



Comparison of Effectiveness of Trunk PNF Versus NDT on Trunk Stability in Stroke Patients

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Abstract: Stroke is the commonest neurological deficit caused by an interruption of the blood flow to the brain and loss of trunk control is commonly observed in patients after stroke. Impaired trunk control has a negative impact on daily activities and quality of life(QOL) in patients after stroke. Proprioceptive Neuromuscular Facilitation (PNF) and Neurodevelopmental technique (NDT), both are effective in improving trunk control in hemiplegic patients by improving trunk muscle endurance, strength, and trunk mobility. This study is aimed to compare the effectiveness of trunk PNF and NDT to improve trunk stability in patients with stroke. The objective of the study was to compare the effectiveness of trunk proprioceptive neuromuscular facilitation and neuro-developmental therapy based on trunk protocol with conventional therapy to improve trunk stability in stroke patients 30 subjects who fulfilled the criteria were taken for the study and was categorised into 2 groups of A and B, each having 15 subjects. Group A received trunk proprioceptive neuromuscular facilitation along with conventional therapy & group B received neuro-developmental therapy based on trunk protocol along with conventional therapy respectively for 4 weeks. Before the study, all the subjects were assessed using a general assessment proforma. Both pre and post-treatment assessments were assessed by using trunk impairment scale and ROM of trunk flexion and extension. The results of statistical analysis were tabulated in terms of mean, standard deviation, variance, t-test, P-value, coefficient of variation in both groups. Paired t-test showed that there was a statistically significant improvement in both groups ($P<0.05$). The coefficient of variation is significant at the CV of group A (83.34) less than the CV of group B (100.16), therefore group A is more effective compared to group B. In this study, it was found that the trunk PNF technique with conventional exercises and NDT based on trunk protocol with conventional exercises was effective to improve trunk stability in acute or subacute stroke patients. But, the trunk PNF technique with conventional exercises was more effective than NDT based on the trunk protocol conventional exercises technique for improving the trunk stability in acute or sub acute stroke patients.

Keywords: acute stroke, sub-acute stroke, trunk impairment scale, Proprioceptive neuromuscular facilitation, neuro-developmental therapy, and range of motion.

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I. INTRODUCTION

Stroke is defined by the World Health Organization as a condition characterized by rapidly developing symptoms and signs of a focal brain lesion, with symptoms lasting for more than 24 hours or leading to death, with no apparent cause other than that of vascular origin^{1, 2}. Stroke is the 3rd largest cause of death after heart disease and all cancers and is the most common cause of disability among adults. It is estimated that there are 5.45 million deaths in a year from stroke in the world and over 9 million stroke survivors. The overall prevalence of stroke in the population is estimated to be 47 per 10,000 people^{1, 2}. The prevalence of stroke in India is approximately 200/ 1,00,000 populations per year.³ It was observed that cerebrovascular strokes are more common in males(64.4%) than the female(35.6%), the most common age group was 58-67 years(28.29%), the most common clinical feature was hemiplegia (71.21%), most common risk factor was hypertension(89.51%)followed by diabetes mellitus (51.70%), most common type of stroke was hemorrhagic (60.24%) followed by ischemic(39.75%)⁴. Along with hypertension, other risk factors for stroke include obesity, elevated blood cholesterol, carotid stenosis, atrial fibrillation, cigarette smoking, and heart disease⁵ The most significant recovery in neurologic function occurs within the months after the injury, although movement patterns may be able to be improved with goal-directed activities for up to 2 to 3 years after the initial injury.⁶ The effects of stroke are variable depending on the location of the lesion as well as the size. The most common symptom of a 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 patients⁷. Contrary to limb muscles in hemiplegia in which motor paralysis affects one side of the body, the trunk muscles are impaired on both the ipsilateral and contralateral side of the body to that of lesion ^{7,8}. Trunk control is the ability of the trunk muscles to allow the body to remain upright, adjust weight shift, and perform selective movements of the trunk to maintain the centre of mass within the base of support during static and dynamic postural adjustments.⁹⁻¹¹. Loss of trunk control is commonly observed in patients with stroke. Trunk control has been identified as an early predictor of activities of daily living after stroke¹²⁻¹³. As stroke patients lose their ability to perform the postural adjustment and maintain postural alignment because of spasticity, weakness, loss of equilibrium, and righting reactions, the trunk assumes asymmetrical posture. Unlike common belief, trunk muscles are impaired on both sides of the body in patients with stroke. Trunk control has been identified as an important early predictor of activities of daily living after stroke.¹⁴ Activation of the trunk muscles has a relationship with gait speed and the functional independence measure,¹⁵ in which loss of motor control leads to multi-directionally impaired trunk muscle strength which has a potential to affect functional activities¹⁶.

Conventional trunk exercises aimed at improving sitting balance and selective trunk movement have a beneficial effect on the selective performance of the trunk after stroke¹⁷. Proprioceptive Neuromuscular Facilitation is a method of facilitating the response of neuromuscular mechanisms through the stimulation of proprioceptors. The PNF procedures helps the patients to gain efficient motor function in stroke.¹⁸ The original goal of the technique is to lay down gross motor patterns within CNS. The diagonal mass movement patterns in PNF resemble normal motor activity. A reduction in truncal tone can be promoted by a PNF trunk pattern (chopping and lifting) that emphasizes rotation movement of the trunk. PNF programs may be appropriate for improving trunk muscle endurance, strength, and trunk mobility ^{11,19,21}. The Bobath concept is also known as the neurodevelopmental technique (NDT). Principles and techniques, described in Bobath's textbook of 1970 and the following edition of 1990 have been modernized, incorporating new knowledge from neurophysiologic research and motor development into the concept ²². Bobath is a technique that helps to get a normal activity out of the affected side for functional use. The Bobath treatment aims to inhibit the patient's abnormal patterns of movement, because normal patterns cannot be superimposed upon abnormal ones. Facilitation of normal movement and task-specific practice using manual guidance are critical elements of bobath concept²³. Individually developed exercise programs in the bobath concept have been demonstrated to improve trunk performance, balance, and walking ability in stroke patients more than do conventional exercises²⁴. From the above literature, it can be concluded that, both the interventions are effective in improving trunk control in hemiplegic patients but there are no studies comparing these two interventions with conventional therapy. Therefore, the aim of the study to compare the effectiveness of PNF (Proprioceptive Neuromuscular Facilitation) technique and Neurodevelopmental technique (NDT) in improving trunk stability in stroke patients.

