

Effectiveness of Proprioceptive Neuromuscular Facilitation Technique along with the Therapeutic Electrical Stimulation Protocol in Subjects with Foot Drop - An Experimental Study

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Abstract: *Background: Foot drop is the result of sensory and motor impairment in the stroke patients. Treatment of foot drop patient is muscle stimulation along with exercise and gave beneficial result. PNF is also having evidences of improvement in sensory motor impairment. Combination of these two treatments gives remarkable result on patients.*

Keywords: Tibialis anterior, Foot drop, PNF, Electrical stimulation

1. Introduction

In recent years, the people are mostly exposed to things like smoking, alcohol, tobacco and drugs. There is also an increase in the stress level among people. All these things have contributed increase in the risk and probability of stroke. Patients mobility is often affected due to motor and sensory impairments.

Foot drop is a widespread and difficult problem that can lead to falls and injury. Although the most frequent cause is peroneal neuropathy other cause includes anterior horn cell disease.¹

Contralateral hemiplegia is a result of damage to the motor cortex or corticospinal tract often with significant persistent distal weakness, that affects the swing phase in the gait which makes the patients unable to actively dorsiflex the foot during the swing phase of gait, which is referred to as drop foot. Due to motor impairment gait variations results in compensatory movement patterns, slowed gait velocity, limited functional mobility, and increased risk of falls.^{2,3,4}

In stroke survivors mobility of the ankle joint is affected due to spasticity and/or contractures.⁵ The Tibialis Anterior muscle failure apparently known as “foot drop,” and more found in patients of stroke.⁶

Proprioceptive neuromuscular facilitation (PNF) is a technique that involves the nerves and the muscles that are related to the sensory receptors that gives information concerning movement and position of the body making the movement easier.⁷

Proprioceptive neuromuscular facilitation (PNF) stretching techniques are commonly used in the clinical setting to improve both active and passive range of motion (ROM) with a view to enhance performance and rehabilitation. PNF

stretching is to be found the most effective technique in the literature for the improvement of ROM with the target to achieve ROM in respect to short-term changes.⁸ Proprioceptive neuromuscular facilitation (PNF) treatment is a very effective therapeutic exercise for the improvement of muscle thickness, dynamic balance, and gait^{9,10}, and widely used in clinical settings to improve the physical functioning of stroke patients.

Along with PNF and conventional physiotherapy treatment, functional electrical stimulation is proven to give better results in the stroke patients with foot drop, as it is an alternative to this. Electrical stimulators (ES) use to stimulate the common peroneal nerve, which is activating the muscles that dorsiflex the foot.¹¹

The use of electrical stimulation of muscle to restore contractile properties following disuse has advantages of ease of application.¹² The ankle dorsiflexors include Tibialis anterior, Extensor hallucis longus, Extensor digitorum longus muscles. The tibialis anterior muscle contributes more towards the movement, hence being the major component among the 4 muscles. The present study were therefore to characterise the changes in the contractile properties and the morphological and histochemical profiles of the tibialis anterior muscle.¹³ The tibialis anterior muscle was selected for its superficial position, allowing ease of stimulation by surface electrodes.¹⁴

The basic facilitation procedure provides the tools for the therapist to help the patient gaining efficient motor function. Verbal instructions and visual information helps the therapist to get maximum active cooperation. In the cases with chronic stroke, the range of motion or the achieved performance in general is not adequate if compared to the patient intention, desire or psychical effort during the exercise.¹⁵

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(i) instant improvement of motor response, (ii) steady and marked progress of the health condition achieved with assistance of functional electrical stimulation.¹⁵ Hence the present study is to find out the effectiveness of PNF along with electrical stimulation to improve the gait pattern, ROM, strength, and posture in the patients with foot drop after chronic stroke. The need of the study is to conduct combine treatment of PNF and electrical stimulation in foot drop patient

