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Effect of Proprioceptive Neuromuscular Facilitation Technique versus Trunk Mobility Exercises On Improving Trunk Control In Hemiplegic Patients-A Comparative Study

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Abstract: The trunk control is a basic motor skill necessary to perform many functional tasks and is deficient in patients suffering from cerebrovascular accident (CVA). Stroke or cerebrovascular accident (CVA) is an abrupt onset of a focal neurological deficit lasting more than 24 hours. The aim of the study is to evaluate the effectiveness of PNF technique over trunk mobility exercises for the improvement of trunk control in hemiplegic patients. It is a comparative experimental study. This study includes (N=30) subjects with hemiplegic patients within age group of 45-55 years. They were randomly assigned into 2 groups (Group A and B). Group A had 15 (N=15) subjects who are treated with Proprioceptive Neuromuscular Technique and Group B had 15 (N=15) who are treated with Trunk Mobility Exercises. The subjects were given intervention of 4 days a week for 4 weeks. The outcome measures used are Trunk Impairment Scales and Functional Independence Measure for trunk control and functional ability. This study was an experimental study where pre-test and post-test design were used. Paired 't' test and Independent 't' test were done for statistical analysis. Statistically a highly significant difference is noticed between both the groups. The pre and post intervention mean of both TIS score and FIM score was statistically significant (p=0.02) in both the groups. The results had shown that both groups noted significant difference. But when comparing between these two groups, there is statistical significance is noted. Therefore, on the basis of the results, it can be concluded that, the present study provided more evidence to support the use of Proprioceptive Neuromuscular Facilitation as compared to Trunk Mobility Exercises for improving trunk control in post stroke hemiplegic case.

Keywords:-Stroke, Proprioceptive Neuromuscular Facilitation, Trunk Mobility Exercises, Trunk Impairment Scale, Functional Independence Measure, Trunk control.

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1. INTRODUCTION

Stroke is a common neurological disorder, representing a major cause of disability. It is considered as a significant health problem, which needs a wide- ranging rehabilitation. Stroke is also known as "cerebral vascular accident" or "brain attack". 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.[1, 2] Stroke is the third leading cause of death and the most common cause of disability among adults in the United States.[3] Approximately 700,000 individuals in United States are affected by this each year. About 500,000 are new strokes and 200,000 are recurrent strokes.[1-4] According to W.H.O (16 November 2011) the incidence of stroke in India was 130/100,000 individuals every year. The Indian Council of Medical Research estimates that among the non-communicable disease, stroke contributes for 41% of deaths and 72% of disability adjusted life years.[1, 2] The incidence of stroke is about 1.25 times greater for males than females.[3, 5]The most common type of stroke is the ischemic stroke. According to recent data released by the American Heart Association, 87% of strokes are classified as ischemic. Infarcts occur as a result of insufficient or interrupted flow of blood to an area of the brain, typically caused by blockage of an artery (though "venous infarcts", may cause similar phenomena). Hemorrhagic stroke occurs when blood vessels rupture, causing leakage of blood in or around the brain. These constitute up to 10-15% of all strokes and have a significantly higher morbidity and mortality than do ischemic strokes.[6]There are primarily two different types of hemorrhagic strokes: subarachnoid hemorrhage and intracerebral hemorrhage. Subarachnoid hemorrhage (SAH) is defined as bleeding into the subarachnoid space, between the pia mater and the arachnoid membrane which overlies it. Intracerebral hemorrhage is defined as brain parenchymal blood collection secondary to local loss of vascular integrity.[7,8] Intracerebral hemorrhage (IH) is caused by rupture of a cerebral vessel with subsequent bleeding into the brain.[3, 7] Transient ischemic attacks (TIAs) also known as mini stroke are episodes of focal neurological symptoms due to inadequate blood supply to the brain. Attacks are sudden in onset, resolved within 24 hours or less and leave no residual deficit.[9, 10]

Risk factors of stroke are –

- Hypertension
- Heart disease
- Diabetes
- Smoking
- History of previous stroke
- Elevated blood cholesterol/ lipids
- TIAs
- Family history
- Age
- Gender.[3, 11]

