"Comparison between effectiveness of Proprioceptive neuromuscular facilitation versus ballistic stretching for improving gait endurance in stroke"

Dr. Neelam Nimawat, Dhruvi Singh Deora

INTRODUCTION

Stroke is the third leading cause of disability worldwide. Cerebral stroke may result in several motor impairments including spasticity, weakness (spastic paresis) and contractures, Which impose significant challenges for patient care . Spasticity is one of the consequences of upper motor-neuron syndrome and is defined as a sensorimotor disorder implicated in some level of Involuntary muscle activation . Changes in mechanical Muscle-fiber properties such as loss of sarcomeres and enhanced Intrinsic stiffness in muscle fibers may contribute to increasing the muscle tone . Spasticity limits muscle lengthening, which may have 2 consequences [1]

- Spastic muscles have a tendency to stay in a shortened position, For longer periods;
- Voluntary activities of antagonist muscles are frequently Restricted [1]

Stroke is the major cause of disability. Disability associated with Hemiplegia or hemiparesis markedly limits the independent living and Social participation in at least half of all stroke survivors.[2]

A stroke is a medical condition in which poor blood flow to the brain causes cell death. There are two main types of stroke: ischemic, due to lack of blood flow, and hemorrhagic, due to bleeding. Both cause parts of the brain to stop functioning properly. [2]

Strokes can be classified into two major categories: ischemic and hemorrhagic[3]. Ischemic strokes are caused by interruption of the blood supply to the brain, while hemorrhagic strokes result from the rupture of a blood vessel or an abnormal vascular structure. About 87% of strokes are ischemic, the rest being hemorrhagic. Bleeding can develop inside areas of ischemia, a condition known as "hemorrhagic transformation." It is unknown how many hemorrhagic strokes actually start as ischemic strokes. [4]

Recovery Of motor function after stroke involves relearning motor skills and is mediated by neuroplasticity. Although many molecular signalling Pathways are involved, brain-derived neurotrophic factor (BDNF) has emerged as a key facilitator of neuroplasticity involved in Motor learning and rehabilitation after stroke. [2]

Recent research has Focused on developing rehabilitation strategies that facilitate such Neuroplasticity to maximize functional outcome post stroke. A variety Of neurologically based techniques are used by physical therapists in The treatment of hemiplegic patients. [5]

Proprioceptive Neuromuscular Facilitation (PNF) is a philosophy of Treatment based on principles of neurophysiology. Kabat[3,4] suggested that patterns of movements performed in combination with other Facilitatory procedures result in enhanced voluntary responses. [2]

PNF is a form of stretching that can boost your flexibility, range of motion (ROM), and strength. In particular, it can boost your passive range of motion (PROM) and active range of motion (AROM). [2]

The PNF approach to treatment uses the principle (based on early Phylogenetic and embryologic observations that control of motion Proceeds from proximal to distal body regions. Facilitation of trunk Control, therefore, is used to influence the extremities. [2]

Studies reported PNF intervention in subacute and chronic stroke.

PNF is a stretching technique utilized to increase ROM and flexibility. PNF increases ROM by increasing the length of the muscle and increasing neuromuscular efficiency. PNF stretching has been found to increase ROM in trained, as well as untrained, individuals. Effects can last 90 minutes or more after the stretching has been completed (Funk et al., 2003). The duration of these effects can vary because of various things, such as changes in the percentage of MVIC asked for and the duration of the contraction of the TM during PNF stretching (Feland and Marin, 2004; Rowlands et al., 2003). [3]

PNF stretching is usually performed with a 100% MVIC, which can possibly lead to of a contraction induced injury and/or muscle soreness. Lower percentages of MVIC might reduce these risks (Feland and Marin, 2004). This contraction has been proven to produce better effects when held a total of 3–10 seconds, while six seconds is preferred (Feland and Marin, 2004). It is necessary to know why six seconds is preferred and if there is any benefit to a longer or shorter contraction. There are also noticeable differences in ROM as a result of PNF found between genders and age groups (Etnyre and Lee, 1988; Feland et al., 2001). [5]

