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Does Kinesio Taping Improve Handgrip Strength and Hand Function in Patients with Chronic Stroke?

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ABSTRACT

Background: The present study aimed to investigate the effects of Kinesiotaping on spasticity, handgrip strength, and functional activity of hand in patients with stroke.

Methods: This double-blinded, placebo-controlled multi-centric study involved 20 patients with chronic stroke randomly assigned to Kinesiotaping (9 male and 1 female) and sham taping groups (7 male and 3 female). Spasticity, range of motion, handgrip strength, and hand function were measured under four conditions: (1) Without taping, (2) Immediately after application of taping, (3) 24 hours, and (4) 48 hours after taping along with conventional physiotherapy in both groups.

Results: No significant differences were observed in spasticity scores, range of motion, and hand function between the two groups in all four time periods ($p>0.05$). Handgrip strength showed improvements immediately after taping in the kinesiotaping group ($U=18.50$, $p=0.016$) compared to the sham taping group.

Conclusion: Kinesiotaping has no added benefits in reducing spasticity, improving range of motion of wrist extension, and hand function in patients with chronic stroke compared to sham taping. Despite statistical significance between groups observed in handgrip strength immediately after kinesiotaping, clinical significance of the same is not conclusive.

Keywords: Chronic Stroke, kinesiotaping, handgrip strength, spasticity, upper limb range of motion, hand function.

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INTRODUCTION

According to WHO, stroke was the cause of 6.7 million deaths in 2012 and is considered the second leading cause of death worldwide. It is also the primary cause of disability worldwide. Considering the rate of the aging population, especially in developing countries, this burden of stroke will increase significantly during the next 20 years [1, 2]. For example, recent population-based studies showed that the incidence rate in India is 119-145/100,000 [3, 4].

Stroke can impact the ability of individuals to balance, maintain static stance, walk independently, perform dynamic functional activities like transfers. Impairment of hand function is common post-stroke and is evident through weakness in muscles, commonly the wrist extensors, spasticity, and contractures and as a result, lack of voluntary control to use the hand in functional activities. In addition, there is an associated sensory and motor importance that contributes to the loss of hand function, which in turn impairs the activities of the patient involving the affected hand and limits functional independence.

Patients with stroke with involvement of hand demonstrate disturbances in hand function, including poor explorative manual movements, disturbed and slow objects manipulations, loss of precision grip, and lack of force control [5].

Recovery in stroke is dependent on various factors like the type of stroke, region of the brain involved, and severity of involvement. Recovery of hand function is commonly delayed in patients with stroke, and upper limb function as a whole occurs in the initial three months after stroke [6, 7].

Stroke rehabilitation focuses on functional recovery by targeting individual physical components and is commonly achieved by improving muscle balances and range of motion. A range of treatment options in rehabilitation is reported ranging from stretching and strengthening muscles and functional activity training. In addition, a few facilitatory techniques to stimulate weak muscles and inhibitory techniques for spastic muscle groups are used for specific hand functions. One such adjunct technique used popularly in recent times is Kinesiotaping (KT) which is claimed to facilitate or inhibit muscle function.

Few studies in the past have reported the effectiveness of KT in decreasing pain, improving range of motion and motor performance in stroke patients. A thorough search of literature review and critical appraisal of the obtained articles suggested minimal evidence to support the efficacy and effectiveness of kinesiotaping in reducing spasticity and improving hand function in patients with stroke. Hence, the present study investigates the effects of Kinesiotaping on spasticity measured using Modified Ashworth Scale (MAS), handgrip strength measured using Hand Dynamometer, and functional activity of hand-measured using Action Research Arm Test (ARAT) in patients with stroke.

METHODS

This double-blinded, placebo-controlled multi-centric study involving 20 patients with chronic stroke was conducted in outpatient Physiotherapy departments in Surat. The study duration was 4 months. Inclusion criteria for participants were: 35 years or older, both genders (9 male and 1 female in kinesio taping group; 7 male and 3 female in Sham group), unilateral upper limb involvement due to stroke (involving middle cerebral artery), appropriate communication and intact cognitive ability. In addition, exclusion criteria included any previous trauma, fracture, dislocation, or bony abnormalities, history of surgeries around elbow & wrist, previous experience using KT, and allergic to KT. Voluntary participation in this study was ensured by obtaining informed consent from the participants before the study. In addition, details of the study were explained to the participants. The study was conducted under the institutional ethical standards of the ethics committee on human experimentation and the Helsinki declaration of 1975.

