Effect of Proprioceptive Neuromuscular Facilitation [PNF] Technique for Knee & Ankle Muscles on Lower Limb Performance in Subacute Stroke

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Abstract: *Background: Gait dysfunction is one of the most serious consequences of stroke due to lower limb impairments. Which results into increased falls, sit to stand disability and restricted mobility leading to individual's poor quality of life and functional dependency. Thus, the significant predictor of mobility after the stroke is the knee and ankle muscle strength. Aim: To find out the effect of proprioceptive neuromuscular facilitation [PNF] technique for knee and ankle muscles on lower limb performance in subacute stroke – an experimental study. Objectives: To study the effect of PNF technique on knee and ankle muscles. To improve the balance and functional training in subacute stroke patients. Methodology: Using a Convenience sampling method, a sample of 20 subacute stroke patients were recruited. An Experimental study was carried out at two tertiary care hospitals and the statistical data was analyzed at Dr. Ulhas Patil College of Physiotherapy, Jalgaon. A protocol of 10 days treatment sessions was given to all the patients. Protocol unified PNF Rhythmic stabilization technique utilizing alternating isometric contractions of both agonist and antagonist against resistance. Five Times Sit to Stand Performance Test [5 STS], Modified Emory Functional Ambulation Profile [mEFAP], Postural Assessment Scale for Stroke [PASS] were used to measure the lower limb performances. Results: The paired t test value was 8.61, 8.51 and 5.06 in 5 STS test, PASS and mEFAP(s) with the p value less than 0.05 in each test showed the significant difference in average pre and posttests scores respectively. Conclusion: Hence, we emphasized a potential role of Rhythmic Stabilization showing an effective method for improving balance and walking ability in subacute stroke patients.*

Keywords: PNF, RHYTHMIC STABILIZATION, PASS, mEFAP, 5 STS test

1. Introduction

A stroke is a medical condition in which poor blood flow to the brain causes cell death. The initial first six months is defined as the subacute phase of stroke[1].Prevalence of stroke in India is approximately 200/1,00,000 population.[8]Stroke results in movement problems like spasticity, atypical pattern of movement which leads to functional limitations and disability.[4]Hemiplegia or hemiparesis is most common presentation of stroke. And Gait dysfunction is one of the most serious consequences of stroke.[4]

During gait, the sequential flow of motor activity is disrupted.[6]Similar to gait, sit to stand transition usually gets affected in the individuals with stroke.[7]After stroke, the recovery of gait capacity is an important factor to ensure increased quality of life and functional independence.[2]Lower limb impairment is associated with increased falls, sit to stand ability and restricted mobility. The significant predictor of mobility after stroke is the knee and ankle muscle strength.[1]

There are numerous therapeutic approaches which are developed based upon a neurodevelopmental approach, neuro physiological approach, motor learning and motor control to enhance the function, PNF is one approach commonly used to improve functional performances.[1]

PNF is defined as method of promoting or hastening the response of the neuromuscular mechanism through stimulation of the proprioceptors.[5]To improve function and enhance muscular strength, flexibility, and balance PNF approach helps to stimulate proprioception of the muscles, tendons, and joints.[2]

PNF consist of therapeutic exercises that use a series of facilitation and synergy patterns in an effort to get muscle strengthening and neuromuscular re-education.[3]PNF includes various techniques that are essential to induce facilitation, inhibition, strengthening, and relaxation of muscle groups in order to promote functional movements.[5]

Various studies have suggested that knee muscle strength and bulk decreases significantly after stroke, which gets directly impacted on the gait speed, gait performance, functional performance and sit to stand transfer ability among stroke survivors.[1]For which knee muscle stabilization and functional performance in stroke patients, rhythmic stabilization technique has shown significant improvement in strength, endurance, flexibility, stability, balance and functional performance.[1]

"Rhythmic Stabilization" technique utilizes alternating isometric contractions against resistance. This technique is useful in maintaining a co-contraction of antagonistic muscles against maximal resistance which builds up excitation and further helps to increase active and passive range of motion, strength, stability, and balance, as well as to control pain.[5]

There are various intervention techniques to improve gait, balance and sit to stand performances. From which

Rhythmic Stabilization is an effective intervention to improve gait, balance and sit to stand disabilities. Therefore, this study aims to find out the most effective intervention for stroke patients. And hence, we assumed that rhythmic stabilization for the knee and ankle muscle may improve the functional performance of the lower limbs in stroke patients.[1]

2. Need for Study

Cerebral stroke causes a significant deterioration of patients functioning and worsening his/her quality of life. Many interventions have focused on improving physical walking and balance ability in patients with stroke. However, hemiparetic/stroke patients often show imbalanced gait caused by asymmetric upper & lower limb movement and unstable left & right balance.

