Effects of Kinesio Tape to Reduce Hand Edema in Acute Stroke

Alison Bell, MOT, OTR/L,[1] and Melissa Muller, OTD, OTR/L[1]

[1]*MossRehab Hospital, Elkins Park, Pennsylvania*

Objective: The purpose of the study was to evaluate the efficacy of Kinesio Tape (Kinesio USA, Albequerque, NM) for reducing hand edema in individuals with hemiplegia post stroke. **Methods**: Seventeen individuals who experienced acute stroke were screened for visual signs of edema and were randomly assigned to experimental and control groups. The experimental group received Kinesio Tape that was applied to hand and forearm for 6 days in combination with standard therapy; the control group received standard therapy. Blinded raters assessed edema reduction via circumferential measurements. **Results**: Application of Kinesio Tape did not result in statistically significant reduction in edema. Large and medium effect sizes were seen for edema reduction at the metacarpophalangeal and wrist joints, respectively, with Kinesio Tape. **Conclusion**: Further research is warranted to investigate the utility of Kinesio Tape in edema reduction. **Key words**: *edema, hemiplegia, stroke*

Edema is a well-known consequence of hemiplegia after stroke. Poststroke edema has been found in 37 % of individuals with chronic stroke (greater than 6 months) and in 33 % of individuals with acute stroke (less than 6 months).[1-3] Although hand edema is common in individuals with stroke, the exact mechanisms and effective course of treatment are unclear.[1] Sympathetic vasomotor dysfunction and venous congestion have been suggested as causes of poststroke edema.[4,5] Edema in the hand can limit joint mobility by allowing tissue to set and become fibrous.[6,7] The potential for limitations in both active and passive range of motion make edema management a necessary part of any rehabilitation program. Despite the need for effective ways to manage poststroke edema, there is little evidence to guide clinical decision making. Common therapy-based treatments for edema management include positioning, compression, massage, application of cold, neuromuscular stimulation, and range of motion.[8] These interventions are well accepted and used in therapy; however, there is limited research to support their efficacy, and they can be cost and labor intensive.[6-8] In the current health care environment, it is vital to find cost- and time-effective solutions to manage poststroke edema.

Kinesio Tape (Kinesio USA, Albequerque, NM) is an innovative treatment modality that addresses the need for cost- and time-effective treatments within clinical settings. Kinesio Tape is a hypoallergenic skin tape with elastic components that is thought to influence edema by lifting the surface tissue to aid in lymphatic drainage.[9] Expert clinicians have suggested that Kinesio Tape may be effective in reducing edema post stroke,[8] but to date this has not been studied. The aim of this study is to evaluate the effectiveness of Kinesio Tape in reducing edema in individuals who experienced acute hemiplegia post stroke.

Methods

Research design

This study was a randomized experimental design. A random numbers table was used to assign participants to a control or experimental group. Randomization was stratified by hand function. Poor hand function is correlated with high levels of edema.[2] To ensure that upper extremity motor impairment was consistent between experimental and control groups, the Upper Limb portion of the Fugl-Meyer Assessment (FMA) was used for stratification. Prior to randomization, participants were stratified based on severity of motor

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impairment.[10] Criteria reported in the literature[11] led to the following classification of study participants: group 1, FMA score 0-11; group 2, FMA score 12-22; group 3, FMA score 23-32; group 4, FMA score 33+.

The FMA demonstrates good reliability (alpha coefficient of .95) and intra and interreliability (intraclass correlation coefficient [ICC] .93) as well as good construct validity for both upper and lower extremity components.[12]

Participants

Patients admitted to an acute stroke rehabilitation floor at MossRehab Hospital in Elkins Park, Pennsylvania, were recruited over a 12-month period. The principal or secondary investigator screened consecutive patient admissions for edema via visual inspection within the first 4 days of admission. A visual difference between the ipsilateral and contralateral hands was used to determine the presence of edema. Research suggests that visual inspection underestimates the presence of edema when compared to volumetric measurement,[3] but visual inspection has been used in previous studies to assess edema and has been reported to be clinically useful.[6, 7,13] In acute stroke, individuals frequently present with hemiplegia, which can make the standardized testing position of the volumeter unachievable (see "Discussion").

