

# Effect of Proprioceptive Neuromuscular Facilitation in Hemiplegic Gait a Randomized Trial of 4 Weeks and a Follow up after 2 Weeks

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## ABSTRACT

**Background and Objectives:** Stroke is the most disabling condition with 30% to 66% of individuals lose their functional ability and gait is the most occurred motor impairment in stroke. Gait is a major determinant of independent living, therefore, walking function is the most commonly stated priority of stroke survivors. Proprioceptive Neuromuscular Facilitation technique is a motor learning approach used in neuro-motor development training to improve motor function and facilitate maximal muscular contraction. The present study aimed to evaluate the effect of Proprioceptive Neuromuscular Facilitation & its sustained improvement in hemiplegic gait. And the objective is to improve the gait pattern in hemiplegic gait.

**Keywords:** Hemiplegic gait, Proprioceptive Neuromuscular Facilitation, Spatial parameters of gait, Wisconsin Gait Scale

## INTRODUCTION

Worldwide incidence of Stroke has been quoted as 2/1000 population per annum about 4/1000 in people aged 45-80 years. In India the incidence of Cerebro-Vascular accident was found to be 13/100,000 population per year conducted at Rohtak<sup>1</sup>.

Stroke is associated with the highest odds of reporting severe overall disability<sup>2</sup>.

Stroke is the most disabling condition with 30% to 66% of individuals lose their functional ability<sup>3</sup>.

Gait is the most Motor impairment in stroke typically involves paresis of the side of the body opposite to the site of the brain lesion. Gait is one of the most common and complex of human movements<sup>4</sup>.

Ability to walk is generally associated with the achievement of four related tasks: maintenance of upright posture; balance or stance stability during the stance phase of the gait cycle; clearance of the swinging foot during the swing phase of the gait cycle; and the supply of sufficient energy to the body with each stride to ensure efficient forward progression<sup>5</sup>.

Gait is a major determinant of independent living, therefore, it is not surprising that improvement of walking function is the most commonly stated priority of stroke survivors<sup>6</sup>.

In persons with hemiplegia, posture tone and coordinate reciprocal movements, which are required for normal gait, are usually impaired. Normal reciprocal pelvic movement is often replaced by a fixed pelvic retraction, which makes it difficult for patients to swing the affected lower extremity forward. The resulting gait is slow, with short step length and asymmetric steps, often called "Hemiplegic gait"<sup>7,8</sup>. This slow gait can be observed in clinical settings as a decrease in gait speed and cadence. Improvement of the quality of gait is often a major goal of physical therapy for patients with hemiplegia. Proprioceptive Neuromuscular Facilitation (PNF) is one approach commonly used to improve the gait of patients with hemiplegia<sup>9</sup>. Various PNF procedures have been used, depending on the affected site<sup>10</sup>. Among these PNF techniques is facilitation of pelvic motion to improve control of the pelvis, because the pelvis has been described as a "key point of control" for maintaining a gait pattern, techniques designed to affect the pelvis

are widely used very few studies however, have documented the therapeutic effects of facilitation of pelvic motion in patients with hemiplegia.

### **Proprioceptive Neuromuscular Facilitation**

Is a motor learning approach used in neuro-motor development training to improve motor function and facilitate maximal muscular contraction. It was developed by Dr. Herman Kabat and Maggie Knot in late 1940's and early 1950's.

Basis of PNF philosophy is the idea that all human beings, including those with disabilities have untapped existing potential<sup>11</sup>.

The PNF approach to treatment uses the principle (based on early phylo-genetic and embryologic observations) that control the motion proceeds from proximal to distal body regions. Facilitation of trunk control, therefore is used to influence the extremities. If this paradigm is valid, gaining control of and strengthening "normal" pelvic motions should improve lower extremity function.

PNF exercises are based on the stretch reflex which is caused by stimulation of the golgi tendon and muscle spindles. This stimulation results in impulses being sent to the brain, which leads to the contraction and relaxation of the muscles. When a body part is injured, there is a delay in the stimulation of the muscle spindles and the golgi tendons resulting in weakness of the muscle. PNF exercises help to re-educate the motor units which are lost due to the injury/impairment.

