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The immediate and sustained effect of proprioceptive neuromuscular facilitation (PNF) technique on upper limb spasticity in stroke patients

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Abstract
Stroke is one of the principal cause of increased morbidity and mortality worldwide, and it is one of the leading cause of physical and functional impairments. It has also been considered as a significant health problem which may induce disability Spasticity and abnormal posture are common feature of stroke. It is most often found in the flexor group of muscle in upper limb and extensor group of muscle in lower limb. This study aims to find out the immediate and sustained effect of proprioceptive neuromuscular facilitation (PNF) technique on upper limb spasticity in stroke patients. Thirty stroke patients with spasticity of upper limb were selected by convenient sampling. Modified Ashworth Grading Scale (MAS) was used as outcome measure. These thirty patients received upper limb PNF pattern and technique. This was one-time intervention. Post-intervention the result was highly significant for immediate effect, after 30 minutes the result was highly significant and later after 2hours the result was insignificant. The study concluded that there is a positive immediate effect on reducing the spasticity using PNF technique, and the sustainability of the technique was significant till 30 minutes after intervention but later after 2 hours the effect was insignificant. Further more functional activity can be added to maintain the effect of PNF technique for longer duration.

Keywords: spasticity, PNF, stroke

1. Introduction
Stroke is one of the leading cause of physical and functional impairments, it is one of the principal cause of increased morbidity and mortality worldwide [1]. It is becoming an important cause of disability and premature death in countries like India, according to demographic change there is increasing prevalence of the key modifiable risk factors [2]. It is also considered as a significant health problem, which needs a continual and wide-ranging rehabilitation [3].
The incidence of stroke in India is ranged from 105/100,000 persons per year, and the prevalence of stroke is from 44.29 to 559/100,000 persons during past decade in different parts of the country. Our country values were higher than those of high-income countries [4].
Stroke is described as development of neurological deficit caused by abnormality of blood supply to the brain [5]. When this happens, the brain does not get oxygen or nutrients, and brain cells starts to die [6]. Ischemic stroke is most common type and it affects about 80% of individual having stroke. Hemorrhagic stroke occurs when the blood vessels ruptures, which causes leakage of blood in or around the brain [24]. It is also known as "cerebral vascular accident" (CVA), "brain attack" or "apoplexy". According to WHO stroke is defined as "acute onset of neurological dysfunction due to abnormality in cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal area of brain lasting more than 24 hours" [3]. It causes muscular and secondary neural changes due to upper motor neuron lesion [1]. The major contributory factor in cerebrovascular disease is atherosclerosis, the common site for lesion are the origin of the common carotid artery or at the middle cerebral artery and at its bifurcation and at the junction of the vertebral arteries with the basilar artery. Hypertension, heart disease, and diabetes are the major risk factor of stroke [24].
Common features of stroke are paralysis of one side body (hemiplegia) or weakness(hemiparesis) on the opposite side of the lesion, perceptual disorders, communication problems [7]. Upper motor neuron lesions may raise negative and positive symptoms, besides brisk tendon reflexes, clonus, spasms, and dystonia, spasticity is one of the positive phenomena and results from impaired reflex function and changes in rheological muscle properties like atrophy, stiffness and fibrosis [8]. Spasticity and abnormal posture are common features of stroke. Clinically spasticity is defined as increased muscle tone and tendon jerk hyperreflexia at rest in stroke patients [9]. The motor symptoms occur after the lesions in the descending corticospinal system such as muscle constriction in the absence of voluntary movement, contraction of both the agonist and antagonist muscles as a result of abnormal pattern of commands in the pathway of descending supraspinal tract [10]. However, the onset of spasticity is variably high and may occur shortly or more than a year after stroke. Currently to understand the onset of spasticity is complicated by the role of contractures, which have been assumed to arise out of spasticity but may have role in its cause. Other predictive factors for the risk of post-stroke spasticity have being identified in which it includes early arm and leg weakness, affected side weakness and reduction in activity of daily living [11]. It is also related to secondary effect of immobility and weakness of skeletal muscles. Initially spasticity is considered to be a positive development which suggests that the nervous system is beginning to initiate the repair mechanism which restore muscle movement and tone [12]. After stroke, due to lack of

coordination between body and brain. This causes the muscle synergies to move in abnormal pattern.

