Effect of PNF Technique on Gait Parameters and Functional Mobility in Hemiparetic Patients

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Abstract

Stroke, also known as cerebrovascular accident (CVA) is an acute neurologic injury in which the blood supply to a part of the brain is interrupted. It is reported that 1.2% of total deaths occur in India due to stroke. Stroke is the 3rd leading cause of death and the 2nd leading cause of disability. Common problems after stroke are impaired motor functions including balance and gait, sensory deficits, perceptual deficits, cognitive limitations, visual deficits, aphasia and depression. The ability to walk independently is a prerequisite for many daily activities. Many patients remain unable to walk or have difficulties with walking after stroke. A common clinical observation was that the stance phase on the affected side was considerably shorter than that of sound leg. Hemiplegics vary in their dependence on a walking aid and in amount of weight they transfer through the affected leg. The objective of the present study is to evaluate the effect of PNF techniques on the gait parameters and functional mobility in hemiplegic patients. Two group pre test- post test design. A sample of convenience of 30 subjects affected by cerebrovascular accident of ischemic injury took part in this study. They were divided into two groups i.e. an Experimental group and a Control group with 15 patients in each group. The subjects of this study were the residents of northern Haryana and the mean age of the patients was 59.30 years. Patients were assessed before commencement and after the completion of treatment sessions by a fixed battery of tests on Stride length, Gait Velocity, Cadence and Functional Mobility parameters with measuring tape, stop watch and Rivermead Mobility Index respectively. The results of this study demonstrated that the PNF technique has significant effect on gait parameters & functional mobility as compared to conventional therapy in patients with hemiplegia. The findings show that the walking speed has a significant effect on functional mobility in stroke patient.

Keywords: CVA, Stroke, PNF, Stride length, Gait Velocity, Cadence and Functional Mobility

Introduction

Stroke, also known as cerebrovascular accident (CVA) is an acute neurologic injury in which the blood supply to a part of the brain is interrupted. It is reported that 1.2% of total deaths occur in India due to stroke. Stroke is the 3rd leading cause of death and the 2nd leading cause of disability *(Aela et al, 2007)*. Major risk factors are Hypertension, Heart disease and Diabetes *(O'Sullivan & Schmitz, 2001)*. Apart from these, other risk factors for stroke are cigarette smoking, blood cholesterols, oral contraceptives, obesity, alcohol, social deprivation, physical inactivity, impaired ventilatory function and maternal history of stroke *(Walton, 2003)*.

Several population – based surveys on stroke were conducted from different Parts in India. Recent studies showed that the age adjusted annual incidence rate was 105 per 100,000 in the urban community

and 262 per 100,000 in the rural community. The ratio of cerebral infract to hemorrhage was 2.21. Hypertension was the most important risk factor. Stroke represented 1.2% of total deaths in India. Common problems after stroke are impaired motor functions including balance and gait, sensory deficits, perceptual deficits, cognitive limitations, visual deficits, aphasia and depression *(Perry, 1969)*. Stroke is the leading cause of disability among adults and frequently results in impaired mobility *(Bohannon et al, 1988)*. Neurological deficits that lead to loss of leg strength and impaired balance are two factors that correlate to walking ability. Many authors have shown that subjects with chronic hemiparetic stroke have profoundly diminished cardiovascular fitness, muscular atrophy in the hemiparetic extremity, and altered body composition that is related to gait deficit severity. Cerebrovascular disease is a leading cause of gait impairment, resulting in long-term disability and handicap *(Collin and Wade, 1990)*.

Many patients remain unable to walk or have difficulties with walking after stroke. The ability to walk independently is a prerequisite for many daily activities *(Mehrholz et al, 2007)*. It has been reported that only a small proportion can walk with sufficient ability to function effectively within the community *(Yang et al, 2007)*. Hemiplegics patients have been shown to bear a greater percentage of body weight on the sound limb, than on affected side *(Agarwal et al, 2008)*.

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 *(Wang, 1994)*. Co-ordination between moving body parts is essential for functional walking and is modified, often in a subtle manner, to accommodate variation in task requirements and circumstances, such as walking speed, path curvature, and environmental clutter *(Roerdink et al, 2007)*.

In physiotherapy a variety of movement therapy approaches are available for retraining motor skills in adult patients with hemiplegia. Certain approaches like Proprioceptive Neuromuscular Facilitation, Rood's, Brunnstrom, and Bobath rely on reflex and hierarchical theories of motor control, while others like Motor Relearning Programme (MRP) and system theory approaches derive clinical implications from more recent theories of motor control and motor learning as well as from the principles of neural plasticity.

Proprioceptive Neuromuscular Facilitation (PNF) is one approach commonly used to improve the gait of patients with hemiplegia. Various PNF procedures have been used, depending on the affected site. 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 *(Wang, 1994)*. The Rivermead Mobility Index (RMI) is a PRO instrument that measures mobility, an important aspect of daily functioning in patients after stroke, and is being used increasingly for international research in patients with stroke.