Proprioceptive Neuromuscular Facilitation is one approach commonly used to improve the gait of patients with hemiplegia. Various PNF procedures have been used, depending on the affected side. Among these PNF techniques is facilitation of pelvic motion to improve the control of the pelvis. Because the pelvis has been described as the key point of control for maintaining a gait pattern, techniques designed to affect the pelvis are widely used<sup>12</sup>.

## **MATERIALS AND METHOD**

### **Type of Study**

Experimental group study,

Comparative in nature.

Sample Size

30 subjects suffering from hemiplegic gait were selected, following random sampling method from a finite population.

### **Duration of study**

6 months

### **Inclusion criteria**

Diagnosis of hemiplegia secondary to cerebrovascular accident, with symptoms lasted from less than 12 months from the incidence of stroke, The ability to walk at least 60 ft (18.3 m) without manual assistance with or without an assistive device, at ones preferential speed, No previous PNF treatment could have been given to the pelvic region, The patients have intact kinesthesia for the Hip, Knee, and Ankle as determined by the evaluator, Patients having hemiplegia and suffering from Hemiplegic Gait on the basis on Brunnstorm Stages of Recovery of lower extremities, Both males and females included, Age (45-65 years), Patients who are able to follow simple instructions, Patients who have suffered from first time stroke with right or left side involvement.

### **Exclusion criteria**

Patients with a history of visual and auditory deficits, Patients with a history of lower limb pathology, Patients with a history of Previous knee and Hip surgeries, Patients with a history of recent significant injury to the Hip, knee or ankle, Patients with a history of Brain tumor, Patients with a history of more than one stroke incident, Patients with contracture and deformities of the lower limb, Patients taking anti-spastic medication.

### **Procedure**

1. After the approval from the ethical committee of Gian Sagar Medical College and Hospital.
2. 30 hemiplegic patients suffering from circumduction gait in case of hemiplegia secondary to cerebrovascular accident were selected on the basis of brunnstrom's stages of recovery for lower extremities (Stage 3, 4 and 5)<sup>9</sup>.
3. The patient's ability to walk at least 18.3 m (60 ft.) without manual assistance, with or without an assistive device, at ones preferential speed.
4. The patient's intact kinesthesia is evaluated before the selection.

5. For the evaluation of kinesthesia-.The patient's hip, knee, and ankle are tested three times.
  - The therapist places the patient's hip in medial or lateral rotation, asking the patient whether the toes are "in" or "out."
  - The therapist places the patient's body region to be considered as knee in flexion or extension, asking the patient whether the lower extremity is "bent" or "straight."
  - To test the ankle, the therapist places hemiplegic patient's foot in dorsi-flexion or plantar flexion and asks the patient whether the foot is "up" or "down."
6. After the selection process was completed the total of 30 subjects were selected, these patients were duly informed about the treatment protocol and informed consent was taken from them.
7. PNF techniques were administered on the patient's for 4 weeks.
8. Techniques of PNF administered on the patients were Rhythmic Initiation, Slow Reversal, and Agonistic Reversals. The sequence was rhythmic initiation first for 10 minutes, followed by slow reversal and agonistic reversal each again for 10 minutes<sup>4</sup>.
  - Rhythmic initiation- The position of the patient was in side lying, neck slightly flexed and the pelvis was moved through the available range of motion of anterior elevation and then to return the pelvis through the posterior depression pattern.
  - Slow reversal- The patients body part moved to the lengthened range of the anterior elevation later switching the manual contacts to the posterior depression.
  - Agonistic reversal- The therapist moves the subjects body part to the point at which the muscle will be lengthened in the desired pattern (anterior elevation)
9. They received a total of 12 sessions of PNF (three times a week) with each treatment session lasting for 30 minutes.
10. Readings at week 0 and readings at week 4 were recorded by Wisconsin Gait Scale and Spatial parameters (foot prints were taken and the changes between both the readings were measured).
11. In a follow up after 2 weeks the readings at week 6 were measured and recorded to determine the sustenance in the improvement from functional ability in circumduction gait.
12. The PNF sessions were given for 4 weeks. 3 sessions weekly, cumulative of 12 sessions.

