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A Study to Find the Effect of Trunk Proprioceptive Neuromuscular Facilitation Exercise on Trunk Muscle Strength and Balance in Chronic Stroke Patients - An Interventional Study

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Abstract: ***Purpose: Despite evidence demonstrating the importance of trunk performance after stroke, therapies aimed at improving trunk function are limited. The Proprioceptive neuromuscular facilitation technique is a method to improve the trunk stability after stroke. The purpose of this study was to determine the effect of trunk Proprioceptive neuromuscular facilitation exercise on trunk muscle strength and balance in chronic stroke patients. Method: A total of 65 chronic stroke patients were taken on the basis of inclusion and exclusion criteria and divided into two groups by simple random sampling. Group A received trunk Proprioceptive neuromuscular facilitation exercise and Group B received trunk conventional exercise. All the outcome measures that is strength of trunk flexors, extensors and rotators and Berg Balance Scale were measured before and after 4 weeks of treatment. Results: Within group analysis was done using Wilcoxon Signed Ranks Test which showed significant improvement in all outcomes after 4 weeks. Between groups comparison was done using Mann-Whitney Test which showed that Group A was more effective in improving strength of trunk rotators. Conclusion: The result of the study suggested that both the groups showed improvement but trunk Proprioceptive neuromuscular facilitation exercise were beneficial for improving strength of trunk rotators in chronic stroke patients.***

Keywords: chronic stroke, PNF, lifting and chopping pattern, Manual muscle testing, berg balance scale, trunk stability.

1. Introduction

The meaning of “stroke” (in scientific and lay literature) has most often been consistent with the 1980 World Health Organization (WHO) definition as “rapidly developed clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 h or leading to death, with no apparent cause other than of vascular origin. (1) The incidence of stroke rises rapidly with increasing age: two thirds of all strokes occur in people older than the age of 65 years; and after the age of 55 years, the risk of stroke doubles every 10 years. (2) The cumulative incidence of stroke ranged from 105 to 152/100, 000 persons per year, and the crude prevalence of stroke ranged from 44.29 to 559/100, 000 persons in different parts of the country during the past decade. (3)

About 80 to 85% of strokes of known etiology are ischemic, with the remaining 15 to 20% being hemorrhagic. (4, 5) Strokes may be classified and dated thus: early hyperacute-a stroke that is 0–6 hours old; late hyperacute-a stroke that is 6–24 hours old; acute-24 hours to 7 days; subacute-1 to 3 weeks; and chronic-more than 3 weeks old. (6)

As stroke patients lose their ability to perform postural adjustment and maintain postural alignment because of spasticity, weakness, loss of equilibrium and righting reactions, trunk assumes asymmetrical posture. The trunk being the central key point of the body, proximal trunk control is a pre-requisite for distal limb movement control, balance and functional mobility. (7)

Stroke patients suffer from balance disability due to abnormalities in the proprioceptive system, sensory system, trunk muscles, and muscles of the limbs. In particular, reduction in the activity of the muscles of the trunk reduces movement of the pelvis, leading to the development of asymmetry of the trunk, and preventing use of strategies protecting against the risk of balance loss. (8)

A by S. Tanaka et al. aimed at assessing the trunk flexors-extensors and rotators muscle performance in stroke patients using isokinetic dynamometer muscle strength testing reported weakness of trunk flexors-extensors and bilateral trunk rotators. (9, 10)

Despite evidence demonstrating the importance of trunk performance after stroke, therapies aimed at improving trunk function are limited. PNF uses the body’s proprioceptive system to facilitate or inhibit muscle contraction. (11) Improving proprioceptive sensation is most important for trunk stability, and PNF exercises are useful for improving trunk stability. (12)

A. Tanvi et al studied Effect of Proprioceptive Neuromuscular Facilitation Program on Muscle Endurance, Strength, Pain, and Functional Performance in Women with Post-Partum Lumbo-Pelvic Pain on 28 females and concluded that pnf improves muscle strength, endurance, pain and functional performance. (13)

B. S. Sneha et al performed the study to find out effects of trunk Proprioceptive neuromuscular facilitation on dynamic

balance, mobility and quality of life in Parkinson's disease. The results showed that trunk based PNF training are beneficial in improving dynamic balance and mobility and quality of life in people with PD stage. (14)

So, the aim of the study was to determine the efficacy of trunk Proprioceptive neuromuscular facilitation approach in chronic stroke patients to improve trunk muscle strength and balance.