Sanjiv Kumar and Shiva Prasad Tiwari et.al [2014] determined the significant improvement in function by the effect of PNF technique for knee muscles on lowerlimb performances in subacute stroke patients.

However, we have not come across any literature showing effect of PNF technique for knee and ankle muscles to improve balance and functional activities among subacute stroke patients in Jalgaon district of Maharashtra. Hence, the study was conducted to find the out the effect of PNF technique for knee and ankle muscles in improving lowerlimb performance among subacute stroke patients from Tertiary Care Hospitals**,** Jalgaon. The study shall be useful for the growing body of literature thereby helping to take necessary measures for the same.

Aim
To find out the effect of proprioceptive neuromuscular facilitation [PNF] technique for knee & ankle muscles on lower limb performance in subacute stroke – an experimental study

Objectives
• To study the effect of PNF technique on knee and ankle muscle performances in subjects with subacute stroke patients.
• To improve the balance and functional training in subacute stroke patients.

3. Materials & Methodology

• **Study Design:** An Experimental Study.
• **Sample Size:** A total of 20 subacute stroke patients were recruited of both genders.
• **Study Place:** The study was conducted from two tertiary care hospitals& thestatistical data was analyzed at Dr. Ulhas Patil College of Physiotherapy, Jalgaon.
• **Study Duration:** The study was carried out for a period of 6 months with a protocol of 10 Days treatment sessions per patient.
• **Materials:** Pen, pencil, marker,chair, measuring tape, cello tape, stopwatch, Two small rectangular obstacles and one large trash can.

Inclusion Criteria:
1) Single unilateral stroke < 6 months.
2) Grade 2 & higher of Brunnstorm's voluntary control of affected lower extremity.
3) Patient should be ambulatory before the current episode of the stroke.
4) Able to understand instructions.
5) MMSE score >24.
6) Individuals with age group between 31 to 80 years old were taken.
7) Both the genders were included.

Exclusion Criteria:
1) Severe cardiopulmonary disease.
2) Orthopedic arthritic condition interfering with walking.
3) Behavioral problems (that interfere with treatment).

Intervention:
1) Following the inclusion and exclusion criteria, all participants received 10 days of intervention of PNF Rhythmic Stabilization for the Knee and Ankle muscles of stroke patients.
2) Here, PNF Rhythmic Stabilizationutilize alternating isometric contractions of agonist & antagonist against resistance.
3) <u>**For Knee:**</u>
   • Subjects were placed in supine lying position with the knee joint maintained in flexion at an angle of 30, 60, & 90 degrees respectively.
   • The examiner has to place their hands above & below individual's knee joint & manually apply the resistance in a Rhythmic fashion to distal & proximal parts of thigh and lower leg respectively.
   • Resistance was increased slowly, first for knee extension and when subjects strongly resists, the examiner changes the hands to resist knee flexion with simultaneous verbal commands.
   • Subjects were encouraged to maintain a given position against manual resistance without performing any movement.
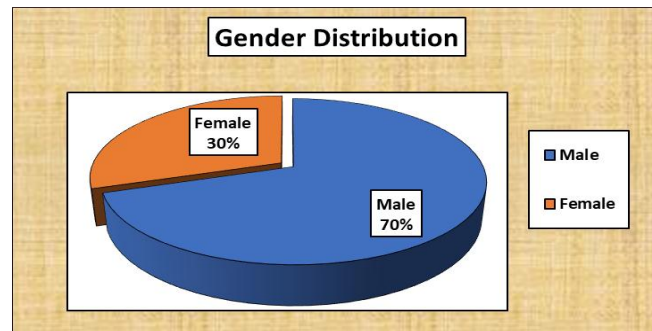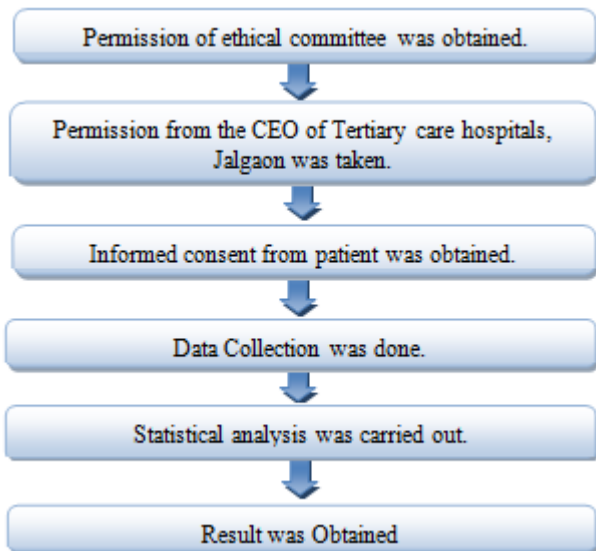
4) <u>**For Ankle:**</u>
   • Subjects were placed in supine lying position with ankle joint at the edge of the table.
   • Theexaminer has to placetheir hand one below the leg and manually apply the resistance in Rhythmic fashion with the other hand to the dorsum aspect of ankle for plantar flexion.
   • As the resistance increases slowly,the examiner thenchanges the hand placementto resist dorsiflexion.
   • And asks patient to maintain the position without performing the movement.