The effects of stroke are variable depending on location of the lesion as well as the size. The most typical symptom of stroke is hemiparesis or hemiplegia, which ranges from weakness to full paralysis of the body opposite to the side of the lesion. In addition to limb muscles, trunk musculature is also impaired in stroke patients.[12] Contrary to limb muscles in hemiplegia in which motor paralysis affects one side of the body, the trunk muscles are impaired on both ipsilateral and contralateral side of body to that of lesion.[2, 12] Stroke survivors have difficulty in balance and postural control for standing upright, sitting, and in the stabilization of proximal body parts during voluntary limb movements because they are impaired by asymmetric posture, abnormal body imbalance, and deficit of weight transfer.[1, 12]Therefore, good trunk stability is essential for balance and extremity use during daily functional activities.[12] In stroke patients, trunk muscle weakness and the loss of proprioception on the affected side can interfere with balance, stability, and functional ability and may reduce the ability to control posture.[13] In stroke rehabilitation; trunk muscle performance is an important factor in predicting the functional outcome.[2,12, 14] Hemiplegia is the most paramount clinical feature, which is described as sided weakness of extremity, facial droop, and slurred speech. It initially develops flaccid hemiplegia during the acute phase. Depending on individual cases, however, flaccid hemiplegia evolves into spastic hemiplegia. It continues to evolve into spastic synergy.[15]
Brunnstrom classified stages of recovery into six stages:-

Stage 1: Flaccidity
Stage 2: Spasticity appears
Stage 3: Increased spasticity
Stage 4: Decreased spasticity
Stage 5: Spasticity continues to decrease
Stage 6:Spasticity disappears and coordination reappears.[15-17]

PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION

PNF has been one of the most recognized treatment concepts in physical therapy since the 1940s. Dr. Kabat and Margaret (Maggie) Knott started and continued to expand and develop the treatment techniques and procedures after their move to Vallejo, California in 1947. After Dorothy Voss joined the team in 1953, Maggie and Dorothy wrote the first PNF book, published in 1956. Proprioceptive**:** sensory receptors that give information concerning movement and position of the body Neuromuscular**:** Involving the nerves and muscles. Facilitation**:** Making easier. Proprioceptive Neuromuscular Facilitation (PNF) is a concept of treatment.[18] It is a method of facilitating the response of neuromuscular mechanism through the stimulation of proprioceptors. The PNF procedures help the patients to gain efficient motor function in stroke.[10,18] The techniques and the method of treatment are aimed to obtain the maximum quantity of activity which can be achieved at each voluntary effort and the maximum possible number of repetitions of this activity to facilitate the response. Treatment by these techniques aims to summate the effects of facilitation to increase the response of the neuromuscular mechanism. The patterns of movement used are spiral and diagonal and they are closely allied to those of normal functional movement; they may be observed in everyday use, e.g. in taking the hand to the mouth, and in or sports, e.g. chopping wood or kicking a football. Therapist's manual contact with the patient provides a means of facilitation and is the only way of applying maximal resistance to movement in patterns of facilitation. Manual contacts must be (i) purposeful, (ii) directional, (iii) comfortable. Proprioceptors situated in the muscles (muscle spindles) are stimulated by stretching, which increases the intramuscular tension. Stimulation of the muscle spindle elicits a reflex contraction of the muscle provided the stimulus is of threshold value and the reflex arc is intact.[19]

TRUNK MOBILITY EXERCISES

The trunk being the central key point of the body, proximal trunk control is a prerequisite for distal limb movement control, balance and functional activities. Trunk control is the ability of the trunk muscles to allow the body to remain upright, adjust weight shift, and to perform selective movements of the trunk so as to maintain the center of mass within the base of support during static and dynamic postural adjustments.[19, 20] Stroke survivors have difficulty in balance and postural control for standing upright because they are impaired by asymmetric posture, abnormal body imbalance, and deficit of weight transfer.[17, 21] The stability of trunk relies on synchronized activity of many trunk muscles. Muscles anterior, posterior and lateral to the spine produce stable and strong contractility and contract in cooperation in order to secure stability in momentary postures, speeds, and diverse states of loads imposed on spine.[22]The improvements in trunk control is due to the trunk exercises mainly consisted of selective trunk movements which helped in strengthening of trunk muscles and also increased awareness of trunk position and anticipatory postural adjustments which also helped in achieving good trunk control.[17, 22]From the above literature, both the intervention that is Proprioceptive Neuromuscular facilitation technique and trunk mobility exercises, both are effective in improving the trunk control in hemiplegic patients and there is no study comparing these two interventions. Therefore, it was the aim of this study to compare the effects of PNF(Proprioceptive Neuromuscular Facilitation) technique and trunk mobility exercises in improving trunk control in hemiplegic patients.

