



# EFFECT OF TRUNK PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION EXERCISE AND CORE STABILITY EXERCISE ON TRUNK CONTROL, BALANCE, AND QUALITY OF LIFE IN INDIVIDUALS WITH STROKE-AN EXPERIMENTAL STUDY.

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## ABSTRACT

### BACKGROUND AND AIM

Basic trunk movement control is often impaired after stroke. Malfunction of limb muscles in stroke is well documented, but little is known about the effect of stroke, in relation to trunk muscle activity. There have been many interventions used for trunk control in stroke like PNF exercise, trunk exercise with physioball, core stability exercise, etc. But there have been very few studies comparing trunk PNF exercise and core stability exercise. The aim is to compare the effect of trunk PNF exercise and core stability exercise on trunk control, balance, and quality of life in individuals with stroke.

### METHOD

32 stroke individuals were taken for the study. They were randomly divided into two groups, Group-A received trunk PNF exercises along with conventional physiotherapy treatment and Group-B received core stability exercises along with conventional physiotherapy treatment, which was given 5 days a week for 4 weeks.

### OUTCOMES

Trunk impairment scale, Berg balance scale, Stroke impact scale.

### RESULT

After 4 weeks of treatment, there was a statistically significant improvement found within group analysis ( $p < 0.05$ ) in TIS, BBS and SIS score. But in between group analysis results were not statistically significant.

### CONCLUSION

From the present study, it can be concluded that Trunk PNF exercise and Core stability exercise both are effective in improving trunk control, balance and quality of life in stroke individuals.

### KEYWORDS

Stroke, Trunk Proprioceptive neuromuscular facilitation, Core stability, TIS, BBS, SIS

## 1. INTRODUCTION

Stroke (cerebrovascular accident [CVA]) is a sudden loss of neurological function caused by an interruption of the blood flow to the brain. Ischemic stroke is the most common type, affecting 80% of individuals with stroke, and results when a clot blocks or impairs blood flow, depriving the brain of

essential oxygen and nutrients. Hemorrhagic stroke occurs when blood vessels rupture, causing leakage of blood in or around the brain.<sup>1</sup>

Common deficiencies in stroke include spasticity, weakness, and loss of equilibrium on the affected side causing inability to maintain postural alignment. The trunk is considered as a central key point to allow the body to remain upright and adjust weight shifts during static and dynamic postural adjustments. Following stroke one side of the limbs are affected but trunk muscles are affected on both the sides leading to insufficient trunk rotation, difficult in maintaining balance and gait.<sup>4</sup>

Specifically, as the thoracic and pelvic movements occur together due to the lack of the trunk motion that separates the thorax and pelvis during walking, stroke patients walk with a pathologically increased trunk movement. Trunk control impairment in stroke patients not only shows spinal problems which can be seen in the sagittal plane, but also shows asymmetric changes in the pelvis. Therefore, these impairments alter the balance and gait performance causing pathological movement.<sup>2</sup>

In order to improve the neuromuscular system's effectiveness in coordinating movement and function, there are different physical rehabilitation approaches used for enhancing recovery in post stroke patients, like frenkle's exercise, tai-chi and task oriented training but neither method was more (or less) effective in terms of improving independence in ADL or motor function. PNF is widely used in rehabilitation practice.<sup>5</sup>

PNF uses the body's proprioceptive system to facilitate or inhibit muscle contraction. The definition of PNF encompasses the terms proprioceptive (which has to do with any of the sensory receptors that provide information concerning movement and position of the body); neuromuscular (involving the nerves and muscles); and facilitation (making it easier). Diagonal pattern training is one of the trunk rehabilitation training methods that improve the movement, trunk asymmetry, flexibility, and strength provided by various planes. Diagonal pattern movement can also rotate the trunk diagonally, separate the thorax and pelvis, and include repetitive weight movements to promote the facilitation of trunk muscles.<sup>6</sup>

A good rehabilitation strategy, which might help improve trunk performance, trunk control and dynamic sitting balance, is approaches using trunk training therapeutic exercises like Core Stability Exercises (CSEs). Recent studies suggest that core strengthening plays a critical role in maintaining balance, functional mobility, gait, and fear of falls and in improving anticipatory postural adjustment in stroke survivors.<sup>7</sup>