The objectives were to determine if trunk Proprioceptive neuromuscular facilitation exercise is used to improve the trunk muscle strength in chronic stroke patients and to determine if trunk Proprioceptive neuromuscular facilitation exercise is used to improve balance in chronic stroke patients.

Hypothesis

Null Hypothesis: There is no significant improvement observed after 4 weeks of intervention with trunk Proprioceptive neuromuscular facilitation exercise on trunk muscle strength and balance in chronic stroke patients.

Experimental hypothesis: There is significant improvement observed after 4 weeks of trunk Proprioceptive neuromuscular facilitation exercises on balance and strength of trunk muscles in chronic stroke patients**.**

2. Methodology

2.1 Subjects

A simple random sampling design was conducted in the physiotherapy college OPD and neuro clinics in and around Jamnagar. The study protocol was approved by Ethical committee of M. P. shah medical college. The purpose of the study was explained to the subjects with chronic stroke and written informed consent was obtained seeking their active participation. The participants who consented were screened for inclusion and exclusion criteria. Subjects with chronic stroke of at least three months duration were included in the study if they met the following criteria: 1) age – 18 to 65 years.2) Unilateral involvement.3) Stage 2 or higher brunnstorm grading 4) able to follow commands.5) Trunk muscle power 2/5. Patients were excluded if they had brain tumor, head injury, infective conditions of brain or any history of musculoskeletal disorders, cardiac disease and cognitive problems.

2.2 Materials and method

Materials used in this study were paper, pen, plinth, pillow, consent form, oxford scale, berg balance scale and case record form. Sample size was calculated using G power version 3.1.9.4 using previous article mean and SD. Total 65 patients were divided into 2 groups; 33 in group A and 32 in group B. Trunk muscle MMT which includes trunk flexors, extensors and rotators and Berg Balance Scale was measured before the treatment and 4 weeks after the treatment in both the groups. Out of 65 patients enrolled in the study, 1 patient from group A and 2 patients from group B discontinued the treatment before completion of 4 weeks due to either personal reason.

GROUP A: 32 patients were given trunk Proprioceptive neuromuscular facilitation exercise for 4 weeks, 5 times per week. The technique was given in supine lying. The starting position for chopping pattern: The patient's left arm was in flexion–adduction–external rotation. The right hand gripped the left wrist with the right arm in modified flexion–abduction–external rotation. The patient was asked to look at the left hand, putting the neck in modified extension to the right. Movement: The patient's left arm was moved through the pattern of extension–abduction–internal rotation with the right arm following into extension–adduction–internal rotation. The patient's head and neck was taken into flexion to the left. At the same time, the patient's upper trunk was moved into flexion with rotation and lateral flexion to the left.

The second technique was lifting pattern. The starting position: The patient's left arm was in extension–adduction–internal rotation. The right hand gripped the left wrist with the right arm in modified extension–abduction–internal rotation. The patient was asked to look at the left hand putting the neck in flexion to the right. The patient's left arm was moved through the pattern of flexion–abduction–external rotation with the right arm following into flexion–adduction–external rotation. The patient's head and neck came into extension to the left. At the same time the patient's upper trunk begins moved into extension with rotation and lateral flexion to the left.

Group B

Out of 33 patients, 31 participated in the study.

These patients received the conventional exercise which includes upper and lower limb exercise, trunk exercise like bridging; curl ups, prone on elbows/hands, trunk rotation exercises in supine and prone position and gait training. The above treatment is given for 30 minutes, five times a week for 4 weeks.

Chopping pattern: starting position

Chopping pattern: ending position

Lifting pattern: starting position

Lifting pattern: ending position

Outcome measures

MMT is well recognized as the most common strength testing technique in physical therapy and other health professions. This assessment serve as baseline to identify key impairments that impact a patient's fall risk, mobility and other functional goals as well as to determine the patient's progress over time. Reliability in MMT varies considerably according to muscle tested, the experience of examiner, the age of the patient, and the particular condition being tested. The Berg Balance Scale (BBS) developed by Berg et al. is an objective measure of static and dynamic balance abilities. The scale consists of 14 functional tasks commonly performed in everyday life. Scoring uses a five-point ordinal scale, with scores ranging from 0 to 4. Populations for which this scale is appropriate include community-dwelling elderly, institutionalized elderly, urban-dwelling elderly, and patients with stroke. The intra-rater relative reliability of the Berg Balance Scale is estimated to be 0.98 (95% CI 0.97 to 0.99). The inter-rater reliability of Berg Balance Scale is estimated to be 0.97 (95% CI 0.96 to 0.98).