2. METHODOLOGY

2.1 STUDY DESIGN

The study was an experimental study and the participants were recruited through random sampling. This study was approved by the Institutional Reasearch and Ethical Committee of Assam Downtown University, Panikhaiti, Guwahati having Ethical clearance no. adtu/Ethics/stdnt-lett/2016/054.

2.2 PARTICIPANTS

The patient's consent was taken after giving proper explanation about the procedures of the study.An experimental design conducted for a period of 4 weeks and a number of 30 subjects were randomly included to Group-A and Group-B after meeting the inclusion criteria.

Inclusion criteria	Exclusion criteria
Both genders will be included	Medically unstable patients
Age group between 45-55 years	Spinal deformity
Subjects with ischemic stroke	Patients having neurological disease other than stroke
Post stroke duration of at least 3 months	Recent history of any major trauma
Brunnstrom stage 4 and 5	Uncontrolled hypertension
Able to understand and follow simple verbal instruction	Impaired cognitive function
	Subjects with visual/ perceptual deficits/ neglect syndrome[12, 21, 25]

2.3 SOURCE OF DATA

The subjects were taken from Physiotherapy Department of Assam Downtown University, Panikhaiti, Guwahati and Bonda charitable dispensary.

2.4 OUTCOME MEASURES

The trunk impairment scale (TIS) is a new tool to measure motor impairment of the trunk after stroke. The TIS scores, on a range from 0 to 23, evaluate static and dynamic sitting balance as well as co-ordination of trunk movement. A higher score indicates a better trunk performance.[32] The functional independence measure (FIM) is widely used and accepted as a functional-level assessment tool that evaluates the functional status of patients throughout the rehabilitation process. FIM scores can be used as an accurate predictor of outcomes in post stroke patients.[33]

2.5 PROCEDURES

The subjects were allocated to two different treatment groups, Group A (PNF and balance training) and Group B (Trunk Mobility Exercises and balance training) by simple random sampling, consisting of 15 subjects each. For each subject, demographic data was collected. The demographic data and baseline assessment/pre-intervention data of the outcome measures was taken. Then intervention was given according to the group for four weeks. After completing the therapeutic session of 4 weeks, post-intervention/final data of the outcome measures was taken. Patients in group A received PNF technique: Bilateral upper extremity pattern for upper trunk chopping and lifting pattern in fig 1 (a) & (b) and fig 2 (a) & (b).Bilateral lower extremity flexion in fig 3 (a) & (b) and extension in fig 4 (a) & (b) for lower trunk.[19, 20]

(a) (b)

Fig: 1 (a), (b) Chopping to the left

(a) (b)

Fig: 2 (a), (b) lifting to the left

(a) (b)

Fig: 3 (a), (b) Bilateral Lower Extremity Flexion, with Knee Flexion, for Lower Trunk flexion

(a) (b)

Fig: 4 (a), (b)Bilateral Lower Extremity Extension, with Knee Extension, for Lower Trunk Extension

All the participants in the group B received trunk mobility exercises, which consisted task-specific exercises of the upper and lower part of the trunk. The exercises were performed both in the supine and in sitting positions. .The exercises in supine were as follows: pelvic bridge (**fig:5**) and unilateral pelvic bridge (**fig:6**) in crook lying position, Upper trunk rotation (**fig:7**), Task-specific reach-out for an object (**fig:8**) and Lower trunk rotation(**fig:9**). The exercises in sitting were as follows: Upper trunk lateral flexion (**fig:10**), lower trunk lateral flexion(**fig:11**), forward reach and lateral reach (**fig:12,13**). It was performed once in a day,5 days in a week or 4 weeks.[25, 26, 28]