2. Review of Literature

- 1) Alexander C. Geurts, Vivian Woerodesteyn- 2012 conducted a study on “Effect of peroneal ES versus on AFO on obstacles avoidance Ability in people with stroke related foot drop on 24 individual with stroke to identify the potential benefits of peroneal functional ES over an AFO and they concluded that peroneal FES seems to be an AFO and is clinically most relevant in the people with relatively low leg muscle strength.
- 2) Katie M. Willkie, Janes E Shiels, Dr, Cathe Bulley, Dr. Lisa G. Salisbury-2011. conducted a study on, functional electrical stimulation impacted on important aspect of my life – a qualitative exploration of chronic stroke patient and carers perception of functional electrical stimulation in the management of dropped foot on 13patient and 9 carers and they concluded that functional electrical stimulation is effective for the management of the dropped foot after stroke.
- 3) Carolina S. Nakada, Paula C. Meningroni and Joao Eduardo de Araujo conducted a study on, “IpsilateraL proprioceptive neuromuscular facilitation patterns improve over flow and reduce stroke foot in patient with demyelinating neuropathy”. In 13 patients Charcot marie tooth diseases after ipsilateral PNF pattern. Concluded that ipsilateral PNF pattern selectively produce tibialis anterior muscle over flow in polyneuropathy patients and can be successfully used as a supportive therapy for foot drop
- 4) Gui Bin Song- 2015, conducted a study on “approach of proprioceptive neuromuscular facilitation on foot drop and crossing obstacles in stroke patient “. On 57 years old male with left hemiplegia. He concluded that use of proprioceptive neuromuscular Facilitation technique is beneficial to reduce the number on foot drop episodes while walking and to improve the ability to cross obstacles in stroke patient.
- 5) Roger M. Nelson, Gary C, Hunt- 1981, conducted a study on strength duration curve: intrarater and interrater reliability and tibialis anterior muscle Was tested in 24 healthy men and concluded that a normalized SD Curve with 95% confidence limits at each plse duration would be more accurate method then conventional method from which to judge changes in the shape of curve for the patient suspected of neuromuscular pulse

3. Methodology

Conventional electrical stimulation was used with Pulse width: 50 to 450 μ s and Total duration: 2.5 hrs /week.¹⁷ Resistance exercise: during dorsiflexion of the foot that will facilitate the contraction ability of the muscle and apply resistance to the dorsum of the foot to resist dorsiflexion.

Diagonal 1: D1Flx: Dorsiflexion and inversion, Diagonal 2: D2Flx: Dorsiflexion and eversion and Mild stretching of tibialis anterior muscle that will stimulate activity of muscle spindle

Outcomes Measurement

Range of motion was measured with goniometer for the enrollment of the participants in the study for that participants were in high sitting position and were asked to move foot inside. MMT was measured to check the muscle power of dorsiflexor muscle, person was in supine position and was asked to dorsiflex the foot .SD Curve was taken for checking the strength of the muscle for those participants was in supine position and intensity was gradually increased till the visible contraction of muscle

Procedures and Data Collection

This research was approved by ethical committee of Nootan College of Physiotherapy Sankalchand Patel University, Visnagar. Participants were selected on the basis of criteria. They were educated about the study and after their permit and written consent the participants were enrolled in the study. With the measurement of MMT, ROM, SD Curve and gait pattern according to that patients of foot drop were taken in the experimental group, Patient was in supine position, therapist stands beside the patient, Manual Resistance exercise was given for dorsiflexors after that with PNF diagonal patterns D1 & D2 reexamination was done (every 15 days)

