

## A Randomized Controlled Trial to Study the Efficacy of Transcutaneous Electrical Nerve Stimulation in Reducing Spasticity of Plantar Flexors in Hemiplegic Patients



### Physiotherapy

**KEYWORDS :** Stroke, TENS, passive stretching, spasticity

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### ABSTRACT

*Stroke is the third leading cause of death and most common cause of disability among adults. Many of the limitations caused by stroke are related to spasticity. The aim of the study was to evaluate the effect of transcutaneous electrical nerve stimulation (TENS) in reducing spasticity of plantar flexors in hemiplegic patients. 30 patients based on inclusion and exclusion criteria were selected from the OPD of University College of Physiotherapy, Faridkot. Patients were equally divided into two groups based on randomisation Group A (n=15) and Group B (n=15). Patients in Group A (Experimental Group) received TENS along with passive stretching and conventional physiotherapy. Patients in Group B (Control Group) received passive stretching conventional physiotherapy. Duration of treatment was 6 weeks with treatment session for 6 days a week. Outcome Measures were Modified Ashworth Scale and Range of motion.*

*Both the groups showed reduction in spasticity of plantar flexors, improvement in ankle dorsiflexion and plantar flexion ROM of post stroke hemiplegic patients (p<0.05). Between groups analysis showed that experimental group demonstrated more significant improvement in spasticity. Thus the study concluded that TENS along with passive stretching is effective in reducing spasticity and increase ROM in post stroke hemiplegic patients.*

### Introduction

Stroke is an acute onset of neurological dysfunction due to an abnormality in the cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal areas of the brain. Hence it is commonly called as cerebrovascular accident. It is characterized as an interruption of the blood supply to the brain or haemorrhage into the brain tissue, commonly involving a disruption in the motor, somatosensory, visual, speech, perceptual, cognitive, bowel and bladder dysfunction. This leads to altered muscle tone, muscle weakness and abnormal movement patterns which consequently limit the ability to perform functional activities such as walking, climbing stairs and self-care (1, 2).

Many of the limitations caused by stroke are related to spasticity. Spasticity has been defined as "a motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks, resulting from hyper excitability of the stretch reflex, as one component of the upper motor neuron (UMN) syndrome (3) Most common symptoms among post-stroke patients associated with spastic paralysis are painful muscle spasms, a series of involuntary rhythmic contractions and relaxations leading to jerking clonus, hyper excitable reflexes, hypertonia and stiffness in the arms, legs or fingers. Spasticity develops when an imbalance occurs in the excitatory and inhibitory input to alpha motor neurons caused by damage to the spinal cord or central nervous system. The damage causes a change in the balance of signals between the nervous system and the muscles, leading to increased excitability in the muscles. The hyperexcitability reflex in stroke patients interferes with motor function. This causes restricted and compromised movement control, limitations in standard functional movement. (4,5). Prolonged spasticity may be accompanied by structural changes of muscle fibres and connective tissue(6, 7, 8). Many therapeutic interventions have been used to manage spasticity following stroke including physical therapy such as passive stretching, transcutaneous electrical nerve stimulation, neuromuscular electrical stimulation, splinting, positional devices oral medication and surgical intervention (4,7,9).

Transcutaneous electrical nerve stimulation (TENS) is the most commonly used noninvasive treatment method in physical therapy. Possible mechanisms could be partly attributable to an enhancement of presynaptic inhibition of the hyperactive stretch

reflexes in spastic muscles, disinhibition of descending voluntary commands to the motor neurons of the paretic muscles, and decrease in co-contraction of the spastic antagonist. TENS stimulation at two to three times the sensory threshold produces vibrations in stimulated muscles and surrounding regions. Moreover, the rapid stimulation of vibration triggers primary afferent neurons and increases the release of acetylcholine, a major neurotransmitter in the context of muscle contraction. However, prolonged stimulation may reduce muscle contraction by lowering the excitability of homonymous motor neurons by depleting acetyl-choline, as occurs during muscle fatigue (9,10).

Passive stretching is another method being followed to reduce spasticity. Passive stretching is an effective treatment options for contraction, spasticity, stretch reflex, maximum voluntary contraction, joint stiffness and gait. The positive impact of passive stretching on muscle fascicles has been attributed to a chain of protein-protein interactions leading ultimately to myofibrillogenesis (8).

Thixotropic property of muscle is changed after passive stretching. The gel type substance (eg water and proteoglycans) become less viscous after stretching, resulting in less stiffness. The H-Reflex can be changed by passive muscle stretching; the possible mechanism is the afferent fiber II: in this case, the muscle spindle of the calf muscle would be fired while the muscle is stretched. The impulse would be transmitted by the afferent fiber II through the spinal cord, thus, inhibiting the neuron excitability of  $\alpha$  motor neuron (10,11)

The main purpose of this study was to investigate whether TENS combined with passive stretching was more effective than passive stretching given alone in reducing spasticity of stroke patients.