2. METHODOLOGY

2.1 Study Design

The study was an experimental study and the participants were recruited through random sampling. The study was approved by the Institutional Research and Ethical Committee of College of Physiotherapy and Medical Sciences, Guwahati, Assam.

2.2 Participants

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

Inclusion Criteria	Exclusion Criteria
Subjects having a history of ischemic stroke with a minimum period of 3 months.	Patients having neurological disease affecting postural control other than a stroke (e.g. cerebellar disease, Parkinson's disease).
Age group 40 to 65 years.	Musculoskeletal disorders such as low back pain, arthritis, degenerative diseases of the lower limbs affecting motor performance, spinal deformity.
Both male and female.	Uncontrolled hypertension.
Had a unilateral stroke.	Uncooperative patients.
Patients who can obey commands.	Recent history of any trauma
TIS Score is ≥ 5	Impaired cognitive function

2.3 Source Of Data

The subjects were taken from

- GNRC Hospital, Dispur, Guwahati
- Palon Rehab Center, Guwahati
- Holistic Rehab Center, Guwahati.
- Out-patient Department of College of Physiotherapy and Medical Sciences, Guwahati.

2.4 Outcome Measures

The Trunk Impairment Scale (TIS) assesses the motor impairment of the trunk after stroke. It assesses static and dynamic sitting balance and trunk coordination. The scale ranges from 0 to 23 points. A higher score indicates a better trunk performance. Adequate reliability and validity of the Trunk Impairment Scale for stroke patients have been reported²⁵. ROM of trunk flexion and extension by using

modified Schober's test (MST). For measuring the MST, we put a mark 5 cm below and 10 cm above the junction. The participant was asked to bend forward as far as possible and stretched, the distance of these two points was measured as the MST value.

2.5 Procedures

The subjects were grouped to two different treatment groups. Group A (PNF and conventional therapy) and Group B (NDT and conventional therapy) by simple random sampling, consisting of 15 subjects each. For each subject, demographic data was collected. The demographic and baseline assessment or pre-intervention data of the outcome measures was taken. Then intervention was given according to the group once a day, 5 days per week, for 4 weeks²⁶ for 45 minutes. After completing the therapeutic session for 4 weeks, post-intervention/final data of outcome measures was taken. Patients in group A received trunk PNF with conventional therapy: The technique used in this study is a) Alternating Isometrics to Increase Trunk Stability in Sitting as in fig: 1 b) Rhythmic Stabilization to increase trunk stability in sitting as in fig:2, c) Agonistic Reversal Technique During Bridging as in fig:3, d) Lifting Pattern as in fig:4 and Reverse Lifting Pattern as in fig:5, e) Pelvic Anterior Elevation-Posterior Depression fig: 6 (A and B)

Conventional Therapy

Conventional therapy was common for both groups for 15 minutes.

It consisted of-

- ROM exercises for affected limbs.
- Selective stretching exercises.
- Bridging in Fig: 10
- Unilateral bridging
- Trunk rotation in crook lying position in Fig: 11



Fig 1: Patient performing Alternating Isometric for flexion



Fig 2: Patient performing Rhythmic stabilization for trunk



Fig 3: Patient performing Agonistic Reversal technique during bridging



Fig 4: Patient performing Lifting pattern



Fig 5: Patient performing Reverses Lifting pattern



Fig 6: Hand placement for Anterior Elevation (A) and Posterior Depression (B) of pelvis

All the participants in Group B received Neuro-Developmental therapy based on Trunk Protocol along with conventional therapy for 4 weeks.

- Facilitation of active weight shifting in Fig :7
- Facilitation of active functional trunk Rotation in Fig: 8
- Reaching activity in Fig: 9



Fig 7: Patient performing Weight bearing on the affected side



Fig 8: Patient performing Trunk rotation



Fig 9: Patient performing Reaching Activity

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- ROM exercises for affected limbs.
- Selective stretching exercises.
- Bridging in Fig:10
- Unilateral bridging.
- Trunk rotation in crook lying position in Fig: 11



Fig 10: Bridging

Fig 11: Trunk rotation in crook lying position

3. DATA ANALYSIS AND RESULTS

The collected data were analyzed using SPSS Software version 2 Paired t-test and analysis of variance (ANOVA) was performed to find the effectiveness of Trunk PNF technique along with conventional therapy and NDT based on Trunk protocol along with conventional therapy to improve trunk stability in post stroke patients.

Table 1: Distribution of Group AGE in A and Group B

Group	Total no	Mean	SD
A	15	56.5333	4.3338
B	15	58.4667	5.0973
Total	30	57.5	4.8287

Table 3 illustrates the mean age (mean \pm SD), group A is 56.53 ± 4.33 and group B is 58.46 ± 4.82 . The overall mean age (mean \pm SD) of the 30 subjects is 57.5 ± 4.83 .