3. Analysis And Results

3.1 Statistical analysis

The statistical analysis was done by using SPSS 20 version for windows software. Mean was calculated as measure of central tendency. Standard deviation was calculated as measure of dispersion. Level of significance was kept at 5% with confidence interval (CI) at 95% (p value= 0.05). Between groups comparison for baseline data of age and Body Mass Index (BMI) was done using unpaired t – test. To check whether the data was normally distributed or not Shapiro Wilk test was done. As the data was not normally distributed non parametric test was used. Within group analysis was done using Wilcoxon Signed Rank Test. Between group comparison of all outcome measures was done using Mann Whitney test.

3.2 Results

Between groups comparison for baseline data of age and Body Mass Index (BMI) showed no significant difference.

TABLE 1: shows between group comparison of age and BMI

Measures	Mean (SD)		Z value	P Value
	Group A	Group B		
Age (years)	54.13 (10.794)	49.43 (11.913)	-1.30	0.193
BMI (kg/m^2)	23.28 (3.550)	23.25 (3.321)	-0.44	0.657

Where group A (n=32) and group B (n=30) and level of significance kept at 5% with confidence interval (CI) at 95% (p value = 0.05)

INTERPRETATION-Table 1 shows: group A mean age and SD score 54.13 ± 10.794; group B mean and SD score 49.43 ± 11.913; p value 0.193 which is not significant. This shows there is no difference in baseline data of age between two groups.

Table 1 shows: group A mean BMI and SD score 23.28 ± 3.550; group B mean and SD score 23.25 ± 3.321; p value 0.657 which is not significant. This shows there is no difference in baseline data of BMI between two groups.

Table 2: Within group comparison of outcome measures of Group A

Outcome Measure		Mean (SD)	P-Value	Results
Manual muscle testing	pref-postf	1.093 (0.689)	0.00	Significant
	pree-poste	0.8125 (0.859)	0.00	Significant
	prer-postr	1.5 (0.762)	0.00	Significant
Berg balance scale	prebbs-postbbs	9.125 (7.386)	0.00	Significant

Where level of significance kept at 5% with confidence interval (CI) at 95% (p value = 0.05)

Abbreviation: pref – pre flexors, postf – post flexors, pree-pre extensors, poste – post extensors, prer-pre rotators, postr-post rotators, prebbs-pre Berg Balance Scale, postbbs – post Berg Balance Scale

Interpretation-Table 2 shows within group comparison of outcomes using Wilcoxon Signed Ranks Test which shows p value is 0.00 suggestive of highly significant result.

Table 3: Within group comparison of outcome measure for group B.

Outcome Measure		Mean (SD)	P Value	Results
Manual muscle testing	pref-postf	0.533 (0.571)	0.00	Significant
	pree-poste	0.633 (0.490)	0.00	Significant
	prer-postr	0.6 (0.563)	0.00	Significant
Berg balance scale	prebbs-postbbs	4.4 (2.415)	0.00	Significant

Where level of significance kept at 5% with confidence interval (CI) at 95% (p value = 0.05)

Abbreviation: pref – pre flexors, postf – post flexors, pree-pre extensors, poste – post extensors, prer-pre rotators, postr-post rotators, prebbs-pre Berg Balance Scale, postbbs – post Berg Balance Scale

Interpretation-Table 3 shows within group comparison of outcomes using Wilcoxon Signed Ranks Test which shows p value is 0.00 suggestive of highly significant result.

Table 4: Comparison of mean difference between group A and group B

		Z value	P value	Results
Manual muscle testing	Postf	-1.770	0.077	Non significant
	Poste	-1.261	0.207	Non significant
	Postr	-2.131	0.033	Significant
Berg Balance Scale	Postbbs	-0.702	0.483	Not significant

Where level of significance kept at 5% with confidence interval (CI) at 95% (p value = 0.05)

Abbreviation: pref – pre flexors, postf – post flexors, pree-pre extensors, poste – post extensors, prer-pre rotators, postr-post rotators, prebbs-pre Berg Balance Scale, postbbs – post Berg Balance Scale

Table 4 shows-
Trunk Flexors: moderately significant difference between two groups.
Trunk Extensors: there is no significant difference between two groups.
Trunk Rotators: there is significant difference observed between two groups.
Berg Balance Scale: there is no significant difference between two groups.

