A COMPARATIVE STUDY ON THE EFFECTIVENESS OF CORE STABILITY EXERCISE AND PELVIC PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON BALANCE, MOTOR RECOVERY AND FUNCTION IN HEMIPARETIC PATIENTS: A RANDOMIZED CLINICAL TRIAL

STUDIU COMPARATIV PRIVIND EFICIENȚA EXERCIȚIILOR DE STABILITATE POSTURALĂ ȘI FACILITARE NEUROMUSCULARĂ PROPRIOCEPTIVĂ PELVINĂ ASUPRA ECHILIBRULUI, A RECUPERĂRII MOTORII ȘI FUNCȚIEI, LA PACIENȚII CU HEMIPAREZĂ: STUDIU CLINIC RANDOMIZAT

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Keywords: core stability exercise, pelvic proprioceptive neuromuscular facilitation, balance, motor recovery, function

Abstract.
Introduction: Development of good trunk stability to promote balance to perform activities is often neglected in stroke-rehabilitation. Evidence state that core stability exercise and Pelvic Proprioceptive Neuromuscular Facilitation(PNF) are effective in improving balance and gait function in hemiparetic patients. **Objective:** The aim is to evaluate the comparative effectiveness of core stability exercise and Pelvic PNF on balance, motor recovery and function in hemiparetic patients. **Procedure:** 30 post-stroke subjects diagnosed with first unilateral stroke with onset less than 6 months were randomized into Core Stability Exercise Group(A) and Pelvic-PNF Group(B), and underwent 45minutes training along with conventional therapy per day, 3days/week, for 4weeks. All subjects were evaluated for Berg Balance Scale(BBS), Motor Assessment Scale(MAS), and Functional Independence Measure Scale(FIMS) pre and post intervention. **Results:** Following intervention, Pelvic PNF showed more statistical significant improvement in FIMS than Core Stability Exercise. However no statistical difference was observed in terms of balance and motor recovery between the groups. **Conclusion:** Focus on trunk control training should also be used initially in stroke-rehabilitation which is an effective way to improve balance, motor recovery and function. Core stability exercise and Pelvic PNF are equally effective in improving balance and motor recovery whereas; Pelvic PNF is more efficient compared to core stability exercise to improve function.

Cuvinte cheie: exerciții postural, facilitare neuroproprioceptivă proprioceptive pelvină, echilibru, recuperare motorie, funcție

Rezumat.
Creștererea stabilității trunchiului pentru obținerea echilibrului în vederea desfășurării activităților cotidiene, este adesea neglijată la pacienții cu hemiplegie. Studiile demonstrează că exercițiile pentru stabilitatea trunchiului și facilitarea neuroproprioceptivă pelvină sunt eficiente în îmbunătățirea echilibrului și a mersului, la pacientul hemiplegic. **Obiective:** Scopul este de a evalua eficiența exercițiilor posturale și a FNP pelvin în îmbunătățirea echilibrului, funcției motorii și mersului la pacientul hemiplegic. **Procedură:** 30 pacienți post AVC, cu mai puțin de 6 luni de la instalare, au fost împărțiți în grupul care urmează exerciții pentru postură (grup A) și grupul care practică FNP pelvin (grup B). Ambele grupe mai fac 45 minute de fizioterapie convențională de 3 ori/zi, 4 săptămâni. Pentru evaluare s-a flosit scala Berg (BBS), Motor Assessment Scale (MAS), și Functional Independence Measure Scale (FIMS) pre and post intervenție. **Rezultate:** După intervenție, s-a constatat o îmbunătățire semnificativă a funcției la grupuul FNP pelvin, comparative cu grupul A. Nu s-au obdervat diferențe semnificative în ceea ce privește echilibrul și recuperarea motorie. **Concluzii:** Inițial, în tratament se va pune accent pe stabilitatea trunchiului, eficientă în recuperarea motorie, a echilibrului și mersului. Exercițiile posturale și FNP pelvin sunt eficiente în egală măsură în îmbunătățirea echilibrului și recuperarea motorie. FNP pelvin este totuși mai eficient în recuperarea funcției.