Graph -I: Comparison of means of age between Group A and Group B

Mean Score (%)

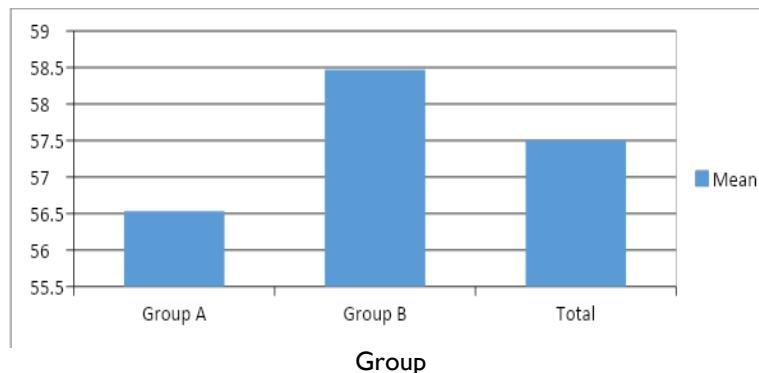


Table 2: Distribution of subjects in accordance to age groups

Age group	Frequency	Percentage of subjects
45 - 50	4	13.33%
50 - 55	2	6.67%
55 - 60	9	30.00%
60 - 65	15	50.00%
Total	30	100%

From table 2, it is evident that there were 4(13%) patients between the age group 45-50 years, 2 (7%) patients between the age group 50-55 years, 9(30%) patients between the age group 55-60 years, 15(50%) patients the age group 60-65 years respectively.

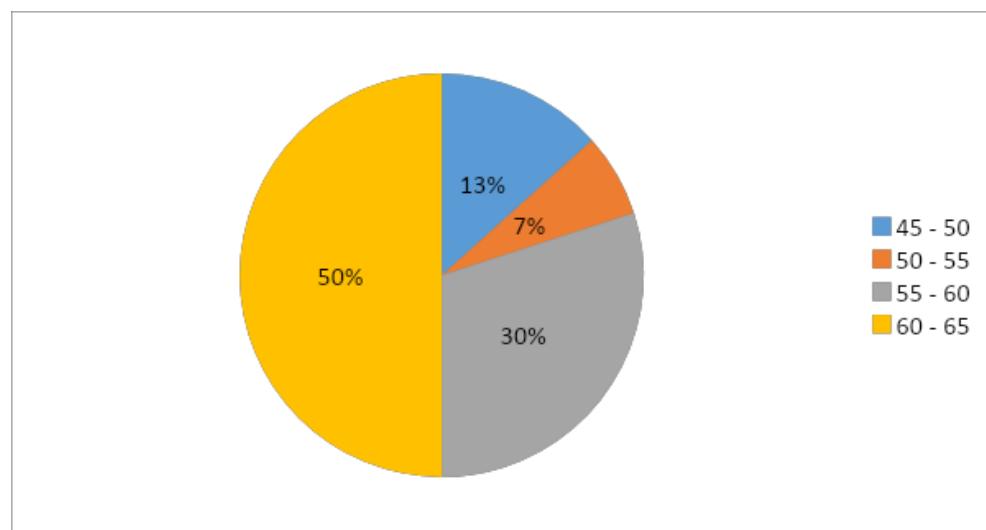


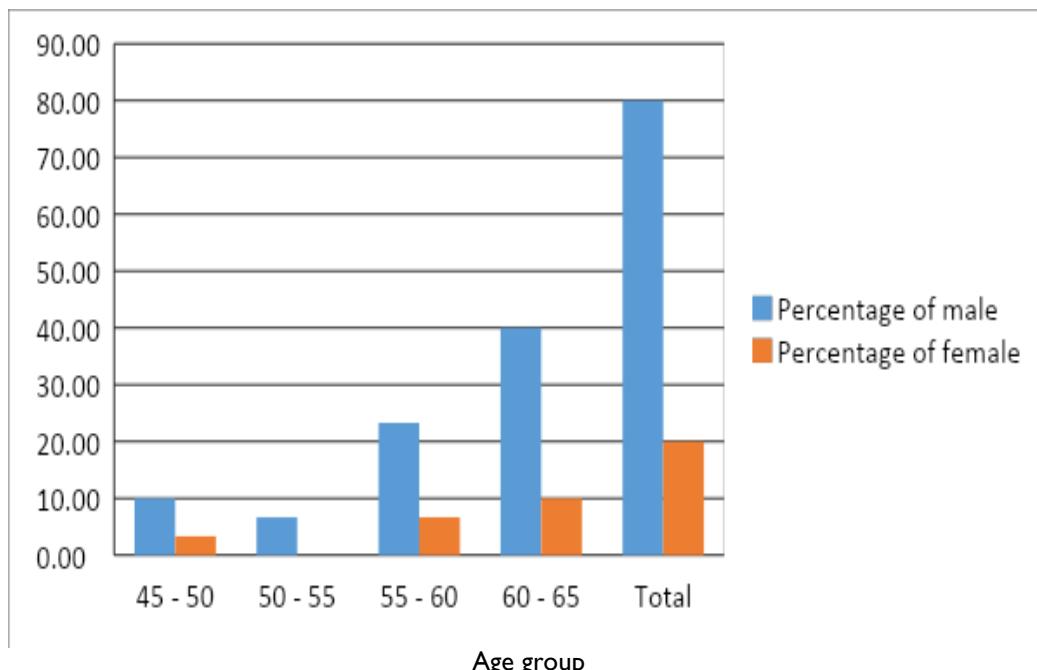
Fig- 12: % of subjects in different age groups

In Fig-13, the 30 subjects were summarized into four age groups viz, 45 - 50, 50 - 55, 55 - 60 and 60 - 65. From the above pie diagram it can be observed that 50% of the subjects are in the age group 60 – 65.

