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ORIGINAL ARTICLE

EFFECTS OF CORE STRENGTHENING VERSUS LOWER LIMB PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION TECHNIQUES ON TRUNK FUNCTION AND BALANCE IN CHRONIC STROKE PATIENTS

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ABSTRACT

Stroke, a significant contributor to disability, primarily affects the trunk's ability to produce movement and function. Patients with stroke experience falls frequently, and have more post-fall activity limitations because of severe postural instability. The incidence of stroke is steadily increasing, which further endangers the body's physical, mechanical and musculoskeletal functions. **Objective:** To compare the effects of core strengthening versus lower limb proprioceptive neuromuscular facilitation techniques on trunk function and balance in chronic stroke patients. **Methods:** The randomized control trial was conducted at Itefaq Hospital and Riphah Rehabilitation Centre, Lahore, Pakistan from June to December 2022. The study included either gender, aged 40-70 years old patients having a chronic stroke. They were randomized into two groups. Group A was treated with core strengthening exercises along with conventional treatment and Group B was treated with PNF and conventional treatment. The Trunk Impairment Scale (TIS) and Berg Balance Scale (BBS) was used to assess outcome measures. Data was analyzed by using SPSS21. **Results:** Out of 42 patients, there were 21 patients in each of the two groups. Scores for Berg Balance and Trunk Impairment Scale showed significant results ($p<0.05$) within a group. Significant findings in all parameters were revealed by the within-group analysis. The between-group comparison showed non-significant results in the case of the Trunk Impairment Scale as the p-value was not less than 0.05. Between-group results were significant in the case of the Berg Balance Scale ($p<0.05$). **Conclusion:** This study concluded that the balance and function of the trunk in chronic stroke patients were improved by the application of core strengthening exercises and lower limb proprioceptive neuromuscular facilitation techniques.

Keywords: Berg Balance Scale, Core strengthening exercises, Proprioceptive neuromuscular facilitation, Stroke, Trunk stability, Lower limb, Trunk Impairment Scale.

INTRODUCTION

Stroke is an essential source of morbidity and mortality in the world's healthcare systems. Typical stroke defects include stiffness, weakness, and loss of balance on the affected side, which makes it difficult to maintain proper upright orientation. The ensuing limitations have a significant detrimental effect on victims' productivity, independence, and overall well-being[1]. After a stroke, trunk muscles on both sides are affected, causing issues with balance and walking due to limited trunk rotation. After a stroke, trunk muscles on both sides are affected, causing issues with balance and walking due to limited trunk rotation[2]. Stroke patients may have impaired trunk muscle activity, affecting balance and daily activities[3]. Rehabilitating stroke patients aims to activate specific muscles on the affected side, including the latissimus dorsi, external oblique, and rectus abdominis. Trunk muscle activity can affect

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balance and daily activities, but the Proprioceptive neuromuscular facilitation (PNF) technique can improve stability and function[4].

For patients with hemiparetic stroke, maintaining core stability is crucial for both activities of daily living (ADLs) and instrumental activities of daily living (IADLs). Evaluating trunk control early on has a positive correlation with full ADL competence in patients who survive for six months post-stroke[5]. After a stroke, motor control changes can cause balance problems for over 80% of patients in the subacute stage. This can lead to falls, reduced mobility and dependence on others. Core stability is important for maintaining spinal health and balance[6].Stroke patients often struggle with balance and stability, which can impact their ability to lift weights and maintain posture. Improving balance is a critical part of their rehabilitation process[7]. PNF is a technique that improves balance in stroke patients by activating muscles and tendons. It includes coordination, balance, strength, and flexibility training[8].

Stroke can cause high blood pressure, diabetes, heart disease, sedentary behaviour, lack of exercise, hyperlipidemia, and being overweight all increase the risk of stroke. Many young adults have unhealthy habits that increase their risk, such as being overweight and sedentary[9]. A strong core is important for controlling movement and balance. Rehabilitation programs prioritize developing core stability to reduce the risk of falls and improve walking[10]. The NDT-Bobath and PNF methods are two comprehensive techniques commonly used for this purpose. PNF focuses on re-educating exercises based on past experiences, multi-sensory impulses, and motor development patterns[11].Stroke survivors often show upright posture and distribute weight differently, minimizing fluctuations and pressure on the weaker leg. This affects all aspects of balance, even for those with high functionality[12].

Stroke patients often experience physical difficulties and disabilities. Rehabilitation therapists commonly address mobility issues, such as slower walking, poor balance, and fear of falling[13].Stroke survivors may experience limited mobility, which can lead to reduced activity and participation[14]. Proprioceptive neuromuscular facilitation (PNF) is a therapy technique that combines cutaneous, proprioceptive, and auditory input to promote functional improvement in motor performance[15]. Neuromuscular reeducation is a manual technique that physical therapists use to boost functionality and productivity for patients with various ailments. It enhances strength, endurance, coordination, and ROM while reducing pain and improving stability. It's particularly useful for stroke patients looking to improve their motor function[16,17,18].