### Material and Method

The ethical approval for this study was granted by Research and Ethical committee of University College of Physiotherapy. This randomized controlled trial included a sample of 30 patients with post stroke hemiplegia. The study was conducted at the OPD of University College of Physiotherapy, Faridkot. The patients recruited in the study were referred from Department of Medicine and Neurosurgery, GGS Medical College and Hospital, Faridkot. Informed consent was obtained from each participants. The participants had to meet the following inclusion criteria: (1)spasticity graded

between 1- 4 on modified Ashworth scale for plantarflexors,(2) both male and female patients, (3) age group between 40-60 years, (4)within 0- 6 months post stroke patients,(5) minimum 0 degree passive ankle dorsiflexion(6) no pain in lower limb .Participants those were excluded: (1)with cognitive and perceptual disorders, (2)on antispastic medication, (3)previous physiotherapy treatment, (4)cardiac & musculoskeletal abnormalities,(5) head injuries and fracture of lower limb,(6) any history of vascular diseases in the lower limb & Diabetic foot. Patients were randomly assigned into two equal groups after initial evaluation. 15 patients assigned to Group A (experimental) and 15 to Group B (control).

**Intervention:**

Group A received TENS and passive stretching along with conventional physiotherapy. For the application of TENS, patient was positioned in prone lying with pillow beneath the anterior aspect of leg. Then electrodes were tied over the calf muscle of affected lower limb. High TENS was applied with following parameters: frequency 100 Hz, pulse width of 50 microseconds, continuous mode for 30 minutes. The intensity was increased up to the patient's tolerance limit (9). After TENS, passive stretching was given for plantar flexors to the patient. The stretch was sustained for 30 seconds with a rest period of 30 seconds. 20 repetitions of passive stretching were done for twenty minutes. Conventional physiotherapy in the form of passive movements of upper limb and lower limb was done after passive stretching session. This pattern of treatment was given six days a week for a period of six weeks. (7,12)

In Group B passive stretching was given for plantar flexors to patient. The stretch was sustained for 30 seconds with a rest period of 30 seconds. Similarly 20 repetitions of stretching were done for twenty minutes. Conventional physiotherapy in the form of passive movements for upper limb and lower limb was given to patient after stretching(7,12).

The participants of the study underwent comprehensive and detailed clinical evaluation both before the start as well as end of the therapy and were assessed by the same investigator. The modified Ashworth scale was used to measure Planter flexors spasticity. To facilitate data analysis, a 6-point rating scale range from 0 (no increase in muscle tone) to 4 (affected part rigid in flexion or extension) was used. A universal goniometer was used to measure passive ankle joint dorsiflexion and plantar flexion range of motion.(13)

**Data analysis:** The data obtained were analysed by using SPSS. Paired and Unpaired t test was done to compare the effectiveness of TENS combined with passive stretching or passive stretching and conventional Physiotherapy on spasticity and ROM of ankle joint for with in group comparison and between group comparisons.

**Results:**

Total 30 subjects participated in this study with age group of 45-60 years in both groups. t test was performed to test significant difference in variables. The p=0.05 was considered as level of significance. The mean age of subjects in group A was 52.60 and that of group B was 52.26.

Analysis was done between the pre-test and post-test values within group A and group B to determine the changes within the variables Modified Ashworth Scale, dorsiflexion and plantar flexion ROM with p value <0.05. The results showed that there were significant improvements in reducing spasticity for both groups (p=0.0001) for group A, (P=0.010) for group B, significant improvement was seen in dorsiflexion ROM (Group A p=0.001, Group B p=0.005) and plantar flexion ROM (Group A p=0.03, group B p=0.031) after intervention in post stroke patients (graph 1, graph 2 and graph 3).

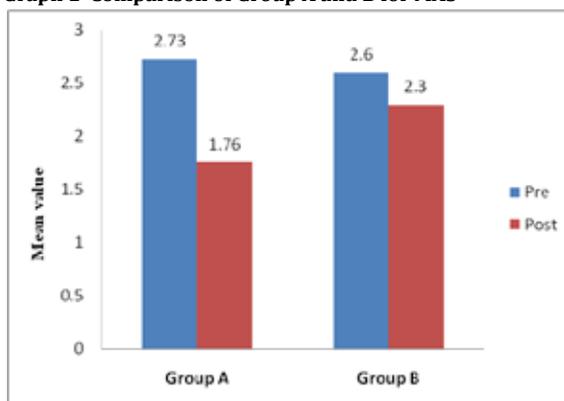
Comparison between the MAS score of both the groups has been done. There was not much difference in MAS score between pre values of both the groups with mean values of 2.73 and 2.67, but in post values of MAS, there was a significant difference in the MAS score between both groups(p<0.05). Group A show significant improvement than group B in MAS score with mean value of 1.76 (Group A) and 2.30 in (Group B) after 6 week treatment session. Comparison between the Dorsiflexion range of motion of

both groups had been done. There was no difference in Dorsiflexion range of motion between pre values of both groups p> 0.05 with mean value of group A was 9.07 and group B 9.80, but there was significant difference between post values for the Dorsiflexion range of motion of ankle joint between both groups (p<0.05). Group A show significant improvement than group B in dorsiflexion ROM of ankle joint with mean value of 14.0 (Group A) and 12.7 in group B after 6 week treatment session.