Table 3: Distribution of subjects in accordance to gender in different groups

Age group	Male	Percentage of male	Female	Percentage of female
45 - 50	3	10	1	3.33
50 - 55	2	6.67	-	-
55 - 60	7	23.33	2	6.67
60 - 65	12	40	3	10
Total	24	80	6	20

Table 3 illustrates that in the age group of 45-50 years the percentage of male is 10% and females is 3.33%. In the age group 50-55 years the percentage of male 6.67% and female 0%. In the age group 55-60 years the percentage of male 40% and female 20%. In the group 60-65 years the percentage of male 40% and female 20%. Therefore, in this study the total percentage of male is 80% and females is 20%. Hence, the distribution of subjects in accordance to the gender in different groups, male subjects are more than female subjects.

Graph - 2: Percentage of distribution of male and female subjects

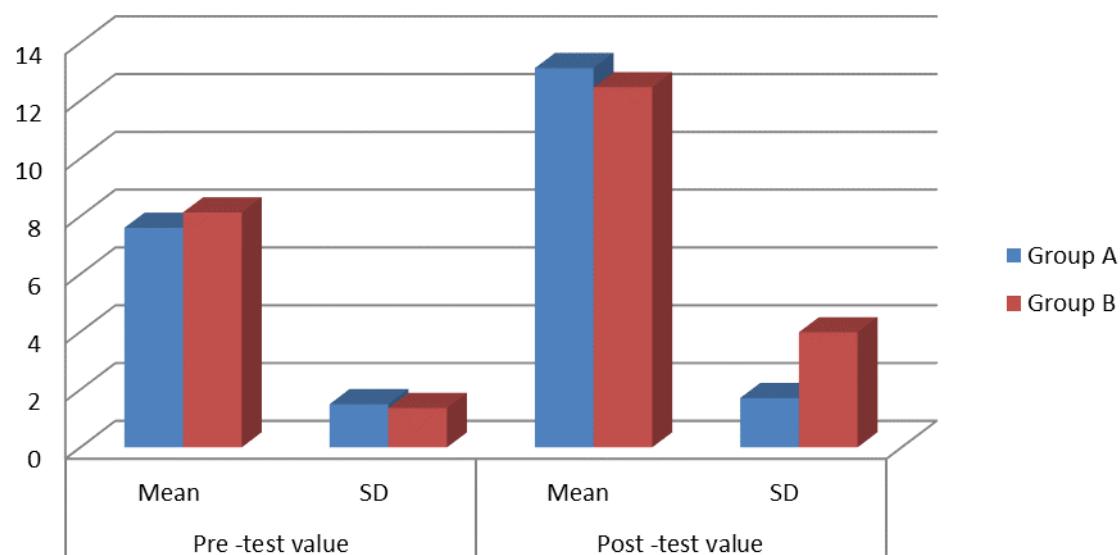
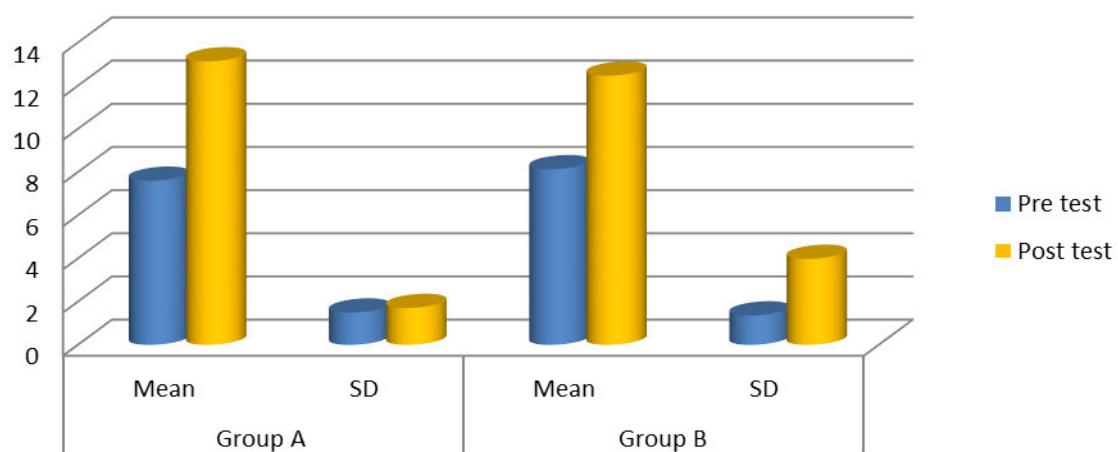
From the above graph-2, of multiple bar diagrams it is clear that of the total subjects under study 80% are male subjects whereas it is 20% in case of the female subjects.

Table 4: Pre and post test analysis under TIS group A & B

Group	Pre test value		Pre test value		95% CI of the difference	t value	P value (Intra)
	Mean	SD	Mean	SD			
A	7.6	1.4967	13.13	1.7075	4.3291 to 6.7309	9.433	<0.0001
B	8.1333	1.3597	12.4667	3.9822	2.1078 to 6.5590	3.988	.0004
P value (inter)	0.3158						

From table 4, it is seen that the result of inter-group comparison of pre-treatment analysis shows P value >0.05. It shows that there is no significant difference between the pre treatment scores of TIS. Thus it can be said that the group is homogeneous. The result of intra-group comparison shows that in group A there is a significant difference between pre-test and post- test since P value is < 0.05 and the protocol (trunk PNF with conventional therapy) is effective since mean

TIS score increases from 7.6 to 13.13. In group B, there is a significant difference between pre-test and post- test since P value is < 0.05 and the protocol (NDT based on trunk protocol with conventional therapy) is effective since mean TIS score increases from 8.13 to 12.46. Changes in the trunk ROM (lumber extension) highly statistically significant improvement for both the groups. This was done using a paired 't' test.

