

## ORIGINAL ARTICLE

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# Effect of Four-Week Kinesio-Taping on Tibialis Anterior Muscle Activation and Functional Mobility in Stroke Patients with Foot Drop: A Pre-Post Intervention Study

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## ABSTRACT

**Background:** Stroke is the second leading cause of mortality worldwide after coronary artery disease and the most common cause of chronic adult disability. A primary impairment following stroke is weakness or paresis, affecting 80 to 90% of patients. Foot drop, caused by weakness of the tibialis anterior muscle and spasticity of the plantar flexors, impairs the ability to raise the foot during the swing phase of walking. This leads to decreased mobility, disrupted walking patterns, and significant limitations in daily activities, potentially resulting in long-term disability.

**Methods:** A total of 20 post-stroke patients with foot drop were included in the study. Baseline data were collected using RMS and TUG. The patients were given Kinesiological taping to TA and HMS, keeping in mind the PNF pattern, conventional physiotherapy, and conventional physiotherapy alone.

**Results:** Compared to baseline data in group-1, there was a significant change in TUG score but no significant change in RMS, while in PNF kinesiological taping to TA and HMS group-2 had a significant effect on TA muscle activation ( $p < 0.05$ ) and functional Mobility ( $p < 0.05$ ). In contrast, no significant changes were found in the conventional therapy group for RMS.

**Conclusion:** The study concluded that four weeks of kinesiological taping in PNF patterns improves Tibialis muscle activation and functional mobility in post-stroke patients with foot drop.

**Keywords:** Hemiparesis, PNF-kinesiological Taping, Functional Mobility, Tibialis muscle activation, foot drop.

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## INTRODUCTION

Stroke is a sudden disruption of brain function due to vascular causes, characterized by symptoms that persist for at least 24 hours or result in death.[1] As a leading cause of disability worldwide, stroke poses a significant burden on healthcare systems and society. The prevalence of stroke is higher in urban areas (334–424 per 100,000 people) compared to rural areas (84–262 per 100,000 people), possibly due to lifestyle differences and greater exposure to risk factors in urban populations [2-3]. Despite advances in acute management and rehabilitation, the residual physical impairments following a stroke remain a significant challenge.

Among the most common impairments is weakness or paresis, affecting 80–90% of stroke survivors and severely limiting their mobility and independence [4]. One specific manifestation, foot drop, is caused by weakness in the tibialis anterior muscle combined with plantar flexor spasticity [5]. Foot drop disrupts the natural gait cycle, increasing the risk of falls and further complicating rehabilitation. Traditional treatments such as physiotherapy and orthotic devices provide varying levels of success. Still, there is a growing interest in complementary interventions like Kinesiology Taping (KT), which offers a non-invasive and cost-effective alternative [6]. Evidence suggests that KT may improve muscle activation and functional outcomes, making it a promising addition to stroke rehabilitation protocols.

This study aims to investigate the effects of KT on tibialis anterior muscle activation and functional mobility in stroke patients with foot drop. Focusing on a four-week intervention, the study seeks to determine whether KT can enhance muscle activation and improve walking ability. The findings will provide insights into KT's potential as an adjunct therapy in stroke rehabilitation, addressing a critical need for effective, accessible treatments for individuals with post-stroke mobility impairments.

## METHODS

Following the acquisition of Institutional Ethical Clearance, the study was conducted from December 2023 to March 2024, including 20 stroke patients with foot drop. The inclusion criteria were 6-month post-stroke patients diagnosed with hemorrhagic or ischemic type on CT/MRI scans or confirmation through medical reports by qualified medical professionals were utilized to ascertain the condition, Age of 35-65 male and female were recruited for participation, Brunnstrom stages of recovery stage: 2 to 4, spasticity of ankle plantar flexor muscle  $\leq 2$  (According to Modified Ashworth Scale) [7], capable of ambulating independently for distances exceeding 10 meters without the aid of assistive devices, Mini-mental scale examination  $\geq 24$ . The exclusion criteria were Neurological deficits other than stroke, recurrent stroke, contracture/ deformity of ankle joint, perceptual, visual, or vestibular deficits, recent surgery to the affected lower limb, Patients with open wounds that prevented the application of Kinesio Tape, and those who developed skin symptoms following

tape application were not included in the study.

## Procedure

Individuals will be conveniently selected from the outpatient department of the South Gujarat region. On the first day of treatment, Subjects will be randomized into two groups using sealed opaque envelopes. Group 1 will be provided with traditional therapy, whereas Group 2 will undergo PNF Kinesiological taping of the tibialis anterior (TA) and hamstrings (HMs) before receiving traditional therapy. Before the study commences, the assessor responsible for evaluating all individuals pre- and post-study will undergo three days of training to practice and master the application of outcome measures according to standard guidelines. Each participant will undergo surface EMG analysis of tibialis anterior muscle activation and the Time Up and Go (TUG) Test On the initial day before treatment and the final day after treatment.