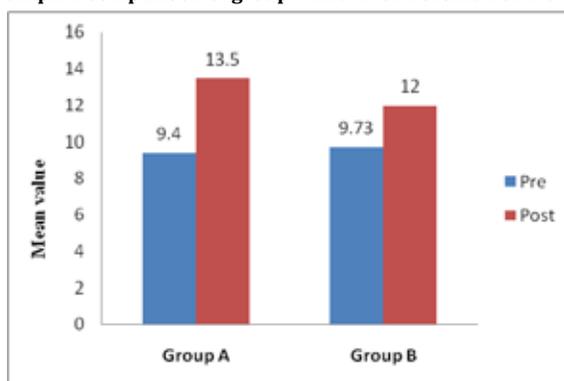
Comperison between the plantar flexion range of motion of ankle joint of both groups has been done. There was no significant difference in plantarflexion range of motion between pre values and post values of both groups' p> 0.05.

Group A and group B were compared, Group A shows more significant improvement in MAS for plantarflexors (Mean=0.97) than in groups B (mean=0.393) and dorsiflexion ROM of ankle joint (mean=4.87) Group A, (mean=2.27) Group B. Same improvement was found in both groups for plantar flexion ROM of ankle joint p> 0.05 with mean value (mean=0.73) group A and (mean=1.73) group B

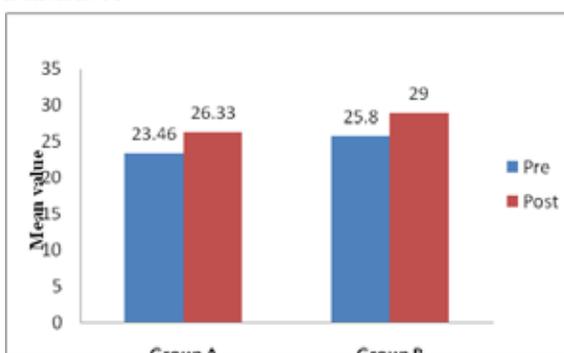
**Graph 1 Comparison of Group A and B for MAS**



**Graph 2 Comparison of group A and B for dorsiflexion ROM**



**Graph 3 Comparison of Group A and Group B for plantar flexion ROM**



### Discussion

The findings of this study suggest that the patients who received Transcutaneous Electrical Nerve Stimulation combined with passive stretching or Passive Stretching alone had an improvement in reducing the tone of the plantar flexors and increases dorsiflexion ROM thus improving their functional ability. However, this study shows that TENS along with passive stretching is more effective than passive stretching alone for treatment of spasticity of plantar flexors.

The results of the present study are consistent with the study by Yan and Chan (2009), who applied 3 week of TENS to lower leg acupuncture points in patients with acute stroke. They concluded that ankle plantar flexor spasticity was significantly decreased and dorsiflexor strength was increased (10). Hussain et al (2013) conducted a study to evaluate the effectiveness of TENS in reducing post stroke spasticity. They concluded that 20 session of TENS decreased plantar flexor spasticity, improved strength, increased gait velocity, ankle passive dorsiflexion movement improved massively followed by 10 meters walk test after TENS combined with Bobath therapy Although they combined TENS with Bobath, yet their study establishes the role of TENS in post stroke patients similar to present study (4).

The results of present study are consistent with the study by Bressel (2002) they applied 30 minutes static stretching and one minutes cyclic stretching of calf muscles on stroke patients. They concluded that ankle joint stiffness decreased after stretching session. Tsai HK et al conducted a study to evaluate

the effect of single session of prolonged muscle stretch on spastic muscles of stroke patients. They concluded that passive ROM of ankle dorsiflexion increased significantly after stretching treatment (7). Selles et al (2005) conducted a study to investigate the effect of repeated feedback controlled programmed stretching of the ankle plantar flexors and dorsiflexors. Significant improvement were found in passive ROM, maximum voluntary contractions, ankle stiffness, and walking speed (8).

### Conclusion

This study concluded that transcutaneous electrical nerve stimulation and passive stretching are effective treatment for spasticity, dorsiflexion and plantar flexion range of motion. Spasticity was best analyzed by Modified Ashworth Scale. Patients who received TENS combined with passive stretching showed more significant improvement in ROM and reduction in spasticity.

Some limitation have been found such as small sample size, this study was done in hemiplegic subjects especially for the spasticity of the muscles of the lower limb and upper limbs muscles were not considered. In this study subjects were tested only on those who presented with extensor type of spasticity in the lower limbs.

Thus future studies need to be done with other parameters such as Clonus, Duration, Gait parameters & Functional outcome measures, large sample size, upper limb spasticity, flexor type spasticity patients.

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