

# Immediate Effects of Kinesio Taping on Upper Extremity Movements in Post-Stroke Hemiplegics

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## ABSTRACT

**Background:** In post-stroke hemiplegics, upper extremity movements are severely affected due to abnormal muscle tone and loss of voluntary control. In upper extremity movements scapula is central in proficient shoulder activities and scapular muscles being spastic and weak results in impaired upper extremity functions. Kinesio tape mainly functions via skin receptors and when applied to specific muscles, it helps in providing joint stability, pain reduction, postural correction and muscle facilitation when applied from origin to insertion and muscle inhibition when applied from insertion to origin.

**Objective:** To assess upper extremity function in post-stroke hemiplegics using Fugl-Meyer Assessment Scale before and immediately after application of kinesio tape.

**Method:** 30 subjects were selected as per inclusion and exclusion criteria. Fugl-Meyer Assessment Scale score for upper extremity were noted before application of kinesio tape and subjects were given rest for 10 minutes after application of tape to scapular muscles and again Fugl-Meyer Assessment Scale score were noted and statistically analysed.

**Result:** The statistical analysis showed significant increment in the motor function of upper extremity, wrist, hand and coordination comprising total of 66 score on FMA-UE(<0.0001). Also, significant shoulder pain reduction scores were analysed after kinesio tape application.

**Conclusion:** The present study concluded that immediate effects were seen and upper extremity movements were improved after application of kinesio tape in post-stroke hemiplegics.

**Keywords:** Kinesio tape, post-stroke hemiplegics, scapular muscles.

## INTRODUCTION

STROKE is defined as “rapidly developing clinical signs of focal (or global) disturbance of cerebral function with symptoms lasting for 24 hours or longer or leading to death, with no apparent cause other than vascular origin.”<sup>[1]</sup> Ischemic stroke is the most common type, affecting about 80% of individuals with stroke, and results when a clot blocks or impairs blood flow, depriving the brain of essential oxygen and nutrients. Hemorrhagic stroke occurs when blood vessel rupture, causing leakage of blood in or around the brain.<sup>[2]</sup>

Clinically, a variety of focal deficits are possible, including changes in the level

of consciousness and impairments of sensory, motor, cognitive, perceptual, and language function. Motor deficits are characterized by paralysis (hemiplegia) or weakness (hemiparesis), typically on the side of the body opposite the side of the lesion.<sup>[2]</sup>

Patients diagnosed with stroke mainly the hemiplegics often present with muscle weakness/ imbalance, decreased postural control, muscle spasticity, poor voluntary control, body mal-alignment, shoulder pain and scapular dyskinesia. Thus, the ability and function of the affected upper extremity in hemiplegics is diminished due to all of these problems.<sup>[5]</sup>

Normally, upper extremity movements are carried out by shoulder complex which is composed of clavicle, scapula and humerus. The scapula is central in proficient shoulder activity, and rotator cuff muscles will not operate optimally if the scapula is poorly positioned. Poor position, alignment, or stability of the scapula on the thorax will significantly impact the available range of motion of the upper extremity and its functions. [3,5]

Looking at scapula from a neurological perspective may attribute to, mal-alignment due to increased muscle tone, abnormal movement (synergy) patterns, muscle weakness, impaired resting muscle tension. [5]

The muscles that attach to both the scapula and the thorax maintain contact between the surrounding articulating surfaces. In addition, stabilization is also provided by the scapulothoracic musculature, which pulls or compresses the scapula to the thorax. [3]

The ultimate function of scapula is to orient the glenoid fossa for optimal contact with the humeral head, to add range to elevation of the upper extremity, and to provide a stable base for controlled motions between the humeral head and glenoid fossa. [3]

The scapula on the thorax contributes to elevation of upper extremity by upwardly rotating the glenoid fossa from its resting position. This motion of scapula is primarily produced by balanced forces between the trapezius and serratus anterior muscles. These muscles work synergistically to produce upward rotation of the scapula on the thorax. [5]