A study by Wissel *et al*. observed that primarily spasticity affects the elbow, wrist and ankle [10]. The functional impairment of the affected upper limb, the spasticity, and the associated complications adversely affect the quality of life of hemiparetic patients. Treatment and prevention of spasticity are two of the main specific goals of rehabilitation of patients with an upper motor neuron lesion. The spastic upper limb is commonly held in a position of flexion adduction and internal rotation of the shoulder with flexion at the elbow. In the forearm, pronation appears to be more common than supination, and pronation attitude impairs the ability of patient to orient the hand. The wrist is frequently placed in a flexed posture. The fingers are clasped into the palm and the thumb is held within the palm [15].

Table 1

Pattern	Muscle involved
Adducted/Internal rotated shoulder	Pectoralis major, teres major, latissimus dorsi, anterior deltoid, subscapularis.
Flexed elbow	Teres major, latissimus dorsi, long head of triceps, posterior deltoid.
Pronated forearm	Pronator teres, pronator quadratus.
Flexed wrist	Flexor carpi radialis, flexor carpi ulnaris, palmaris longus, extensor carpi ulnaris.
Clenched fist	Flexor digitorum superficialis, profundus.
Thumb-in-palm deformity	Flexor pollicis longus and brevis, adductor pollicis, dorsal interosseous.

About 50-60% of stroke patients' experiences motor impairment at some degree, efforts should be made to improve and maintain physical function to reduce abnormality of muscle tone through therapeutic exercise [1]. Proprioceptive neuromuscular facilitation (PNF) is a treatment which is commonly used by physiotherapists. Since long back the nature of sensory feedback and biomechanical alignment to motor output was recognized by Dr Herman Kabat proposed that PNF is an approach to rehabilitation (Kabat-Kaiser Institute, California, late 1940s). Proprioceptive neuromuscular facilitation has been defined as 'methods of promoting or hastening the response of the neuromuscular mechanism through stimulation of the proprioceptors' [13]. Proprioceptive Neuromuscular Facilitation (PNF) techniques are used often to induce relaxation of muscle and increased joint Range of Motion (ROM) [14]. PNF techniques mainly stimulates the proprioceptors for increasing the demand on the neuromuscular mechanism to obtain and facilitate the response. It uses cutaneous, auditory, proprioceptive input to functional improvement in motor output. The exercise pattern is initiated with muscle group in the stretched or lengthened position, then the muscle group is contracted, moving the body part through the range of motion to a shortened position, through this it will relax the muscle, facilitate the movement and improve the pattern of movement [25]. Proprioceptive neuromuscular facilitation techniques targets all aspects of muscle training, e.g. sustained isometric activity to mobilizes the muscle groups which improve range of movement and/or reduce pain, functional patterns and handling techniques to facilitate both co-ordination and stability of group of muscle [13].

Need and Significance of the Study

Most of the stroke patients are facing problems in their day to day life and hence the care taker is also facing it, to make the patient independent more therapeutic interventions are required in aspect of effect of the therapy as well as sustainability of therapy effect. Many researchers have found that PNF is effective in reducing spasticity, improvement in movement pattern and less research has been done about the immediate and sustainability of PNF technique effect on spasticity in stroke patients.

Therapist can design functional re-education training when he/she knows the duration of effect of PNF technique.

Aim

To find out the immediate and sustained effect of Proprioceptive Neuromuscular Facilitation (PNF) technique on upper limb spasticity in stroke patients.

