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Research article

THE EFFECTS OF KINESIO^{TM} TAPING ON PROPRIOCEPTION AT THE ANKLE

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ABSTRACT

An experiment was designed to determine if Kinesio^{TM} taping the anterior and lateral portion of the ankle would enhance ankle proprioception compared to the untaped ankle. 30 subjects, 15 men, 15 women, ages 18-30 participated in this study. Exclusion criteria: Ankle injury < 6 months prior to testing, significant ligament laxity as determined through clinical evaluation by an ATC, or any severe foot abnormality. Experiment utilized a single group, pretest and posttest. Plantar flexion and inversion with 20° of plantar flexion reproduction of joint position sense (RJPS) was determined using an ankle RJPS apparatus. Subjects were barefooted, blindfolded, and equipped with headphones playing white noise to eliminate auditory cues. Subjects had five trials in both plantar flexion and inversion with 20° plantar flexion before and after application of the Kinesio^{TM} tape to the anterior/lateral portion of the ankle. Constant error and absolute error were determined from the difference between the target angle and the trial angle produced by the subject. The treatment group (Kinesio^{TM} taped subjects) showed no change in constant and absolute error for ankle RJPS in plantar flexion and 20º of plantar flexion with inversion when compared to the untaped results using the same motions. The application of Kinesio^{TM} tape does not appear to enhance proprioception (in terms of RJPS) in healthy individuals as determined by our measures of RJPS at the ankle in the motions of plantar flexion and 20º of plantar flexion with inversion.

KEY WORDS: Reproduction of joint position sense, Kinesio^{TM} tape, target angle

INTRODUCTION

In recent history, ankle taping has been the principal means of preventing ankle sprains in sport (Robbins et al., 1995). Despite the fact that ankle bracing is growing in popularity, anecdotal evidence suggests that ankle taping with white athletic tape is still very popular among athletes, athletic trainers, and physicians. However other means of ankle taping have emerged for the treatment and prevention of ankle injuries. Kinesio^{TM} taping is a novel method of ankle taping utilizing a specialized type of tape by the same name. Kinesio^{TM} tape differs from traditional white athletic tape in the sense that it is elastic and can be stretched to 140% of its original length before being applied to the skin. It subsequently provides a constant pulling (shear) force to the skin over which it is applied unlike traditional white athletic tape. The fabric of this specialized tape is air permeable and water resistant and can be worn for repetitive days. Kinesio^{TM} tape is currently being used immediately following injury and during the rehabilitation process.

The proposed mechanisms by which Kinesio^{TM} tape works are different than those underlying traditional ankle taping. Rather than being structurally supportive, like white athletic tape, Kinesio™ tape is therapeutic in nature. According to Kenzo Kase, the creator of Kinesio™ tape, these proposed mechanisms may include: (1) correcting muscle function by strengthening weakened muscles, (2) improving circulation of blood and lymph by eliminating tissue fluid or bleeding beneath the skin by moving the muscle, (3) decreasing pain through neurological suppression, and (4) repositioning subluxed joints by relieving abnormal muscle tension, helping to return the function of fascia and muscle (Kase et al., 1996). A fifth mechanism has been suggested by Murray (2001), which describes Kinesio™ tape causing an increase in proprioception through increased stimulation to cutaneous mechanoreceptors. This proposed fifth mechanism has been examined using our current research method.

Little is known of a possible proprioceptive effect of Kinesio™ tape, however it has been anticipated that there will be a facilitatory effect of cutaneous mechanoreceptors as seen in studies examining the effects of linen-backed adhesive athletic tape (Murray, 2001). Kinesio™ tape may have a similar effect on ankle proprioception due to its aforementioned characteristics. This concept underlies our hypotheses stating that proprioception will be enhanced through increased cutaneous feedback supplied from the kinesio™ tape.