Graph 3: Pre and Post - test analysis under TIS for Group A & B**Graph – 4: Group wise distribution of TIS score pre-test and post-test**

From the graph -4, it is clear that for both pre and post- test analysis under TIS for group A and group B average change in means is high, specifically in post -test analysis. Variability is also high for Group B in post -test analysis.

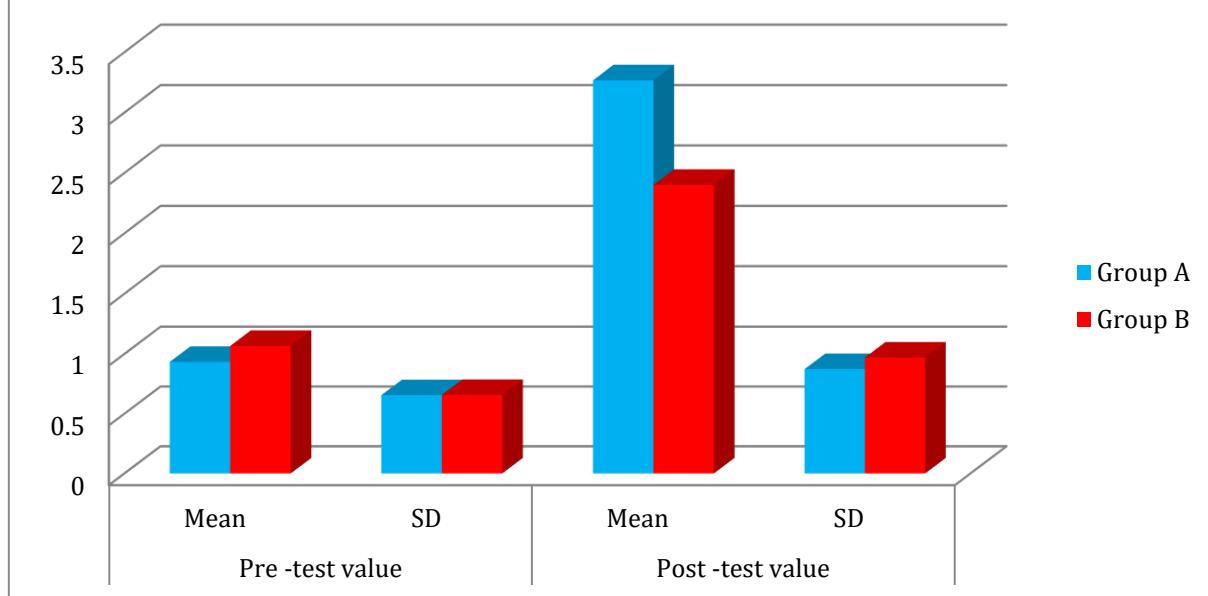
Table 5: Pre and post test analysis under ROM (Lumber flexion) for group A &B.

Group	Pre test value		Pre test value		95% CI of the difference	t value	P value (Intra)
	Mean	SD	Mean	SD			
A	0.9333	0.6549	3.2667	0.8731	1.7562 to 2.9106	8.280	<0.0001
B	1.0667	0.6569	2.4	0.9695	0.7145 to 1.9521	4.414	0.0001
P value (inter)	0.5814						

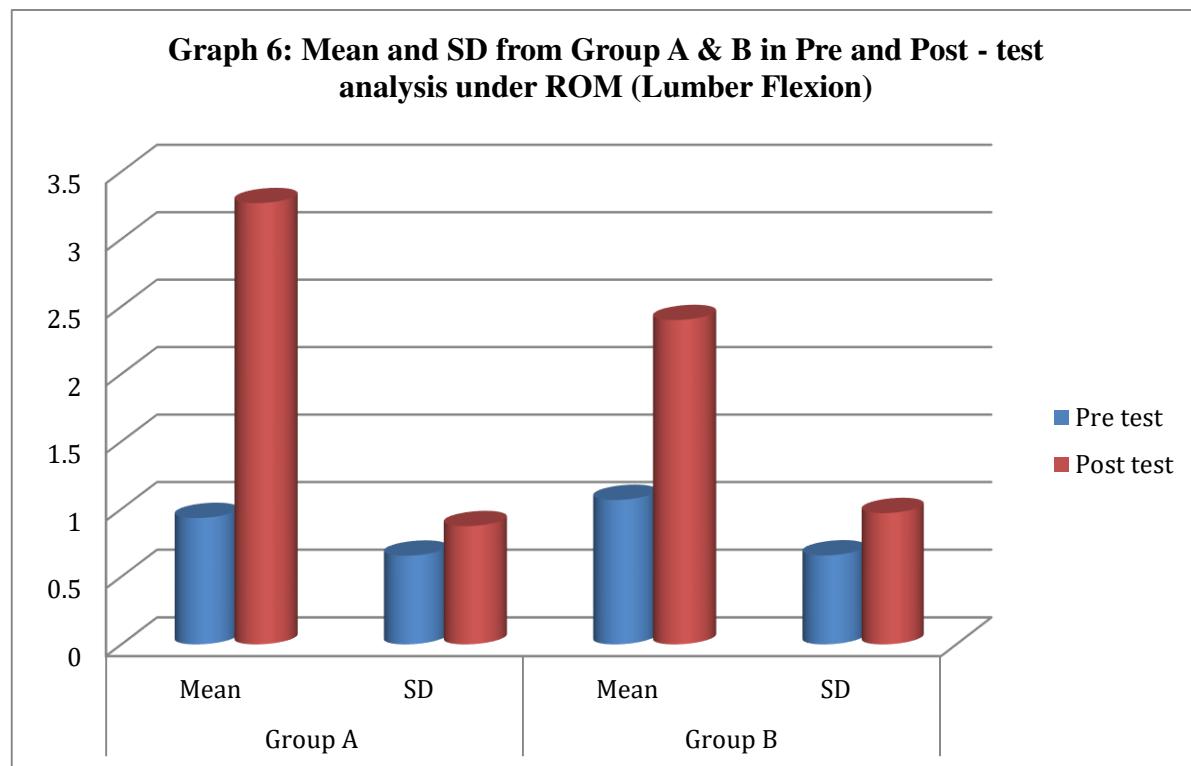
From table 5, it is seen that the result of inter group comparison of pre-treatment analysis shows P value >0.05 . It shows that there is no significant difference between the pre treatment scores of trunk ROM (lumbar flexion). Thus it can be said that the group is homogeneous. The result of intra group comparison shows that in group A there is a significant difference between pre- test and post- test since P value is <0.05 and the protocol (trunk PNF with conventional therapy) is effective since mean trunk ROM (lumbar flexion) score increases from 0.93 ± 0.65 to 3.26 ± 0.87 In group B , there is a significant difference between pre-test and post- test since P value is < 0.05 and the protocol (NDT based on trunk protocol with conventional therapy) is effective since mean trunk ROM (lumbar flexion) score increases from 1.06 ± 0.65 to 2.4 ± 0.96 . Changes in the trunk ROM (lumbar extension) highly statistically significant improvement for both the groups. This was done using a paired 't' test.