## Signal recording from Tibialis anterior muscle

Subjects were instructed to sit in a chair with their knees bent at a 90-degree angle and ankles positioned neutrally. Electrodes were placed over the subject's leg's tibialis anterior (TA) muscle, with a reference electrode at the ankle. EMG signals were recorded for 10 seconds during maximum voluntary contractions (MVCs) of ankle dorsiflexors. The recorded EMG signals were amplified and filtered using Bio-amplifiers, with a sampling frequency of 1 kHz. The data were saved and later processed using Matlab © (MathWorks, Inc.) [8,9]. High-pass and low-pass filters were employed with 5 Hz and 300 Hz cutoff frequencies, respectively. The signal was then rectified using an absolute function to produce a linear envelope representation of the data.

## Functional mobility assessed by Time and Go Test (TUG) [10]

During the Timed Up and Go Test (TUGT), participants are directed to rise from a standard armchair with defined dimensions (height 46 cm and arm height 65 cm), walk a distance of 3 meters, turn around, return to the chair, and sit down again. The total time taken to perform the test, measured in seconds, is recorded as the TUGT score.

## Intervention

Individuals of the experimental group will be given PNF Kinesiological taping of TA and HMs followed by conventional therapy. The control group will be given conventional therapy for 45-60 minutes for five sessions per week for four weeks.

The Conventional Physiotherapy protocol comprised several components: Stretching exercise for tight muscles in both upper and lower extremities (30-second hold for 3 times), active assisted training provided for individuals unable to execute full-range exercises independently, with each exercise performed ten times, Active movements were implemented for participants capable of performing the tasks as mentioned above, with each exercise executed ten times, Trunk exercises were conducted five times, Balance

training encompassed both static and dynamic balance exercises, each performed ten times, Gait training was also incorporated into the regimen [11].

**Tapping intervention:** Taping is administered at the start of each session, which will occur five times a week for four weeks, totaling 20 sessions from the beginning of the study. A 5-cm wide kinesio tex tape is applied from the lateral condyle of the tibia to the base of the first metatarsal bone while the patient is lying supine, with the ankle joint in maximal plantar flexion. Regarding the hip muscles (HMs) taping, the table height is adjusted to align with the patient's anterior superior iliac spine while standing, promoting anterior pelvic tilt as the patient flexes their trunk. Next, the tape is applied from the ischial tuberosity of the pelvis to the medial condyle of the tibia and fibular head. Initially, no tension is applied for the first 5 cm from the starting point, followed by a 30% stretch for the rest of the tape application [12].

## RESULTS

The collected data were entered into SPSS (Statistical Package for the Social Sciences) version 20.0 for Windows, developed by IBM, for analysis.

**Table 1: Baseline Characteristics of Participants**

Characteristics	Group 1	Group 2
Age (Years) (Mean±SD)	52.80 ± 8.12	51.10 ± 12.68
Height (cm) Mean±SD	162.00 ± 12.52	164.60 ± 11.51
Weight(kg) (Mean±SD)	71.50 ± 14.35	71.10 ± 13.65
Gender (Male/Female)	7/3	7/3
Involved Side(right/left)	6/4	7/3

**Table 2: Comparison of Rms and Tug Between Group-1 And Group-2**

Group	Variables	Pre-inter-vention (Mean ±SD)	Post-inter-vention (Mean ±SD)	t-value	p-Value
Group-1	RMS	33.30 ± 15.68	33.70 ± 15.34	-1.809	.128
	TUG SCORE	26.80 ± 6.92	25.60 ± 25.60	3.343	.009*
Group-2	RMS	64.20 ± 39.54	80.60 ± 41.61	-4.175	.002*
	TUG SCORE	26.30 ± 10.62	23.70 ± 9.84	5.750	.000*

(p value<0.05 significant)

**Table 3: Comparison of Rms And Tug Between Group-1 And Group-2**

Variables	z-value	p-Value
RMS	8.50	.009*
TUG SCORE	2.61	.123

(p value<0.05 significant)

## DISCUSSION

The study aimed to determine the effect of 4 weeks of PNF Kinesio-tapping on Tibialis anterior muscle activation

and functional mobility in stroke patients with foot drop. The patients were divided into two groups and given conventional physiotherapy and kinesiological facilitatory taping in PNF pattern and conventional physiotherapy, respectively. The activation of the Tibialis anterior muscle was assessed by EMG Parameter Root Mean Square (RMS) and Functional Mobility by Time up and Go Test (TUG). The evaluation was done before and after four weeks of the intervention. Table 1 shows a basic characteristic of the participants. A total of 20 post-stroke patients with foot droop were given intervention.

