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original research

Extended Use of Kinesiology Tape and Balance in Participants With Chronic Ankle Instability

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Context: Participants with chronic ankle instability (CAI) have been shown to have balance deficits related to decreased proprioception and neuromuscular control. Kinesiology tape (KT) has been proposed to have many benefits, including increased proprioception.

Objective: To determine if KT can help with balance deficits associated with CAI.

Design: Cohort study.

Setting: Research laboratory.

Patients or Other Participants: Thirty participants with CAI were recruited for this study.

Intervention(s): Balance was assessed using the Balance Error Scoring System (BESS). Participants were pretested and then randomly assigned to either the control or KT group. The participants in the KT group had 4 strips applied to the foot and lower leg and were instructed to leave the tape on until they returned for testing. All participants returned 48 hours later for another BESS assessment. The tape was then removed, and all participants returned 72 hours later to complete the final BESS assessment.

Main Outcome Measure(s): Total BESS errors.

Results: Differences between the groups occurred at 48 hours post–application of the tape (mean difference = 4.7 ± 1.4 errors, $P < .01$; 95% confidence interval = 2.0, 7.5) and at 72 hours post–removal of the tape (mean difference = 2.3 ± 1.1 errors, $P = .04$; 95% confidence interval = 0.1, 4.6).

Conclusions: The KT improved balance after it had been applied for 48 hours when compared with the pretest and with the control group. One of the most clinically important findings is that balance improvements were retained even after the tape had been removed for 72 hours.

Key Words: Balance Error Scoring System, ankle sprains, proprioception

Key Points

- Balance deficits improved in individuals with chronic ankle instability after kinesiology tape had been applied for 48 hours.
- The balance improvements were retained 72 hours after the kinesiology tape had been removed.

Lateral ankle sprains are one of the most common injuries in athletics today.[1] They can hinder both athletic performance and activities of daily living. After sustaining a lateral ankle sprain, some people are predisposed to recurrent injuries, which may eventually lead to chronic ankle instability (CAI).[2] People with CAI can have postural-control deficits because of a decrease in neuromuscular control at the ankle.[3] These deficits can hinder athletic performance and lead to an increased risk of injury.[2,4] Many factors can influence postural control, including sensory information obtained from the somatosensory, visual, and vestibular systems and motor responses that affect coordination, joint range of motion, and strength.[5]

Numerous treatment strategies can be used to improve balance, including whole-body vibration, taping, bracing, orthotics, balance training, and joint mobilizations. Kinesiology tape (KT) is a type of clinical tape that was developed in the 1970s by chiropractor Dr Kenzo Kase[6] and made popular by athletes at the 2008 Olympics in Beijing, China. Kase[6] claimed the tape can improve proprioceptive awareness. It is theorized that the pressure and compression created by the KT stimulates cutaneous mechanoreceptors, which convey information about joint position and movement, and therefore, may enhance proprioception.[7] One group[8] reported that KT can have a positive effect on ankle proprioception, but another group[9] identified no improvement in proprioception. Both sets of authors[8,9] used laboratory-based measures to evaluate proprioception, and these types of procedures may not be readily accessible in the sports medicine clinic. Thus, procedures to evaluate postural stability that are more readily available in the clinical setting may be more applicable to clinicians using KT. Examples of these measures include single-legged balance tests or reaching tasks that require a combination of strength, flexibility, and proprioception. The Balance Error Scoring System (BESS) is a measuring technique that requires minimal equipment and is a quick and easy assessment of balance.[10] The BESS has also been used in previous research[4] that evaluated balance in people with a history of ankle injuries.