To carry out these tests, the physical therapist always puts one hand around the patient's knee and the other hand around the patient's ankle. The patient must give correct response, on all three trials for each body region to be considered as having intact kinesthesia.

### Outcome measures

WGS is a useful tool to rate Qualitative alterations of post-stroke hemiplegic subjects and assess changes over time during rehabilitation training<sup>13</sup>.

Documented gait improvement at walking performance and to point out the correlations between patterns in patients with hemi paresis using the Wisconsin gait scale (WGS) which is a visual gait analysis system that examines 14 observable variables related to the hemiplegic gait deviations. Rodrigues provided validation for the newly developed scale, an instrument of gait measurement that may assist in comparing outcomes<sup>14</sup>.

Footprint method involves the application of ink to the soles of the patient's shoes or feet and walking along strips of paper. This method is easy to apply, is not time consuming and has high reproducibility. Quantitative analysis of movements in specialized gait laboratories is expensive and unaffordable in most clinics in Africa<sup>15</sup>.

### RESULTS

Statistical analysis of data using paired t-test comparing the week0 & week 4 and week 4 & week 6 and week0 & week6 values of Spatial parameters of gait analysis (Step length, Stride length, Toe-out angle, Base of support) and one way ANOVA to compare the values of week0, week 4 and week 6 of the experimental group. Similarly non parametric Wilcoxon signed rank test for week0 & week4 and week 4 & week 6 and Friedman's test for comparing the interrelation of week0,4& 6.

Wisconsin Gait Scale- Gait Improved. Wilcoxon test – for 0 week & 4 weeks= 4.7 ( $p < 0.05$ ), 4 weeks & 6 weeks= 1.4 ( $p > 0.05$ ), 0 week & 6 week = 4.5 ( $p < 0.05$ ) Friedman test (0 weeks, 4 weeks & 6 weeks)= 39.7 ( $p < 0.05$ ). Spatial Parameter of gait analysis- Step length- t-test for 0 weeks & 4 weeks= 20.7 ( $p < 0.05$ ), 4 weeks & 6 weeks= .273 ( $p > 0.05$ ), 0 week & 6 week = 22.0 ( $p < 0.05$ ) ANOVA (0 weeks, 4 weeks & 6 weeks)  $F = 72.5$  ( $p < 0.05$ ), Stride length- t-test for 0 week & 4 week = 18.9 ( $p < 0.05$ ), 4 week & 6 week = 1.4 ( $p > 0.05$ ), 0 week & 6 week = 19.62 ( $p < 0.05$ ) ANOVA-  $F = 102.42$  ( $p < 0.05$ ), Toe out angle- t-test- for 0 week & 4 week = 10.20 ( $p < 0.05$ ), 4 weeks & 6 weeks= .44 ( $p > 0.05$ ), 0 weeks & 6 weeks = 9.8 ( $p < 0.05$ ), ANOVA-  $F = 26.0$  ( $p < 0.05$ ), Base of support- t-test for 0 weeks & 4 weeks = 2.2 ( $p < 0.05$ ), 4 weeks & 6 weeks = .29 ( $p > 0.05$ ), 0 weeks & 6 weeks = 1.6 ( $p > 0.05$ ) ANOVA-  $F = .64$  ( $p > 0.05$ ). Paired t-test was applied to examine the changes in dependent variable from base-line to after completion of intervention in the group. Level of significance was defined at  $p \leq 0.05$  and confidence interval of 95% was taken.

