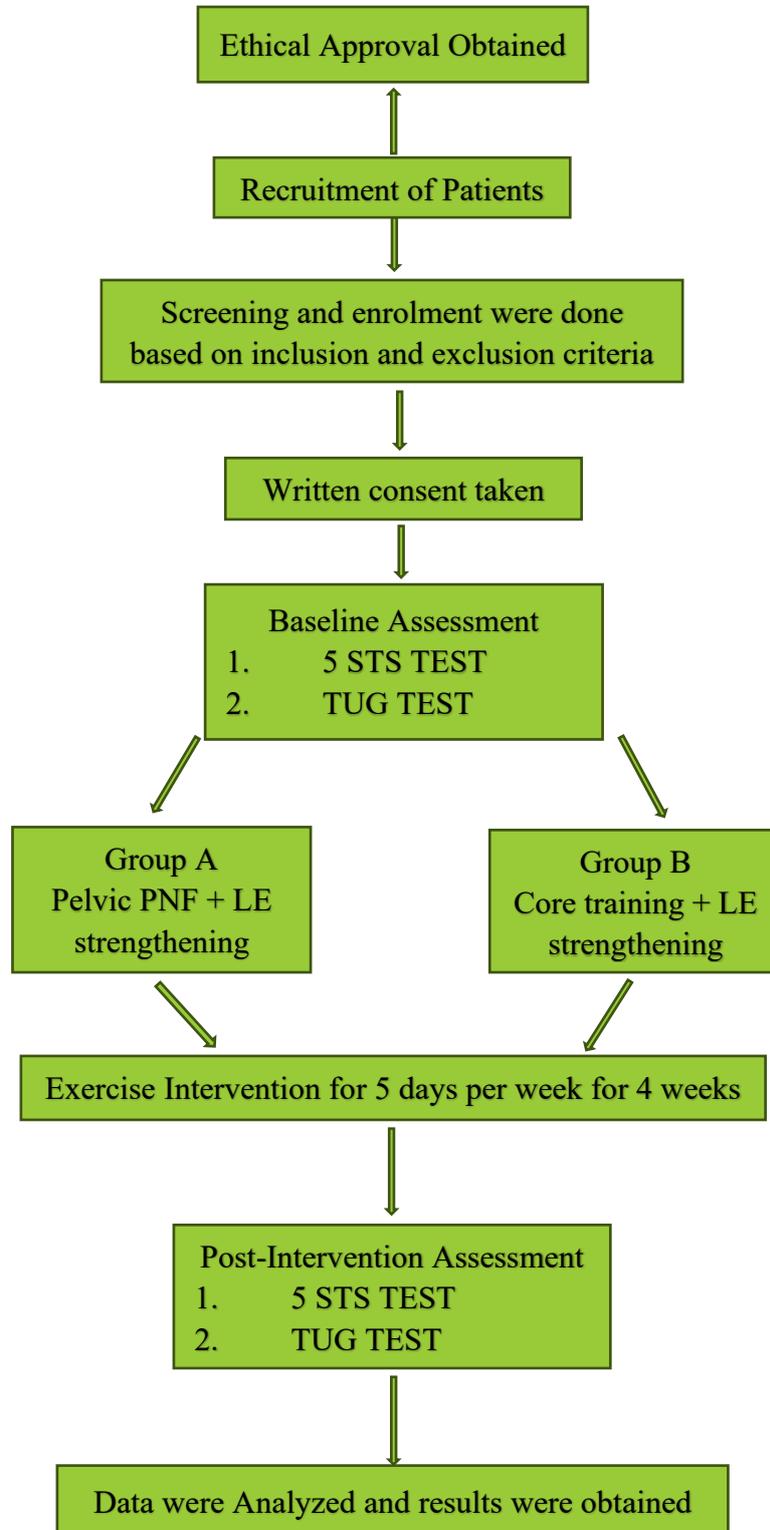
### **Exclusion Criteria**

- Geriatric population
- Patients who are not willing to participate
- Any previous or recent traumatic history of affected LE

- Any sever psychological condition
- Active seizures

**OUTCOME MEASUREMENT:**  
5-REPETATION SIT TO STAND TEST (5STS)<sup>10</sup>:  
TUG TEST

### FLOW CHART



**Figure 1: Flow chart of the study.**

**Group A: Pelvic PNF with LE strengthening exercises**  
Pelvic PNF<sup>12</sup>

Anterior Elevation	one side of the pelvis moves up and forward toward the trunk.	
Posterior Elevation	one side of the pelvis moves up and backward	
Anterior Depression	one side of the pelvis moves down and backward.	
Posterior Depression	one side of the pelvis moves down and outward	

**Table 1: Pelvic PNF exercise for group A**

**Group B core training with LE strengthening exercises**

1. Core training with Swiss ball<sup>13</sup>
2. Bridging
3. One leg bridging
4. Knee to chest
5. Trunk rotation
6. Curl-ups

**Exercise for LE (For quadricep and gluteus)<sup>14</sup>**

1. Bridging
2. Squats
3. SLR
4. High Sitting Knee Extension

5. VMO

**RESULTS AND DISCUSSION**

This study compared the effects of pelvic PNF with lower limb exercises (Group A) and core training with lower limb exercises (Group B) on sit-to-stand performance and fall risk in stroke patients. Data analysis was performed using SPSS 20, with tables prepared in Excel 2021. Normality was checked through histograms and the Shapiro–Wilk test (sample size <50 per group). As the data showed normal distribution, parametric tests were applied at a 5% significance level (95% CI).