Following stroke, due to muscle imbalance these forces are disturbed and the upper extremity movements are impaired. The upper trapezius and rhomboid muscles are in shortened position and its ability to generate tension is affected. The middle and lower trapezius and serratus anterior muscles are vulnerable to overstretching, increased contraction, and premature fatigue. Thus, the balanced force between

these muscles to produce upward rotation of scapula is altered. [5] This muscle imbalance needs to be corrected in order to achieve a smooth and coordinated movement of upper extremity. The over activated muscles need to be inhibited and the weak muscles need to be facilitated.

In order to understand these motor deficits in hemiplegics the affected upper extremity needs to be assessed. Fugl-Meyer Assessment (FMA) Scale is a gold standard instrument for determining the motor function following stroke ( $r=0.9$ ). [2] FMA is a cumulative numerical scoring system that assesses six aspects of the patient: range of motion, pain, sensitivity, motor function of the upper and lower extremities and balance, in addition to coordination and speed, totaling 226 points. An ordinal scale of three points is applied to each item: 0- cannot be performed, 1- partially performed and 2 completely performed. This scale has a total of 100 points for normal motor function, where the maximum score for the upper extremity (FMA-UE) is 66 and for the lower, 34. Sanford et al; observed high reliability for the subscale FMA-UE ( $r=0.97$ ). [4]

Many interventions have been used to improve upper extremity movements in hemiplegics like neuromuscular electrical stimulation, manual therapy and approaches, functional training and taping or bracing applications. Taping consists of an adjunct technique, which uses an elastic adhesive tape over the skin in order to stimulate mechanoreceptors via continuous skin stretching and compression during joint motion. [5,6]

Based on accepted principles in neuroscience, it can be hypothesized that these afferent stimuli are transmitted to the contralateral area of the somatosensory cortex, which integrates information from different sensory and motor modalities. One taping technique widely used in clinical practice is the Kinesio Taping method. Dr. Kenzo Kase in 1979 invented Kinesio Taping a therapeutic modality in Japan. [6,7]

The physiological systems affected by Kinesio Tape are, the skin, the fascia, the circulatory/lymphatics, neural and muscular systems as well as joints. K-Taping functions primarily via the skin receptors and proprioceptors-influencing muscles, fascia, ligaments and nerves. [5,6] Benefits of Kinesio Taping include, proprioceptive facilitation, reduce muscle fatigue, muscle facilitation/inhibition, improve joint sense position, reduce delayed-onset muscle soreness, pain inhibition, enhance healing such as reducing oedema and improvement of lymphatic drainage and blood flow. [5,6] Thus, for smooth and coordinated movements and functions of upper extremity the imbalance of muscular forces needs to be corrected. Focusing on scapula, since scapula is central in proficient shoulder activities, the overactivated muscles of scapular needs to be inhibited and weak muscles needs to be facilitated. Applying kinesio tape to specific scapular muscles may result in balance of these forces and improvement in upper extremity movements and its functions.

## **MATERIALS AND METHODS**

The study was an experimental study where 30 post-stroke hemiplegics were selected using convenient sampling. Inclusion criteria: Subjects willing to participate in the age group of 45-55 years, hemiplegics with post-stroke duration of 6 months and above with muscle tone of upper extremity between 1-2 on Modified Ashworth Scale and voluntary control of upper extremity with stage 3 and as per Brunnstrom stages of recovery, subjects with and without shoulder pain. Exclusion criteria: Glenohumeral subluxation, Shoulder hand syndrome, Uncontrolled diabetes and hypertension, Other musculoskeletal conditions of upper extremity, Language and cognitive impairments (MMSE score less than 24). Materials used in the study included FMA sheet, pencil, Kinesio tape, scissor, reflex hammer, universal full circle and half circle goniometer.