There is an increase in ROM and flexibility found regarding each variance, but to different degrees. Literature looking into each of these variations of PNF stretching, and just PNF stretching on ROM, are discussed further on. While there was a large amount of literature that solely looked at changes in ROM over time, or after one bout of PNF stretching, there was a limited amount found regarding the effects of the variations on ROM. This was also true in regard to the effects of PNF on athletic performance and muscular strength. Athletic performance was generally found to decrease when PNF stretching was performed before exercise, and increase when performed independent of exercise, or after exercise was completed (Marek et al., 2005; Mikolajec et al., 2012; Nelson et al., 1986). In general muscular strength has also been shown to increase due to PNF. [7]

The authors reported that traction, stretch reflex, irradiation, resistance and other proprioceptive input could influence A muscle response. PNF integrates the use of spiral and diagonal pattern specific of movements (with antagonist and agonist muscles) with procedures and superimposed techniques that induce the muscular contraction, relaxation and muscle strength.[2] PNF applies neurophysiological principle of sensory/motor system to manual evaluation and treatment of neuromuscular skeletal system. [7]

PNF is based on the principles of human anatomy and neurophysiology. Contracting a fully stretched muscle against resistance inhibits the stretch reflex and allows a muscle to stretch farther than it normally would. This may sound dangerous, and it can be, so it's important to follow the technique exactly and not force the stretch. But when done properly, proprioceptive neuromuscular facilitation allows an athlete to increase the range of motion around a joint. This is useful during rehab after an injury, as well is during post-workout deep stretching. [8]

PNF provides the therapist with an efficient mean for evaluating and treating neuromuscular and structural dysfunctions.

The purpose of completing a warm up and/or stretching is to prepare the body for upcoming demands of workouts or team practices. There are several different types of stretching techniques, each having their own advantage and disadvantages. For example, ballistic stretching can be used to maintain flexibility. [6]

Ballistic stretching is defined as "rapid lengthening of the muscle by use of jerking or bouncing movements" (Thacker, Gilchrist, Stroup & Dexter Kimsey, 2003, p. 372). One purpose of ballistic stretching is to activate the musculotendinous unit and stretch reflex allowing for the muscle to become stretched further during activity and increase force absorption (Scifers, 2011,p. 88). A variety of studies using dancers as their population found Ballistic stretching to be effective at increasing flexibility (Deighan, 2005, p. 13;Prentice, 2014, p. 115). This type of stretching technique is more commonly seen in sports that demand a larger range of motion such as dance and gymnastics. [6]

Ballistic stretching is meant to be used as a warm up before your workout and is often used by athletes.The goal is to stretch the muscle groups with quick movements past their natural full range of motion in order to help improve flexibility and enhance movement performance. [8]

It is intended for warming up instead of cooling down because the forceful stretching of the muscles can help you prepare for athletic activities, especially those that involve explosive movements.This technique is a type of passive stretching because an external force, or the momentum caused by your movement, provides a pull for the stretch. Ballistic stretching inhibits your stretch reflex, which is the body's natural defense mechanism from muscle strains and tears. For this reason, it is sometimes frowned upon due to the risk of injury, however there can be a time and a place for it. [9]

Walking dysfunction occurs at a very high prevalence in stroke survivors. Human walking is a phenomenon often taken for granted, but it is mediated by complicated neural control mechanisms. The automatic process includes the brainstem descending pathways and the intraspinal locomotor network. Stroke leads to damage to motor cortices and their descending cortico-spinal tracts and subsequent muscle weakness. On the other hand, brainstem descending pathways and the intraspinal motor network are disinhibited and become hyper-excitable. The wide range and hierarchy of post-stroke hemiplegic gait impairments is a reflection of mechanical consequences of muscle weakness, spasticity, abnormal synergistic activation and their interactions . [10]