CSEs are voluntary movements that aim at promoting the neuromuscular control, coordination, strength and endurance of muscles that are central to maintaining dynamic stability of the spine and trunk. It is the ability to control the position and motion of the trunk over the pelvis and leg that allows optimal production, transfer and control of force and motion to the terminal segment in integrated kinetic chain activities. It is essential to providing a solid base of core to exert or resist force, as it stabilizes the pelvis and spinal column for "proximal stability for distal mobility". Static core functionality is the ability of the core to align the skeleton to resist a force that does not change.<sup>8</sup>

## 2. MATERIALS AND METHOD

This study was approved as a less than minimal risk research by the ethical committee of Institution. Prior to the interview, individuals read carefully the consent form, which contains information on the objectives of the study, the selection process, risk, benefits and freedom of the participation, as well as information on confidentiality.

- STUDY DESIGN: An Experimental study
- SOURCE OF DATA: Different Physiotherapy OPDs
- SAMPLING TECHNIQUE: Simple Random Sampling.
- SAMPLE SIZE: 32 (16 in each group) according to power analysis.
- STUDY DURATION: 1 year

## 2.1 Selection Criteria

### Inclusion criteria:

- Participants with stroke willing to participate.
- Diagnosed with a stroke through CT scan or MRI.
- Age: 35-65years.
- Duration of illness of 1 month or longer.
- The ability to sit and stand independently.
- Able to stand independently for 30 sec or longer.
- Individuals with moderate and low risk of fall according to Berg Balance Scale.
- Ability to walk 10m or longer alone indoors.
- Not using assistive devices.
- Should be able to understand and follow simple verbal instructions (Mini Mental Status Examination  $\geq$  24)

### Exclusion criteria:

- With sensory ataxia or cerebellar ataxia.
- Severe spasticity (Modified Ashworth Scale grade  $>3$ ).
- Active cardio-respiratory problems.
- Individuals with spinal problems or post spine surgery within 1 year.
- Concurrent neurological disorder (e.g., Parkinson's disease) or major orthopedic problem that hampers balance.

## 3. METHODOLOGY

### 3.1 Outcome measures:

#### a) Trunk Impairment Scale<sup>29</sup>

The trunk impairment scale measures the static balance, dynamic balance, and the coordination of the body adjustment in a sitting position. The trunk impairment scale consists of a total 23 point with 7 points for static sitting balance, 10 points for dynamic sitting balance, and 6 points for co-ordination respectively. The higher the score, the better the trunk control ability.

#### b) Berg Balance Scale<sup>30</sup>

The Berg Balance Scale consists of sitting posture balance (1 question), standing posture balance (8 questions), and dynamic balance (5 questions). The total score is calculated as 0-56 points. Each item is scored on a 5-point ordinal scale ranging from 0 (unable to perform) to 4 (normal performance). The higher the score, the better the balancing ability.

#### c) Stroke Impact Scale<sup>31</sup>

The purpose of this questionnaire is to evaluate how stroke has impacted your health and life. English and Gujarati both the versions were used for the individual's convenience. Gujarati version of the SIS is a self-reported measure that includes 59 items and assesses 8 domains (strength, memory, emotion, communication, ADL, mobility, hand function, and social participation). Each domain contains different number of items ranging from 4- 10. Low total score indicates high impact quality of life (QOL) of stroke individuals.

### 3.2 Procedure:

32 stroke patients were recruited from different Physiotherapy OPDs and Neuro rehabilitation centers from Ahmedabad. The sample consisted of patients age between 35-65 years and the individuals were verbally explained the purpose of the study.

Patients were initially screened based on the inclusion criteria written informed consent was taken from all the participants. Participants were assessed and screening was done. All the baseline data were collected of the all participant. Allocation to the group was done using simple random sampling. Participants were on aware about the allocation. Study was single blinded.

Participants were randomly assigned into two groups: 16 patients in Trunk PNF Group and 16 patients in

Core Stability Group.

Both the group received conventional Physiotherapy Treatment as well.