Applying pressure to, and stretching the skin can stimulate cutaneous mechanoreceptors. The sense of stretching is thought to possibly signal information of joint movement or joint position (Grigg, 1994). Furthermore, it has been stated that cutaneous mechanoreceptors might play a role in detecting joint movement and position resulting from the stretching of skin at extremes of motion, much like joint mechanoreceptors (Riemann and Lephart, 2002). While the exact role of cutaneous mechanoreceptors is still under discussion, it has become evident they can signal joint movement and to some extent joint position (Simoneau et al., 1997). It is important to note the exact role cutaneous mechanoreceptors play in joint movement and position. Several authors have attributed these cutaneous afferents with a precise ability to convey joint movements through skin strain patterns (Riemann and Lephart, 2002). It was hoped that the results of this study would add to the body of literature on proprioception.

There have been studies documenting a significant effect of the application of white athletic tape to the ankle on ankle proprioception (Karlsson and Andreasson, 1992; Robbins et al., 1995; Heit et al., 1996; Simoneau et al., 1997). However, very little research has been done examining the effect alternative tape applications (such as that of Kinesio™ tape) may have on increasing cutaneous afference. Murray and Husk (2001) examined the effect of kinesio taping on ankle proprioception. They concluded that kinesio taping for a lateral ankle sprain improved proprioceptive abilities in non-weight bearing positions in the midrange of ankle motion where ligament mechanoreceptors were inactive.

The return of normal proprioception following orthopedic injury has been, and should continue to be, a major clinical rehabilitation goal (Lephart et al., 1997). Increased somatosensory stimulation that can be used as proprioceptive input, that is imparted by an elastic tape such as Kinesio™ tape, may enhanced an athlete's postural control system and facilitate their earlier return to activity.

The popularity of the application of tape during the rehabilitation process, and the need for empirical evidence on the effect of Kinesio™ tape and it's potential effect on proprioception were compelling reasons to perform this experiment. The purpose of this study was to determine the effect of the application of this novel tape and specialized taping method to an aspect of ankle proprioception, reproduction joint position sense (RJPS). It was hypothesized that using Kinesio™ taping on the ankle/lower leg would: (1) decrease (improve) the absolute error (AE) of RJPS when compared to the untaped ankle in two ranges of motion: plantar flexion (PF) and inversion at 20º of plantar flexion (INV/PF), (2) decrease (improve) the constant error (CE) of RJPS when compared to the untaped ankle in PF and INV/PF, and (3) show no significant differences in wither constant or absolute error measures amongst gender in either range of motion.

METHODS

Thirty healthy (15 women, 15 men) subjects were screened using a questionnaire, which asked for details on age, gender, and medical history. Individuals with a history of any previous serious ankle injury or surgery, and/or those who currently had ankle pathology, were excluded from this study. Thirty subjects were interviewed and received a pre-participation orthopedic ankle exam by a certified athletic trainer (ATC) to rule out any abnormalities (i.e. abnormal ligament laxity, congenital deformities, neurological deficits, etc.) that may have affected experimental data. The orthopedic evaluation included an assessment for presence of pain, stress tests to determine ligamentous stability, circulatory tests, assessment of cutaneous sensation, and tests of active, passive, and resisted ranges of motions.

Reproduction of joint position sense (RJPS) was measured in accordance with the subject's ability to actively recreate a randomly selected target position. These ankle measures were taken for both plantar flexion and inversion with 20º plantar flexion before and after the application of Kinesio^{TM} tape. An active RJPS paradigm was selected in order to utilize a well accepted repositioning technique originally forwarded for the ankle by Glencross and Thornton (1981) and then further developed by Barrack and colleagues (1983) for RJPS at the knee. Due to the fact that cutaneous mechanoreceptors are stimulated during both passive and active movements, it was assumed that the chosen paradigm would successfully test for a treatment effect of Kinesio^{TM} tape.