Materials and Methods:

Population and Sampling: A sample of convenience of 30 subjects affected by cerebrovascular accident of ischemic injury took part in this study. They were divided into two groups i.e. an Experimental group and a Control group with 15 patients in each group. The subjects of this study were the residents of northern Haryana and the mean age of the patients was 59.30 years.

Study design: Two group Pre-test Post-test Experimental design.

Inclusion criteria:

Patients with MCA ischemic infarction of less than 6 months post stroke duration.

Patients between 50-70 years of age and of either sex.

Patients with stage 2-4 on Brunnstrom recovery stage for hemiplegics and able to perform 6 min. walk test.

Exclusion criteria:

i Patients with ACA and PCA tertiary involvements.
ii Patients with severe disabling arthritis.
iii Patients with any cardiac disease like MI.
iv Patients with any cognitive dysfunction.
v Patients with any movement disorders.
vi Any other neurological deficits like Parkinson's disease.

Instrumentation:

Measuring Tape/Scale, Stop watch, Chart Walkway, Ink.

Rivermead Mobility Index – English version of RMI developed for patients who had suffered a head injury or stroke at Rivermead Rehabilitation Centre in Oxford, England was used.

Protocol Used: The subjects in both Experimental group and Control group actively participated in the study. In Experimental group all subjects received a protocol of 3 PNF techniques i.e. rhythmic initiation, slow reversal and agonistic reversal for pelvis for 30min. for 3days a week for a total duration of 4 weeks (12 sessions). Each technique was given for 10 minutes. These procedures were done to facilitate anterior elevation and posterior depression of pelvis in a side lying position. The elements of PNF, such as manual contact, stretch, resistance, and verbal cuing, were incorporated into the treatment scheme.

In control group all the subjects received the conventional stretching exercises for hip flexors, hip adductors and extensors, side lifting of pelvis physiotherapy which includes all the active and passive movements of hip joint, in sitting position, bridging exercises, resisted exercises for pelvis and weight bearing on affected leg in standing for the same time period as in experimental group i.e. 30min. for 3 days a week and for a total duration of 4 weeks (12 sessions).

Procedure

Thirty patients with hemiplegia who fulfilled the inclusion criteria were took in study. Their demographic profile and detailed medical history were collected through individual interviewing and from medical records. The stage of motor recovery of the lower extremities was determined by Brunnstrom's recovery stages. For kinesthetic evaluation, the patient's hip, knee, and ankle were tested

three times. The therapist places the patient's hip in medial and lateral rotation, asking the patient whether the toes are "in" or "out". The therapist places the patient's knee in flexion or extension, asking the patient whether the lower extremity "is bent" or "straight". To test the ankle, the therapist places the patient's foot in dorsiflexion or planterflexion and asked the patient whether the foot is "up" or "down". To carry out these tests, the physical therapist always put one hand around the patient's knee and other hand around the patient's ankle. The patient must give correct response on all three trials for each region to be considered as having intact kinesthesia. All patients were divided into two groups with 15 patients in experimental group and 15 in control group.

On the first day, the volunteers were informed about the purpose, procedure, possible discomforts, risks and benefits of the study prior to obtaining an informed consent form from the subject. The subjects were asked not to participate in any other exercise form for the duration of the study and to follow the designated protocol. During the pre-assessment session footprints of all the patients were taken with the help of ink on chart paper. The ink was put on the feet of patient with the help of a piece of cloth and patients were asked to walk on the chart paper fixed on the floor. For the measurement of stride length 2 footprints of affected sides from the middle portion of each walking trial were analyzed. *Stride length:* The stride length was measured from the heel of the affected foot to the heel of the same foot when it again contacts the ground with the help of a measuring tape/scale. *Cadence:* The cadence i.e. steps per minutes were counted with the help of stop watch. *Gait velocity:* Gait velocity was studied at comfortable walking speeds. The mean of 3 repeated walking speed measurements was calculated in order to reduce measurement error. During each session, the subjects walked 10m at a comfortable pace and a digital stop watch was used for registration of time. Between the 10-m walking tests, subjects rested for about 1 minute. *Functional mobility:* The functional mobility was assessed by Rivermead Mobility Index. The same gait parameters and functional mobility were reassessed after the completion of 4 week (12 sessions) of treatment protocol for both experimental group and control groups with the help of same battery of tests.

Data Analysis and Interpretation

Data analysis was done by using SPSS version 13.0 software. Paired 't' test was used to compare the Pre and Post within the Group A & B and Unpaired 't' test was used to compare between the Group A and Group B.

Table 1: Comparison of Stride length and Cadence at Pre Vs Post Interval.