Outcome Measures
1) Modified Emory Functional Ambulation Profile [mEFAP]
2) Postural Assessment Scale for Stroke [PASS]
3) Five Times Sit to Stand Performance Test.

Procedure

4. Statistical Analysis & Results

Table 1

Variable	Groups	Frequency	Percentage
Age	31-40	3	15.00
	41-50	3	15.00
	51-60	4	20.00
	61-70	4	20.00
	71-80	6	30.00

Interpretation: The above table & graph shows the age distribution of the study samples. The 15% of the samples have the age between 31-40 years of age, 15% in the 41-50 years, 20% in the 51-60 years, 20% in the 61-70 years and 30% of them in the age group 71-80 years of age.

Table 2

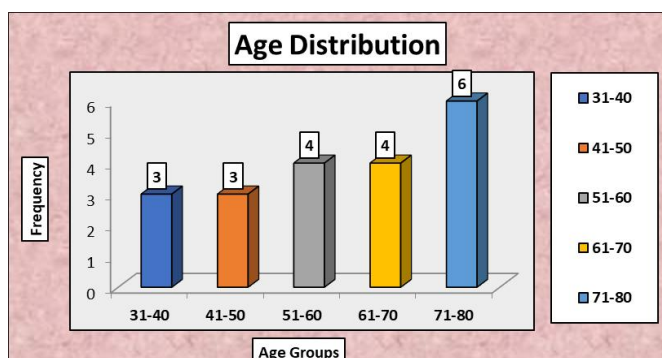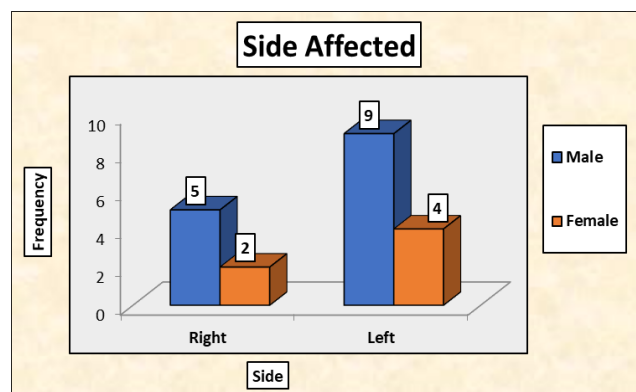| Variable	Groups	Frequency	Percentage
Gender	Male	14	70.00
	Female	6	30.00
	Total	20	100.00

Interpretation: The above table & graph shows the gender distribution of the study samples. The 70% males and 30% females were included in the study.

Table 3

Side	Groups	Gender Male	Gender Female	Total
Side	Right	5	2	7
	Left	9	4	13
	Total	14	6	20

Interpretation: The above table& graph shows the Side affected according to the gender of study samples. In the males 35.71% of them affected right side and 64.28% of them affected left side. In the females 33.33% of them affected right side and 66.66% of them affected left side.