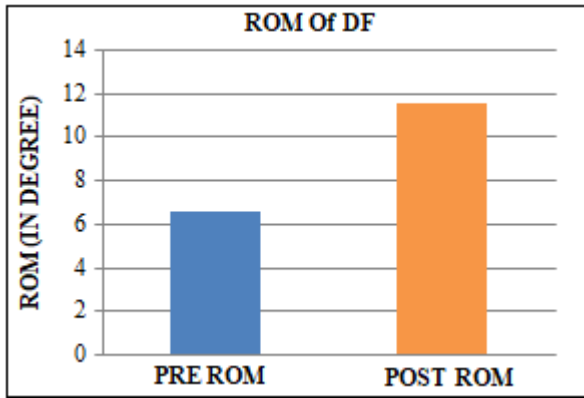


Figure 5.5.1: PNF-stretching

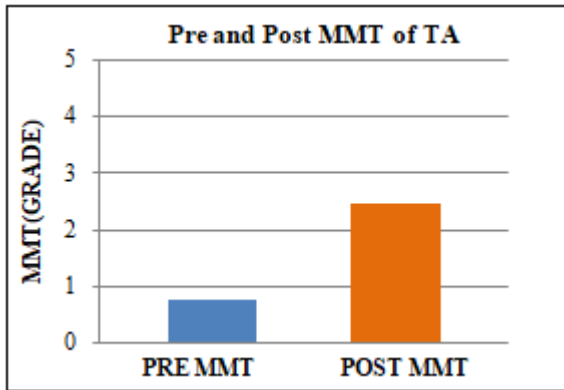


Figure 5.5.2: Electrical stimulation on the belly of tibialis anterior muscle

4. Result



Graph 6.1: Group A & B Pre Post ROM



Graph 6.2: Group A & B Pre Post MMT

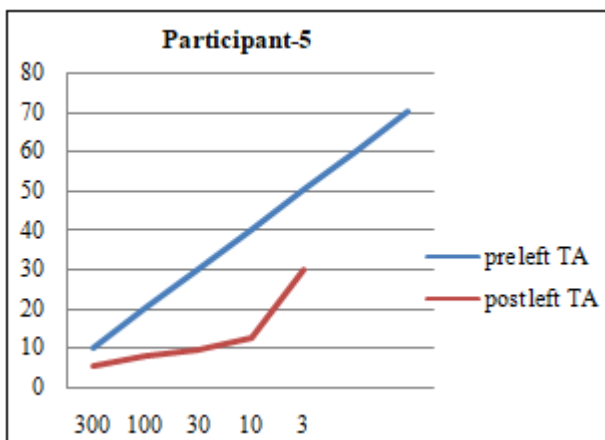
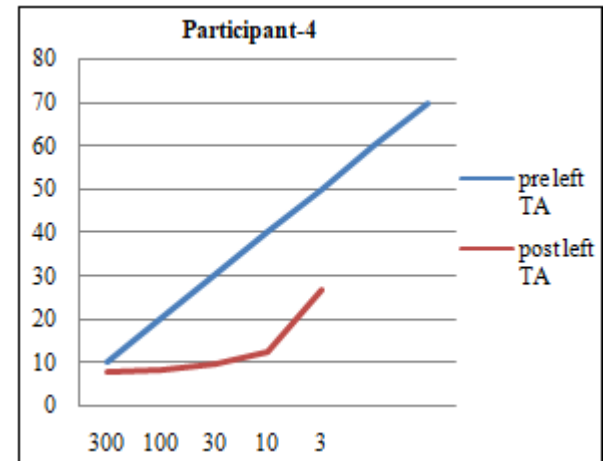
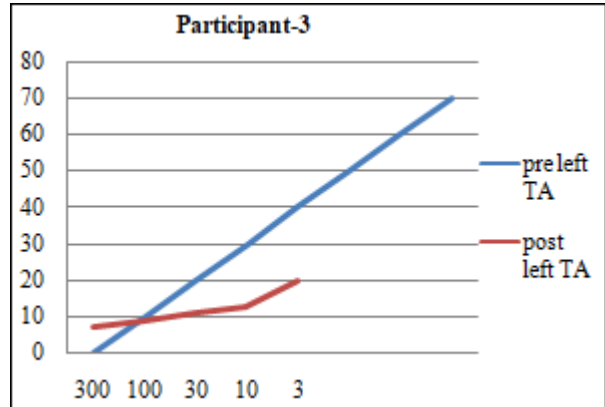
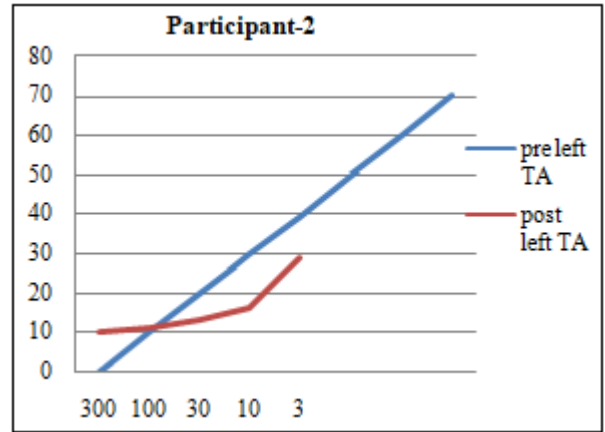
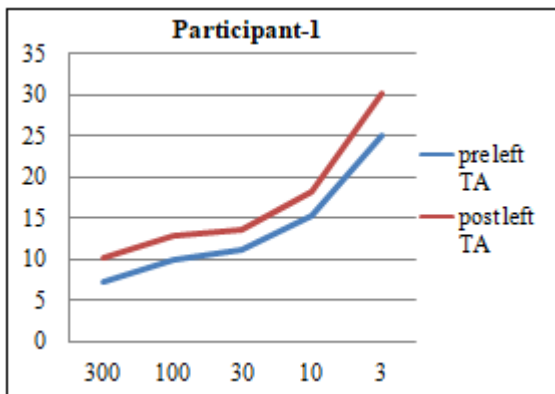
Table 6.1: Pre & Post ROM