## **Procedure:**

A written consent was taken from all the subjects in the language best understood by them. Selection of the subjects was done as per the inclusion and exclusion criteria. Purpose of the study and procedure was explained to the subjects prior to the study. Demographic data was noted down. FMA Score for upper extremity was noted before application of kinesio tape.

**METHOD:** Patient position: Sitting position.

A) **K-Taping for Upper Trapezius:** I-strip K-Tape was applied from insertion to origin. Tape was anchored with no tension distal to the acromion. Lateral flexion of the neck to opposite side, rotation to same side. Paper off tension or 15-25% tension was applied towards C7 spinous process and nuchal line and end with no tension.(Fig 1)



Figure 1: Kinesio taping for upper trapezius.

B) **K-Taping for Middle and Lower Trapezius:** Origin to insertion application was used for the middle and lower trapezius. Both applications require 2-inch I strip Kinesio tape approximately affixed on spinous processes of C6-T3 for middle trapezius and on spinous processes of T4-T12 for lower trapezius. The tape was laid down along the muscle fibers with paper off tension, and it was affixed to the acromion

and the spine of the scapula, respectively.(Fig 2)



Figure 2: Kinesio taping for middle and lower trapezius.

C] K-Taping for Serratus Anterior A K-Tape of I strip from origin to insertion with paper off tension. Upper extremity in full elevation, patient was instructed to take a deep breath to elevate the rib cage. Tape was anchored between ribs one through eight, and the end of the tape was attached to the medial border of the scapula.(Fig 3)



Figure 3: Kinesio taping for serratus anterior

D] K-Taping for Rhomboids:A K-Tape with X strip from origin to insertion. One end of strip was anchored with no tension at T2-T5. Subject asked to perform horizontal adduction.15-35% tension was applied. Other end of strip was anchored with no tension at medial border of scapula below the spine of scapula.(Fig 4)



Figure 4: Kinesio taping for rhomboids.

After k-tape application subjects were given rest for 10 minutes.(Fig 5)

Again FMA scores for upper extremity after k-tape application were noted down.

The data was collected and statistically analysed.



Figure 5: Kinesio taping for Upper Trapezius, Middle and Lower Trapezius, Rhomboids and Serratus Anterior.

### STATISTICAL ANALYSIS:

Collected data was entered in Microsoft Excel and Graph Pad Prism 8.4.0 was used for the data analysis. Normality of the data for all the categories of FMA-UE scale was tested using the Shapiro-Wilk normality test. Since the data was not normally distributed for all the categories of FMA-UE scale, statistical analysis was done

using the non-parametric test, i.e. the Wilcoxon test.

**RESULTS**

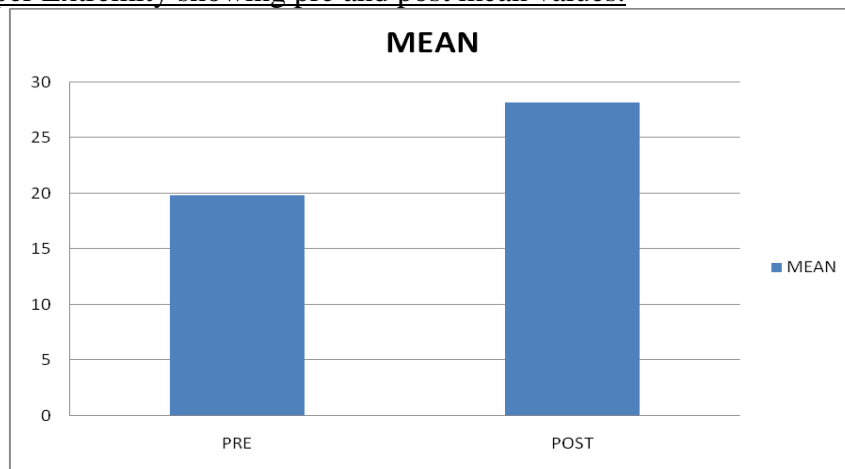
When analysed statistically using Wilcoxon test, the motor function of Upper

Extremity, wrist, hand and coordination comprising total of 66 score on FMA-UE shows significant p-value (<0.0001) after application of kinesio tape to scapular muscles.