Table 4

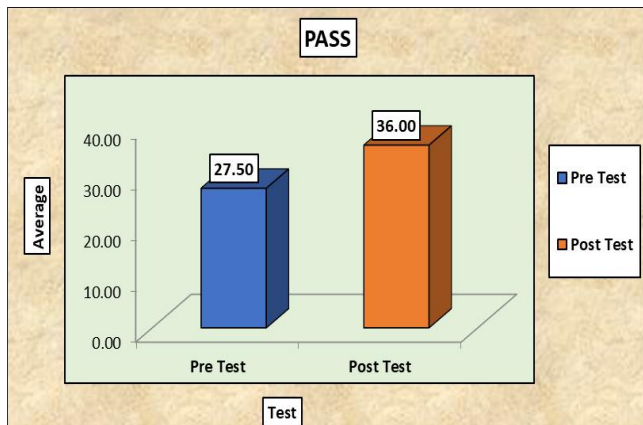| Outcome	Time	Mean	SD	Mean Diff.	t value	p Value
5STS (s)	Pre-Test	38.46	14.24	15.27	8.61	0.000
	Post Test	23.19	8.80			
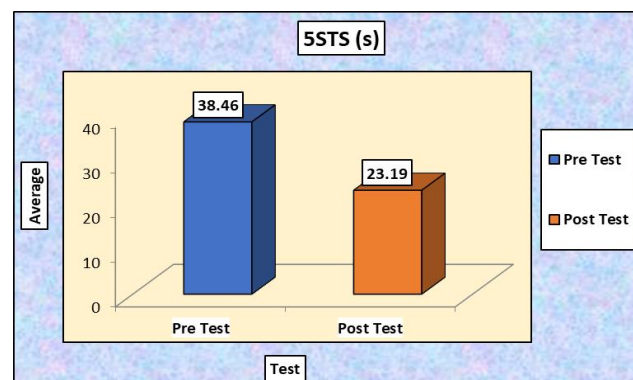
Interpretation: The pre-test average score of 5 STS was 38.46 with SD of 14.24. The post-test average score of 5 STS was 23.19 with SD of 8.80. The Paired t test value of

the paired t test was 8.61 with the p value 0.000. The p value less than 0.05, shows the significant difference in the average pre and post-test 5 STS scores.

Table 5

Outcome	Time	Mean	SD	Mean Diff.	t value	p Value
mEFAP (s)	Pre-Test	27.50	4.46	8.50	8.51	0.000
	Post-Test	36.00	0.00			

Interpretation: The pre-test average score of PASS was 27.50 with SD of 4.46. The post-test average score of PASS was 36 with SD of 0.00. The Paired t test value of the paired t test was 8.51 with the p value 0.000. The p value less than 0.05, shows the significant difference in the average pre and post-test PASS scores.
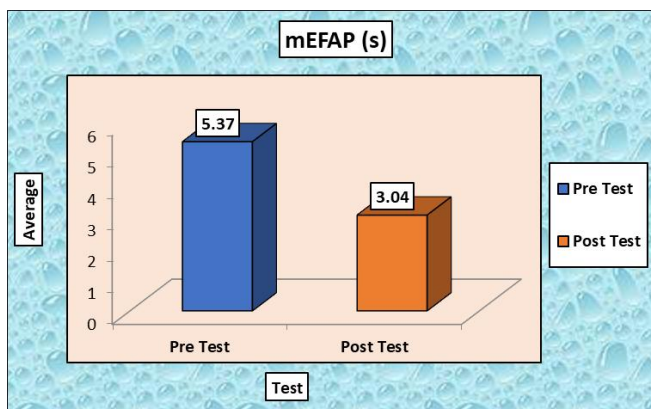
Table 6

Outcome	Time	Mean	SD	Mean Diff.	t value	p Value
mEFAP (s)	Pre-Test	5.37	4.87	2.33	5.06	0.000
	Post-Test	3.04	2.84			

Interpretation: The pre-test average score of mEFAP (s) was 5.37 with SD of 4.87. The post-test average score of mEFAP (s) was 3.04 with SD of 2.84. The Paired t test value of the paired t test was 5.06 with the p value 0.000. The p value less than 0.05, shows the significant difference in the average pre and post-test mEFAP (s) scores.

5. Discussion

The present study was conducted to find out the effect of PNF technique in improving lower limb performances among subacute stroke patients in Jalgaon.

The sample size consisted of 20 subjects. We have performed Rhythmic Stabilization among subacute stroke patients to improve their Knee and Ankle muscles for balance and gait training as we found those patients were affected also with balance impairment and gait training. The study also showed that Rhythmic Stabilization has significant improvement in strength, endurance, flexibility, stability, balance as well as functional performance. The result of the current study concluded that there was a significant difference found among pre & post interventions of PASS, 5STS, mEFAP scores.