Walking is a common goal after stroke, and manystroke survivors attain some ability to walk in the monthsafter onset .Walking ability, however, is markedlycompromised. The vast majority of stroke survivors whoregain walking ability in the months following stroke failto achieve the normal walking speed of 1.2 m/s, the speeddemonstrated by healthy elderly adults . Decreasedendurance also contributes to compromised functionalwalking after stroke. It has been demonstrated that'stroke survivors are not physically fit, and this affectstheir functional abilities . If interventions for thosepoststroke are to include endurance training, a clinicalmeasure of fitness is necessary. Recently, it has been sug-gested that the 6-minute walk test be used as a clinicalmeasure of cardiovascular endurance for adults withstroke .

The 6-minute walk test requires a subject to walk asfar as he or she can in 6 minutes, with rests as needed.This test is particularly appealing for clinicians, becauseit is relatively quick and easy to implement and can becompleted by many patients. A suggestion has beenmade that the 6-minute walk test is a measure of condi-tioning and that performance is hampered by the pres-ence of cardiac, respiratory, or peripheral circulationpathology .

The purpose of the present study was to assess whichstroke-related physical impairments influence functionalwalking endurance as measured by the 6-minute walktest. We hypothesized that measures of lower-limb motorfunction, lower-limb sensory function, and balancewould be powerful modifiers in predicting 6-minute walkdistance. A second purpose of this study was to evaluateif, in the presence of existing mobility impairments, the6-minute walk test did stress the cardiovascular system

The Functional Independence Measure (FIM) is one of the most widely used, valid and reliable instruments for collecting observational data on the patients' degree of self reliance in various areas of everyday life. The Functional Independence Measure (FIM) was introduced several years ago at the Rehabilitation Centre of the Medical Clinic, Buerger Hospital Solothurn, Switzerland, to assess the outcome of the rehabilitation. In measuring patients' functional independence on admission and discharge we were able to monitor any significant changes and improvements in different areas of everyday life and in various diagnostic groups of patients.

The Functional Independence Measure (FIM) has been used in several studies related to ADL. Evaluating item-level FIM scores is crucial when applying treatment regimens to individual patients. However, previous studies using Rasch analysis have demonstrated the relative difficulty of item-level FIM assessment. Koyama et al.8) investigated variability in the performance profiles of motor items by applying ordinal logistic modeling analysis using the FIM-motor score as the independent variable and the independence levels of single motor items as the dependent variables. Based on their study, clinicians can now assess which of the motor items should receive more intensive training as per the patient's FIM-motor score.

METHODOLOGY

It is a comparative study in which 30 patients with stroke for improving gait endurance were randomly selected. All patients have participated in the study after voluntarily signing the consent form.Duration of the study **is** 12 weeks (30 minutes per day , 5 days in a week)

OUTCOME MEASURES :

1. 6 Minute walk test (6MWT)
2. Functional independence measure locomotor (FIMT)

INCLUSIVE CRITERIA :

1. Both Male and Female patients
2. Age 35-65 years
3. Diagnosed with Stroke

EXCLUSIVE CRITERIA :