Objective

- To find out the immediate effect of PNF technique on upper limb spasticity reduction in stroke patients
- To see the sustainability of PNF technique after 30 minutes and later after 2 hours on upper limb spasticity in stroke patients.

2. Materials and methods

Ethical clearance was obtained from institution ethical committee of Dr. A.P.J. Abdul Kalam college of physiotherapy, Loni. The study was an Experimental study which included 30 participants using Convenient sampling. The data was collected from the Neuro physiotherapy department, PIMS, Loni and Asha Kendra, Puntamba, Maharashtra. The duration of the study was 5 months with one-time intervention. The outcome measure was Modified Ashworth Grading Scale. The inclusion criteria were both gender, patients diagnosed with stroke, age group between 45-60 years' old, with Muscle tone grades 1 to 4 [MAS] and exclusion criteria was patients who had perceptual disorder, with prolonged flaccidity in upper extremity, any recent fracture in upper extremity, hemianesthesia over hemiplegic side, hemiplegia with shoulder pain.

The participants were screened, according to the inclusion and exclusion criteria, they were requested to participate in the study They were explained about the study and intervention. The participants were briefed about the nature of study, the duration of intervention and the intervention being used in the language best understood by the participants. An informed written consent from the participants' prior the study. All the patients were assessed for elbow flexors and wrist flexors of the affected upper limb by using Modified Ashworth Scale before the intervention and the grades were noted down, it was made sure that while intervention session no treatment other than PNF is given. After the intervention and the spasticity grade was noted down immediately, after 30min and later after 2 hours using MAS.

The intervention protocol was built to observe the immediate effect of PNF and its sustainability on muscle tone which will help to reduce spasticity in stroke patient

essential for functional activity of daily living. The following were the step by step procedure.

i) The patient was in supine position.
ii) The pattern D2 extension includes shoulder- extension, adduction, internal rotation; elbow- extension; forearm- pronation; wrist flexion, ulnar deviation; fingers flexion or extension was given to the affected limb.
iii) Along with it contract – relax technique was given to elbow flexors and wrist flexors. In contract relax method muscle targeted was being held in the lengthened position while the subject was asked to contract the target muscle by telling to touch their opposite shoulder to its maximum isometric contraction for an allotted time, this was followed by shorter relaxation of the targeted muscle with passive stretch.

Each movement pattern was given for 8-10 repetition one session.

3. Data analysis and results

The objective of the study was to find out the immediate effect and sustainability of PNF technique on spasticity in stroke patients which was analysed on the basis of result obtained from Modified Ashworth Grading Scale (MAS).

The statistical analysis was done using Graphpad Instat 3 Trail. Various statistical measures such as mean, standard deviation [S.D.] and test of significance such as repeated measures ANOVA were utilized to analyse the data. The result was concluded to be highly significant with, the P value is < 0.001.

3.1 Demographics

A total of 30 participants were selected for the study considering the inclusion exclusion criteria and who agreed to participate in the study.

The mean age of participants of male is 53.11±4.04 and of female is 54.38±5.36.

The gender ratio was 17:13 (17 male and 13 female)

Table 2: Comparing the average mean of male and female in the group.

group item	male(n=30)	female(n=30)
age mean	53.11	54.38
Gender	17 (56.7%)	13 (43.3%)

