Original Article

Dynamic Neural Mobilization Versus Proprioceptive Neuromuscular Facilitation on Grip Strength and UpperLimb Function in Sub-Acute Stroke Subjects

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Abstract

Background: Neural mobilization and Proprioceptive Neuromuscular Facilitation (PNF) help in reducing spasticity, improve muscle flexibility and balance, enhancing mobility and elasticity of the nervous system in stroke subjects.

Objectives: The objective of the study was to compare the effect of Dynamic Neural Mobilization and PNF on grip strength and upper limb function in sub-acute stroke subjects.

Materials and methods: 30 post-stroke subjects were recruited and were randomly divided into two groups. 15 subjects in Group A received Dynamic Neural Mobilization while 15 subjects in Group B received PNF. The treatment sessions were scheduled for 30 minutes per day, 5 times a week, for 4 weeks. Subjects were assessed for upper limb function and grip strength prior to- and post-intervention using Fugl Meyer Assessment-Upper Extremity (FMA-UE) subscale and Hand Held Dynamometer.

Results: Pre-test score of FMA-UE and grip strength were 33.60±7.13 and 2.92±1.07 in Group A and 32.60±9.85 and 1.70±0.68 in Group B respectively. The post-test scores of FMA-UE and grip strength were 41.00±7.07 and 5.12±203 in Group A and 34.13±10.40 and 3.32±0.82 in Group B. Within group comparison showed significant improvement in Group A and in grip strength of Group B subjects. FMA-UE in Group B did not show significant results compared to pre-test scores. Between groups comparison showed statistically significant improvement in Group A in both the outcomes.

Conclusion: Based on the results, it can be concluded that Dynamic Neural Mobilization was more effective than PNF in improving grip strength and upper limb function in subacute stroke subjects.

Keywords: Subacute stroke, Dynamic Neural Mobilization, Proprioceptive Neuromuscular Facilitation, Neurodynamics, Upper Limb Function, Grip Strength

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Introduction

Post-stroke, hemiplegia leading to upper extremity (UE) dysfunction,[1] is associated with activity limitation and reduced quality of life.[2] Voluntary control and functional arm movements are lost affecting activities of daily living (ADL).[3,4] Most tasks need co-ordination between both upper limbs requiring recovery of bilateral arm function.[5] After stroke, voluntary function recovers in first three to six months and then slows down with chronic phase.[1] Most individuals with mild paresis recover well but in individuals with severe paresis, only around 20% of the upper limb functions are recovered leading to secondary complications.[6]

Adverse tension is seen in the entire nervous system when nerves are affected limiting movement and adaptation capacity. Neural Mobilization attempts to restore normal neurodynamicswhich can restore the homeostasis in and around the nervous system and the structures around itthrough manual techniques and exercise.[7-11] Inspite of many motor therapies and their benefits, the paralyzed hand exhibits slow recovery.[12] Dynamic neural mobilization is an advanced version of the existing neural mobilization technique where dynamic movement in the paralyzed hand is performed. Improving upper limb function needs rehabilitation of not just proximal functions but also minute ones.[13]

Neuromuscular re-education involves proprioceptive facilitation.Proprioceptive impairment slows down motor re-education as sensory information from proprioceptors is transmitted via afferent neural pathways which forms the basis for cortical motor patterns that are reflected in muscle behaviour.[14] Proprioceptive Neuromuscular Facilitation (PNF) involves movements in diagonal patterns.[15] At cortical level, the facilitation positions increase evoked motor potentials, thus increasing the movement's effectiveness.[16,17] PNF generates greater changes in cortical activity, as assessed by absolute power levels in beta band of parietal cortex, a cortical region whose functions relate to the integration of motor information. This suggests possible beneficial effects of PNF at cortical level, further justifying its use in clinical practice.[18]

Neural mobilization is cost effective and reliable. Literature suggests the use of stretching the peripheral nerves through neural mobilization in central nervous system lesions. Neural mobilization was observed to be beneficial in reducing spasticity, improving range of motion and function in stroke subjects. Dynamic Neural Mobilization improved the mechanosensitivity of the nervous system and induced changes in its viscoelasticity.[19] Dynamic Neural Mobilization was studied extensively in the lower limb but there is a dearth of literature on its effect on upper limb function. Therefore, there exists a need to compare the effect of Dynamic Neural Mobilization and PNF on grip strength and upper limb function in sub-acute stroke subjects.