Twenty participants were randomly assigned to two groups: Kinesiotaping (KT) and Sham taping (ST) groups. The randomization was done through concealed allocation performed using a computer-generated randomized table of numbers done by a blinded investigator not involved in the treatment or assessment of participants. Kinesiotaping and Sham taping was applied by a Physiotherapist trained and certified in Kinesiotaping, who was not a part of the conventional treatment or measurement of outcome measures. Participants were also blinded to whether they underwent kinesiotaping or sham taping.

Spasticity, range of motion, handgrip strength, and hand function were measured under four conditions: (1) Without taping, (2) Immediately after application of taping, (3) 24 hours, and (4) 48 hours after taping (with tape in situ)[8, 9]. All outcome measurements were carried out at the same time on all participants by the same person.

Kinesiotaping Group

The flexor and extensor aspects of the wrist musculature were taped using inhibition and facilitation techniques (NITTO Kinesiology Tape, Nitto Denko Corporation, Osaka). All taping techniques were applied following Kenzo Kase's Kinesiotaping Manual [10]. KT was applied using the origin to insertion technique for facilitation on the extensor aspect and insertion to origin technique for inhibition on the flexor aspect. The tension of the tape was the same for both techniques, and this was standardized by maintaining the length of the tape. For each patient, the distance between the lateral epicondyle of the humerus to the tip of the middle finger was measured. The appropriate length of the strip was taken as per the measurement. Then, the anchor was applied to the skin without tension, and the rest of the tape was stretched to 25% to 35% and covered the length of the muscles to be taped.

For the inhibition technique, the tape was applied from the dorsum of the head of the metacarpal by entering the fingers in the cuts made in the tape. Then the tape was applied around the wrist flexor muscles, from the head of the metacarpals to the medial epicondyle of the humerus on the affected hand. The elbow was maintained in full extension during the application, forearm supination, and wrist in full extension.

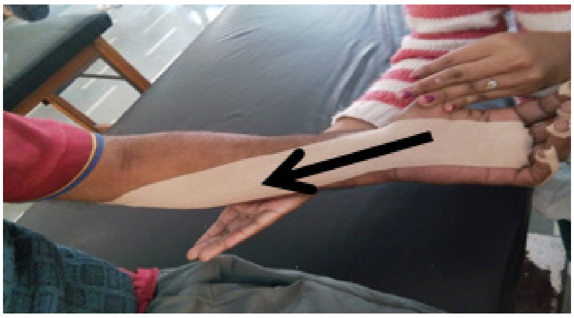

Figure 1: Inhibition technique of taping for wrist flexors

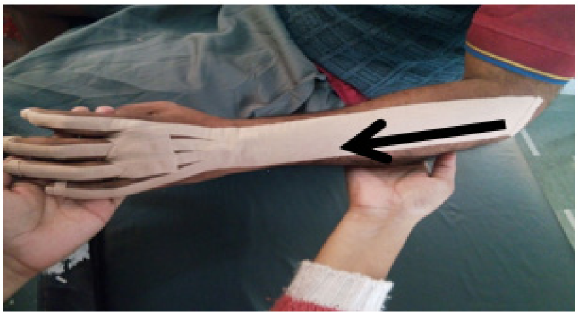

Figure 2: Facilitation technique of taping for wrist extensors

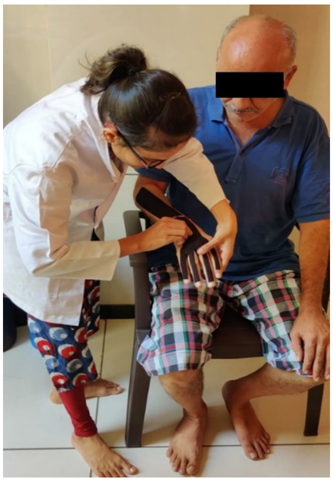

Figure 3: Application of Facilitation technique to wrist extensors

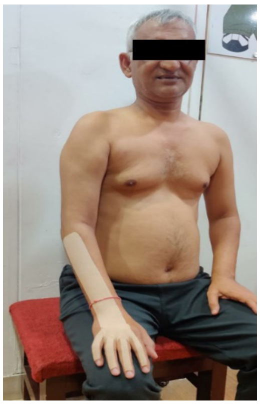

Figure 4: Post application of Kinesio tape

For the facilitation technique, the tape application began from the lateral epicondyle and covered the target muscle to the tips of all four fingers. At the level of the wrist joint, the tape was cut into four strips for all fingers and then taped over it. Taping was applied with elbow maintained in extension, forearm in pronation, and wrist and finger flexion [11].

In the sham taping group, taping was applied the same as above but without any tension and no specific direction of application which differentiates it from the kinesiotaping procedure.

Conventional Physiotherapy program

Both the groups underwent conventional Physiotherapy with the tape in the site, and the therapists handling the participants were trained to refrain from discussing or commenting on the taping technique being applied to them, thus maintaining the blinding procedure.