Fig: 5 Bridging

Fig: 6 Unilateral bridging

Fig: 7 Upper trunk rotation

Fig: 8 flexion rotation of the upper trunk

Fig: 9 Lower trunk rotation

Fig: 10 Upper trunk lateral flexion Fig: 11 Lower trunk lateral flexion

Fig:12 forward reach Fig:13 lateral reach

3. STATISTICAL ANALYSIS

The data obtained were analyzed using SPSS version 22. The data were presented as mean + standard deviation (SD). The paired t- test and independent sample t- test was used to compare the effectiveness of PNF and Trunk mobility Exercises in improving trunk control. The P value of less than 0.05 was used to determine the statistical significance.

4. RESULTS

Trunk impairment scale (TIS) Within groups analysis -

TABLE 1.Within group analysis of Group A and Group B for TIS

Outcome Measure	Group	Day	Mean ± S.D.	p value	Comment
Trunk Impairment scale(TIS)	Group A	Day 0	12.4 ± 2.29	0.02	Significant difference between day 0 and day 28.
		Day 28	19.46 ± 1.45		
	Group B	Day 0	11.933 ± 2.12	0.02	Significant difference between day 0 and day 28.
		Day 28	16.866 ± 1.99		

p<0.05, n=30

The average pre-interventional i.e. day 0 in the group A (Table 1) was 12.4+2.29 and in the group B (Table 1) was 11.933+2.12 where as post interventional i.e. day 28 the scores increased to 19.46+1.45 in group A (Table 1) and 16.866 + 1.99 group B (Table 1). Changes in the TIS scale revealed statistically significant increase in post intervention for both the groups. This was done using paired t test.

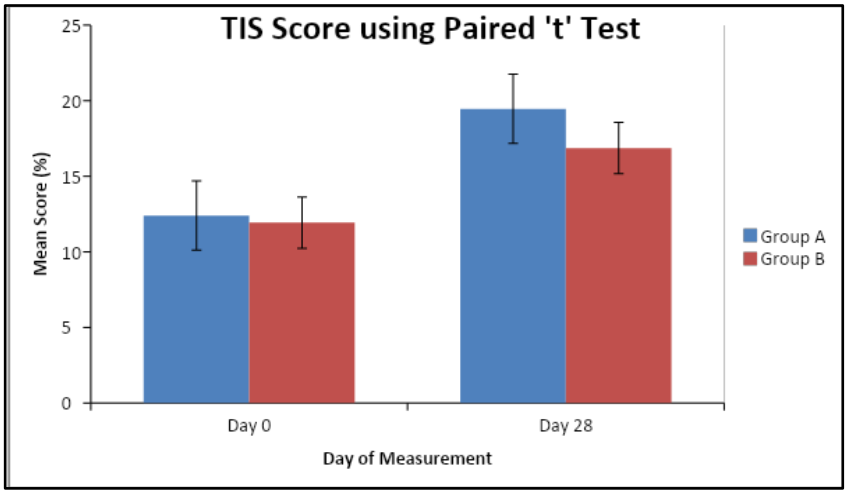

Fig: 14 **Within group TIS score**

Table 2 : Between groups analysis of group A and group B for TIS

Outcome measure	Group	N	Mean ± SD	T	p value	Comment
Trunk Impairment Scale (TIS)	Group A (PNF)	15	19.466 ± 1.45	2.144	0.02	Significant difference between groups after treatment
	Group B (TME)	15	16.866 ± 1.99			

Between group analysis-p<0.05, , n=30

The between group analysis in (Table 2) for TIS was done using Independent t test showed statistically very significant trunk control in the group A (PNF) as compared to group B (TME)