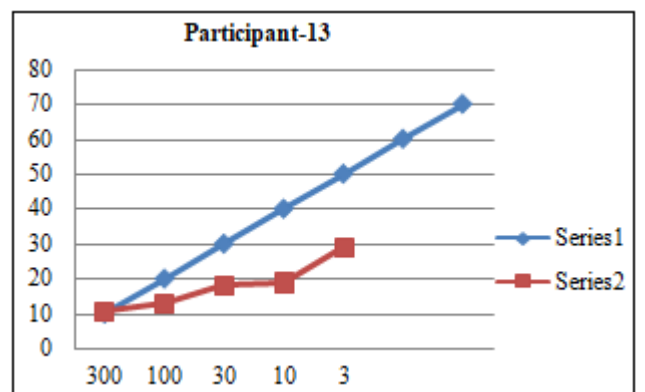
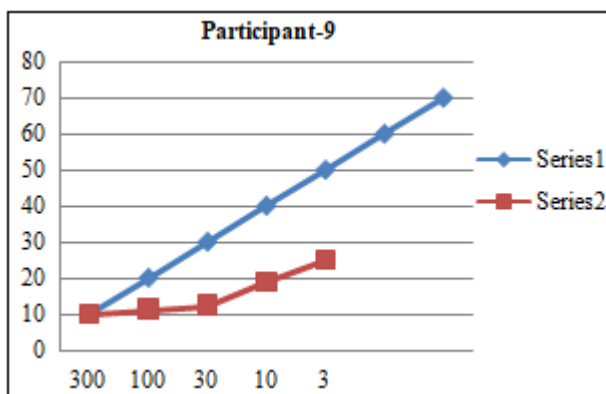
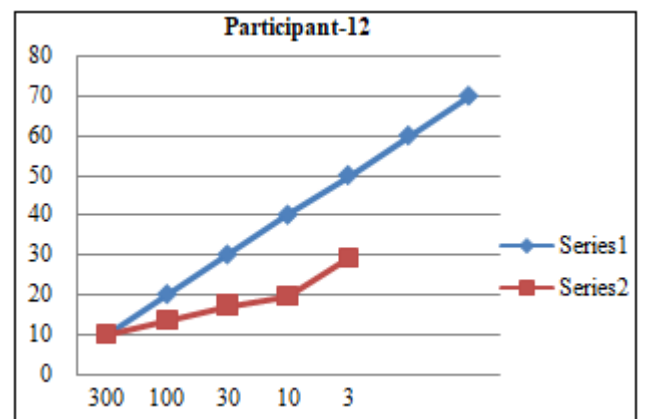
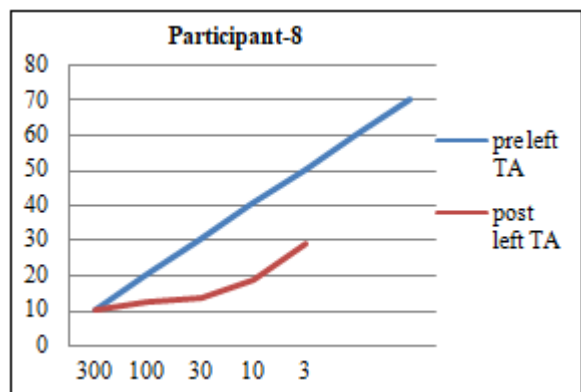
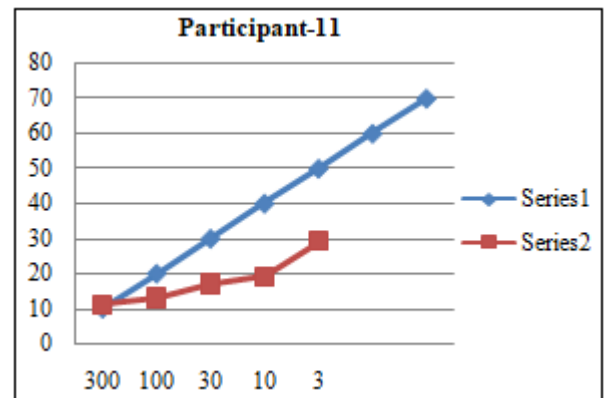