1. Infections
2. Epilepsy
3. Edema in lower extremities
4. Ankle joint instability

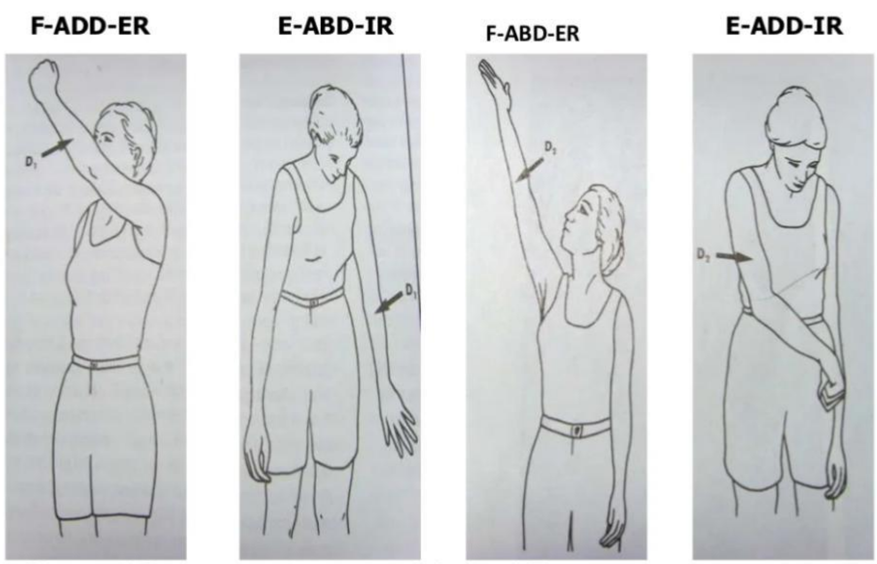
PROCEDURE

After collecting the consent form from the patients selected by inclusive and exclusive criteria they were divided into two groups. Group A and Group B.

Group A were treated with Proprioceptive neuromuscular facilitation PNF patterns for improving gait endurance in stroke.
Each pattern have 3 dimensions

1. Flexion and extension
2. Abduction and adduction
3. Rotation
   Movement occurs in straight line, in a diagonal direction with a rotary component.