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Introduction

Stroke is a global health problem that is the second commonest cause of death and fourth leading cause of disability worldwide.[1]Stroke or brain attack is a sudden loss of neurological function caused by an interruption of the blood flow to the brain.[2] WHO defines Stroke as 'The rapid development of clinical signs and symptoms of a focal neurological disturbance lasting more than 24 hours or leading to death with no apparent cause other than vascular origin'.[1]

The Global estimate of Stroke was 400-800 per 100,000 every year with mortality of 5.7 million; approximately 16 million cases of acute strokes every year and about 28,500,000 Disability Adjusted Life-Year. The prevalence of Stroke in India was 90-222 per 1,00,000 with mortality of 1,02,620 million and approximately 1.44-1.64 million cases of acute stroke added every year and 6,398,000 Disability Adjusted Life-Year. Overall in India, the adjusted annual incidence (per 1,00,000 persons) of stroke is 124 in rural area and 145 in urban area.[3] In developed countries, Stroke is the first leading cause for disability and 15% - 30% being permanently disabled. It is also a leading cause of functional impairments, with 20% of survivors requiring institutional care after 3 months. Stroke is a life-changing event that affects not only the person who may be disabled, but their family and caregiver's life.[1]

The most common clinical symptom of stroke is motor weakness (hemiparesis), or paralysis (hemiplegia) with loss of balance or coordination, leading to difficulty in walking.[1,2,3] Impaired postural control is a key characteristic of the mobility problems in stroke patients. It is caused by a complex interplay of motor, sensory and cognitive impairments.[4] Many hemiplegic patients with stroke shift their center of gravity (COG) to the unaffected side when maintaining a quiet stance and show left-right asymmetry in motor function; with decreased balance ability.[5] Good trunk stability is an essential component for balance and the use of extremities while performing daily functional activities with higher level tasks.[6]

Motor recovery is regaining the previously lost motor function seen in the form of improvement in the motor performance or activities in CVA patients. It occurs predominantly in the earlier months following stroke, although some patients may show considerable recovery in later phases. The most important predictor for motor recovery is the initial grade of paresis.

While some patients may show complete recovery, in others the degree of paresis may not change at all. It is difficult to determine a precise time window for motor recovery in individual patients.[7]

Functional recovery is improvement observed in the activities of daily living which may be influenced by a range of biological and environmental factors, and recoveries profiles are characterized by a high inter individual variability. A recent critical review indicated that several clinical and demographic variables may be valid predictors of general functional recovery. This includes neurological factors such as consciousness at onset, disorientation, sitting balance, and severity of motor deficits.[7] Only 12% of the patients with stroke are independent in basic activities of daily living (ADL) at the end of the first week.[8]

Core muscles serve as a muscular corset that works as a unit to stabilize the body and spine, with or without limb movements referred as the "powerhouse", the foundation or engine of all limb movement.[9] It enhances proper load balance within the spine, pelvis, and kinetic chain.[10] The patients with stroke need to rebuild core stability in order to attain proper postures of the lumbar and pelvic regions during activities.[11] Recent studies suggest that the core stability exercises are effective in improving the muscle activity of the lower trunk thereby enhancing trunk control, balance and gait functions in stroke patients.[12,13]

Proprioceptive Neuromuscular Facilitation (PNF) is a method to facilitate or increase the reactions of neuromuscular mechanisms through proprioceptive stimuli.[14] PNF is a therapeutic exercise for stroke to stretch and strengthen the muscles, and train them in functional activities. It is frequently used as an alternative to progressive resistance exercises in order to avoid injury in stroke patients.[15] As pelvis is the "key point of control" for maintaining a gait pattern, hence techniques designed to affect the pelvis are commonly used among PNF techniques.[16,17,18]

Post stroke rehabilitation mainly emphasizes to restore the arm function and independence in gait and to some extent the focus on development of good trunk stability to promote balance to perform activities of daily living is neglected in the stroke-rehabilitation.[6]

Evidence state that core stability exercises and Pelvic PNF are effective in improving balance and gait function in hemiparetic patients. However, there are no studies that have evaluated the effect of these exercises in terms of motor recovery and functional outcome measures. Hence this study is undertaken to compare the effectiveness of core stability exercise and Pelvic PNF on balance, motor recovery and function in hemiparetic patients.