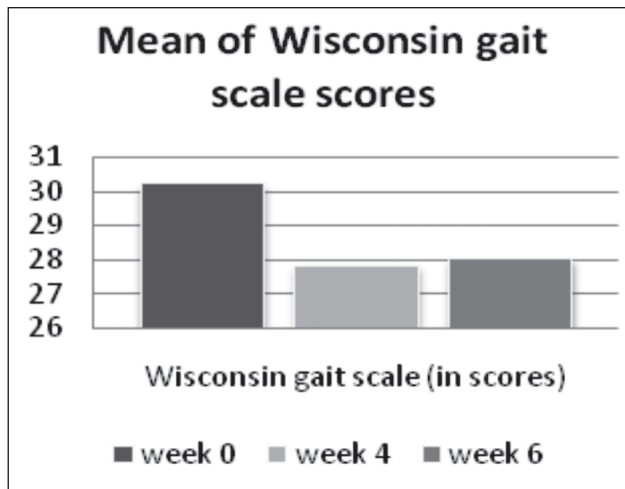


Figure 1: Mean of Wisconsin gait scale

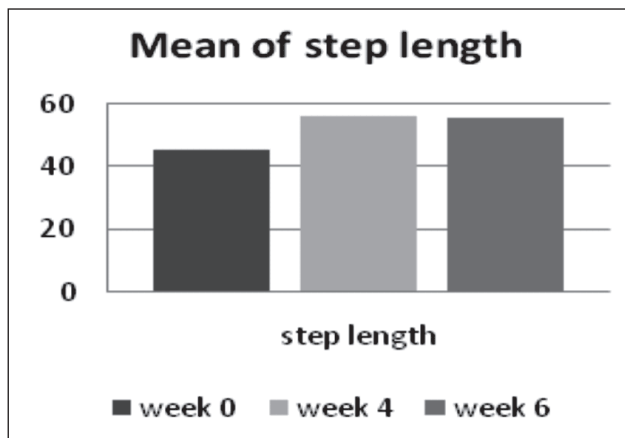


Fig. 2. Mean of Step length

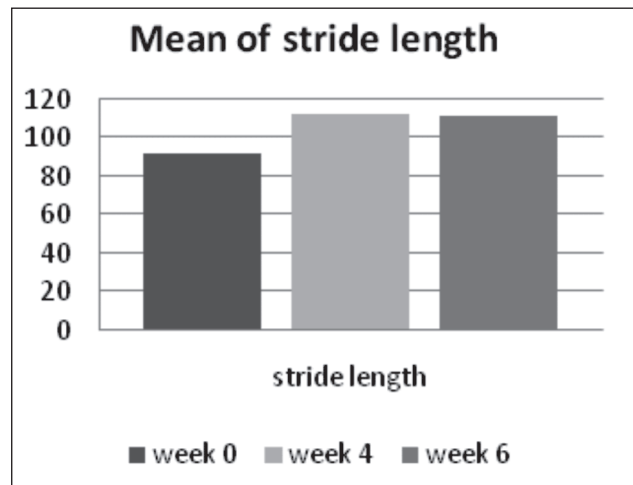


Fig. 3. Mean of stride length

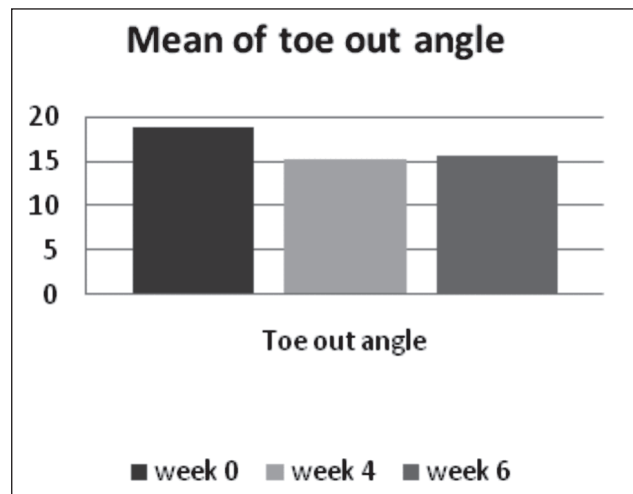


Fig. 4. Mean of Toe out angle

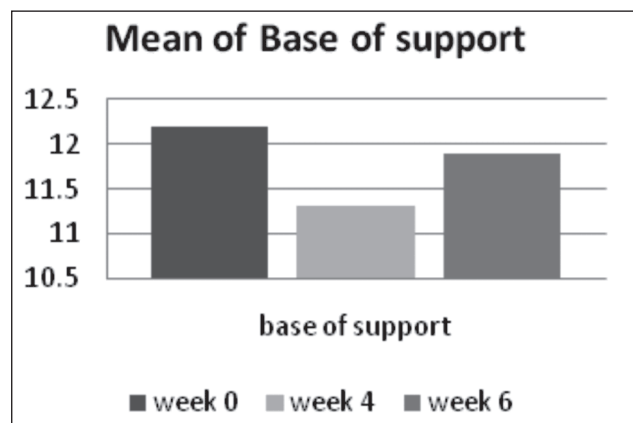


Fig. 5. Mean of Base of support

## DISCUSSION

It is found from the present study that the PNF procedures for the pelvic region are highly beneficial for patients suffering from hemiplegic gait. This study

aimed at evaluating the effect of Proprioceptive Neuromuscular Facilitation in subjects with hemiplegic gait after 4 weeks and also to evaluate the sustained improvement on the gait pattern in a follow up after 2 weeks from the cessation of the Proprioceptive Neuromuscular Facilitation treatment protocol.

The following discussion intends to explain the observations made and the results obtained through this study in the light of the available scientific evidence. The subjects who suffered from hemiplegic gait following an incidence of cerebrovascular accident (Stroke) symptoms lasted less than 12 months from the incidence of stroke were taken in this study with accordance to brunnstrom stages of recovery, as the improvement of gait is a major goal of physical therapy for patients with hemiplegia.

Gait is one of the most common of all human movement's. It exists to transport the body safely and efficiently across ground level<sup>4</sup>.

Hence, retraining of walking is a major goal in a rehabilitation program for persons with stroke<sup>5</sup>. Proprioceptive Neuromuscular Facilitation (PNF) is one approach commonly used to improve the gait of patients with hemiplegia<sup>9</sup>.