Methodology

38 male and female subjects with sub-acute stroke,[20]aged between 40-65 years were assessed and 30 subjects who met the inclusion criteria were recruited for the study. Subjects with 1st episode of stroke, Mini Mental State Examination (MMSE)score of 24 and above,[21] spasticity grade II or lower according to modified Ashworth scale and voluntary grading of ≥4 on the Brunnstrom stage of recovery were included in the study. Subjects with visual, auditory, or cognitive deficits who were incompatible with the treatment protocol, any other neurological comorbidities, and musculoskeletal complications in upper extremity that can restrict passive range of motion on the paralyzed arm, any cardiorespiratory complications and uncooperative subjects were excluded from the study. Informed consent was obtained from the subjects and Institutional Ethical Committee clearance was taken prior to the study. The subjects were assigned to one of the two groups and demographic variables such as age, gender, dominance, height, weight, BMI and side of affection were documented for all subjects. Prior to- and post-intervention, all subjects were assessed for upper limb function and grip strength using Fugl-Meyer Assessment-Upper Extremity (FMA-UE) subscale and Hand Held Dynamometer respectively which are valid and reliable tools.[22-28] Hand grip strength test was repeated three times and the best result was noted in kilograms of force.

Intervention used on the subjects

Subjects in Group A (n=15) received Dynamic Neural Mobilization for radial, median and ulnar nerves.The technique was performed as follows:

For radial nerve mobilization - The subject was in supine position. The shoulder was lowered toward same side while internally rotating shoulder, extending elbow, and pronating forearm and laterally flexing the neck to the opposite side. Therapist performed dynamic hyper-internal rotation of the subject's wrist every 2 seconds, for 20 seconds using metronome.

For median nerve mobilization - The subject was in supine position with shoulder and elbow at approximately 90° and wrist in extension. The therapist then fixed the subject's shoulder with one arm while externally rotating it, extending elbow, supinating forearm and finger and wrist extension and neck was laterally flexed to the opposite side. The therapist performed dynamic hyperextension of the distal area of subject's arm, once every 2 seconds, for 20 seconds, using metronome.

For ulnar nerve mobilization - The subject was in same position as the median nerve mobilization. The therapist externally rotated subject's shoulder with forearm pronation and wrist and finger extension, with neck flexed to the opposite side. The therapist performed dynamic hyperextension of the subject's wrist, once every 2 seconds, for 20 seconds using metronome.[9]

Subjects in Group B (n=15) received PNF exercises. Patterns chosen are used for ADL and may have higher strength gains which were Flexion/Adduction/External rotation and Extension/Abduction/Internal rotation.[29]

Participants in both groups received intervention for 30 minutes once a day, 5 days a week for 4 weeks along with conventional exercises for another 15 minutes which included manual dexterity exercises like grasp release, stacking cones, functional task practice when possible, and stretching/weight-bearing by the affected arm, and activities of daily living using the less-affected side.[30] Subjects were allowed to rest during the treatment session to avoid fatigue as and when required.

Results

Table 1: Distribution of subjects in both groups according to their age, gender, dominance, side affected, duration of stroke, BMI and type of stroke.

S.No.	Variables	Experimental Group	Control Group
		Mean±SD	Mean±SD
1	Age (in Years)	49.80±4.64	47.69±6.09
2	Gender (M / Fe)	11(73.3%)/4(26.7%)	9(60.0%)/6(40.0%)
3	Dominance (L/R)	1(6.7%)/14(93.3%)	2(13.3%)/13(86.7%)
4	Side Affected (L/R)	4(26.7%)/11(73.3%)	5(33.3%)/10(60.7%)
5	Duration of stroke (in Months)	3.60±1.99	3.67±1.76
6	BMI	25.0±2.62	26.81±2.73
7	Type of Stroke (Ischemic/Hemorrhagic)	12(80.0%)/3(20.0%)	12(80.0%)/3(20.0%)

Table 2: Range, mean and SD of outcome measures of subacute stroke subjects in Group-A

S.No.	Outcome Measures	Group-A (DNM)				Wilcoxon test/ Paired t-test	p-value
		Pre-test		Post-test			
		Range	Mean±SD	Range	Mean±SD		
1	FMA	22-48	33.60±7.13	31-58	41.00±7.07	z=3.413*	p<0.001
2	Grip strength	2-4	2.92±1.07	2.5-9.7	5.12±2.03	t=10.421*	p<0.001

Note: * denotes Significant (p<0.05), NS-Not significant (p>0.05)

Table 3: Range, mean and SD of outcome measures of subacute stroke subjects in Group-B