In this research group-1, given conventional physiotherapy, which includes stretching of tight muscles, strengthening of weak muscles in the form of assisted, active, and resisted exercise, trunk exercise, balance training, and gait training, Table 2 compares the RMS and TUG values before and after the 4 weeks of intervention in which Group 1, Mean values for RMS pre-intervention and post-intervention is 33.30 ± 15.68 and 33.70 ± 15.34 respectively. The mean values for TUG pre-intervention and post-intervention are 26.30 ± 10.62 and 25.60 ± 25.60 respectively. There is not much difference between score of RMS, indicating no effect on recruitment of tibialis anterior muscle but a slight reduction in TUG Score. Effective exercise regimens can potentially improve functionality following a stroke [13]. Here, the reduction in the score of TUG might be because of the effect of exercise or due to compensation because physiologic recovery and compensatory strategies cannot be differentiated on clinically based functional measurements. A systematic review by An, Minjeong et al., 2011 affirms that particular exercise methods can enhance balance and walking ability [14].

In group 2, along with Conventional therapy, facilitatory kinesiological taping was applied to the tibialis anterior and hamstring muscle from origin to insertion to analyze the effect on activation of TA muscle and functional mobility; mean values for RMS pre-intervention and post-intervention is 64.20 ± 39.5 and 80.60 ± 41.61 respectively. Thus, the present study concluded that the RMS Score was improved significantly after 4 weeks of intervention suggesting the kinesiological taping in PNF Pattern to TA and Hms, along with conventional physiotherapy, showed significant improvement in Tibialis Anterior muscle Activation. Emre Baskan et al., 2022 investigated the immediate impact of applying kinesiological tape with muscle stimulation technique on the tibialis anterior muscle on gait parameters among stroke individuals. Twenty-eight stroke patients were split into two groups, receiving either kinesiological taping or sham taping. Gait parameters were assessed using the BTS G-Walk Analysis System. The study found no notable superiority in the effects of kinesiological taping compared to sham taping applied to the tibialis anterior muscle [15].

PNF flexion patterns D1, and D2 involve ankle dorsiflexion and knee flexion. Stretching these patterns helps improve muscle mobility and activation. Applying tape in these patterns during walking may enhance proprioception

and activate the tibialis anterior muscle, as both ankle dorsiflexion and knee flexion are essential for proper gait [12]. Donghwan Park et al., 2021 concluded that Utilizing PNF-KT may offer a promising therapeutic strategy for improving ankle mobility and balance in individuals with chronic stroke. Another study by Kim Beom-Ryong et al. 2018 Explored the effects of treadmill training (TT) in combination with PNF lower-leg taping (PNFLT) on walking and balance capabilities in stroke. The study involved 27 stroke patients divided into control and experimental groups. While the control group underwent TT alone, the experimental group received TT along with PNF taping five times a week for six weeks. The study's results indicated that the PNFLT-TT intervention effectively enhanced walking and balance skills in stroke patients [16].

The mean values for TUG pre-intervention and post-intervention are  $26.80 \pm 6.92$  and  $23.70 \pm 9.84$  respectively. A significant reduction in the TUG score suggests a significant improvement in functional mobility following the intervention. This result is supported by the study by Kyung-hun Kim et al., 2020; in this study, the kinesiological tape was applied to the tibialis anterior muscle, and the immediate effect on ankle joint mobility and balance ability was assessed. The study observed a decrease in foot-dragging, diminished compensatory movements of the hip and knee joints, and improved alignment of the leg joint. A study by Kim and colleagues (2024), in which 26 patients with stroke with regular physiotherapy were given kinesio-taping after 8 weeks, reported that kinesio-taping significantly reduced TUG duration [17].

Table 3 compares the groups' RMS (root mean square) and TUG (Timed Up and Go) values. The results show a significant improvement in RMS values, indicating enhanced muscle activation facilitated by applying KT. However, no significant improvement was observed in TUG scores. These findings suggest that applying tape from muscle origin to insertion facilitates muscle function. The tape provides cutaneous fusimotor reflex, increasing fiber tension and exciting primary and secondary nerve endings [18-19]. This, in turn, aids in enhancing afferent sensory nerve activities. Moreover, the application of tension to the muscle fibers activates numerous gamma motor nerves, leading to spatial summation and the generation of post-synaptic potential without the action potential of the pre-synaptic nerve. Additionally, taping induces an additive effect by stimulating multiple nerve fascicles within the synapse [19].

## CONCLUSION

The study concluded that 4-week kinesiological taping in PNF patterns improves Tibialis muscle activation and functional mobility in post-stroke patients with foot drop.

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