The gait of patients with hemiplegia is characterized by several abnormal features such as asymmetry of stride time and length, reduced velocity, poor joint and posture control, muscle weakness, abnormal muscle tone, abnormal muscle activation patterns and altered energy expenditure, mostly affecting the paretic side<sup>13</sup>. Hence according to the data collected in this research, via the spatial parameters of gait and Wisconsin gait scale. The inference gathered from the results is such that the t-test between the values of Step length, Stride length and the Toe-out angle from week 0 to week 4 is significant with  $p \leq 0.05$  suggesting overall improvement in the gait pattern, probability in the reduction of spasticity in the stronger antagonist muscle groups, releasing of the abnormal synergy pattern and strengthening and reeducation of the weaker agonist set of muscle group. Proprioceptive Neuromuscular Facilitation procedures facilitate the near normal range of motion and continues practice helped the patient implement the newly learned pattern into the daily life.

From the statistical data present the base of support unlike the rest of the parameters showed the least

amount of improvement from the treatment protocol the reason for that could be inability to assess the patient in the premorbid conditions. The patients in this study presented with highly variable base of support.

## CONCLUSION

It is concluded statistically from the research that Proprioceptive Neuromuscular Facilitation techniques when applied on the patients with hemiplegic gait, improves the gait pattern, leading the patient one step closer to functional independence. Also after the cessation of the treatment the effect of the technique is maintained by the patient's lower extremity. The difference in week 4 and week 6 was not statistically significant hence suggesting sustenance in the improvement of hemiplegic gait, prior to cessation of treatment.

## Conflict of Interest

There is no conflict of interest amongst authors to prepare this manuscript.

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