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Graph 5: Pre and Post - test analysis under ROM (Lumber Flexion) for Group A & B



Graph – 6: Group wise distribution of trunk ROM (lumbar flexion) score pre-test and post- test



From the diagram it is clear that for both pre and post- test analysis under ROM (Lumbar Flexion) for Group A& B, the average change in means in Group A is high, specifically in post -test analysis. Variability is also high for Group B in post -test analysis whereas it is the same in pre- test analysis

Table 6: Pre and Post - test analysis under ROM (Lumbar Extension) for Group A & B

Group	Pre -test value		Post -test value		95% CI of the difference	t value	p value
	Mean	SD	Mean	SD			
A	0.7	0.6782	2.0333	0.9393	0.7205 to 1.9461	4.457	0.0001
B	0.3	0.4397	1.5333	0.4643	0.8951 to 1.5715	7.470	< 0.0001
p value (inter)	0.0655						

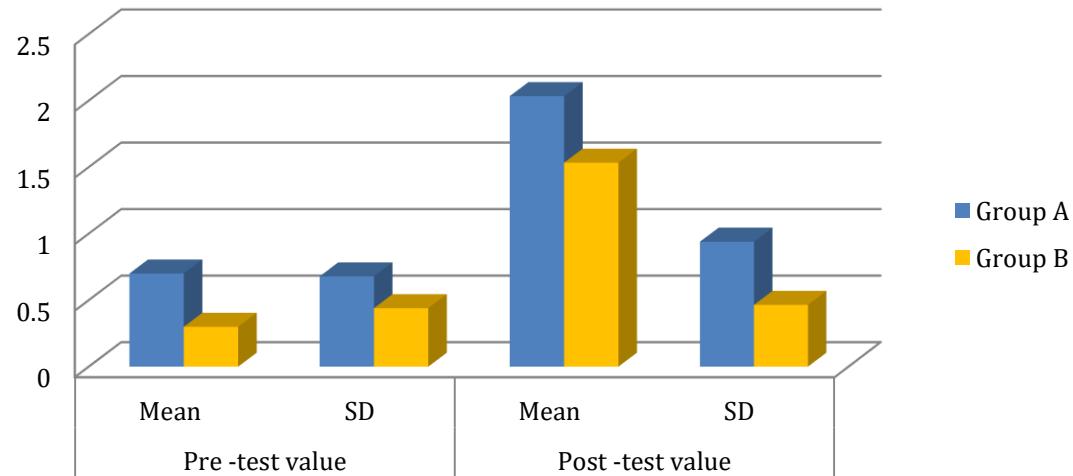
From table 6, it is seen that the result of inter group comparison of pre-treatment analysis shows P value >0.05. It shows that there is no significant difference between the pre

treatment scores of trunk ROM (lumbar extension). Thus it can be said that the group is homogeneous. The result of intra group comparison shows that in group A there is a

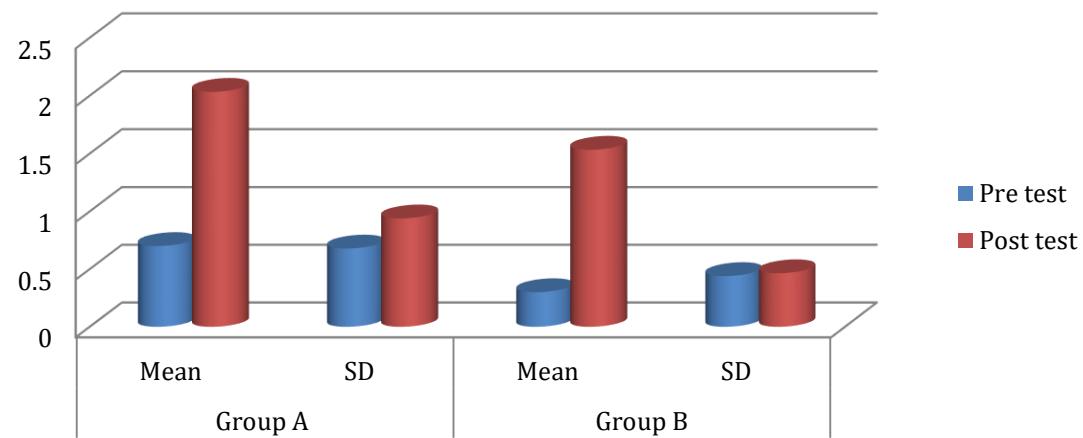
significant difference between pre- test and post- test since P value is < 0.05 and the protocol (trunk PNF with conventional therapy) is effective since mean trunk ROM (lumbar extension) score increases from 0.7 ± 0.67 to 2.03 ± 0.93 . In group B , there is a significant difference between pre-test and post- test since P value is < 0.05 and

the protocol (NDT based on trunk protocol with conventional therapy) is effective since mean trunk ROM (lumbar extension) score increases from $.03 \pm 0.43$ to 1.53 ± 0.46 . Changes in the trunk ROM (lumbar extension) highly statistically significant improvement for both the groups. This was done using a paired 't' test.