Methods

Participants

Prior to the commencement of the study, approval was obtained from the Ethical Committee of the Institution Review Board. 52 post-stroke subjects from Secondary and Tertiary Care Hospitals in Belagavi were screened for the study. 30 patients were recruited based on the inclusion and exclusion criteria. Patients should also be willing to receive intervention for a minimum of 12 sessions for 4 weeks duration. The participants were briefed about the nature of the study and informed consent was taken. The participants were randomized into two groups: Group A (n=15) where core stability exercise was given and group B (n=15) Pelvic PNF, using the lottery method. The inclusion criteria included participants diagnosed with first unilateral stroke with onset less than 6 months, age between 45 to 70 years, able to ambulate 10 meters with or without walking aids, Mini-Mental State Examination score greater than 24/30. The exclusion criteria were neurological disease affecting balance other than a stroke, such as cerebellar disease, Parkinson's disease and/or a vestibular lesion. Recent surgeries of abdomen & pelvis fracture less than 6 months, medically unstable, musculoskeletal disorders such as low backache, arthritis or degenerative diseases of the lower limbs affecting motor performance.

Outcome Measures

The outcome measures of Berg Balance Scale (BBS), Motor Assessment Scale (MAS), and Functional Independence Measure Scale (FIMS) was collected pre and post 4 weeks.

Berg Balance scale: The scale is a 5-point ordinal scale to assess balance, ranging from 0 to 4 with higher scores given on the basis of speed, stability or degree of assistance required for completion of the task. The task scores are summed to give a total score out of a possible 56 points with higher scores representing better balance. The BBS is psychometrically sound measure of balance impairment for use in post stroke assessment.[19]

Motor Assessment Scale: The test is designed to assess the motor recovery and return of function following a stroke or other neurological impairment. Each item is scored on a scale ranging from 0 to 6 pertaining to upper extremity motor recovery, balance, and function. Higher the score higher will be the functioning of the patient on the affected side. [20]

Functional Independence Measure Scale: The 18 items on the FIM assess the patient's degree of independence in function. Thirteen items define disability in motor functions and five define disability in cognitive functions. Each item is rated on a 7-point scale, with 1 = total assist (<25% independence) and 7 = complete independence (100% independence). Ratings are added to all the items and are used to determine the degree of help the patient needs to carry out basic, routine daily tasks.[21]

Intervention

Both the groups participated in 30 minutes of conventional therapy and 30 minutes of core stability exercise or Pelvic PNF. Conventional therapy included stretching and strengthening exercises for upper and lower extremities, techniques to normalize tone and weight bearing exercises, active functional training for postural and functional control.[2] Group A received core stabilization exercises where participants were taught to contract multifidus and

transverse abdominus before the commencement of exercise, which was expected to be in a contracted state during the exercise program..The exercises included curl-ups with straight reaching, curl-ups with diagonal reaching, bridging, bridging with legs crossed, bridging with one leg, bird dog exercise, and side bridging.[12,13] Group B received Pelvic PNF which included 10 minutes each of rhythmic initiation, slow reversal, and agonistic reversals applied to the pelvic region. The procedures were done to facilitate anterior elevation and posterior depression of pelvic movement in a side-lying position which allows free motion of the pelvis.

The element of PNF such as manual contact, stretch, resistance, and verbal cuing was incorporated into the treatment session. Stretch was applied immediately and gently after the target muscle had been fully lengthened by relaxing the muscle before the subject started to move. For anterior elevation the contra lateral internal and external oblique abdominal muscle and for posterior depression internal and external oblique abdominal muscle was stretched. [16,17,18]

Results

The primary data of the study was analyzed in terms of improvement in the scores of BBS, MAS and FIMS after four weeks of intervention program. Intra and inter group differences were compared so as to evaluate the effectiveness of the two treatment techniques under consideration in the present study. Statistical analysis was done using the statistical software SPSS version 21.0. Demographic data was analyzed using paired - t test for age, Body Mass Index (BMI) and duration of stroke and chi square test for gender and affected side distribution.