Ankle position data was measured using and instrumented platform (Figure 1) with a moveable footplate capable of providing measures of ankle joint position. The footplate was stabilized throughout testing with the use of a counterbalance system, which created an unresisted range of motion at the talocrural joint. Attached to the platform was a precision potentiometer (Spectrol, Type 157, Ontario, CA), which allowed a measure of specific angular position digitally, displaying the position to the nearest tenth of a degree on a digital liquid crystal display and computer data collection system (see below). Joint repositioning trials were colleted at a rate of 100 Hz. Laboratory tests of this apparatus have demonstrated a repeatable range of motion error of less that ± 0.05°. The potentiometer was aligned with lateral aspect of the ankle to assure that the numbers supplied were accurate readings for the talocrural joint in the sagittal plane. During inversion with 20° of plantar flexion condition, the potentiometer was aligned with the center of axis of motion of the sub-talar joint in the coronal plane with an anterior tilt of 20°. This information was then recorded on a computer through a 16-bit analog to a digital board using Bioware® V.3.22 (Kistler Instrument Corporation, Amherst, NY) data collection software. A range of motion block was used to set the talocrural neutral position (0º), achieved when the foot is at a right angle to the tibia. Upon completion of data collection with each subject the RJPS apparatus was recalibrated to assure accuracy throughout data collection.

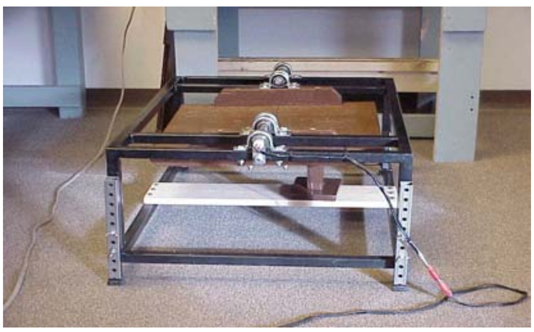

Figure 1. Ankle joint position sense apparatus.

Procedures

To ensure RJPS was affected only by mechanoreceptors within the ankle, subjects were blindfolded and asked to wear headphones playing white noise to ensure both visual and auditory cues did not affect the results. In attempts to limit undesired cutaneous feedback, no straps were used to hold the subject's foot to the platform. RJPS was then assessed in conditions of no ankle tape (no-tape) and kinesio taped (taped) ankle in the motions of plantar flexion and inversion with 20º plantar flexion. All subjects were placed in a seated position with the foot resting on the footplate of the apparatus.

RJPS measures were taken by passively placing the dominant ankle to a random target angle and asking the subject to actively reposition their ankle to the target angle from a neutral starting position. Target angle positions in the plantar flexion rang varied from only 1º to 35º in attempts to eliminate extreme ranges of plantar flexion. Inversion with 20º of plantar flexion had an angular position range from 1º to 10º. Five trails were given at each range of motion with absolute and constant error recorded for each.

Subjects were allowed to sit comfortably with their foot on the testing apparatus. They were then passively placed to a random target position. The subjects were held in that position for five seconds, asked to remember the target angle, and then passively returned to their neutral starting position. Subjects were then asked to actively reposition their foot as closely to the target angle as possible. Through headphone communication, audio mixed over the white noise, subjects were instructed to press an indicator button placed in their right hand, signaling the completion of their target-reposition task (Figure 2). Data was recorded in the Bioware system after passive target positioning (by the researcher), and following the subject's signal of completion of the target-repositioning task.

Figure 2. Subject positioning during data collection.

A cross-over design was employed with respect to the order of the un-taped and taped conditions. Specifically, the application of the

Kinesio™ tape occurred after completion of the first 10-trail assessment of RJPS in plantar flexion and inversion with 20º of plantar flexion for 15 (or half) of the participants. The other participants performed the positioning tasks under the taped condition first, followed by the un-taped condition. The participants were randomly assigned with regard to the order of the taped and un-taped conditions. There was a 5 minute waiting period between conditions and RJPS assessment. All thirty subjects we assessed of a period of one week.

Taping

Subjects were taped for a lateral ankle sprain in accordance to Kenzo Kase's Kinesio™ taping manual (Kase et al., 1996). Taping procedures were applied by the principal investigator (a certified athletic trainer) to ensure consistency throughout the study.