Graph 7: Pre and Post - test analysis under ROM (Lumber Extension) for Group A & B



Graph 8: Mean and SD from Group A & B in Pre and Post - test analysis under ROM (Lumber Extension)



From the diagram it is clear that for both pre and post- test analysis under ROM (Lumbar Extension) for Group A & B, the average change in means in Group A is high, specifically in post -test analysis. Variability is also high for Group A in post -test analysis. Thus it is clear that the treatment is more effective for improvement in Group A

Table 7: Comparison of Post test results for both Group A and Group B

	Group A				Group B			
	Mean	SD	Variance	CV	Mean	SD	Variance	CV
TIS	13.13	1.7	2.89	12.95	12.4	3.9	15.21	31.45
ROM (Lumbar Flexion)	3.26	0.87	0.76	26.69	2.4	0.96	0.92	40.0
ROM (Lumbar Extension)	2.03	0.93	0.86	45.81	1.53	0.46	0.21	30.07
TOTAL	6.14	5.12	26.19	83.34	5.44	5.45	29.69	100.16

Table 7 indicates coefficient of variable (CV) was performed to compare the effectiveness of group A and B in improving trunk stability, the test was carried out separately for both group A and B. For group A, total CV was 83.34 and for group B, total CV was 100.16. However, since the total CV of Group A < total CV of Group B which shows that Group A is more effective compared to Group B.

4. DISCUSSION

Most of the studies in 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. The present study aimed to evaluate and compare the effect of trunk PNF along with conventional therapy and NDT based on trunk protocol with conventional therapy to improve trunk stability in stroke patients. Trunk stability was chosen in this study because post-stroke, patients suffer from loss of trunk control due to loss of activity of trunk muscle. So patients suffer from severe balance problems which decreases the gait performance of the individual and leads to an increase in fall of risk. Various authors in their study also noted this. The study was conducted on 30 subjects in which, the subjects were randomly assigned and selected into 2 groups of A and B, each having 15 subjects. Group A received trunk PNF with conventional and group B NDT based on trunk protocol with conventional therapy. Both the groups were assessed to determine the trunk stability in stroke patients using TIS and trunk ROM (flexion and extension). All the interventions were given 5 times a week for 4 weeks in both groups. There were no dropouts and the subjects completed the treatment program with excellent adherence. After 4 weeks Post-test assessment was done by the two outcome measures TIS and trunk ROM (Flexion / Extension). The Trunk Impairment Scale is a reliable and valid tool that is used clinically to measure motor impairment in some patients having a stroke, Parkinson's disease²⁷. The trunk ROM is used to assess the amount and quality of movement in multiple planes of motion.²⁸ The mean age of the subject in group A was 56.53 ± 4.33 and the mean age of the subject in group B was 58.46 ± 5.09 . In group A, the pre-intervention mean TIS score was 7.6 ± 1.49 , which was increased to a post-intervention mean of 13.13 ± 1.70 which was statistically significant. In group B, the pre-intervention mean TIS score was 8.13 ± 1.35 , which was increased to a post-intervention mean of 12.46 ± 3.98 , and was statistically significant. It suggests that there was a significant improvement in trunk stability of both groups. In group A, the pre-intervention mean trunk ROM (lumbar flexion) score was 0.93 ± 0.65 , which was increased to post-intervention 3.26 ± 0.87 and the pre-intervention mean trunk ROM (lumbar extension) score was 0.7 ± 0.67 , which was increased to post-intervention 2.03 ± 0.93 which were statistically significant. In group B, the pre-intervention mean trunk ROM (lumbar flexion) score was 1.06 ± 0.65 , which was increased to post-intervention 2.4 ± 0.96 . the pre-intervention mean trunk ROM (lumbar extension) score was 0.3 ± 0.43 , which was increased to post-intervention 1.53 ± 0.46 which were