For the outcome measures paired - t test was used with p value less than 0.05 ($p<0.05$) as statistical significance. Demographic characteristics of both the groups are shown in Table 1.

The pre-test mean in BBS of group A was 20.87 ± 6.19 and post-test was 29.40 ± 7.58 with a difference of 8.53 ± 5.58 which was statistically significant(p=0.00001). The pre-test mean of group B was 27.80 ± 9.24 and post-test was 37.87 ± 7.68 with a difference of 10.07 ± 5.23 which was statistically significant (p=0.00001). The group A showed better improvement compared to group B which was not statistically significant (p=0.4439).

The pre-test mean in MAS of group A was 25.53 ± 5.60 and post-test was 40.67 ± 7.49 with a difference of 15.13 ± 4.94 which was statistically significant(p=0.00001). The pre-test mean of group B was 25.53 ± 3.96 and post-test was 43.20 ± 3.65 with a difference of 17.87 ± 3.60 which was statistically significant (p=0.00001). Between the groups, the score was not statistically significant (p=0.0944) but group B showed better improvement compared to group A.

The pre-test mean in FIMS of group A was 80.67 ± 10.69 and post-test was 101.87± 15.97 with a difference of and 21.20 ± 9.80 which was statistically significant (p=0.00001). The pre-test mean of group B was 84.07 ± 13.40 and post-test was 112 ± 7.5 with a difference of 27.93 ± 8.14 which was statistically significant (p=0.00001). The group B showed better improvement compared to group A which was statistically significant (p=0.05). (Table 2)

TABLE 1 : Demographic characteristics of both the groups.

Demographic Data	Group A	Group B	p-Value
Age (years)	52.07±5.98	55.27±8.25	0.2341
BMI	26.01±4.6	24.77±4.43	0.4571
Duration of stroke (months)	1.20±1.72	2.67±2.53	0.0736
Gender: Male/ Female	13/2	12/3	0.6242
Side affected: right/left	9/6	11/4	0.4397

TABLE 2: Intra and Inter values of Outcome Measures of both the groups (*p<0.05, paired t test)

OUTCOME	VALUES	DIFFERENCE IN VALUES	PERECENTAG

MEASURES										E OF CHANGE	
		GROUP A	GROUP B	t VALUE	p VALUE	GROUP A	GROUP B	t VALUE	p VALUE	GROUP A (p VALUE)	GROUP B (p VALUE)
MAS (Motor Assessment Scale)	PRE	25.53 ± 5.6	25.53 ± 3.96	0.1129	0.9109	15.13 ± 4.94	17.87 ± 3.6	-1.7312	0.0944	59.27 % (0.00001*)	70.53 % (0.00001*)
	POST	40.67 ± 7.49	43.2 ± 3.65	-1.1777	0.2488						
BBS (Berg Balance Scale)	PRE	20.87 ± 6.19	27.8 ± 9.24	-2.4141	0.0226	8.53 ± 5.58	10.07 ± 5.23	-0.7766	0.4439	40.89 % (0.00001*)	36.21 % (0.00001*)
	POST	29.4 ± 7.58	37.87 ± 7.68	-3.0396	0.0051						
FIMS (Functional Independence Measure Scale)	PRE	80.67 ± 10.69	84.07 ± 13.4	-0.768	0.4489	21.2 ± 9.8	27.93 ± 8.14	-2.0494	0.05	26.28 % (0.00001*)	33.23 % (0.00001*)
	POST	101.87± 15.97	112 ± 7.5	-2.224	0.0344						

Discussion

The Randomized Clinical Trial was conducted to compare the effectiveness of core stability exercise and Pelvic PNF on balance, motor recovery and function in hemiparetic stroke patients. All the subjects showed no statistical difference in age, gender, BMI, and side affected in both the groups which represent homogeneity of the patients.