Criteria for study participation included diagnosis of stroke within the last 3 months, hemiplegia/hemiparesis in the upper extremity, and presence of edema by visual inspection. Exclusion criteria included inability to speak English, stroke onset greater than 3 months, bilateral strokes, fragile skin deemed at risk for tearing from tape application, intravenous lines in the hand that would prevent application of Kinesio Tape, and history of mastectomy.

The research protocol was approved by the international review board, and all participants provided written informed consent.

Instruments

Edema was assessed via circumferential measurements at the metacarpophalangeal (MCP) and wrist joints using a Gulick anthropometric measuring tape. The Gulick measuring tape is spring loaded to offer accurate and consistent tension to prevent compression of body tissue. Anatomical landmarks used for the wrist measurements included distal to the radial styloid and proximal to the scaphoid on the radial side of the affected upper extremity. On the ulnar side of the arm, the raters measured distal to the ulnar head and proximal to the pisiform bone.

Data on the use of diuretic medications were collected. Participants were screened for the following medications: Lasix, ethacrynic acid, hydrochlorothiazide, spironolactone, metolazone, bumetandie, and Dyazide. Diuretic medications increase the extradition of water, which would influence edema in the hemiplegic hand.[14]

Intervention

For participants in the experimental group, Kinesio Tape was applied to the affected extremity within 30 minutes of initial assessment using the application method for edema reduction described by the manufacturer.[9] The taping application for edema reduction in the hand is a dorsal to volar application using a buttonhole technique (**Figure 1**). The participant's wrist was passively moved into a flexed position and the tape was applied to the dorsal surface of the affected hand with a 20% stretch. The wrist was then extended to end range passively and the volar portion of the tape was applied, again with a 20% stretch. The wrist was moved during the taping application to facilitate the dynamic properties of the tape. The tape covers up to two-thirds the length of the forearm. Kinesio Tape stretches along the longitudinal axis and comes prepackaged on the paper at a 10% stretch. For edema and skin "lifting" techniques, it is recommended to apply Kinesio Tape with 10% to 35% tension in order to maximize the recoil benefits of the tape. This range allows clinicians to provide individualized stretch by using the 10% "paper off" tension as a guide. For the purposes of this study, a 20% stretch was used to apply the tape, which is slightly more than "paper off" tension.[9,15]

The tape was on for 6 days. A certified Kinesio taping practitioner who had been formally trained and certified on the application procedures (author M.M.) applied the tape for all subjects. Tape was

Figure 1. Application of the Kinesio Tape.

reapplied as needed when there were visual signs that it was coming off the skin.

Both groups received standard physical, occupational, and speech therapy throughout the duration of the study. Edema reduction techniques that showed utility other than edema control (eg, positioning, active, and passive range of motion) were not excluded for either group. The use of cold application, compression, and massage techniques were excluded for both the control and experimental groups. Upon conclusion of the study period, all interventions for edema reduction, including the application of Kinesio Tape, were available to all participants. Treatments provided were at the discretion of the treating therapist and the participant.

Data collection

On day 1, FMA and circumferential measurements were taken at the wrist and MCP joints on both hands by an occupational therapist rater blinded to grouping. The measurements occurred with participants seated in a wheelchair and were recorded in centimeters. Six days after initial measurements, the same blinded rater reassessed wrist and MCP circumference. Assessments of the experimental group were done within 30 minutes of tape removal. Raters were consistent for each participant, and only 2 raters were used for the study.

Statistical analysis

Chi-square analyses were used to determine group differences in sex, side of stroke, and use of diuretic medications. Mann-Whitney *U* tests were used to determine group differences on baseline data of age, onset since stroke, pre FMA score, and circumference of MCP and wrist prior to intervention.

Change (in centimeters) was calculated with the Mann-Whitney *U* test for the MCP and wrist. Nonparametric testing was chosen because of low sample size. An alpha level of $P<.05$ was set for statistical significance. The effect size was determined using Cohen's *d*. All statistical analyses were performed using IBM SPSS 20 (IBM, Armonk, NY).