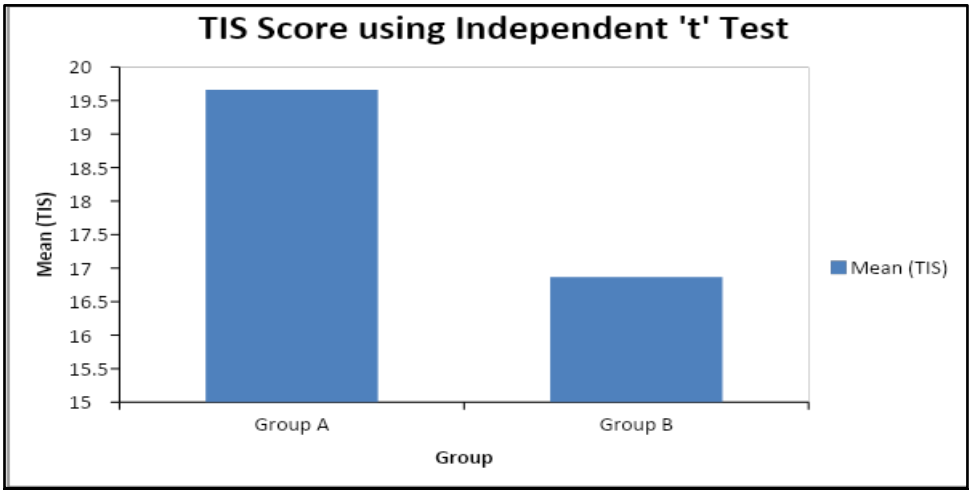

Fig: 15 **:Between groups TIS score**

Functional Independence Measure (FIM):

Within group analysis –

TABLE 3.Within group analysis of group A and group B for FIM -p<0.05, n=30

Outcome Measure	Group	Day	Mean ± S.D.	p value	Comment
Functional Independence Measure (FIM)	Group A	Day 0	54.4 ± 5.80	0.02	Significant difference between day 0 and day 28
		Day 28	94.066 ± 6.56		
	Group B	Day 0	55.4 ± 5.19	0.02	Significant difference between day 0 and day 28.
		Day 28	84.06 ± 5.24		

The average pre-interventional i.e. day 0 FIM in the group A (Table 3) was 54.4 ± 5.80 and in group B (Table 3) was 55.4 ± 5.19 whereas post interventional i.e. day 28 FIM increased to 94.066 ± 6.56 in group A (Table 3) and 84.06 ± 5.24 in group B (Table 3). Changes in FIM revealed highly statistically significant improvement or both the groups. This was done using paired t test.

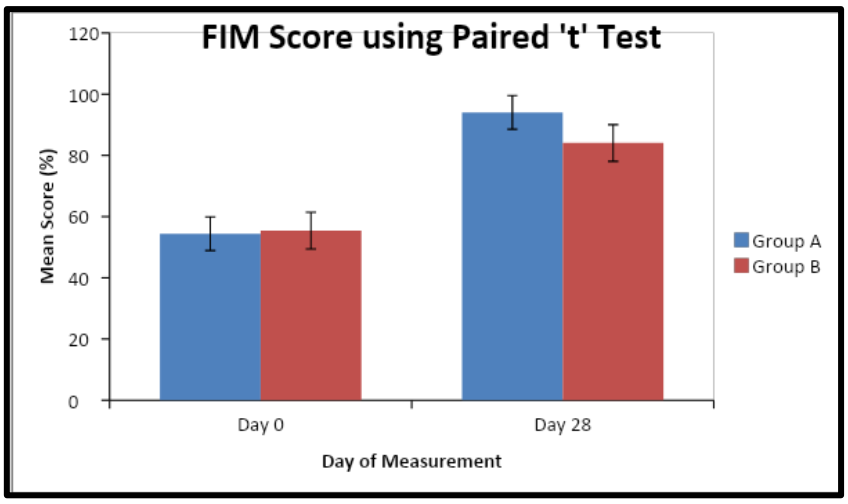

Fig: 16**: Within group FIM score.**

Between group analysis –

Table 4: Between Group Analysis of group A and group B for FIM

Outcome measure	Group	N	Mean ± SD	T	p value	Comment
Functional Independence Measure (FIM)	Group A (PNF)	15	94.06 ± 6.56	2.144	0.02	Significant difference between groups after treatment
	Group B (TME)	15	84.06± 5.24			

- p<0,05, n=30

The between group analysis in (Table 4) for FIM was done using Independent t test showed statistically significant trunk control improvement in group A as compared to group B.