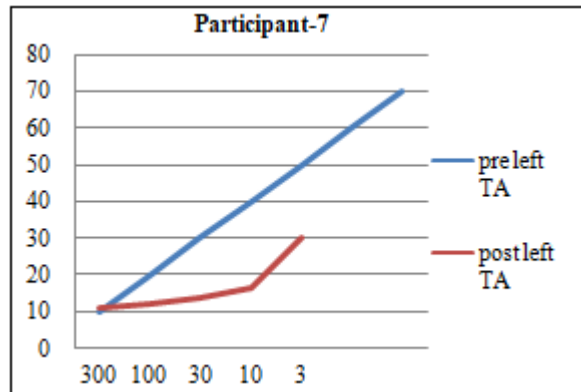
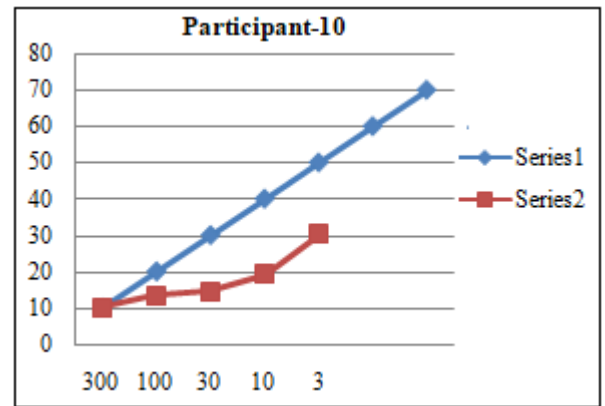
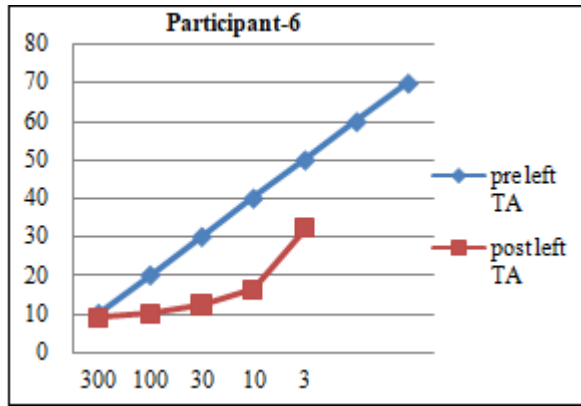
N=20	Mean	Std. deviation	t-value	p-value
PRE	6.5	2.16	-11.973	.000
POST	11.5	2.06		