Results

During the study period, 314 patients with stroke were admitted to the stroke unit. Five were discharged prior to screening, leaving 309 for possible recruitment. Of the admissions, 68 (22%) showed visual signs of edema and met the inclusion criteria. Twenty-five individuals consented to participate in the study (37%); of those, a complete data set was obtained on 17 (9 in the experimental group and 8 in the control group).

Eight participants had an incomplete data set. (Six were unable to complete the protocol because of early discharge; one consented but edema management was initiated in therapy prior to onset of the study and therefore could not participate; and one was unable to complete because of unavailability of rater for post measurement protocol.) Experimental and control groups were similar for demographic information (**Table 1**). Although a greater number of participants in

Table 1. Demographic characteristics

Characteristic	Experimental group (n = 9)	Control group (n = 8)	*P* value
Age, years Median (SD) Range	67.2 (13.0) 44-79	64.0 (13.5) 47-83	.541
Sex (male/female)	4/5	5/3	.457
Side of stroke (left/right)	4/5	6/2	.201
Onset since stroke, days Median (SD) Range	18 (22.3) 5-57	14 (9.1) 7-31	.606
Pre FMA Median (SD) Range	9 (16.9) 4-58	14.5 (22.0) 5-53	.481
Pre MCP circumference, cm Median (SD)	21.4 (2.0)	20.7 (1.7)	1.0
Pre wrist circumference, cm Median (SD)	18.0 (1.7)	17.8 (1.5)	.888
Diuretic use	4	1	.149

Note: FMA = Fugl-Meyer Assessment; MCP = metacarpophalangeal joint.

the experimental group were prescribed diuretic medications (4) compared to the control group (1), this difference was not statistically significant ($P = .149$). In the experimental group, diuretic use resulted in a lower change score in both the MCP and wrist. For the MCP measurements, the mean change for nondiuretic use was 0.72 cm, and with diuretic use it was 0.475 cm. At the wrist, the mean change was 0.540 cm for participants who were not taking diuretics and 0.275 cm for participants who were taking diuretics. Similar analysis was not performed on the control group, because only one participant was prescribed the diuretic medications. Testing did not reveal statistical significance between change scores in the experimental group between those who took diuretics and those who did not ($P = .405$ at MCP; $P = .556$ at wrist).

The experimental group showed a small reduction in MCP and wrist circumferential measurements with greater results seen at the MCP. The control group showed an increase in the circumferential measurements at the MCP and wrist joints, indicative of increased edema (**Table 2**). There was no statistical difference between the 2 groups for change at MCP ($P = .111$) or change at the wrist ($P = .189$). A large effect size was seen at the MCP (0.82), and a medium effect size was seen at the wrist (0.77).

Discussion

The use of Kinesio Tape did not result in statistically significant reduction of edema in this sample. However, the experimental group did show a greater reduction in edema compared to the control group overall. The control group had a median negative change in the MCP and wrist measurements, indicating that edema had worsened in the 6-day trial. In the experimental group, 8 of 9 participants (88 %) had some edema reduction; only 1 participant (12 %) had increased edema. In the control group, 5 of 8 participants (63 %) had an increase in edema at one or both joints. The increased use of diuretics in the experimental group did not appear to have an effect on change scores in the experimental group. The greater number of participants with diuretic usage in the experimental group does not appear to be a confounding variable.

Edema management interventions reported in the literature include use of intermittent compression, electrical stimulation, continuous passive range of motion machines, and custom compression garments. To compare the effect of Kinesio Tape (Cohen's $d = 0.82$ for the MCP and .77 for the wrist) to those reported for other interventions, effect sizes were calculated, using Cohen's d, based on the data reported by other researchers.