Upper Extremities



Diagonal One Diagonal Two

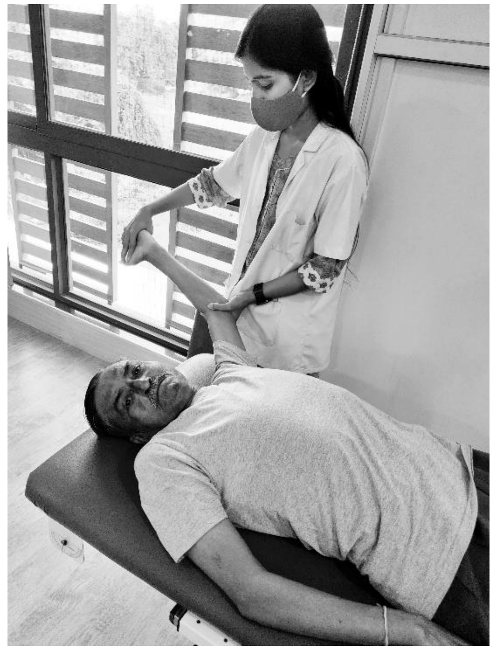
D 1 FLEXION

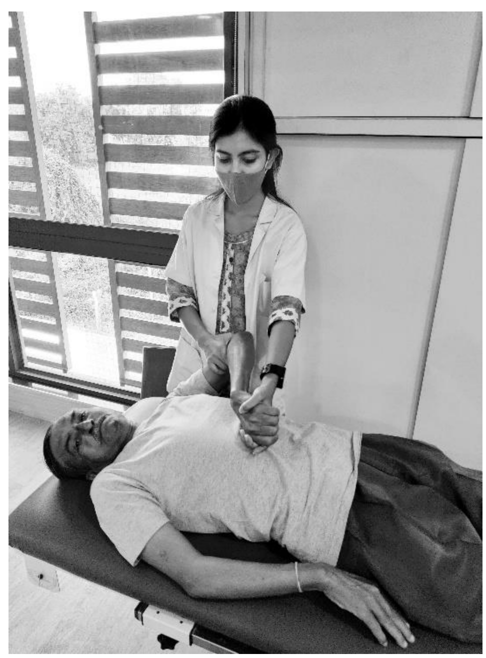
D 1 EXTENSION

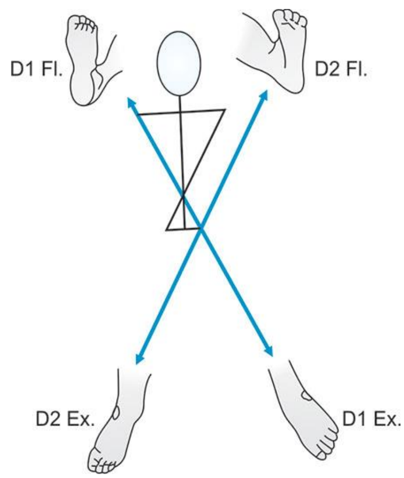
D 2 FLEXION



D 2 EXTENSION



Lower Extremities



1. D-1 Flexion – Dorsiflexion
   Supination
   Inversion
   Toe extension

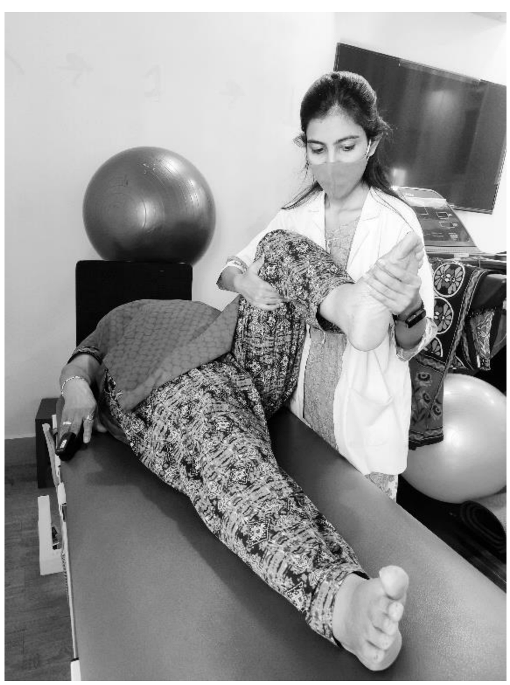
2. D-2 Flexion – Dorsiflexion
   Pronation
   Eversion.
   Toe extension

3. D-1 Extension –Plantar flexion
   Supination
   Inversion
   Toe flexion

4. D-2 Extension – Plantar flexion
   Pronation
   Eversion
   Toe flexion

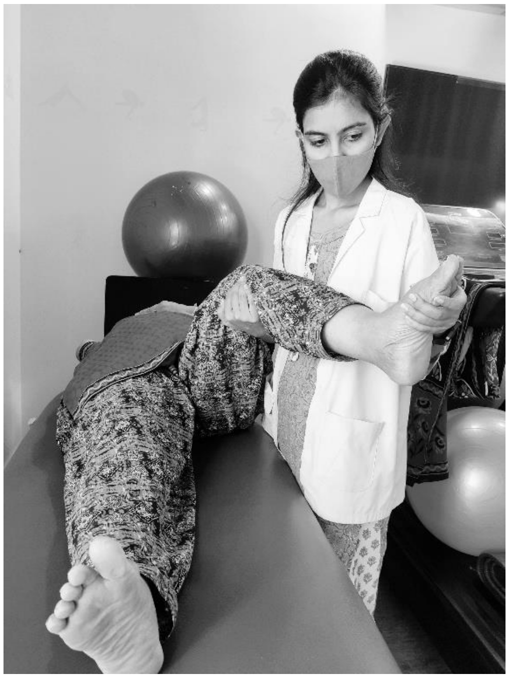
D 1 FLEXION

D 1 EXTENSION



D 2 FLEXION

D 2 EXTENSION



TECHNIQUES OF PNF

- Contract relax
- Hold relax
- Hold relax contract
- Contract -relax- antagonist -contract

CONTRACT-RELAX

- Patient muscle is placed in a passive stretch.
- Therapist isometrically contract the muscle that's being passively stretched for 5 to 15 seconds.
- Relax the muscle for 20 seconds.

HOLD RELAX

- Patient muscle is placed in a passive stretch.
- Therapist applies isometric pressure and ask to hold the position for 5-10 seconds.