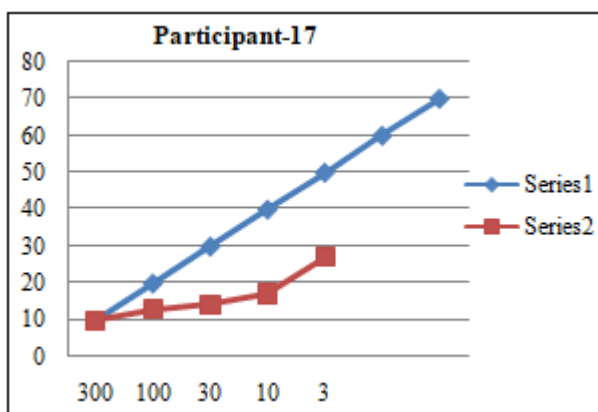
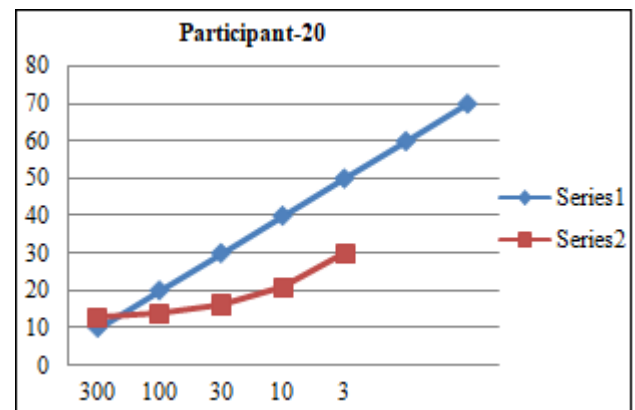
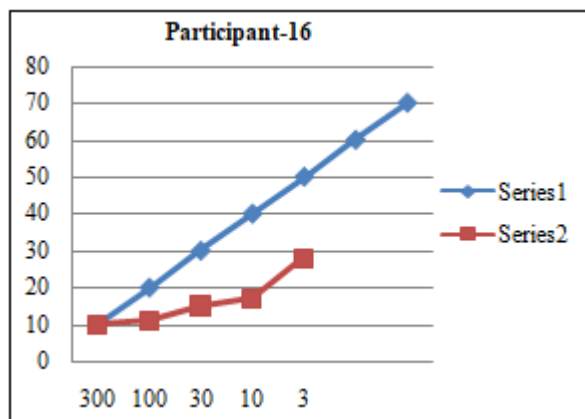
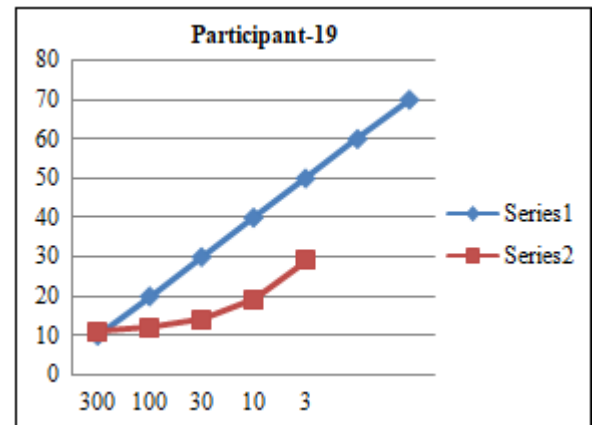
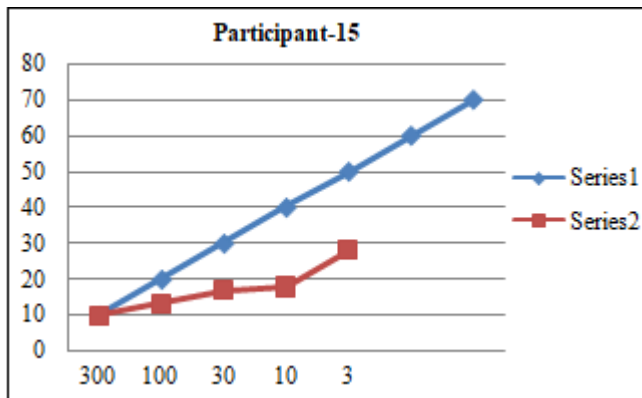
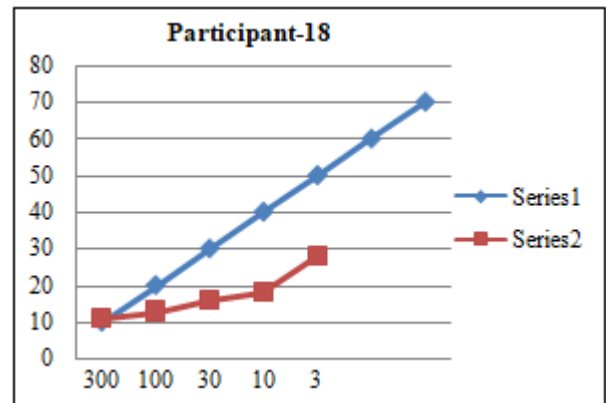
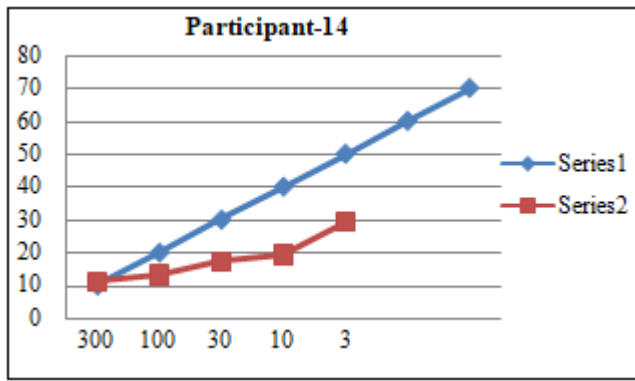
Table 6.2: Pre & Post MMT