4 Discussion

The purpose of the present study was to find the effect of trunk Proprioceptive neuromuscular facilitation exercise mainly lifting and chopping pattern on trunk muscle strength and on balance in chronic stroke patients. The data was equally distributed at baseline level in terms of age and BMI. The results of the present study showed that both groups had significant difference on muscle strength of trunk flexors, trunk extensors and trunk rotators and on balance post 4 weeks of intervention. This suggest that trunk Proprioceptive neuromuscular facilitation exercise and trunk conventional exercise shows improvement in trunk muscle strength and balance in chronic stroke subjects.

For trunk rotators there was significant difference between both the groups but group A whose mean difference was 1.5 ± 0.672 was more effective than group B whose mean difference was 0.6 ± 0.563. So overall, the trunk Proprioceptive neuromuscular exercise mainly lifting and chopping pattern showed effect on trunk muscle strength and balance but showed significant improvement in trunk rotators strength compared to trunk conventional exercise in chronic stroke subjects.

Thus on the basis of the result, the present study rejected the null hypothesis and experimental hypothesis was accepted. There was significant improvement observed after 4 weeks of trunk Proprioceptive neuromuscular facilitation exercises on balance and strength of trunk muscles in chronic stroke patients**.**

Studies have shown that resistance training program helps to gain strength by stimulating the increase of muscular mass. The PNF techniques also use resistance which leads to

increase in muscle response to cortex. The PNF uses manual for contact resistance and stretching which generates a unit's maximum neuromuscular stimulation. It is also believed that muscle strength could be improved as result of intra and intermuscular neural adjustment during the execution of movement. (15)

The improvement in trunk muscle strength is consistent with Chhaya Verma et al. conducted a study in 120 healthy individuals which were divided into three groups. The result showed that the proprioceptive neuromuscular facilitation (PNF) techniques have significant effect on core strength and endurance in healthy individuals. (16)

Findings of improvement in control group are consistent with the study by Norah Alhwoaimel et al who conducted a systematic review on Do trunk exercises improve trunk and upper extremity performance, poststroke and concluded that Trunk exercises improve trunk performance for people with acute, subacute and chronic strokes. (17)

Our study showed significant improvement in trunk rotators in group who received trunk Proprioceptive neuromuscular exercise for 4 weeks when both groups were compared. This is supported by book neurological intervention for physical therapy by ST. Martin who said that Combining Upper extremity PNF patterns can promote activation of the trunk musculature, especially the rotators. (18)

A study done by Logeshwari Selvaraj, is also consistent with our study. They conducted to determine the effects of PNF technique on trunk control, balance and mobility function in cerebral palsy children with spastic hemiplegia on 30 spastic hemiplegic children. They were divided into two groups out of which Group A received trunk stabilization exercise and trunk exercise and Group B received trunk exercise and trunk PNF exercise. The result showed that both the groups were statistically significant in trunk impairement scale and tinetti oerformance oriented mobility assessment scale. Within group comparison showed that Group B was more effective than Group A. (19)

So, in the present study, it was found that trunk PNF and trunk conventional exercise showed statistical difference in strength of trunk flexors, trunk extensors and trunk rotators and also on berg balance scale which is justified by the above studies. They showed that pnf technique and other trunk exercise are equally effective on strength and functional outcomes.

Clinical implication: Trunk Proprioceptive Neuromuscular Facilitation exercise can be added in rehabilitation of chronic stroke patients. Trunk PNF along with other conventional exercise will help to get better result in increasing the strength of trunk muscles and also in terms of improving balance.

5 Limitation of the Study

Only lifting and chopping pattern was used.2. Neither the therapist nor the patients were blinded.3. Long term follow up was not taken.4. Confounding factors like onset of stroke or spasticity grading which could have affect the outcome was not taken into consideration.

6 Future Recommendation

1) Future study can be done by using different PNF techniques.
2) Further study can be done by taking gait as outcome measure.
3) Long term follow can be taken.
4) Confounding factors like onset of stroke, gender and level of spasticity can be correlated with the outcome measure.

7 Conclusion

The present study showed that Trunk Proprioceptive Neuromuscular Facilitation exercises as well as trunk conventional exercise were effective in improving trunk muscle strength and balance in people with chronic stroke. But, trunk PNF exercise that is lifting and chopping pattern showed better performance when compared to control group in terms of strength of trunk rotators. Hence this technique, which doesn't require any equipment or extra cost, can be regularly incorporated to all hemiplegic subjects in any setup or at home.

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