A.UPPER EXTREMITY	STANDARD DEVIATION	STANDARD ERROR	P-VALUE
PRE Taping	2.70	0.49	<0.0001
POST Taping	3.44	0.62	

A) The above table shows the pre and post data of upper extremity on FMA scale and the data is highly significant with p-value <0.0001.

Graph of Upper Extremity showing pre and post mean values.

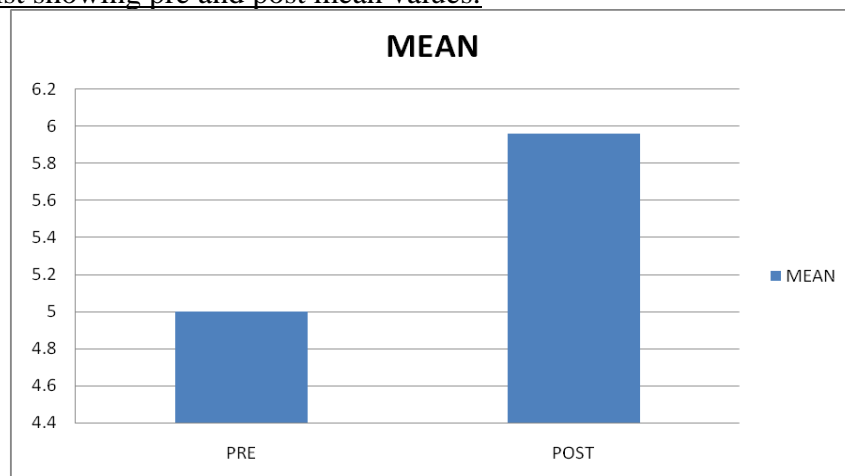


A)The above graphs shows increment in the mean value of the upper extremity in post data when compared to pre data.

B.WRIST	STANDARD DEVIATION	STANDARD ERROR	P-VALUE
PRE Taping	0.94	0.17	<0.0001
POST Taping	1.40	0.25	

B)The above table shows the pre and post data of the wrist on FMA scale and the data is highly significant with p-value <0.0001.

Graph of Wrist showing pre and post mean values.



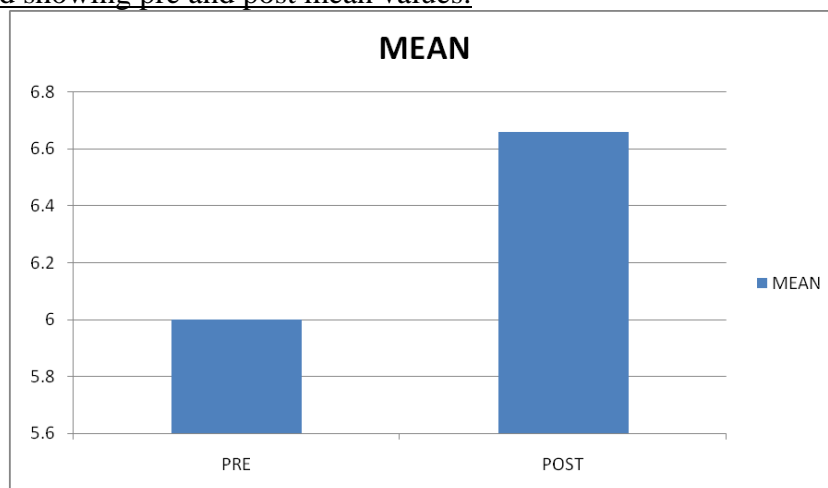
B)The above graph shows increment in mean value of the wrist in post data when compared to pre data.



C.HAND	STANDARD DEVIATION	STANDARD ERROR	P-VALUE
PRE Taping	1.80	0.32	<0.0001
POST Taping	1.82	0.33	

C)The above table shows the pre and post data of the hand on FMA scale and the data is highly significant with p-value <0.0001.