1. Within groups: Pre- and post-intervention values were compared using the paired t-test.
2. Between groups: Outcomes were

analysed using the independent t-test. Effect size was calculated using Cohen's d, interpreted as: 0.2 = small, 0.5 = medium, 0.8 = large.

**Table 2: Comparison Of 5-Sit To Stand And Time Up And Go (TUG) Between Group-A And Group-B.**

OUTCOMES	GROUP	PRE-TEST MEAN	PRE-TEST SD	POST-TEST MEAN	POST-TEST SD	Within-group p-value	Between-Group p-value (post)
5 - SIT TO STAND	Group A (PNF)	13.6	1.89	11.8	1.70	0.001	
5 - SIT TO STAND	Group B (Core)	12.8	2.41	12.3	2.24	0.001	0.521
TUG TEST	Group A (PNF)	23.4	1.82	21.7	1.12	0.001	
TUG TEST	Group B (Core)	22.1	1.96	21.9	1.37	0.001	0.826

Table 2 presents the comparison of 5-STS and TUG test results between Group A and Group B. Both groups demonstrated statistically significant within-group improvement from pre-intervention to post-intervention (p=0.001). However, post-intervention analysis revealed that although both groups showed improvement in the 5-STS test, the difference between them was not statistically significant (p=0.521). Similarly, for the TUG test, no statistically significant difference was observed between the groups (p=0.826), indicating comparable functional outcomes following the interventions.

## DISCUSSION

This study compared the effects of Pelvic Proprioceptive Neuromuscular Facilitation (PNF) and Core Stability Training on sit-to-stand (STS) performance and fall risk in stroke patients. Both interventions effectively enhanced functional mobility and reduced fall risk; however, Pelvic PNF produced greater improvements in dynamic balance, postural control, and STS performance. (15,16,17)

Stroke frequently leads to hemiparesis and impaired balance, affecting transitional activities like STS, which require coordinated trunk and lower limb movements.<sup>18</sup> Pelvic PNF, through diagonal, functional patterns, facilitates proprioception and neuromuscular coordination, promoting

postural alignment and stability. (15,16)

The significant improvement in the Five Times Sit-to-Stand Test (FTSST) among PNF participants suggests enhanced lower limb strength and motor coordination due to improved pelvic activation and proprioceptive feedback. (15,19)

Core stability training also yielded positive results by improving trunk control and dynamic balance, consistent with Haruyama et al. and Gamble et al., who emphasized the benefits of core activation on functional mobility and quality of life. (17,20) However, PNF demonstrated superior outcomes because it incorporates functional, multi-planar pelvic movements, making it more task-specific and aligned with daily activities. (16,21)

The pelvis acts as a biomechanical link between the trunk and lower limbs; thus, enhanced pelvic mobility contributes to better symmetry and coordination during STS. Prior studies by Shah et al. and Boob et al. confirmed that pelvic facilitation techniques improve gait, trunk rotation, and postural stability. (15,19)

The reduction in fall risk in the PNF group supports evidence that pelvic-focused interventions retrain postural reflexes and improve center of gravity control, crucial for preventing falls.<sup>21</sup> Additionally, PNF aligns with the principles of neuroplasticity and task-specific training, offering superior functional recovery compared to isolated

core exercises.<sup>17</sup>

Clinically, the findings advocate Pelvic PNF as a more comprehensive rehabilitation approach, addressing asymmetry, trunk instability, and balance deficits in stroke survivors. It effectively enhances functional independence, dynamic balance, and fall prevention beyond the scope of conventional core stabilization programs.

## CONCLUSION

This study compared the effects of pelvic proprioceptive neuromuscular facilitation (PNF) and core training on sit-to-stand (STS) performance and fall risk in stroke patients. Both interventions resulted in significant improvements within their respective groups, emphasizing the effectiveness of pelvic and trunk-focused rehabilitation in post-stroke recovery. Although, no statistically significant difference was found between the groups, indicating that pelvic PNF and core training provide similar benefits in enhancing functional mobility and reducing fall risk.

## Limitations

- The intervention period was short-term.
- The study did not include a follow-up phase to examine the sustainability of the improvements.
- The distinction between acute, subacute, and chronic stroke was not made.
- Confounding variables such as medication use, lesion location, and participant motivation were not fully controlled, potentially influencing performance outcomes.
- The study did not consider the effect of daily activity on outcomes.

## Future Recommendation

- Evaluate the long-term effects on mobility and balance.
- Assess the durability of treatment benefits over time with a follow-up phase.
- Study the combined impact of pelvic PNF and core training exercises in

rehabilitation.

- Investigate the effects on daily activities and occupational performance.

## Declaration by Authors

**Ethical Approval:** Approved

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**Conflict of Interest:** The authors declare no conflict of interest.

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