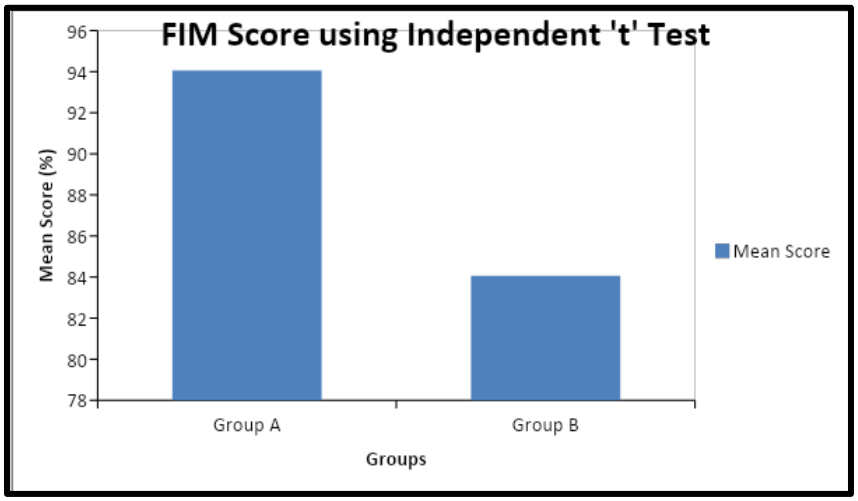

Fig: 17: **Between groups FIM score.**

Statistical analysis in the present study shows that there is significant difference between Proprioceptive Neuromuscular Facilitation (group A) versus Trunk mobility exercises (group B) in improving trunk control in post stroke hemiplegic patient. But during the between groups analysis in (Graph 2 & 4) by Independent 't' test it is proved that group A(PNF) is better than group B (TME) in terms of improving trunk control and postural control by (TIS) and (FIM) in hemiplegic stroke patients.

4. DISCUSSION

Most of the studies in the stroke rehabilitation are concerned with the management of the upper or lower extremity dysfunction. In contrast with limb rehabilitation, trunk restoration is a rather neglected area of stroke rehabilitation research. Hence, this study aimed to evaluate the effects of PNF versus Trunk Mobility Exercises to improve trunk control in hemiplegic stroke patients. This study was conducted on thirty subjects in which they were randomly assigned into two groups, that is 15 in group A and 15 in group B. Both the groups were assessed to determine the trunk control in hemiplegic stroke patients using TIS and FIM as outcome measures. The mean age of the subject in group A was 50.4 ± 3.60 and mean age of the subjects in group B was 50.2±3.48. Hence, the age distribution of both the group showed the homogeneity of subjects. In group A, the pre-intervention mean TIS score was 12.4±2.29, which was increased to the post-intervention mean score of 19.46±1.45, which was statistically significant. In Group B, the pre-intervention mean TIS score was 11.93±2.12, which was increased to the post intervention mean of 16.86±1.99 which was statistically significant. It was suggested that there was a significant improvement in trunk control of both the groups. In Group A, the pre-intervention mean FIM score of 54.5±5.80 was increased to the post-intervention mean score of 94.06±6.56 and in Group B, the pre mean FIM score of 55.5±5.19 was increased to the post mean of 84.06±5.24,which were both statistically significant. There was an increase in score of FIM which indicates significant improvement in both the groups. The mean values of data from the study indicate that both PNF and Trunk mobility exercise could be beneficial in the treatment of trunk control among hemiplegic stroke patients. There was statistically significant difference in the TIS and FIM scores in both group A and group B from 'day 0' to 'day 28'. Between the group comparisons the results showed highly statistically significant values in group A as compared to group B. Results of the present study revealed that there was a considerable effects of PNF technique (group A) in improving trunk control as compared to Trunk mobility exercises (group B) in terms of TIS and FIM outcome measures for trunk control in 4 weeks. This study is supported by Natália Noman, de Lacerda,*et. al.,* conducted an intervention study to evaluate the effect of proprioceptive neuromuscular facilitation (PNF) on trunk balance and risk of falls in patients with sequelae of stroke. From the study, it was concluded that PNF has beneficial effects in stabilizing the trunk and impact on risk of falls in subjects with left hemiparesis.[40] Trueblood,*et. al.,* found in their study, PNF based resisted anterior elevation and posterior depression of pelvic movements for lower trunk muscles resulted in an improvement in walking in early phase stroke participants.[48] The study of Dilip Khanal, *et. al.* found improvement in trunk performance in terms of static sitting balance and dynamic sitting balance that positively affects the gait and balance.[1]Jung,*et. al.,* suggested that a trunk stability exercises by using PNF on trunk control ability, balance and gait in patient with hemiplegia.[50] The probable mechanism by which PNF could have worked is by facilitating the neuromuscular mechanism, by stimulating the proprioceptors. Kabat reported that a greater motor response can be attained when employing facilitating techniques in addition to resistance. Facilitation resulted from a number of factors such as application of stretch, use of particular movement patterns and use of maximal resistance in order to induce irradiation.[2] A study done by Deletis, *et. al.,* explained in detail about neuromuscular mechanism. They stated that in PNF position, sensory inputs from the periphery leads to stronger excitation of the cortical areas, leading to variations in the thresholds of a number of motor neurons, which was reflected in the motor evoked potentials. This was further supported by a study of Benecke, *et. al.,* which reported that the amount of sensory input coming from the periphery was greater in PNF position than in normal position, which induces changes in the excitability of the pyramidal tract and the final motor