HOLD RELAX CONTRACT

- Patient muscle is placed in a passive stretch.
- Therapist isometrically contract the muscle that's being passively stretched for 7 to 15 seconds.
- Before relaxing the muscle, flexion is applied to a targeted muscle for 5 seconds.

CONTRACT RELAX ANTAGONIST CONTRACT

- Patient muscle is in a passive stretch.
- Therapist holds the muscle that's being stretched in an isometric contraction for 7 to 15 seconds.
- Relax the muscle while performing an isometric contraction on its antagonist. Hold for 7 to 15 seconds.
- Relax the muscle for 20 seconds.

Group B is treated with Ballistic stretching

Ballistic stretching is a warm-up stretch method that involves quick and sudden movements to increase flexibility. It is mainly used to increase muscle power and range of motion.

BALLISTIC STRETCHING EXERCISES

STANDING TOE STRETCH :

- Make patient stand in a natural position with feet hip-width apart.
- Move hips slightly back and slide arms down thighs and shins, toward feet.
- Keeping back straight, lower to the point of mild discomfort.
- Hold the position for 30 seconds.
- Repeat the stretch 3 times.

SITTING TOE STRETCH :

- Make patient in a seated position with legs extended in front and point toes towards the ceiling without bending knees.
- Stiffen abdominal muscles to stabilize spine, then gently exhale and slowly bend forward from hips, sliding hands down legs towards ankles.
- Continue to bend and reach forward. Hold this position for 15 – 30 seconds, then relax by returning to starting position and repeat 2-4 times.

SWINGING EXERCISES FOR LEGS :

- Patient stand sideways and keep an arm's distance from the wall.
- Patient puts the body weight on the left leg and keep the right palm on the wall to maintain balance.
- Then, swing the right leg forward and backward for several rounds.
- Repeat with other leg.

SWINGING EXERCISES FOR ARM :

- Patient stand with both legs slightly bent.
- The feet should be hip-width apart.
- Keep the back is straight. And swing both the arms on the sides.
- Then cross them in front.


SHOULDER ROTATIONS :

- Patient stands in an upright posture and extend both the arms to the sides and straighten them.
- The palms should face the roof and elbows should be a little flexed.
- Flex the shoulders to move the arms behind repeatedly.

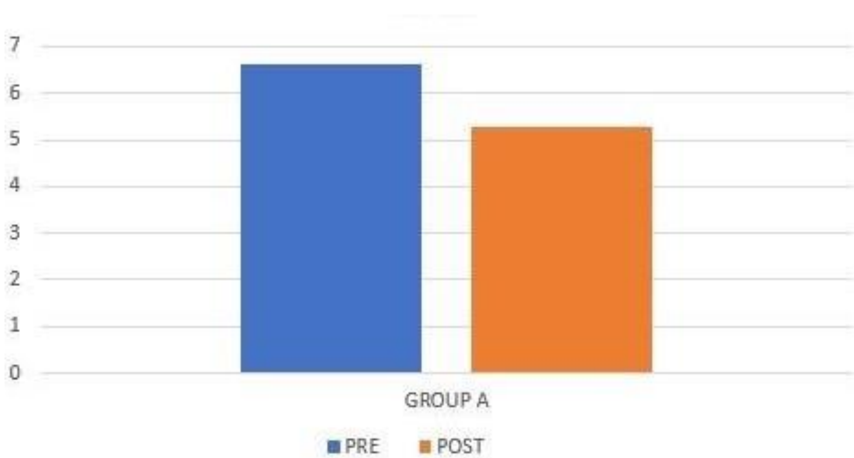

DATA ANALYSIS

Mean, Standard Deviation, paired t test and independent t test performed for analysis of pre and post data evaluation within and between groups.