N=20	Mean	Std. deviation	t-value	p-value
PRE	.75	.44	-10.376	.000
POST	2.45	.60		

Graphical Presentation of SD Curve







Total 20 participants were selected in this study, data analysis of all 20 participants has been carried out and all the test and data showed significant differences in pre and post outcomes. The p value was justified <0.01 for all the post treatment data. The study revealed that treatment with PNF and electrical stimulation showed significant result in ROM of ankle joint, MMT of tibialis anterior and SD Curve showed improvement in the graphical presentation.

5. Discussion

The study was concluded to know the combined effect of PNF techniques and the conventional electrical stimulation on the patients of foot drop after stroke. The 20 participants were selected on the basis of inclusion and exclusion criteria and were assessed with ROM, MMT, SD Curve and gait pattern.

This study is unique and gives the introduction of PNF Technique and electrical stimulation as many researchers

have conducted the researches in electrical stimulation but very few researches are in evidence of electrical stimulation and PNF. We get the significant improvement in this study with increased muscle power in patients with PNF and electrical stimulation.

According to Gui-Bin to the use of PNF treatments is completely beneficial to reduce the number of foot drop episodes with improving gait pattern obstacles in stroke patients¹⁸.

According to. Zhihao Zhou, Yuan Zhou, Ninghua Wang, Fan Gao, Kunlin Wei, Qining Wang, PNF integrated robotic ankle-foot rehabilitation system which is effective in improving ankle mobility¹⁹

According to Kim SM, Kim YM both lower extremities proprioceptive neuromuscular facilitation training with functional electrical stimulation had positive effects on the balance and gait of stroke patients²⁰

According to Pasiut, S., Banach, M., Longawa, K. and Windak, F Proprioceptive Neuromuscular Facilitation (PNF) is considered to be especially effective rehabilitation method based on neuro-physiological mechanisms²¹

6. Conclusion

PNF technique along with electrical muscle stimulation is effective in foot drop for improvement in ROM of dorsiflexion and muscle power of tibialis anterior.

7. Limitations of the Study

- Small sample size
- An only Selected sample in Visnagar

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