One study found that the use of an intermittent compression machine protocol and positioning in an acute stroke population did not reduce edema ($d = 0.0$).[16] However, another study found the use of 3 hours of compression, via a custom fitted Lycra sleeve and glove, was effective in reduction of acute poststroke edema ($d = 1.25$ for size of third digit; $d = 0.42$ for size of forearm).[17] Additionally, 30 minutes of a continuous passive range of motion machine (CPM) of the edematous upper extremity resulted in large effect sizes for change in hand volume ($d = 1.46$) and change in finger circumference ($d = 1.78$); these effect sizes were not significantly better than positioning alone.[7] Even larger effect sizes were reported for a 30-minute

Table 2. Outcomes

Measure	Experimental group (n = 9)	Control group (n = 8)
Post MCP circumference, cm		
Median change (SD)	0.5 (0.65)	-0.3 (0.91)
Range	-0.1 to 2.2	-1.0 to 1.6
Post wrist circumference, cm		
Median change (SD)	0.2 (0.4)	-0.1 (0.57)
Range	0 to 1.1	-0.5 to 0.8

Note: MCP = metacarpophalangeal joint.

program of neuromuscular electrical stimulation (NMES). This treatment resulted in superior edema reduction outcomes than positioning alone, with large effect sizes seen in hand volume ($d = 2.33$), total arm volume ($d = 1.98$), lower arm girth ($d = 2.46$), and upper arm girth ($d = 1.6$). However, edema returned to pretreatment levels within 24 hours of intervention, suggesting limited lasting effects.[6]

The effect sizes seen with Kinesio Tape are smaller than those reported with the NMES, CPM, and custom Lycra garments. However, the medium and large effect sizes obtained with Kinesio Tape were significantly less expensive then these interventions. Additionally, the time to complete Kinesio Tape (5 minutes every 2-3 days) is much less than the time required for the NMES and CPM protocols (30 minutes). This cost and time savings are an important consideration in choosing interventions, particularly because edema reduction is typically not the primary goal but rather is an intervention to support participation outcomes.

This study has several limitations. Circumferential measurements were used for edema assessment rather than volumetric measurements. Volumetric measurement is well validated in the literature and used as the gold standard for assessment of edema in various populations.[18,19] It uses the concepts of water displacement to measure composite extremity mass.[20] The volumeter is challenging to use in the acute stroke population, because of the difficulty in achieving the required position to ensure volumetric accuracy. Placing the patients' hemiplegic or hemiparetic upper extremity into the volumeter is problematic; many patients cannot stand or bend forward to achieve the position. Even if the upper extremity position is attainable, most patients are unable to achieve the testing position, which includes resting the web space of the third and fourth digit onto a dowel.

Circumferential measurement by use of a figure-of-eight method has been shown to be valid for measuring hand edema in the hand in the general population.[18,21,22] However, these studies do not include individuals with hemiplegia or hemparesis secondary to stroke. Clinically, the authors found it difficult to achieve reliable interrater reliability using circumferential figure-of-eight techniques in this population because of the changing position of the paretic hand. The method found to be most useful is circumferential measurements described in this study. This method has been used in other studies evaluating edema in poststroke hemiplegia.[1,17]

Additional limitations include a small sample size that was not powered, and exclusion of patients who developed edema after the screening process. Many patients who did not present with edema during the screening process went on to develop edema during the rehabilitation stay. The treating therapist applied Kinesio Tape, but data were not collected on the results.

The incidence of edema in this sample was 22 %, which is less than what is reported in other studies.[2,3] The average time since stroke in these samples was 6.7 weeks, whereas onset of stroke was only 21.3 days in this study. Time since stroke may account for the difference in incidence reports and may provide insight into the course of edema development in acute stroke. Additionally, these studies used volumeter to screen for edema and reported the use of visual inspection as underestimating the incidence.

Conclusion

The large and medium effect sizes and the median increase in edema in the control group suggest that Kinesio Tape may have utility in edema management; further research is necessary. Research in edema reduction in poststroke hemiplegia is limited, and Kinesio Tape is a fast and relatively inexpensive way to attempt edema reduction. The results of this pilot study warrant further research on the efficacy of Kinesio Tape as a method for edema management poststroke.

Lasting effects of this intervention need to be investigated further.

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