Table: 1 Comparison of pre and post test values of 6 MWT scores in Group A and Group B

6MWT	GROUP-A			GROUP-B		
	MEAN	SD	PVALUE	MEAN	SD	PVALUE
PRE	6.9333	0.79881	P<0.05	7.9333	0.70373	P<0.05
POST	5.2667	0.70373		4.2	0.7746	

6MWT



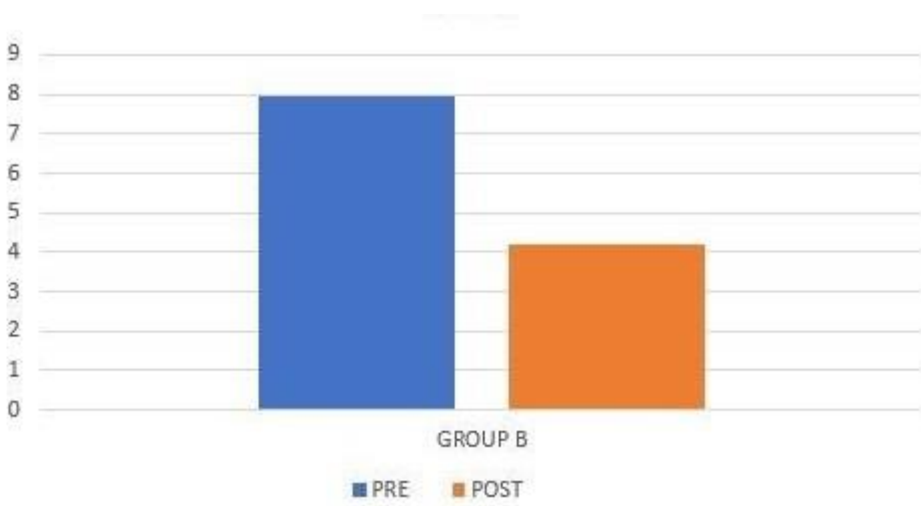
Graph 1: Showing the Pre-test and Post test differences in 6 MWT Scores in Group A

INTERPRETATION: The above table shows the Mean of Pre Test and Post test values were 6.933 and 5.2667 . the mean improvement in group A was 1.6667 . p value are <0.05.

Table: 2 comparison of Pre and Post test values Functional independence measure locomotor (FIMT) Group A and Group B

	GROUP-A			GROUP-B		
FIMT	**MEAN**	**SD**	**P VALUE**	**MEAN**	**SD**	**P VALUE**
PRE	18.6667	1.63299	p<0.05	20.0667	1.38701	p<0.05
POST	11.4667	2.13363		9.0001	1.60357	

Graph 2: Showing the Pre-test and Post test differences In 6 MWT in Group B



6 MWT

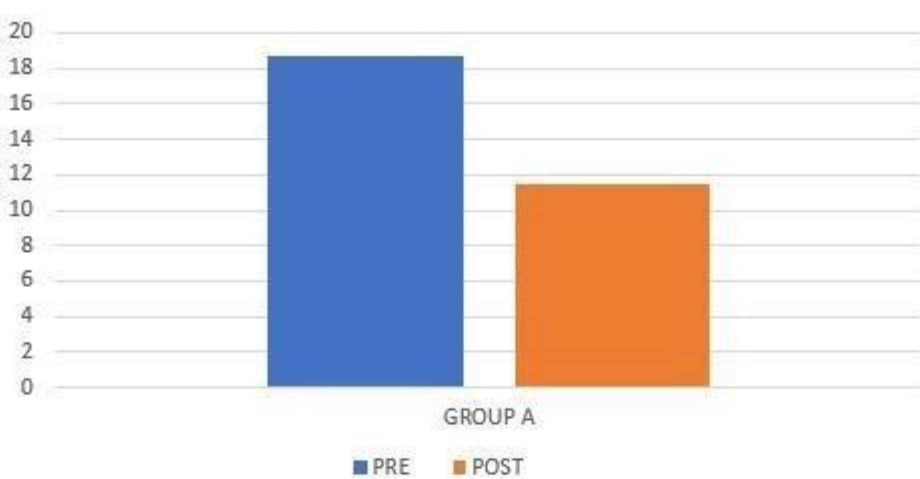
INTERPRETATION : The above table shows the Mean of Pre Test and Post test values were 7.93333 and 4.2000 . the mean improvement in group A was 3.73333 . p value are<0.05 .