S.No.	Outcome measures	Group-B (PNF)				Wilcoxon test/ Paired t-test	p-value
		Pre-test		Post-test			
		Range	Mean±SD	Range	Mean±SD		
1	FMA	17-45	32.60±9.85	17-51	34.13±10.40	z=1.694, NS	p>0.05
2	Grip strength	1-3	1.70±0.68	1.9-5.0	3.32±0.82	t=6.546*	p<0.001

Note: * denotes Significant (p<0.05), NS-Not significant (p>0.05)

Table 4:Comparison of pre and post-test outcome measures of subacute stroke subjects in between the groups

S.No.	Outcome measures	Pre-test		Post-test	
		Group A	Group B	Group A	Group B
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
1	FMA	33.60±7.13	32.60±9.85	41.00±7.07	34.13±10.40
2	Grip strength	2.92±1.07	1.70±0.68	5.12±203	3.32±0.82
Between group comparisons: Unpaired t-test/ Mann –Whiney U test		• FMA: z=1.437, p>0.05, NS • Grip strength: t=1.13, p>0.05, NS		• FMA: z=2.953, p<0.05, S • Grip strength: t=3.356, p<0.05, S	

Note: S denotes significant (p<0.05); NS – not significant (p>0.05)

Discussion

The aim of the present study was to compare the effect of Dynamic Neural Mobilization and PNF on grip strength and upper limb function in sub-acute stroke subjects. The baseline characteristics of age, gender, BMI were analyzed on frequency and percentage analysis with level of significance at 5% and were found to be statistically not significant ($p>0.05$). Based on dominance, duration of stroke and the side of affection, subjects were analyzed for statistical difference between the groups and were found to be homogenous. The results showed that subjects in both the groups were similar prior to the intervention.

When the pre and post-intervention results of Group A were compared, there was a significant improvement seen in these individuals in both the outcomes ($p<0.001$). The results of this study are in line with a previous study conducted by Jessica Castilho, et al who found improvement in the EMG motor activity and pain using upper extremity neural mobilization by improving retrograde axoplasmic flow which was seen to be abnormal in spastic muscles. Neural tension reduces adhesions of the nerve and surrounding tissue, thereby better recruitment of muscle fibres and motor activity, improving range of motion and flexibility.[31,32]

When the pre and post-intervention scores of Group B were compared, it was seen that the results were not significant for FMA-UE score ($p>0.05$) but a significant improvement was seen in grip strength ($p<0.001$). It was observed that there was altered performance in the wrist, hand and coordination and speed components of the FMA-UE scale while clinically assessing the subjects after intervention. Most of the subjects in this group were unable to perform the movements in specific components, while few partially completed the tasks with compensatory movements. In contrast, post-intervention grip strength was better than the pre-intervention scores. The findings are supported by previous literature which shows that PNF is effective in promoting neural and synaptic regeneration. PNF exercises can help in improving muscle tone by stimulating muscle proprioceptors and nerve roots, enhancing functional movement. Effect of irradiation from stronger to weaker muscles also helps in muscle tone and strength.[33]

When between the group comparison was done in pre-intervention scores, it was seen that there was no significant difference in the FMA-UE ($p>0.05$) and grip strength ($p>0.05$) scores signifying that both the groups were homogenous. Post-intervention, there was a significant improvement seen in both scores ($p<0.05$). Literature evidence suggests that Neural mobilization stimulates mechanical receptors, muscle spindles and Golgi tendon organs, but introducing dynamic movement to the technique can be more effective in activating them leading to better muscle activity.[19] It is also observed that PNF position, though not in a single trial brings change in the baseline muscle excitability through muscle stretch, influencing cortical and spinal activation before the voluntary movement leading to better performance[18] which could help in understanding the better improvement observed in Group A.

Although no subgroup differences were found in principal component loadings concerning age, paretic side and type of stroke, the results must be interpreted with caution when generalizing to a wider population. Dynamic Neural Mobilization can be used to promote smooth body movement and recovery of arm function for post-stroke individuals. Additional clinical studies are warranted to investigate the effects of dynamic neural mobilization on other parts of the body. Further investigations in this field might improve the knowledge on the impact of Dynamic Neural Mobilization on motor control.

Conclusion

Though both the groups improved significantly post-intervention, it was observed that Dynamic Neural Mobilization was more effective than PNF in improving upper limb function, post-stroke. The present study implies that Dynamic Neural Mobilization helps in improving body movement and arm function suggesting its application in post-stroke upper limb rehabilitation.

Ethical Clearance – Obtained from Institutional Ethical Committee of Padmashree Institute of Physiotherapy (Dated 11/03/2020 with Ref No. PIP/EC/11-07/03-2020).

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Conflict Of Interest – Nil

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