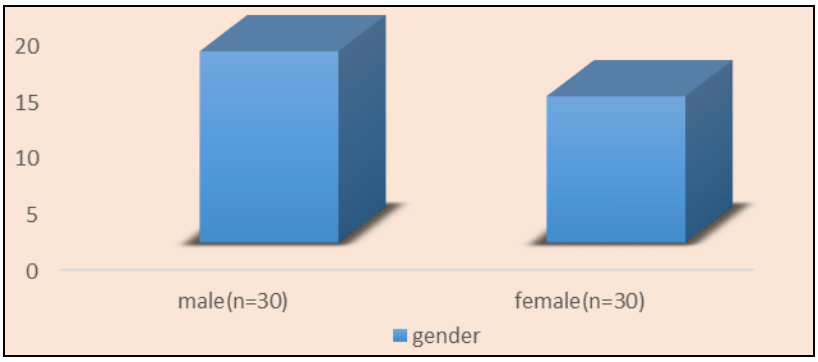

Fig 1: Demographic Data

3.2 Modified Ashworth Grading Scale (MAS)

The spasticity grade was measured using Modified Ashworth Grading Scale.The pre intervention mean average score and standard deviation for MAS was 3.00±0.78. After the intervention period, immediately the mean average score and standard deviation for these participants was 1.83 ±0.83, after 30 minutes the mean average score and standard deviation for these participants was 2.40 ±1.06 and later after 2 hours the mean average score and standard deviation for these participants was 3.00±0.78.

The value of 'q' for before intervention to immediately after intervention was 1.16, p<0.001 statistically it is highly significant. It shows that PNF technique is highly effective immediately in reducing the spasticity of elbow flexors and wrist flexors in post stroke patients.

The value of 'q' for before intervention to after 30 min of intervention was 0.60, p<0.001 statistically it is highly significant. It is observed that PNF techniques is effective and it is sustained for 30 min but there was slight increase in the spasticity as compared to the immediate values of spasticity.

The value of 'q' for before intervention to later after 2hrs of intervention was 0, p>0.05 statistically it is not significant. Hence, the PNF technique does not sustain for 2hrs after treatment.

Table 3: Comparison of average values spasticity grades using outcome measure MAS

Spasticity	Before intervention	Immediately after intervention	After 30 min	After 2hrs
mean	3.00	1.83	2.40	3.00
SD	0.78	0.83	1.06	0.78

Table 4: Comparing the 'q' values at different intervals

	Before intervention to immediate	Before intervention to 30 min after intervention	Before intervention to 2hrs after intervention
'q' value	1.16	0.60	0
P value	<0.001	<0.001	>0.05
Results	Highly significant	Highly significant	Not significant

Where:

a. Values expressed as mean [SD]
b. Analysed by repeated measures ANOVA test

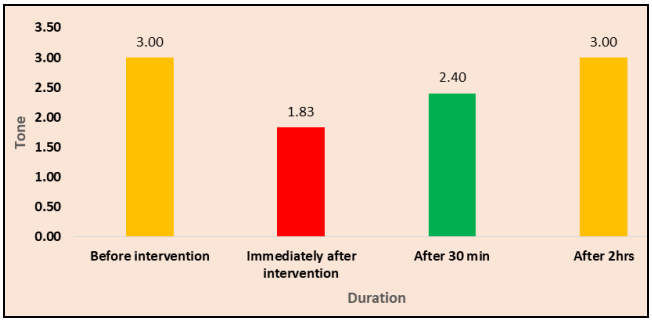

Fig 2: Comparison of avearage values of spasticity grades using MAS

3.3Distribution of patients according to MAS

There were total 30 patients in the group and number of patient having the same grade were taken together in every period of interval during the procedure. The average mean and standard deviation of 30 patient having same grades at different intervals are before intervention was 5±5.58, immediately after intervention was 5±5.05, after 30 min post intervention was 5 ±4.19, later after 2hrs of intervention was 5±5.58.

Table 5: MEAN and SD of 30 patients' same grades (MAS) at different intervals.