Group A- Trunk Proprioceptive Neuromuscular Facilitation<sup>3</sup>

- Diagonal patterns 1 to 10 were performed.
- 5 repetitions were performed for each diagonal pattern.
- 30 sec rest period was given in between each diagonal pattern.
- The duration for the exercise was 25-30 min.

Group B- Core Stability Exercise<sup>4</sup>

Participants were positioned in supine. They were asked to recognize their neutral spine position that is midrange between flexion and extension.

The core muscles trained were Transverse abdominis, Multifidus, Para spinals, Quadratus lumborum, and Oblique's.

In first stage the participants were taught to activate abdominal wall musculature. They were initially trained to perform abdominal bracing in order to ensure that the participants were contracting the right musculature a biofeedback device were used.

The lower end of inflatable bag was placed at the posterior superior iliac spine. Before starting the contraction, the bag were inflated to a pressure of 40 mmHg with valve closed and participants were instructed to breathe deeply using abdominal wall musculature, then the inflated bag were adjusted to 40 mmHg.

Participants were requested to perform abdominal muscle contractions with following verbal commands standardized by examiner: "Tighter your abdomen in order to make it like a rigid cylinder without moving your ribs and pelvis".

Once the participants mastered the technique of abdominal bracing progression were made to other core stability exercise.

Participants were then positioned in quadruped position and asked to lift alternate arms, gradually progressing to alternate leg lifts and alternating arm/leg raises to activate multifidus.

The progression of the exercises was done once the patient were able to perform 30 repetition of each exercise with 8 sec hold. The participants were told to maintain normal diaphragmatic breathing throughout the intervention.

Conventional physiotherapy exercise<sup>5</sup>

- Sustained stretching of all spastic muscles.
- Antigravity/weight bearing postures such as kneeling and quadruped as tolerated by patient with necessary assistance.
- Reach outs with unaffected hand in weight bearing in sitting and quadruped.
- PNF pattern of bilateral upper and lower extremity.
- Strengthening of weak antagonist muscle with manual resistance.
- Balance training with perturbations in sitting and standing position.
- Functional training and transfers.
- Gait training, forward walking, backward walking and lunges.

#### 4. RESULTS

The present study was conducted to compare the effect of trunk proprioceptive neuromuscular exercises and core stability exercise on trunk control, balance and quality of life in individuals with stroke.

Total 32 patients were included in the study out of which 16 patients were the part of trunk proprioceptive neuromuscular exercise group who received trunk proprioceptive neuromuscular exercise and conventional physiotherapy and other group included 16 patients were part of the core stability exercise and conventional physiotherapy.

Data of 32 individuals were analyzed using statistical package of social science version 29 (SPSSv.29) and Microsoft excel 2018. Before applying statistical tests, data was screened for normal distribution using Shapiro Wilk test. The level of significance was kept at 5%. All the outcome measures were analyzed at baseline and after 4 weeks of treatment. Changes in outcome measures were analyzed within group as well as between groups.

On the basis of Shapiro-Wilk test, the data was not normally distributed. So for the within group analysis Wilcoxon test and for the between group analysis Mann Whitney test was used.

## 5. DISCUSSION:

The present study was conducted to compare the effect of trunk PNF exercise and core stability exercise on trunk control, balance and quality of life in individuals with stroke. This experimental study suggests that training given in the study is effective in improving trunk control, balance and quality of life in stroke individuals.

Both the group showed statistically significant improvement in TIS, BBS and SIS score. After the 4 week intervention program, participants in both the groups showed statistically significant improvement in TIS, BBS and SIS scores. But in between group comparison the result was not statistically significant.

Group A who received Trunk PNF exercise along with conventional exercise showed statistically significant improvement in trunk control and balance and quality of life:

PNF primarily aims to improving the functional mobility and daily living activity by facilitating muscle elongation about the basic PNF produces resistance, irradiation and reinforcement, manual contact, body position and body mechanism, verbal command, vision, stretch, timing, and patterns.