The study showed significant improvement in pre and post-intervention score of the core stability exercise and Pelvic PNF when evaluated by BBS. However between the groups the score was not statistically significant and core stability exercise showed better improvement compared to Pelvic PNF. Core training apparently improved the balance of the lumbo-pelvic-hip complex, corrected postural alignments, therefore it could have led to a gradual improvement in balance in the BBS. Core stability exercises lead to stabilization of the trunk by strengthening the lumbar musculature and improving trunk control which resulted in correction of the shift of COG from the unaffected side back to the center. In a pilot study conducted to investigate the effect of core exercises on balance and selective trunk movement in hemiplegics, a significant improvement in sitting balance was noted on trunk performance.[22] As stated in the literature, Pelvic PNF not only exercises the pelvis motion and stability but also facilitates trunk motion and stability.PNF might have improved the flexibility, muscle strength, neural control, and proprioception contributing to a better postural control and dynamic stability.[14]

There was significant improvement in pre and post-intervention score of the core stability exercise and Pelvic PNF when evaluated by MAS to measure the motor recovery. However no significant difference was observed between the groups but Pelvic PNF showed better improvement compared to core stability exercise. The improvement shown in the Pelvic PNF group was because of focus of this approach on upgrading of the lost motor capacities. It could also have led to the facilitation of trunk control by the application of stretch, use of particular movement patterns and use of maximal resistance in order to induce irradiation indirectly to upper trunk & cervical areas. This may be the reason for the improvement in the level of motor recovery. Kabat reported that a greater motor response can be attained when facilitating techniques are employed in addition to resistance which could have lead to an improved motor recovery in our study.[14,16] The improvement in the motor performance in core stability exercise could be due to the repeated contraction of the core muscles of the spine thereby

increasing strength and stability of trunk. This might have lead to plasticity of the sensorimotor regions of the central nervous system. Similar results were shown by a study to verify the effects of a 4-week core stability-enhancing exercise where core control ability was evaluated using TIS and surface electromyography. Significant difference was found in the TIS score and increased activation of the core muscles of patients with hemiplegia was recorded on surface electromyography.[13]

Both the techniques core stability exercise and Pelvic PNF showed significant improvement in pre and post intervention scores in the function when evaluated by of FIMS. Pelvic PNF may possibly improve functional independency through increased emphasis on symmetry between the affected and non affected side and induces patients to use the affected extremities voluntarily. The improved balance had aided in functional recovery and decrease dependency in ADLs. The Pelvic PNF resulted in more significant improvement and was effective in improving function than core stability exercise. The techniques used were Repeated Stretch technique which helps to strengthen trunk muscles. Reversal of Antagonist technique trains coordination and can prevent or reduce fatigue of the working muscles and Rhythmic Stabilization technique applied to lower trunk and pelvic stability which might have helped in improving the control of the pelvis. As pelvic motion and stability is required for proper function of the trunk and lower extremities during different activities. The Pelvic elevation patterns facilitate stepping or leg lifting motions and pelvic depression patterns facilitate weight bearing motions of the leg which are prerequisites for normal function.[14] Trunk control is the ability of the core muscles to maintain an upright posture, regulate weight shifts and perform selective movements.[4] The techniques used in core stability exercise might have helped to improve function by maintaining selective movement control which is altered in patients with stroke due to the order of muscle movement. This results in malfunctioning movement pattern with increased energy expenditure. The limitation of the study was that a long term follow up could not be assessed.

Conclusion

Instead of concentrating only on the limbs, focus on trunk control training should also be used initially in stroke-rehabilitation that is an effective way to improve balance, motor recovery and function. Core stability exercise and Pelvic PNF are equally effective in improving balance and motor recovery whereas; Pelvic PNF is more efficient compared to core stability exercise to improve function.

Future scope

Multicentre trials with long-term follow-up can be carried out to check the carry over effect. Outcome measure to evaluate quality of life can be considered.

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Conflict of interest

None

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