For taping, each subject's foot was placed in relaxed position while they sat on a taping table with the ankle in slight plantar flexion. The first strip of tape was placed from the anterior midfoot, stretched approximately to 115-120% of its maximal length and attached just below the anterior tibial tuberosity over the tibialis anterior muscle. The second strip began just above the medial malleolus and wrap around the heel like a stirrup, attaching just lateral to the first strip of tape. The third strip stretched across the anterior ankle, covering both the medial and lateral malleolus. Finally, the fourth strip originated at the arch and stretched slightly, measuring 4-6 inches above both the medial and lateral malleolus (Figure 3).

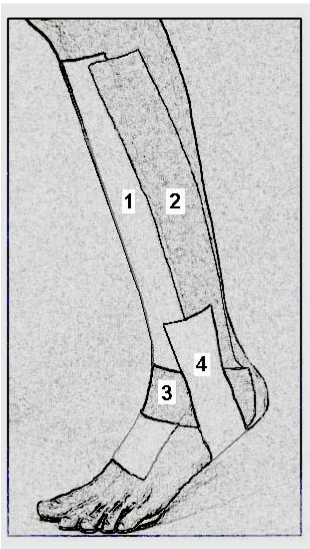

Figure 3. Tape strips comprising Kinesio™ tape job. Numbers indicate order of application.

Data Analysis

Constant error and absolute error values were examined by taking the difference between the target angle and the trial angle for each subject. Constant error examined the direction of imprecision, measuring the number of positive or negative degrees the actively reproduced ankle position was from the target position. Whereas absolute error took only the number of degrees the actively reproduced ankle position was from the target position. In examining possible gender differences, changes in absolute error and constant error between un-taped conditions and taped conditions were examined for both plantar flexion and 20° of plantar flexion with inversion.

This study used a pretest-posttest design. The independent variable was the Kinesio™ taping procedure, and the dependent variable was reproduction of joint position sense. Results were evaluated for statistical significance ($p < 0.05$) using a paired, two-tail *t*-test computed for both constant and absolute error values among subjects and independent *t*-tests to evaluate across genders.

RESULTS

Upon completion of data analysis, no significant differences of absolute error between the no-tape condition (M=2.19° ± 1.20°) and the taped condition (M=2.07° ± 0.98°) were found in plantar flexion, nor were any significant differences seen between the no-taped condition (M=1.87° ± 0.89°) and the taped condition (M=1.95° ± 0.90°) in the combined motion of inversion with 20° of plantar flexion (Figure 4). These results contest our first hypotheses, which stated Kinesio™ taping would decrease (improve) the absolute error on RJPS when compared to the untaped ankle.

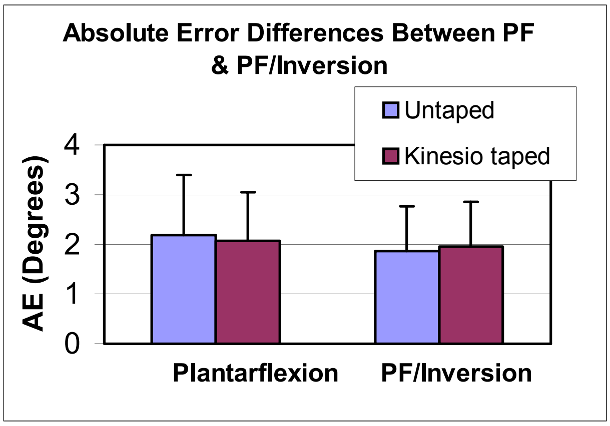

Figure 4. Group absolute error (AE) differences between pre and post tape conditions.

No significant difference in constant error was shown in plantar flexion between the no-tape condition (M = -0.28°±2.01°) and the taped condition (M = 0.08°±1.77°). Furthermore, there was no evidence of significant change in the combined motion of inversion with 20° of plantar flexion between the no-taped condition (M = 0.24°±1.80°) and the taped condition (M = -0.02°± 1.46°) (Figure 5). These results discount our second hypotheses, which stated Kinesio™ taping would decrease (improve) the constant error of RJPS when compared to the un-taped ankle.