PNF is the neuro physiological approach in which impulses from the periphery are facilitated to the central nervous system through the stimulation of sensory receptors present in muscles and around the joints by stretch, resistance, traction, approximation and audiovisual command to the patient. PNF integrates the use of spiral and diagonal pattern specific of movements (with antagonist and agonist muscles) with procedures and superimposed techniques that induce the muscular contraction, relaxation and muscle strength.<sup>32</sup>

Group B who received core stability exercise program showed statistically significant improvement in trunk control and balance and quality of life:

Stroke affects core performance, which subsequently causes impairments to core motor control, issues with the patient's perception of position, and difficulty with coordination and postural adjustment, while also affecting core and extremity functions and impairing balance abilities, gait, and ambulation.

The impairments to core musculature not only affected the acute stage but also the chronic stage. Studies have shown that stroke patients still present with mild-to-severe trunk impairment at the chronic stage.

Another study found that weaker trunk extensor and flexor activations, as well as lower peak torques, have been noted in stroke patients six months after stroke onset when compared to healthy controls. Core stability exercises induce co-contraction of the trunk muscles and improve inter segmental coordination restricted to the degree of freedom of the body and allow a more selective.<sup>35</sup>

Another possible explanation could be that these exercises can induce generic neural changes and cortical reorganization in the premotor areas and in the contra lateral sensorimotor cortex. These exercises could help to restore inter hemispheric connections of both hemispheres, transcallosal fibers, and therefore, has an important role in stroke recovery.

Group A and Group B did not showed statistically significant difference in TIS, BBS and SIS scores:

Group A – Trunk PNF exercise and Group B – Core stability exercise did not showed statistically significant difference in TIS, BBS and SIS score when between group analyses was done.



It suggests that both Group A and Group B are effective in improving trunk control, balance and quality of life in stroke individuals. Vishal Sharma and Jaskirat Kaur et al. conducted a study comparing core stabilization and pelvic PNF and concluded that core stabilization combined with pelvic PNF was more effective for improving trunk impairment, balance and gait of chronic stroke patients.<sup>4</sup>

Chan et al. showed that six weeks of core stability exercises and task-related trunk training improved dynamic sitting balance at four weeks after training ended. Regarding standing balance, subjects from the core stability exercises group in our study showed significant differences with regard to the control group for the Berg Balance Scale, while there were no differences in the other scales.<sup>36</sup>

## 6. CONCLUSION

There is statistically significant improvement in trunk control, balance and quality of life in individuals with stroke who were treated with trunk PNF exercises and core stability exercises.

After 4 week of treatment both the groups showed improvement in scores of TIS, BBS and SIS score. But when between groups analysis was done, it did not showed statistically significant difference. Group A received trunk PNF exercises with conventional physiotherapy treatment and Group B received core stability exercises with conventional physiotherapy treatment.

Thus, it is concluded that both trunk PNF exercise and core stability exercises both are effective in improving trunk control, balance and quality of life in individuals with stroke.

## FUTURE RECOMMENDATION

- Future study with a larger population.
- Future studies are needed to examine long term effects of the treatment.
- Future study can be conducted with gait parameters.

## LIMITATION

- No long-term follow-up was done.
- Duration of treatment was less.
- The study did not included individuals with varying durations of stroke.

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## CONFLICT OF INTEREST

There is no conflict of Interest in publishing this article.

## ABBREVIATIONS:

TIS- Trunk Impairment Scale

BBS- Berg Balance Scale

SIS- Stroke Impact Scale

PNF- Proprioceptive Neuromuscular Facilitation

ADL- Activities of Daily Living

SPSS- Statistical Package for Social Science

## 7. REFERENCES

- 1) Susan B.O' Sullivan, Thomas J. Schmitz, George D. Fulk. Physical rehabilitation- seventh edition.
- 2) Francesc Xavier Guiu-Tula, Rosa Cabanas-Valdés, Mercè Sitjà-Rabert, Gerard Urrútia, Natàlia Gómara Toldrà-The Efficacy of the PNF(PNF) approach in stroke rehabilitation to improve basic activities of daily living and quality of life: a systematic review and meta-analysis protocol.2017.