Grades MAS	No of pt, Before intervention (total=30)	Immediately after intervention (total=30)	After 30 min of intervention (total=30)	After 2hrs of intervention (total=30)
0	0	0	0	0
1	0	13	7	0
2	9	8	10	9
3	12	6	8	12
4	9	3	5	9
5	0	0	0	0
MEAN±SD	5±5.58	5±5.05	5.±4.19	5±5.58

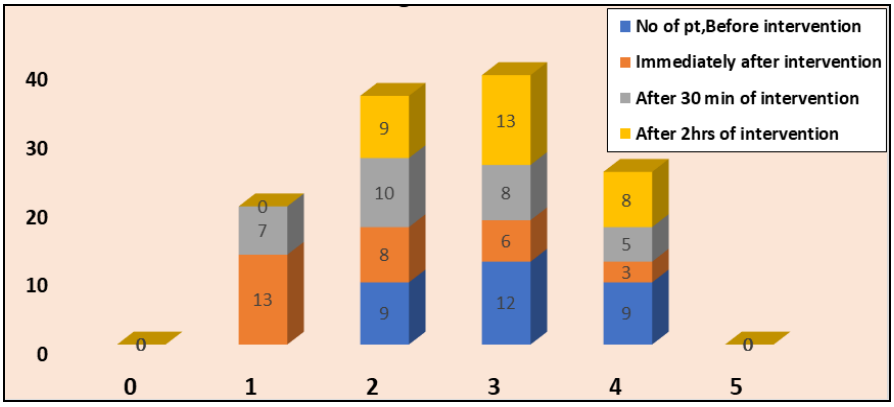

Fig 3: Patient Distribution

3.4 Discussion

The present study result shows that PNF technique is effective in reducing the spasticity and sustained for 30 min which is beneficial for improvement in the movement pattern which is required to do the normal functional activity of daily living in post stroke patients. The one-time intervention of PNF technique on elbow flexors and wrist flexors on the affected upper limb resulted in significant immediate effect on spasticity and sustainability till 30 minutes was significant. While the results later, after 2 hours was insignificant.

The mechanism of this technique is that it stimulates the proprioceptors for increasing the demand on the neuromuscular mechanism to obtain and facilitate the response. In the exercise pattern the muscle group are in the stretched or lengthened position, then the muscle group is contracted, moving the body part through the range of motion to a shortened position, through this it relaxes the muscle, facilitating the movement and improves the pattern of movement. There was sustained isometric activity to mobilize the muscle groups which improves the range of movement and/or reduce pain, functional patterns and handling techniques that facilitates both co-ordination and stability of group of muscle.

In stroke patients as it is UMN lesion spasticity results in as positive feature. It hampers the activity of daily living of the patient which is needs to be treated as early as possible.

Many researches have been conducted which states that PNF is found to be effective. Joong-San Wang observed in his study that PNF is effective in both affected and non-

affected sides to decrease the tone and stiffness in lower extremity of stroke patients. In his study he used tone measurement device to detect the changes in muscle tone and stiffness while we had used modified ash worth grading scale (MAS) for spasticity. Using this scale there was significant difference in the grades of scale immediately after the intervention, the effect sustained till 30 minutes' post intervention but the spasticity grade was increasing as compared to the immediate grades post intervention, while the grades later after 2 hours of intervention had returned back to the initial grades prior the intervention.

The result of the study suggests that there is positive effect of proprioceptive neuromuscular facilitation (PNF) on spasticity and its sustainability on upper limb in stroke patients. Thus, by knowing the sustainability of PNF technique the therapist can design the additional functional re-education training along with PNF technique to make the therapy session more effective, which will help to improve their functional ability and to face the problem of daily activity and to make them independent.

4. Conclusion

The conclusion based on the results of pre-post mean scores of Modified Ashworth Grading Scale for spasticity in stroke patients shows that there is a significant immediate effect in reducing the spasticity using PNF technique, and the sustainability of the technique was significant till 30 minutes after intervention but later after 2 hours the effect was insignificant.

Hence, it proves that there is immediate effect of PNF on reducing spasticity and the maximum limit of the sustainability of the effect was for 30 minutes on upper limb spasticity in stroke patients.

4.1Clinical implication

According to this study, PNF technique is beneficial and efficient to reduce spasticity of muscles in post stroke patients. This can be implemented to teach functional activities by the physiotherapist as it is very similar to our functional movement and can be done along with activities of daily living.

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