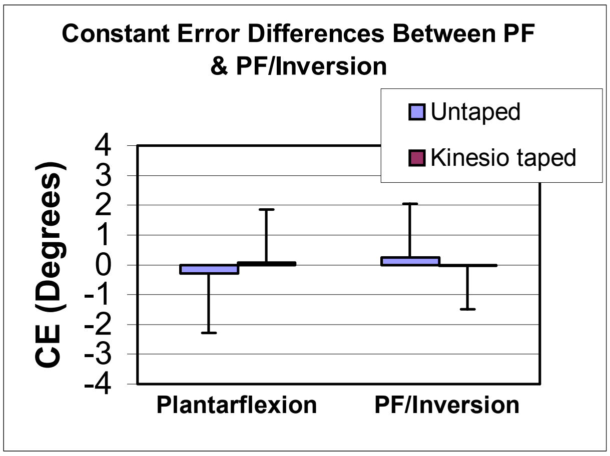

Figure 5. Groups constant errors (CE) differences between pre and post kinesio tape conditions.

The data was also analyzed according to gender. No significant ($p > 0.05$) differences were detected in changes of absolute or constant error in plantar flexion or plantar flexion with inversion (Table 1) between genders. The third research hypothesis was supported.

Table 1. Mean (SD) values for Error Measure Differences (degrees, °) amongst genders.

	Plantar flexion		PF/Inversion	
	Men	Women	Men	Women
AE	-.15 (1.79)	-.10 (.99)	.40 (1.19)	.23 (1.34)
CE	.32 (2.38)	.44 (1.46)	-.11 (1.46)	-.86 (1.58)

Abbreviations: AE= Absolute error, CE= Constant error. * No significant difference between men and women error values.

In summary, group data revealed no AE or CE effects of Kinesio™ tape in any of the ranges of motion. In gender analysis, Kinesio™ tape had no effect on the changes of absolute error or constant error amongst gender in either plantar flexion or 20° plantar flexion with inversion.

DISCUSSION

Results indicated no significant differences in either absolute or constant error between the no-tape and Kinesio™ taped conditions in either plantar flexion or inversion with 20º of plantar flexion, indicating that kinesio™ tape likely does not enhance proprioception when measured by active ankle RJPS in healthy subjects. These results do not concur with Murray's (2001) findings, which showed that Kinesio™ tape enhanced RJPS through increases in cutaneous stimulation received from the Kinesio™ tape .

It is important to note, however, since the present study did not specifically measure changes in cutaneous sense, that kinesio™ tape cannot be ruled out as a contributor to increasing cutaneous sense. We can only speculate on the role cutaneous sense may or may not play in RJPS. It may be that kinesio™ tape does contribute to increasing cutaneous feedback, however it appears that it plays only a minimal role in RJPS. This explanation has been forwarded by authors who have suggested muscle and joint mechanoreceptors are the primary contributors to proprioception (Grigg et al., 1973; Gandevia and McCloskey, 1976; Barrack et al., 1984; Riemann and Lephart, 2002). Conversely, cutaneous ankle mechanoreceptors may rapidly accommodate and not provide useful feedback during repeated movements.

While comparing differences in CE and AE between genders, no significant differences were noted in either plantar flexion or inversion with 20º plantar flexion. These findings concur with those of the Walter's study (2000), which showed no significant gender differences when examining the effects of taping on RJPS.

The findings of the present study lend support to the concept that ankle taping has no significant effect on ankle RJPS in plantar flexion or inversion with 20º of plantar flexion. In Walters' study (2000) examining the effects of taping on RJPS, she found no significant differences in absolute error or constant error when comparing data before and after the application of tape to the ankle in the ranges of plantar flexion and plantar flexion with inversion. The application of Kinesio™ tape for a lateral ankle sprain in this study was less restrictive than her application of the more traditionally restrictive Gibney Basketweave, and no significant changes in absolute error or constant error were witnesses in either study. The present findings suggest that these two distinctively different taping procedures are similar in the sense that neither enhances RJPS.