Diagonal exercises for the scapula and pelvis can normalize the trunk. Gait training can improve movement. Combined with core stability exercises, pelvic PNF enhances balance and gait[19]. PNF is a therapeutic technique that stimulates proprioceptors to improve neuromuscular responsiveness[20].Trunk mobility exercises and proprioceptive neuromuscular facilitation can improve trunk control in hemiplegic patients[21].PNF and trunk mobility exercises can help improve trunk control in hemiplegic stroke patients. Restoring trunk control is an understudied topic in stroke therapy, but important for preventing falls[22].

A strong core helps with lower limb use. The lumbopelvic-hip complex stabilizes the spine and restores balance after sudden movements. Past treatments involved physiotherapy, occupational therapy, nursing care, and postural control exercises[23]. Improving core muscles on an unstable surface enhances balance, stability, and proprioc-eptive skills. Precise movement and sensory input inform the body about its surroundings. The trunk makes anticipatory adjustments to maintain balance during motor activities[24].In a trunk stability workout, the stabilisation reverse PNF technique was used. Alternating muscular contractions and static instruction were employed to promote posture stability. The therapist provided manual resistance for isometric exercises and completed PNF Levels I and II while reducing anxiety and preventing falls[25].

Early trunk control is linked to long-term functional improvement. Few studies have looked into using

proprioceptive neuromuscular facilitation (PNF) trunk suspension exercises with an adjustable chair to address this issue[26]. Postural control is crucial for daily activities, but stroke patients with limb and trunk weakness can have trunk imbalance due to impaired proprioceptive senses. Trunk muscles are innervated by both cerebral hemispheres[27]. After a stroke, patients may experience weakened trunk muscles on both sides, affecting core postural control. Early assessment of trunk control can predict future ability to perform daily functions[28].

This study helps researchers and clinicians to explore adherence to exercise recommendations to better assist in prescribing core strengthening treatment and conventional exercises that can be completed through the lifespan. This study will help to understand essential concepts of core strengthening and proprioceptive neuromuscular facilitation with high amplitude multiple repetitions.

MATERIALS AND METHODS

This study was a randomized controlled trial that used a single-blinded design. The data was collected from Riphah Rehabilitation Centre and Itefaq Hospital in Lahore, where patients were given informed consent. The study lasted for 10 months after it was approved. Non-probability consecutive sampling was used to select 42 patients of both genders. These patients were randomly assigned to two groups using a lottery method. Group A received core strengthening exercises and conventional stroke treatment, while Group B received lower limb PNF technique[4] along with conventional treatment such as rhythmic initiation, slow reversal, stabilizing reversal, and a combination of isotonic. Participants were selected according to specific inclusion and exclusion criteria and were asked to take part in the study after giving written informed consent in English and Urdu. A lottery method was used to assign each participant to a treatment group. Patients were asked to draw a chit from a box, and each chit was marked as either Group A or Group B. The baseline and end-of-sess-ion values were used to measure the effectiveness of the intervention, and the outcomes of the trials were measured using the berg balance scale and the trunk impairment scale[34].

Statistical Analysis

Data were entered in SPSS (23.0) and descriptive statistics were measured through mean and standard deviation for both groups. Normality was checked through Shapiro-wilk test and data was not normally distributed. Non parametric Mann-Whitney U test was used to compare both groups and for within group comparison, Wilcoxon signed rank test was used. P value equal to or less than 0.05 was set as significant.

RESULTS

Table 1 shows demographic distribution among two groups. In group A of Core strengthening males were 61.9% and females were 38.1%. In group B of PNF, males were 66.7% and females were 33.3%. In the sample of 42 participants, body mass index (BMI) was 0% underweight, 30.8% normal, 38.5% overweight and 11.5% obese. According to socio-economic status of the participants, 23.8% of participants of group A and 9.5% of group B were in lower class, middle-class was 71.4% and 61.9 % and upper class was 4.8% and 28.6% respectively in both A and B group. 13.5% were teacher,11.5% were farmer, 19.2% was housewife, 9.6% were doctor, 9.6% were labour, 7.7% were lawyer and 9.6% were businessman. It showed that in a sample of 42 participants, the mean age of participants was 59.14±5.44, the mean height of participants was 167.92±9.74, the mean weight of participants was 75.71±9.68 and the mean BMI of participants was 26.34±3.79. The mean of type of stroke was 1.23±0.43, mean side of stroke was 1.30±0.46 and mean days after stroke was 1.42±0.63.

The data was not normally distributed therefore non-parametric tests were used for further analysis. Table 2 showed that the p-value of post-Berg balance scale was 0.06 and that of post trunk impairment scale was 0.34.

Table 3 showed that the effect of core strengthening on the berg balance scale is statistically significant. The z value is 4.03, suggesting a strong effect size, and the r value is 0.87, indicating a relatively strong positive correlation between core strengthening and the berg balance scale. Similar to the berg balance

scale, the p value is less than 0.00, signifying statistical significance in the effect of core strengthening on the trunk impairment scale. The z value is 4.03, indicating a strong effect size, and the r value is 0.87, suggesting a relatively strong positive correlation between core strengthening and the trunk impairment scale.