- 3) Shin Jun Park and Seunghue Oh. Effect of Diagonal Pattern Training on Trunk Function, Balance, and Gait in Stroke Patients.2020.
- 4) Vishal Sharma, Jaskirat Kaur. Effect of core strengthening with pelvic PNF on trunk, balance, gait, and function in chronic stroke.2017.
- 5) Rosa Cabanas-Valdés, Lúcia Boix-Sala, Montserrat Grau-Pellicer, Juan Antonio Guzmán-Bernal, Fernanda Maria Caballero-Gómez and Gerard Urrútia. The Effectiveness of Additional Core Stability Exercises in Improving Dynamic Sitting Balance, Gait and Functional Rehabilitation for Subacute Stroke Patients (CORE Trial): Study Protocol for a Randomized Controlled Trial.2021.
- 6) Shruti Prabhakaran Nair, Shailesh Satyanarayana Gardas and Rukaiya SMithaiwala. Efficacy of chest expansion resistance exercise on respiratory function, trunk control and dynamic balance in patients with chronic stroke: A Comparative study.2021.
- 7) Hariharasudhan Ravichandra, Hidangmayum Richa Sharma, TsiwayeGebreyesus Haile, AsmareYitayeh Gelaw, BerihuFisseha Gebremeskel, Balamurugan Janakiraman. Effects of trunk exercise with physioball to improve trunk balance among subjects with stroke: a systematic review and meta-analysis.2020.
- 8) Joong-San Wang, PT, PhD, Sang-Bin Lee, PT, PhD, Sang-Hyun Moon, PT, MS. The immediate effect of PNF pattern on muscle tone and muscle stiffness in chronic stroke patient.2016.
- 9) Wajeeda Mahmood, Hafiz Syed Ijaz Ahmed Burq, Sarah Ehsan, Basita Sagheer and Tahir Mahmood. Effect of core stabilization exercises in addition to conventional therapy in improving trunk mobility, function, ambulation and quality of life in stroke patients: a randomized controlled trial.2022.
- 10) Shraddha Jasmin Diwan, Zarna Ronak Shah, Pranav Bhanubhai Joshi Validation of Gujarati Translated Version of Stroke Impact Scale Physiotherapy Section.2018.
- 11) Kyo Chul Seo, PhD1), Hyeon Ae Kim, PhD2) The effects of ramp gait exercise with PNF on stroke patients' dynamic balance.2015.
- 12) KyoChul Seo, PhD1), Seung Hwan Park, PhD2), KwangYong Park, MS3). The effects of stair gait training using PNF on stroke patients' dynamic balance ability.2015.
- 13) Chang-Beom Kim, PT, MS, Jun-Ho Shin, PT, MS, Jong-Duk Choi, PT, PhD .The effect of chest expansion resistance exercise in chronic stroke patients: a randomized controlled trial.2015.
- 14) Pil Neo Hwangbo, PhD, PT, Kyoung Don Kim, PhD, PT.Effects of PNFneck pattern exercise on the ability to control the trunk and maintain balance in chronic stroke patients.2016.
- 15) Vivek Nambiar, Manu Raj, Damodaran Vasudevan, Renjitha Bhaskaran, Remya Sudevan. One-year mortality after acute stroke: a prospective cohort study from a comprehensive stroke care centre, Kerala, India.2022.
- 16) Stephanie P Jones, Kamran Baqai, Andrew Clegg, Rachel Georgiou1, Cath Harris , Emma-Joy Holland. Stroke in India: A systematic review of the incidence, prevalence, and case fatality.2022.
- 17) Sureshkumar Kamalakannan, Aashrai S. V. Gudlavalleti, Venkata S. Murthy Gudlavalleti, Shifalika Goenka & Hannah Kuper. Incidence & prevalence of stroke in India: A systematic review. 2017.
- 18) Marimuthu Dinesh, Paluchamy Thenmozhi, Selvaraj KalaBarathi. PNFNeck Pattern and Trunk Specific Exercise on Trunk Control and Balance— an Experimental Study. 2022.
- 19) Manali A. Boob , Rakesh K. Kovala Effectiveness of Pelvic PNFTechniques on Balance and Gait Parameters in Chronic Stroke Patients: A Randomized Clinical Trial. 2022.
- 20) Phan The Nguyen, Li-Wei Chou and Yueh-Ling Hsieh. Proprioceptive Neuromuscular Facilitation-Based Physical Therapy on the Improvement of Balance and Gait in Patients with Chronic Stroke: A Systematic Review and Meta-Analysis. 2022.
- 21) Jaya Shanker Tedla, Erika Rodrigues, Arthur S. Ferreira, Jose Vicente, Ravi Shankar Reddy, Kumar Gular. Transcranial direct current stimulation combined with trunk-targeted, PNF in subacute stroke: a randomized controlled trial.2022.
- 22) Renata Janaína Pereira de Souza , Daniella Cunha Brandão, José Vicente Martins3, Juliana Fernandes and Armele Dornelas de Andrade. Addition of PNF to cardiorespiratory training in patients poststroke: study protocol for a randomized controlled trial. 2020.
- 23) Seenu Mathew, Remya N, Manju Unnikrishnan, Chinchu Alwin, Rejimol Jos Pulicken, Reethu Elsa Baby, Rakhi Balagopal, Reeba Roy, Anumol C. Effect of Core Muscle Stabilization Exercises in