Table:3 Comparison of pre and post test differences in 6 MWT scores in Group A and Group B

			Paired Differences				
6MWT		Mean	Std.Deviation	Error Mean	T value	P value	
Group 1	Pre - post	1.66667	.89974	.23231		p <0.05	
Group 2	Pre - post	3.73333	.96115	.24817	1.765	P <0.05	

Graph: 3 Showing the Pre-test and Post-test differences in Functional independence measure locomotore (FIMT) in Group A

FIMT



INTERPRETATION: The above table shows the Mean of Pre Test and Post test values were 18.6667 and 11.4667 . the mean improvement in group A was 7.20000 . p value are <0.05

Table:4 Comparison of pre and post-test differences Functional independence measure locomotor (FIMT) in scores in Group A and Group B

FIMT	Paired Differences				P value
	Mean	Std. Deviation	Std. Error Mean		
GROUP-A PRE-POST	7.20000	3 00476	.77583		P<0.05
GROUP-B PRE-POST	11.06667	1.83095	0.47275		

Graph: 4 Showing the Pre-test and Post-test differences in Morris disability questionnaire in Group B

INTERPRETATION: The above table shows the Mean of Pre Test and Post test values were 20.0667 and 9.0001 . the mean improvement in group A was 11.06667. p value are <0.05

RESULTS

A between-group analysis showed significant differences in the group A with Compared to the Group B for both Six Minute Walk Test and Functional independence measure locomotore (FIMT). The mean difference of both group are for group A 7.20000 and for group B 11.06667 standard deviation are for group A 3.00476 for group B 1.83095 $P<0.05$

DISCUSSIONS

The present study was conducted to find out comparison between Proprioceptive Neuromuscular Facilitation Versus Ballistic stretching for improving gait endurance in Stroke patients.

This study was conducted on 30 subjects with age Group of 35 – 65 years and were divided into two groups. Group A was treated with Proprioceptive Neuromuscular Facilitation techniques and Group B was treated with Ballistic stretching. Pre and post test scores were taken on the basis of 6 MWT and Functional independence measure locomotore scale.

The result of the study are more positive towards the physiotherapy intervention in this Study, stroke patients treated with proprioceptive Neuromuscular Facilitation have more effective physiotherapy then ballistic stretching.

Significant improvements occurred in most of the measures that were recorded before and after training program. The values of pre-test and post-test were compared by the mean difference. From the data analysis group A were considered to be beneficial in improving gait endurance. Group A (Proprioceptive Neuromuscular Facilitation technique) significantly shows more improvement than Group B (Ballistic stretching)

Also there is Functional independence measure locomotore questionnaire method in which there are 18 question asked to the patient before and after the exercises in which the significance level of Proprioceptive Neuromuscular Facilitation techniques was $P<0.05$ and and with ballistic stretching was $p<0.05$ the mean difference in both groups are for pre analyzing value 18.6667 and post analyzing value 11.06667 in which the Proprioceptive Neuromuscular Facilitation techniques based group are more significant then ballistic stretching based group.

CONCLUSION

A comparative study was conducted to investigate the effectiveness of Proprioceptive Neuromuscular Facilitation versus Ballistic stretching in improving gait endurance in Stroke patients using Six minute walk test and functional independence measure locomotore scale.
According to the statistical analysis the study shows that there is significant improvement in gait endurance in Stroke patients by Proprioceptive Neuromuscular Facilitation techniques rather then ballistic stretching.
While comparing both the techniques, there is significant difference present in between the groups.
So, Group A Proprioceptive Neuromuscular facilitation techniques is more effective for enhancing gait endurance in Stroke patients.

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