Graph of Hand showing pre and post mean values.

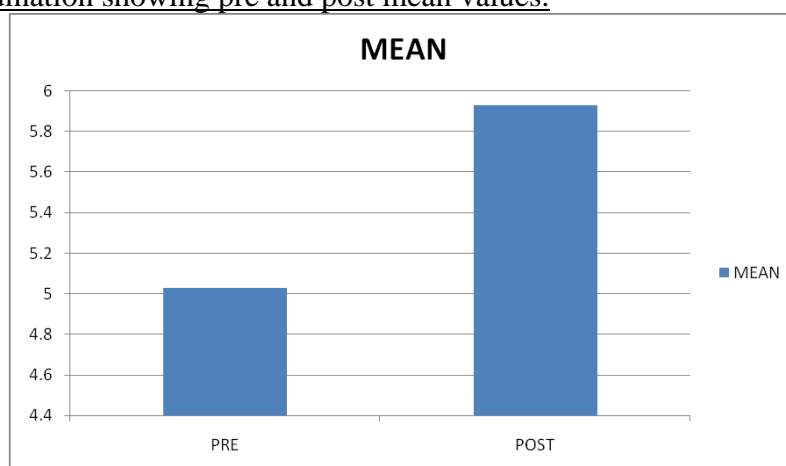


C)The above graph shows increment in mean value of the hand in post data when compared to pre data.

D. COORDINATION	STANDARD DEVIATION	STANDARD ERROR	P-VALUE
PRE Taping	0.18	0.03	<0.0001
POST Taping	0.25	0.04	

D)The above table shows the pre and post data of coordination on FMA scale and the data is highly significant with p-value <0.0001.

Graph of Coordination showing pre and post mean values.



D)The above graph shows increment in mean value of coordination in post data when compared to pre data.

## DISCUSSION

STROKE results in abnormal muscle tone, synergy patterns, poor voluntary control, shoulder pain and scapular

dyskinesia. Thus, the function of the affected upper extremity in hemiplegics is diminished. [5] Upper extremity movements are carried out by the shoulder joint

complex and scapula is central in proficient shoulder activities. Poor position, alignment and stability of the scapula significantly affect the movements of upper extremity. [3,5]

Looking at the scapula from a neurological perspective, studies suggest that there is increased tone in upper trapezius muscle and weakness in other scapular muscles like serratus anterior, rhomboids, middle and lower trapezius. [5] Also, scapular rhythm is altered in post-stroke hemiplegics. [8] Thus, considering these points this study was performed on a sample size of 30 post-stroke hemiplegics as per inclusion and exclusion criteria and kinesio tape was applied to scapular muscles and its immediate effects were noted using FMA upper extremity as an outcome measure. Data was collected and statistically analysed using Wilcoxon test. Data was highly significant with p value of <0.0001.

According to FMA-UE in volitional movement within synergies while performing an action of hand from contralateral knee to ipsilateral ear and in volitional movement mixing synergies while performing hand to lumbar spine significant changes (<0.0001) are attributed in movements like retraction, abduction and external rotation. Movements of elbow and forearm were same as before applying the tape. Minimal changes are attributed in volitional movement with little or no synergy while performing shoulder abduction from 0°-90°.

Movements of wrist were noted as included in FMA-UE, significant changes are attributed (<0.0001) in providing stability to maintain the static position for the movements of wrist like dorsiflexion, volar flexion, circumduction and of hand mass flexion-extension along with all types of grasps. Movements were not improved of wrist and hand but stability was provided by K tape at proximal shoulder joint by taped scapular muscles to maintain shoulder at 0° for the movements to be carried out of the most distal wrist joint.

Coordination, speed and sensation did not show any significant change but time taken to perform coordination activity like tip of index finger from knee to nose as described in the scale was quicker and even easier after K tape application (<0.0001). Passive joint motion showed no significant changes but significant changes (<0.0001) are noted in joint pain reduction in post K tape application data.