The p value is also less than 0.00, demonstrating statistical significance in the effect of PNF on the berg balance scale. The z value is 4.02, indicating a strong effect size, and the r value is 0.87, implying a relatively strong positive correlation between PNF and the berg balance scale. Similar to the berg balance scale, the p value is less than 0.00, indicating statistical significance in the effect of PNF on the trunk impairment scale. The z value is 4.02, suggesting a strong effect size, and the r value is 0.87, implying a relatively strong positive correlation between PNF and the trunk impairment scale.

Table 1. Comparison of socio-demographic variables of two groups

Variable	Mean ± Std.	
	Group A	Group B
Age (years)	58.80±4.51	59.47±6.33
Height (cm)	166.9±9.38	168.89 ±10.22
Weight (kg)	74.28±8.77	77.14±10.53
BMI	26.16±3.59	26.51±4.06
Type of stroke	1.33±0.48	1.14±0.35
Side of stroke	1.38±0.49	1.23±0.43
Days after stroke	1.33±0.57	1.52±0.67

Table 1. Comparison of socio-demographic variables of two groups
**Std= Standard deviation*

Table 2. Comparison of end value

Variable	Groups	Mean Rank	Median	z value	p - value	r - value
Pre-berg balance scale	Group A	24.90	21.00	1.81	0.06	0.28
	Group B	18.10	19.00			
Pre-trunk impairment scale	Group A	13.26	9.00	0.93	0.34	0.14
	Group B	19.74	8.00			

Table 3. Within group (non-parametric) wilcoxon signed ranks test control group (PNF and core strengthening)

Variable		p value	z value	r value
Core Strengthening	Berg balance scale	<0.00	4.03	087
	Trunk impairment scale	<0.00	4.03	087
PNF	Berg balance scale	<0.00	4.02	087
	Trunk impairment scale	<0.00	4.02	087

DISCUSSION

Initially, pre and post-treatment effect was compared. Between and within group comparison of pre-treatment and post-treatment effects of the trunk impairment scale and berg balance scale was done based on mann whitney U test and wilcoxon signed rank test. The within-group comparison showed that the p value of the berg balance scale was 0.000 ($p < 0.05$) in both the interventional and control groups. That means the difference between both groups was significant. Between-group comparison of NDI showed p value of NDI was <0.05 (p= 0.03). There was a significant difference between the two groups. Pre and post-values were significantly improved when the two groups were compared based on the Mann-Whitney U test.

PNF was found to improve balance and gait in chronic stroke patients, according to a recent study in which significant improvements in balance and trunk mobility were noted within and between groups, with a p value of <0.05. The marked improvement was attributed to the application of 3 passive stretches on the muscle for 30 seconds and 2 sets of 12 muscle stretches followed by shoulder lifting exercises at the end of treatment[29]. In conforming to that results, another study by Pallavi *et al.* (2021) checked how PNF training helped to improve balance and trunk mobility in stroke patients. The study showed qualitative and significantly improved results in both within and between group assessments. Results showed p value was less than 0.05 because the strengthening and motor relearning programme of an unaffected side was also performed[30].

A recent study found that using PNF techniques with tapping improved stroke patients' functional activity, gait, and balance. There was a significant ($p < 0.05$) improvement in their condition[31]. Hazarit *et al.* (2022) found that combining trunk PNF and NDT can improve trunk stability in stroke patients, with statistically significant results. Including acute and subacute stroke patients in the assessment was a key factor[32]. Anothor study checked PNF and trunk-specific exercises improved trunk control and balance in pre and post-evaluations, with better results from combining trunk-specific exercises and PNF techniques[33]. A core strengthening program improved trunk muscle response, leading to improved mobility and balance after a stroke, according to a study by Pilkar *et al.* (2022) The program combined postural training and core strengthening, resulting in significant improvements[34].

Another study find out that stroke patients who did physical therapy with core stability exercises showed statistical improvement in trunk control, with a p value of <0.05[35]. Moreover a core stabilization exercises combined with conventional therapy improved trunk mobility and balance in stroke patients, as measured by the Trunk Impairment Scale[36]. A study predicted gait independence using a trunk impairment scale in patients with acute stroke. Results were significantly improved because acute cases of stroke were taken as a subject to assess the findings[37]. Moreover, investigation on Electrical stimulation improves core muscle strength, easing trunk immobility[38]. The results of the present study were the same as that of Kim *et al.* (2022) who find out the improved function of control of the trunk and balance due to robot-assisted trunk control training in stroke patients. Results were significantly improved because robotic trunk devices were used to improve the core strength[39].

CONCLUSION

The study concluded that balance and trunk function in chronic stroke patients was improved by the application of core strengthening exercises and lower limb proprioceptive neuromuscular facilitation techniques. Positive and additive effects of core strengthening and PNF techniques on trunk balance were seen. Hence, both techniques have proven to be efficient and effective techniques in improving the functional level and balance of the trunk.

DECLARATION

Conflict of Interest: The authors declared no conflict of interest.

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