Variable		Groups A Mean±SD	Groups B Mean±SD	't' value	'P' value
Stride Length (mtr)	Pre	0.3313 ± 0.082	0.3460 ± 0.09	25.93	0.001
	Post	0.5943 ± 0.10	0.5033 ± 0.11	-7.50	0.001
Cadence (steps/min)	Pre	30.27 ± 7.34	31.27 ± 8.70	41.16	0.001
	Post	49.87 ± 8.25	43.07 ± 9.81	26.26	0.001

Table 2: Comparison of Gait Velocity and Functional Mobility at Pre Vs Post Interval.

Variable		Groups A Mean±SD	Groups B Mean±SD	't' value	'P' value
Gait Velocity (mtr/min)	Pre	12.43 ± 3.39	13.76 ± 4.9	30.57	0.001
	Post	22.20 ± 3.27	17.27 ± 4.68	16.45	0.001
Functional Mobility	Pre	6.00 ± 0.75	6.20 ± 0.94	27.49	0.001
	Post	10.80 ± 1.14	8.47 ± 1.06	-9.93	0.001

Discussion

The results of this study demonstrated that the PNF techniques have significant effect on gait parameters as well as functional mobility as compared to conventional therapy in patients with hemiplegia. The findings show that the working speed has a significant effect on the functional mobility in stroke patient. PNF is a method of neuromuscular dysfunction treatment, primarily by means of facilitating the flow of information, mainly by stimulation of proprioceptors *(Trueblood et al, 1989).*

The results of the study done by *Wang (1994)* on twenty patients with hemiplegia of short and long duration assessed the use of PNF pelvic techniques for gait rehabilitation support the results of the present study. The results of his study showed that in subjects with hemiplegia of short duration, gait speed and cadence improved immediately after 1 session of PNF and the improvement was further enhanced by 12 treatment session in contrast, subjects with hemiplegia of long duration did not improve immediately, although the cumulative effect of the treatment was similar to that observed in the hemiplegia of short duration. The difference in the immediate effect of treatment between subjects with hemiplegia of short duration and those with hemiplegia of long duration may be due to both neural and structural changes (*Wang, 1994). Hufschmidt (1982)* assessed the mechanical properties of relaxed lower leg muscle by torque measurement during imposed constant velocity dorsiflexion - plantar flexion cycles. He observed that at lower angular velocities, the subjects' exhibited an elastic and energy consuming velocity independent resistance. In most patients with long standing spasticity, both of these were enhanced. The results support the hypothesis of secondary structural changes of muscle in spasticity.

Trueblood et al (1989) studied 20 hemiplegic patients (10 men, 10 women). Out of these nine subjects (45%) were right hemiplegic, and 11 subjects (55%) were left hemiplegic. The resisted pelvic PNF techniques were given to these patients. The results of their study revealed that the resisted PNF techniques have significant effect in the gait disturbances in hemiplegic patients *(Trueblood et al, 1989).*

Shimura and Kasai (2002) studied the effects of proprioceptive neuromuscular facilitation on the initiation of voluntary movement and motor evoked potentials in upper limb muscles. The findings of their study corroborate the presumed effects of PNF and provide insights into the neurophysiological mechanisms underlying the PNF method. Compared to the neutral position, they found that (i) the facilitation position changed the muscle discharge order enhancing the movement efficiency of the joint, (ii) the facilitation position led to a reduction in EMG-RT, the magnitude of which depended on the proximity of the muscle to the movement joint, and (iii) MEP amplitude increased and MEP latency decreased in the facilitation position as a function of the proximity of the muscle to the joint *Shimura and Kasai (2002).*

Kawahira et al (2004) studied 22 subjects with stroke and 2 brain tumor-operated subjects who were made to undergo two week facilitation sessions applied at 2-week intervals in patients with hemiplegia, who were being treated

with continuous conventional rehabilitation exercise without the facilitation technique for hemiplegia. The results of their study revealed that intensive repetition of movement elicited by the facilitation technique (chiefly proprioceptive neuromuscular facilitation, stretch reflex and skin-muscle reflex) improved voluntary movement of a hemiplegic lower limb in patients with brain damage *(Kawahira et al, 2004)*. *Elzbieta (2006)* assessed gait kinematics in patients with hemiplegia after the PNF; and noticed the difference of the values of analyzed kinematic parameters of gait according to the norm. It was concluded that the therapy of PNF method enabled the partial improvement of the performed gait disabilities in the subject. Mean velocity of the patient gait improved from 0.44m/s to 0.59m/s. Similarly *Poscic et al* studied the 10 hemispastical patients after stroke and of 5 patients with spastical paraparesis of different causes who received the PNF treatment and concluded that the PNF model gave good results in rehabilitation and improvement in quality of life of such patients.

Conclusions: PNF is a very beneficial technique for improving functional independence in patients with strokes and other neurological disorders but the results of the study further prove that one can quantify the improvement especially in area like locomotion and can be used as an adjunct to the other gait training techniques for improving gait of the stroke patients.

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