Hemiplegics when asked to perform activities of upper extremity, the movements are not smooth and coordinated. The probable causes are impaired shoulder joint stability and mobility, scapular mal-alignment, spasticity/weakness of involved muscles of upper extremity, synergy patterns and pain around shoulder joint. So, the movements of the upper extremity and its functions to be carried out smoothly the bony alignment, joint stability and mobility, the kinetic forces produced by muscles, the tone of muscles and length-tension relationship all these are required adequately.

DePalma et al. notes that the scapula is central in proficient shoulder activity, and rotator cuff muscles will not operate optimally if the scapula is poorly positioned. [5] Jaraczewska et al. states that following stroke, the upper trapezius muscle is often placed in shortened position and its ability to generate tension is affected, the middle and lower trapezius muscles are vulnerable to overstretching, increased contraction, and premature fatigue. [5] Thus, in this study, when upper trapezius was inhibited by taping technique and middle and lower trapezius, serratus anterior and rhomboids being facilitated, the volitional movements within synergies and mixing synergies shows improvement through actions of shoulder abduction, retraction and external rotation. Volitional movement with little or no synergy shows improvement in shoulder abduction.

Landel and Fisher states that, only after scapular stabilization is achieved should treatment focus on distal upper extremity dysfunction. [5] Thus, when

scapular muscles were taped in this study stability was provided to the proximal shoulder joint which was needed to perform movements at the distal wrist joint and hand. Huang YC et al. showed positive effect of K taping on hemiplegic shoulder pain.<sup>[9]</sup> In this study too, shoulder pain was reduced after K tape application and as stated by dos Santos GL et al., it can be suggested that a possible explanation for the effect of elastic taping may be related to the neural activation (mechanoreceptors) and biomechanics support.<sup>[6]</sup>

Yang SR et al. showed immediate effects of kinesio taping on fixed postural alignment and foot balance in stroke patients.<sup>[10]</sup> In this study scapula was being considered as an integral part in the hampered upper extremity movements seen in hemiplegics. The scapula on the thorax contributes to elevation of the humerus through its kinetic forces. The motions of scapula are primarily produced by a balance of the forces between trapezius and serratus anterior muscles through their attachments on the clavicle and scapula. These muscles work synergistically to produce upward rotation of scapula on the thorax. Middle trapezius as a smaller moment arm in upward rotation of scapula in later stages of elevation and acts as a downward rotator. Rhomboids the downward rotator of scapula, are active during upward rotation and work eccentrically to control the motion of scapula produced by upper trapezius and serratus anterior.

Thus, in this study, these scapular muscles were taped and immediate effects were significantly noted which showed increment mainly in motor function score and in the grand total score of the FMA-UE scale. By applying K tape to these muscles the over activated muscles are attributed to be inhibited and weak being facilitated which in turn helped in upper extremity movements within and mixed synergies and also providing stability to proximal shoulder joint for the movements to be carried out at the distal joints. Thus, k tape should be considered as an adjunct to the functional

training given for the upper extremity and scapula to be focused in post-stroke hemiplegics.

There are few limitations in the present study. Firstly, the study was performed on a small size. Large sample size can be used for more in-depth data analysis.

Secondly, in this study immediate effects were seen. Long term effects needed to be studied by introducing kinesio taping in the training program of hemiplegics along with functional exercises.

## CONCLUSION

The present study concluded that immediate effects were seen and upper extremity movements were improved after application of kinesio tape in post-stroke hemiplegics.

## Clinical Implication:

The present study highlights the significant effects of kinesio taping for improvement of upper extremity movements in post-stroke hemiplegics and scapula to be focused when treating the upper extremity motor functions. Thus, taping scapular muscles should be added as an adjunct to the functional training of upper extremity in stroke rehabilitation program.

## Abbreviations

FMA-UE: Fugl-Meyer Assessment-Upper Extremity

K tape: Kinesio Tape

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