statistically significant. There was an increase in the score of trunk ROM (lumbar flexion/extension). It suggests that there was a significant improvement in trunk stability of both groups. The post-test results of TIS and trunk ROM (lumbar flexion and extension) in both group A and group B coefficients of the variable were performed. CV was performed to compare the effectiveness of groups A and B in improving trunk stability. The test was carried out separately for both groups. For group A, the total CV was 83.34 and for group B, total CV was 100.16. However, since the total CV of group A < total CV of group B which shows that group A is more effective compared to group B. Before the treatment intervention, it was found that the subject's trunk stability is poor because of loss of activation of trunk muscle and fear of falling. However, their trunk control level improved. After treatment, it has been found that trunk PNF with conventional therapy showed a significant improvement as compared to NDT based on trunk protocol along with conventional therapy. The PNF techniques that were used in this study i.e., rhythmic initiation, slow reversal and agonistic reversal might help to lengthen the contracted structures, normalized the tone, help in initiating the movements, strengthen the weak muscles, and help in improving the control of the trunk and pelvis. Hence, all these effects might directly or indirectly aid in improving the trunk control and balance. Hence, trunk PNF technique along with conventional therapy is a beneficial approach and can be used by clinician and therapist to improve trunk stability and balance in acute or sub-acute stroke patient. In this study the subjects were acute / sub acute stages, was well supported by the study done by Krishna et al²⁹, which they conducted a study to find out the effectiveness of trunk PNF to improve trunk control and balance. It shows patients with trunk impairment due to acute or chronic stroke may benefit from participation of trunk PNF. In this study the subjects were 30, it was well supported by Khanal et al³⁰, they conducted a study on the effectiveness of pelvic proprioceptive neuromuscular facilitation technique to improve trunk movement in 30 hemiplegic patients. The age of the subjects were 40-65 years which was similar to that of the population studied by Shanmuganath E. et al²⁶ in improving postural control in hemiplegic patients using upper trunk and lower trunk PNF. They were younger as compared to the population studied by other authors. Another study was done by Micheal et al⁴⁰ the age of the subjects were 45-60 years for improving sensation in post stroke patients using Butler Neuromobilization and PNF. However, this age group was chosen because stroke affects the productive period of

life (40 – 60 years) as said by Rayamajhi et al³¹. This present study is supported by Natália Norman 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.³⁵ 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.³⁶ The study of Dildip 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.³⁸ Jung et al. suggested that a trunk stability exercises by using PNF on trunk control ability, balance and gait in a patient with hemiplegia.³⁷ Wang et al. conducted study on the immediate effects of pelvic PNF in patients with hemiplegia of short duration and long duration. They found , subjects with hemiplegia of short duration demonstrated immediate improvements in gait speed and cadence after 1 PNF treatment but subjects with hemiplegia of long duration had no improvement after 1 treatment, but did improvement with repeated treatment.⁴¹ Vishal Sharma et al. conducted study on effect of core strengthening with pelvic PNF on trunk ,balance , gait and function in chronic stroke resulted that core stabilisation combine with pelvic PNF was more effective for improving trunk impairment , balance and gait of chronic stroke patients.⁴² 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 irradiation⁸. A study done by Deletis, et al. explained in detail about neuromuscular mechanisms. 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 is reflected in the motor evoked potentials⁸. 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.⁸ The subjects were treated with Bobath based trunk exercise (NDT based on trunk protocol) ; it was well supported by the study done by K. Muhammed et al³², the effects of Bobath –based trunk exercises on trunk control, functional capacity, balance and gait. It showed bobath based trunk exercises improve trunk performance, balance and walking ability in stroke patients more than do conventional exercise. It was also noted that hypertension was the main risk factor in causing stroke in this case. This is well supported by Magistris et al³³, who mentioned in their study that 'high blood pressure is a contributing factor in more than 12.7 million strokes annually worldwide'. Banerjee et al, khan et al³⁴, Rayamajhi et al³³ also supported the study by mentioning that 'hypertension was the most important risk factor in causing stroke'. It was also noted that before treatment patients suffering from stroke, trunk stability was poor because of loss of activation of trunk muscle but after treatment, improvement of trunk stability has been found ,it was well supported by Tamaya

Van Crielinge et al. which they conducted a study to find out the effectiveness of trunk training on trunk control, sitting and standing balance and mobility post-stroke. It showed trunk training improve trunk control, sitting and standing balance and mobility.⁴³ In this study, both the groups were assessed to determine the trunk stability in stroke patients using TIS and trunk ROM (flexion and extension). The Trunk Impairment Scale is a reliable and valid tool, it was well supported by Sinem Sag et al. which they conducted a study on assessing the validity and reliability of the Turkish version of the trunk Impairment Scale in stroke patients. From the study it was concluded that it has sufficient reliability, internal consistency and validity for use in clinical practice and stroke investigation.⁴⁴ The reliability of trunk or lumbar flexion and extension supported by R Williams et al conducted a study on reliability of the modified –modified Schober and double inclinometer methods for measuring lumbar flexion and extension. It showed that the modified schober method thus appears to be a reliable method for measuring lumbar flexion and extension.⁴⁵ Shind k et al ,which they conducted a study on the effectiveness of Trunk Proprioceptive Neuromuscular Facilitation Techniques to improve trunk control in 75 stroke patients . trunk impairment assessed with the Trunk impairment scale (TIS) in two studies showed statistically significant results. Trunk lateral flexion Range of Motion (TLF ROM) and Tinetti Test (TT) also showed statistically significant results.⁴⁰

5. CONCLUSION

The 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 in conclusion, group A subjects who received PNF technique showed a remarkable improvement in trunk stability as compared to group B subjects who received Trunk NDT.

6. LIMITATIONS

- The study consists of 30 subjects, which is a small sample size.
- There was no follow up to determine the long term effect of the treatment.
- The study does not have a proper limit in the consideration of acute and sub -acute stroke patients.
- There was gender variation in this study.
- Duration of the study was short

7. RECOMMENDATIONS

- The same study can be conducted with a large sample size.
- Future study can include trunk PNF Along with lower limb PNF it may be more beneficial.
- Follow up can be recommended.
- The same study can be done with same gender

8. AUTHORS CONTRIBUTION STATEMENT

Dr. Simi Hazarika (PT) and Dr.Pallabi Goswami (PT) conceptualized the study and the data. Dr. Simi Hazarika (PT) carried out the study and gathered the data concerning this work. Dr. Abhijit Kalita (PT), Dr. Abhijit Dutta , Dr.Pallabi

Goswami (PT) analyzed these data. and necessary inputs were given towards the designing of the manuscript. All authors discussed the methodology, results and contributed to the final manuscript.

9. CONFLICT OF INTEREST

Conflict of interest declared none.

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