pathways.[2] As in this study the trunk mobility exercises are also effective in hemiplegic stroke patients to improve trunk control as it helped in strengthening of trunk muscles and also increased awareness of trunk position and anticipatory postural adjustments which helped in achieving good trunk control.[17] Gellhorn and Loofbourroe showed that when a muscle contraction is resisted, that muscles response to cortical stimulation increases. The use of particular movement patterns also causes changes in spinal and supraspinal level.[3,18] Moodie,*et. al.,* found that training the patient in the awareness of trunk position could improve weight symmetry in sitting after the early phase of the stroke.[49] Verheyden, *et.al.* found that in addition to conventional therapy, trunk exercises aimed at improving sitting balance and selective trunk movements have a beneficial effect on the selective performance of lateral flexion of the trunk after stroke.[43] Jung Kyung-Sim, *et. al.,* suggested that trunk exercises performed on an unstable surface improve trunk muscle activation, postural control, and gait speed in patients with stroke.[51] A study done by John Chae et al. suggested that active repetitive training of the hemiparetic limb shapes subsequent functional reorganization in the adjacent intact cortex and the undamaged motor cortex plays an important role in motor recovery.[44,45] Karni et al. using functional MRI, and Classen et al. using Transcranial Magnetic Stimulation, both reported a slowly evolving, long-term, experience-dependent reorganization of the adult primary motor cortex after daily practice of task-specific motor activities.[47-49]

5. CONCLUSION

This study has shown that subjects in group A who received PNF technique are more effective when compared with the subjects of group B. The use of particular movement patterns, resistance and stretch were found more effective in trunk facilitation. Therefore we have come to a conclusion that group A subjects who received PNF technique showed a remarkable improvement in trunk performance and functional ability as compared to group B subjects who received Trunk Mobility Exercises.

6. LIMITATIONS OF THE STUDY

- The results only showed the short term effects of the intervention.
- The study did not include long term follow up. Thus results can't tell us about the effectiveness of both the intervention in long term.
- In this study only trunk PNF intervention was taken into consideration.

7. FUTURE RECOMMENDATION

- A long term study with more subjects might give more lucid conclusion.
- The study on same treatment approaches for both upper and lower extremity along with the trunk could be done.

8. AUTHORS CONTRIBUTION

Niharika Dihidar carried out the research work in data collection, review of literature and prepared the thesis as a part of the curriculum of Masters in Physiotherapy under the supervision of Dr. S. Anita Devi. DrAbhijit Dutta, Associate Professor, Assam down town university guided in the whole study with methodology, result analysis and discussion of the study.

9. CONFLICT OF INTEREST

Conflict of interest declared none.

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