Improving Upper Extremity Physical Performance and Trunk Control in Middle Cerebral Artery Stroke. 2022.

24) Duaa Awais , Sana Batool , Ashfaq Ahmad , Asad Ali Aftab and Rida Naqvi. Comparison of Routine Physical Therapy with and without Core-Stability Exercises on Dynamic Sitting Balance and Trunk Control in Sub-Acute Ischemic Stroke Patients. 2022.

25) Carina Salgueiro , Gerard Urrútia and Rosa Cabanas-Valdés . Influence of Core-Stability Exercises Guided by a Telerehabilitation App on Trunk Performance, Balance and Gait Performance in Chronic Stroke Survivors: A Preliminary Randomized Controlled Trial. 2022.

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26) Riyas Basheer K. B., Dinesh K. V., Subhashchandra Rai, Mohammed Arshak A. T. Effects of neuromuscular electrical stimulation and core muscle strengthening on trunk instability following stroke. 2021.

27) Andrew Harb; Stephen Kishner. Modified Ashworth Scale. 2023.

28) Lenore Kurlowicz, PhD, RN, CS and Meredith Wallace, PhD, RN, MSN. The Mini Mental State Examination (MMSE). 1999.

29) G Verheyden, Katholieke Universiteit Leuven, R Preger, C Kiekens, Leuven and W De Weerd. The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. 2022.

30) Natalia Miranda-Cantellops; Timothy K. Tiu. Berg Balance Testing. 2023

31) Shraddha Jasmin Diwan, Zarna Ronak Shah, Pranav Bhanubhai Joshi. Validation of Gujarati Translated Version of Stroke Impact Scale. 2018.

32) Poonam Chaturvedi, Ajai Kumar Singh, Dinkar Kulshreshtha, Anup Kumar Thacker. PNF in acute stroke. 2018.

33) Si-Eun Park, PT, PhD, Sang-Hyun Moon, PT, MD. Effects of trunk stability exercise using PNF with changes in chair height on the gait of patients who had a stroke. 2018.

34) Dr. Simi Hazarika PT, Dr. Pallabi Goswami PT, Dr. Abhijit Dutta and Dr. Abhijit Kalita PT. Comparison of Effectiveness of Trunk PNF Versus NDT on Trunk Stability in Stroke Patients. 2022.

35) Rosa Cabanas-Valdés, Caritat Bagur-Calafat, Montserrat Girabent-Farrés, Fernanda M Caballero-Gómez, Helena du Port de Pontcharra-Serra, Ana German-Romerol and Gerard Urrútia. Long-term follow-up of a randomized controlled trial on additional core stability exercises training for improving dynamic sitting balance and trunk control in stroke patients. 2017.

36) Koshiro Haruyama, RPT, MSc, Michiyuki Kawakami, MD, PhD, and Tomoyoshi Otsuka, MD, PhD. Effect of Core Stability Training on Trunk Function, Standing Balance, and Mobility in Stroke Patients: A Randomized Controlled Trial. 2016

37) Carina Salgueiro , Gerard Urrútia and Rosa Cabanas-Valdés. Influence of Core-Stability Exercises Guided by a Telerehabilitation App on Trunk Performance, Balance and Gait Performance in Chronic Stroke Survivors: A Preliminary Randomized Controlled Trial. 2022