Outcome measures

Modified Ashworth Scale (MAS) [12]: Spasticity was measured using MAS, which is a 6 point ordinal scale from 0 to 4 (0, 1, 1+, 2, 3, 4). Wrist and finger flexor muscles were assessed for changes in tone by measuring the resistance perceived to passive stretch with the participants seated comfortably.

Range of motion (ROM): Wrist extension ROM was measured as any change in flexor spasticity will improve wrist extension movement. It was measured using a standard goniometer.

Handgrip strength (HG) [13]: SAEHANS® Handheld dynamometer, which was validated, was used to measure the participants‘ isometric handgrip strength. The dynamometer was set in the second position of gripping. Participants were comfortably seated with forearm supported and back straight, hip and knee in 90’of flexion, shoulder in adduction with the elbow in 90^0 flexion, wrist, and forearm in a neutral position [14]. The participants were instructed to maintain the maximum contraction for 5 seconds in each trial after a verbal cue provided by the assessor. Three trials were taken with a rest period of 30 seconds between trials. The average of three trials was calculated and recorded for data analysis. Unit of measurement of handgrip strength was in kilograms.

Action Research Arm Test (ARAT) [15]: Upper limb functioning was measured using ARAT, a 19 item measure to assess upper extremity performance in stroke recovery. It is divided into four sub-tests (grasp, grip, pinch, and gross arm movement), with each item rated on a 4-point ordinal scale ranging from 0 to 3. The tests were sequenced so that if a participant scores 3 on the first test, it is recorded, and no more tests need to be administered in that subscale, and the participant scores are recorded as top marks (all 3s) for all tests in that subscale. Conversely, if the participant fails the first test (score 0) and in the second test (score 0) of the subscale, they automatically score zero for all tests in that subscale, and again no more tests needed to be performed in that subscale. The participant then needs to complete all tasks within the subtest. Scoring for this test was recorded as per the standard scoring guidelines [16]. The reproducibility of the sub-tests ranged from 0.98-0.99 and the scalability from 0.94 to 0.98.

Data Analysis

All collected data were analyzed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics of mean, standard deviation for continuous variables and frequency, percentage for categorical variables were used to describe participants‘ demographic and clinical characteristics. The normality of data was analyzed using the Shapiro-Wilk test, which showed the data was not normally distributed ($p<0.05$). Mann-Whitney U test was used to compare the differences in wrist extension ROM, handgrip strength, and ARAT scores between the two groups. The significance level was set at $p<0.05$.

RESULTS

Twenty patients with chronic stroke participated in this study and were randomized to the KT group (n=10) and ST groups (n=10). All 20 participants completed the study, and no adverse effects due to taping were reported. The mean age of participants (in years) in the KT group was 54.0±4.0 and in the ST group was 55.7±7.3 with no statistical difference between the groups (p=0.529). Duration since stroke (in months) in the KT group was 14.0±7.5 and in the ST group was 13.4±5.9 with no statistical difference between the groups (p=0.846). Gender-wise distribution and affected side of the hemiplegic arm in the groups are shown in Table 1.

Table 1. Baseline demographic and Clinical characteristics of participants in both groups

Variable	KT Group (n=10)	ST Group (n=10)	p-value*
	Mean (SD)		
Age (in years)	54.0±4.0	55.7±7.3	0.529
Duration since stroke (in months)	14.0±7.5	13.4±5.9	0.846
	n (%)		
Gender			
Male	7 (70)	9 (90)	
Female	3 (30)	1 (10)	
Hemiplegic side			
Right	7 (70)	3 (30)	
Left	3 (30)	7 (70)	

Baseline analysis of outcome measures used in this study (MAS, ROM, HG strength, and ARAT) are shown in (Table 2). There were no significant differences between the groups in all the outcome measures at baseline ($p>0.05$).

Table 2. Comparison of baseline values of outcome measures used in the study

Variable	KT Group (n=10)	ST Group (n=10)	p-value*
	Median (Range)		
MAS+	2.5 (2 to 3)	2.5 (2 to 3)	1.000
	Mean (SD)		
ROM (Wrist Extension)	65.5±12.34	61.5±19.15	0.646
HG strength (affected side)	6.1±5.1	4.3±2.62	0.464
ARAT	8.4±7.04	12.0±4.1	0.847

*Means compared using Mann-Whitney U test
+ Median comparison using χ^2 test

Table 3. Between-group comparison of Modified Ashworth Scale for spasticity

Variable	KT Group (n=10)	ST Group (n=10)	p-value*
	Median (Range)		
MAS			
Immediate	2.5 (1.5 to 3)	2.5 (2 to 3)	1.000
24 hrs	2.25 (1 to 3)	2.5 (2 to 3)	1.000
48 hrs	1.75 (1 to 3)	2.5 (2 to 3)	0.650