With regard to methodology and its effect on results, Heit et al., (1996) examined the effects of bracing and taping on proprioception, noting that both treatments significantly improved RJPS in plantar flexion (AE). In comparison to the present study, their un-taped condition demonstrated an AE of 5.93°±1.91° compared to our observation of an AE of 2.19°±1.20°. When taped, their subjects demonstrated a significant change in AE of 3.90°±1.80° compared to our non-significant observation of an AE of 2.07°±0.98°. Heit and co-workers' (1996) methods utilized a Cybex II™ electronic goniometer, which required foot straps to hold the foot in place while testing. It is possible that these straps may have provided additional cutaneous feedback cues to the subject during the reproduction task, thus facilitating the subject's ability to more accurately reposition themselves to the previous target position. This may offer one explanation for the difference in their findings. Unlike the present study design, which utilized randomly selected target positions with each individual trial, Heit and co-workers used predetermined target positions that were repeated over a sequence of trials. By repeating these predetermined target positions, it is possible that a learning effect could have been introduced, thus enabling the subjects to improve (decrease) absolute error scores over the duration of their four trial sequence. Another difference between these studies can be seen in the positioning of the subject. It has been suggested that gravitational positioning may have an affect RJPS measures (Brock, 1994). The subjects in this study were seated vertically to eliminate any possible gravitational effects that may have accompanied lying prone during non-weight bearing testing, dissimilar to Heit and co-workers' methods.

The present results also differ with the findings of Simoneau and co-workers (1997), who witnessed significant change in RJPS error in plantar flexion upon application of two five inch strips of white athletic tape applied to the lower leg. Strips of white athletic tape were placed along the Achilles tendon and down the anterior aspect of the ankle. Simoneau and co-workers' (1997) findings indicated that proprioception, as assessed by RJPS, might have been facilitated through the increase in cutaneous feedback supplied by the two strips of athletic tape. However, the findings of this study do not concur.

Again, as was the case in Heit et al.'s study, subjects in Simoneau and co-workers' study were positioned to a predetermined target position for four consecutive trials, possibly introducing a learning effect. Finally, Simoneau placed two straps around each calf to ensure accurate foot positioning throughout the duration of his data collection. However, it is reasonable to believe these straps may have influenced cutaneous feedback in the ankle due to their contact with the gastrocnemius and soleus muscles (primary plantarflexors of the foot). With this increased cutaneous feedback and possible mechanical restriction, it is plausible that the subjects' ability to actively recreate target position was affected.

CONCLUSIONS

The application of Kinesio^{TM} tape does not appear to enhance RJPS, when measured by active ankle RJPS in healthy subjects. The hypotheses stating that ankle taping would decrease (improve) absolute error and constant error of RJPS were not supported by the data.

Despite the unknown proprioceptive effects of Kinesio^{TM} tape, it has been suggested as a possible proprioceptive facilitator in the acute phases of the injury process (Murray, 2001). Conversely the present results suggest that the application of Kinesio^{TM} tape to lower leg and ankle does not provide proprioceptive enhancement as measured by RJPS. If Kinesio^{TM} taping is a mechanism that facilitates RJPS, further investigation on subjects suffering from acute proprioceptive loss due to injury is needed so a possible enhancement of proprioception can be specifically examined.

In order to fully understand the effect of Kinesio^{TM} tape on proprioception, further research needs to be conducted on other joints, on the method of application of Kinesio^{TM} tape, and the health of the subject to whom it is applied. Further research may provide vital information about a possible benefit of Kinesio^{TM} taping during the acute and sub acute phases of rehabilitation, thus facilitating earlier return to activity participation.

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KEY POINTS

- Proprioception research
- Evaluation of a new taping method
- Augmentation of sensory feedback
- Rehabilitation technique

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