Sanjiv Kumar and Shiva Prasad Tiwari et. al. in (2015) determined improvement in sit to stand performance and also improvement in balance and gait outcomes through their study. Maximal resistance applied during contraction leads to storage of elastic energy, which enhances the force production in contracting muscles. As force production is directly related to motor unit activation. Maximum no. of motor units are activated, resulting in improvement in sit to stand. **Walker JM, Surhurg PR et. al (1999)** showed significant improvements in strength, endurance and balance because of Rhythmic Stabilization.

In present study, we found significant improvement in the five times sit to stand test, which signifies there was a significant improvement in knee and ankle muscle strength after the training. The reflex activities of the GTOs and improvement in function may also be influenced by centrally generated motor commands due to repeated training, which leads to learning. Verbal command that was provided during the training acts as the augmented feedback and also adds to promote learning. This is enhanced with the observation by participants, and use of manual contact.

Truebload PR, Perry L et. al (1989) Improved performance in functional activities in their study, which is in accordance with the results from previous studies, which showed significant improvements in strength, endurance and balance because of rhythmic stabilization. **Kajal Patel et. al in 2015** reported that neuromuscular spindle gets activated during prolonged PNF stretch and isometric contractions of stretched agonists muscles. The increase in tension created gives better improvement in calf flexibility.

Kim Kang et. al (2014) in their study confirmed that a PNF rhythmic stabilization regimen was effective in improving walking and balance ability. During PNF stretch and isometric contraction of stretched agonists for extended period may cause activation of its neuromuscular spindle. The increase in tension created during the isometric contraction of the prelengthened agonist contracts concentrically. Hence PNF stretching is more effective and thus helps improving calf flexibility.

Various studies have suggested that lower extremity strength training can improve the functional performance in individuals with stroke. Whereas in our study we found improvement in strength and function because of the rhythmic stabilization. However, in contrast to our study other studies reported that increase in strength does not show improvement in ambulation. **Sanjiv Kumar and Shiva Prasad Tiwari et. al. in (2015)** study suggests that the gain

in strength occurs after the training in stroke patients, and strength training does not associate with increase in spasticity.

The components of mEFAP includes the task required for overall functional ambulation profile, which suggests that the given treatment enhances the ability of the patient to undertake the activities of daily living (ADL) thus contributing to improved quality of life in hemiparetic patients.

Charles Benaim et. al (1999) conducted a study in France, stated that Postural assessment is a key point of the rehabilitation program in stroke patients. During the first week after stroke has been found to be important indicator for the long-term prognosis of the gait ability. And thus, found that PASS is more relevant and has undergone one of the complete validation phases. In our study, PASS scale was effective for assessing the static and dynamic balance by maintaining the functional equilibrium of stroke patients.

The final finding of this study shows, the goals of treatment basically directs towards physical and functional rehabilitation through various effects such as neuromuscular re-education, facilitation, reduction of impairments, induction, re-enforcement, and relaxation. The specific objectives within the patient management included in the PNF studies are: to facilitate movement, increase stability, to increase coordination, functional ambulation, to reduce sensory deficits, home exercise as a rehabilitative program, gait training, restoration and improvement of voluntary movements, to facilitate physical activity, to increase muscle strength, to increase motor control, and muscle relaxation.

6. Conclusion

- To conclude, although the knee and ankle flexors as well as extensors muscles are different from anatomical point of view, the experiments performed in the present study provided consistent results.
- This study was effective in improvinglower limb function in stroke patients by using rhythmic stabilization.
- Hence, we have emphasized a potential role of Rhythmic stabilization, but other mechanisms such as combining Rhythmic Stabilization with Stabilizing Reversals undoubtedly also plays a role.
- So, this present study suggests that Rhythmic stabilization is an effective method for improving balance and walking ability in subacute stroke patients.

Clinical Implication:
- Efficacy of Rhythmic Stabilization can help improving sensory motor function in patients with stroke.
- Using PNF with Rhythmic stabilization tone, balance, gait speed and functional performances can be improved.

7. Limitation

- The sample size taken was less.
- Follow-up was not taken therefore long-term effects were not known.

- This study was focused only on walking and balancing activity.
- Subjects with sub-acute stroke patients were taken into consideration.

8. Future Scope

In further studies, Rhythmic Stabilization and Stabilizing Reversals techniques can be combined and used in a variety of patient positions, static or dynamic, depending on the level of independence with functional mobility and on the goal of treatment.

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