*Median comparison using χ^2 test

Table 4. Between group comparison of ROM of wrist extension, handgrip strength and ARAT

Variable	KT Group (n=10)	ST Group (n=10)	p-value*	Effect size
	Mean (SD)			
ROM (Wrist Extension)				
Immediate	68.6±12.51	62.0±17.98	0.304	
24 hrs	71.0±11.49	62.5±17.98	0.170	
48 hrs	73.5±10.28	63.5±17.64	0.109	
HG strength (affected side)				
Immediate	8.0±4.47	4.0±2.58	**0.016**	0.974
24 hrs	8.0±5.67	5.0±3.09	0.301	
48 hrs	8.10±5.66	5.0±2.98	0.182	
ARAT				
Immediate	9.0±7.34	12.0±4.12	0.969	
24 hrs	9.0±7.38	12.0±4.12	0.969	
48 hrs	9.3±7.54	12.6±4.26	0.878	

Outcome measurements were taken immediately after the application of taping, 24 hours, and again 48 hours after the initial application of taping. Mean comparisons were made between the two groups to observe any differences in outcome measures in timelines specified above (Table 3). Results showed no statistical significance between the two groups in all outcome measures, except handgrip strength, which showed significant differences immediately after the taping (U=18.50, p=0.016).

DISCUSSION

This study was conducted to determine the effect of kinesiotaping on spasticity of the forearm and hand flexor muscles, range of motion of wrist extension, handgrip strength, and functional ability of upper limb in patients with chronic stroke. In this double-blinded, placebo-controlled study, outcome variables were measured immediately after taping, 24 hours, and 48 hours after the initial application of taping. This study demonstrated no statistical significance between the kinesiotaping and sham taping groups in all the variables except handgrip strength (immediate). However, the KT group showed improvements compared to the ST group (p=0.016).

The results of the present study agree with the results from a study by Chang et al. [8]. They concluded that neither facilitation nor inhibition technique of kinesiotaping improves maximal grip strength.

Similar results were found in a study by Merino-Marban et al. in 2012 [9], who examined the long-term effects (48 hours) on muscle strength following application of KT and found no significant difference between the taped and untapped forearm. In addition, Schneider et al. [17] reported no changes in strength in forearm muscles after application of KT using the facilitation technique.

In a previous study by the present author [11], facilitatory KT applied on forearm extensors of healthy individuals showed improvements in handgrip strength after 48 hours of application, with a medium effect size (0.78), subjecting the efficacy of KT to question.

Similar results were reported from Fu et al. [18] in 2008 and Wong et al. [19] in 2012; however, both these studies were conducted on Quadriceps muscles. In addition, while Fu et al. conducted the study on healthy young athletes, Wong et al. conducted it on healthy participants.

Vithoulk et al. [20] found a significant increase in peak torque during eccentric isokinetic contraction of Quadriceps in the KT group compared to the non-taped group. Similarly, Hsu et al. [21] conducted on baseball players revealed significant improvement in lower trapezius strength.

Huang et al. [22] studied the effect of kinesiotaping on hemiplegic hands in patients with upper limb post spasticity for 3 weeks and was followed up at the end of the 5th week. They concluded that patients in the KT group had better hand performance at the end of 5th week with significant reductions in post-stroke spasticity.

In contrast to our results, Lemos et al. [23] reported the greatest handgrip strength after 24 hours and lasted up to 48 hours in the right hand and after 48 hours in the left hand. Thus, they concluded that the application of KT augments muscle function.

Handgrip strength measured using a handheld dynamometer does not accurately capture subtle changes in strength, and probably very mild improvements might be overlooked. However, for an adjunct technique like KT to be clinically effective, minor improvements are considered insufficient to highlight its efficacy with an appropriate effect size.

Most of the studies mentioned above-had issues with consistency in the application of KT as critical appraisal of the articles by the authors showed lack of systematic approach in data collection, choice of population, and sample size. In addition, there is a lack of evidence in the literature about the long-term effects of KT, and a few studies have focused on the immediate and short-term effects and reported KT to be more effective immediately after the application. However, scientific evidence to substantiate that the immediate effect is purely due to the effect of KT is still lacking.

CONCLUSION

From the present study results, it can be concluded that KT has no additional benefit in reducing spasticity, improving ROM of extension, handgrip strength, and hand functionality in patients with chronic stroke. More clinical studies to prove the efficacy of KT is needed.

Limitations

The major limitation was the small sample size and the period of intervention. Therefore, studies involving a large sample size and a more extended period of intervention, probably with long-term follow-up to determine the efficacy of KT, can be designed.

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