A number of authors[11–15] have evaluated how KT affects reach distances during the Star Excursion Balance Test, consistently finding no improvement. Other groups[16–18]

Table 1. Participant Demographics

Characteristic	Group	
	Kinesiology Tape (n = 15)	Control (n = 15)
Age, mean ± SD, y	19.9 ± 1.7	20.9 ± 2.1
Height, mean ± SD, cm	168.4 ± 11.2	173.2 ± 10.4
Mass, mean ± SD, kg	69.8 ± 15.0	77.1 ± 14.4
Sex, No.		
Males	4	8
Females	11	7
Leg tested, No.		
Right	6	13
Left	9	2
Identification of Functional Ankle Instability questionnaire score, mean ± SD	21.6 ± 4.8	21.5 ± 3.9
No. of previous ankle sprains, mean ± SD	3.4 ± 1.5	2.7 ± 1.9
Time since last ankle sprain, No.		
>2 y	4	6
1–2 y	5	3
6–12 mo	3	4
1–6 mo	3	2
<1 mo	0	0
Frequency of instability during sport or recreational activity, No.		
Once a month	5	4
Once a week	6	9
Once a day	4	2

evaluating postural sway during quiet standing or single-legged–balance tests have noted more promising results. In each study, small yet potentially clinically meaningful improvements were identified in balance after tape application.

An interesting aspect of these studies is the length of time the tape was applied. Many authors performed the posttest immediately after tape application; however, when participants wore the tape for 1 to 2 days, the outcome measure improved.[8,16] Clinically, we apply the tape for multiple days, so it makes sense to design a research study that also continues the intervention for multiple days.

The fact that KT can be left on the skin for several days and can therefore provide continual feedback to the mechanoreceptors is one of the primary reasons it has the potential to improve balance. The KT might also assist in activating weak muscles that have been damaged during previous ankle sprains.[19] Improved proprioception enables the person to have a better sense of where his or her foot or ankle is positioned. This improved positioning creates more stability during movement and potentially improves overall quality of life. Thus, the purpose of our investigation was to determine the effects of KT application on postural stability in people with CAI.

METHODS

Participants

A total of 30 participants were included in this study. Participants were recruited from the School of Public Health, the Student Recreational Sports Center, and the local community to participate in this study. All participants had CAI, which was determined by the Identification of Functional Ankle Instability (IdFAI) questionnaire.[20] Specific inclusion criteria for participation were (1) a history of at least 1 lateral ankle sprain, (2) having experienced the sensation of "giving way" at least once within the last 6 months, and (3) a score of 11 or more on the IdFAI. Means, standard deviations, and frequencies for age, height, weight, IdFAI score, sex, and leg tested are reported in Table 1.

Participants were excluded from the study if they had acute symptoms of a lower extremity injury (pain, swelling, etc), had recently been diagnosed with a concussion or head injury, or had a previous lower leg surgery, previous experience using KT on the ankle, or symptoms of a head cold. Before the study, all participants read and signed an informed consent form, and the study was approved by the host university's institutional review board for the protection of human subjects.

Procedures

On the first day, participants completed the health history questionnaire, the informed consent, and the IdFAI. Participants then completed 2 practice trials of the BESS test to become comfortable with the procedures. On day 2, participants completed the BESS as a pretest and then were randomly divided into 2 groups: the KT group and the control group. The KT group received the taping intervention to the ankle. The control group received no intervention. All participants, both KT and control, were asked to return 48 hours later. Those in the KT group were instructed to keep the tape on their ankle until they returned. Participants were instructed to shower, exercise, and complete activities of daily living as usual. All participants returned in 48 hours for the next test; they repeated the BESS test and, if they were in the KT group, the tape was removed. All participants were then instructed to return 72 hours later for the final BESS test.

Figure 1. A, Lateral and, B, Medial views of the application of kinesiology tape. We applied the tape in the following order: red tape over the posterior tibialis muscle, yellow tape over the anterior tibialis muscle, purple tape over the peroneus longus muscle, and green tape over the transverse arch.

Balance Error Scoring System. The BESS consists of 6 conditions on 2 test surfaces: a hard flat surface and a foam surface (Airex Balance Pad; Perform Better, Cranston, RI). Three stances are tested: double-legged stance, single-legged stance, and tandem stance. A single examiner administered the test to all participants. With each condition, the participant was instructed to try and remain motionless with the hands on the iliac crest and with eyes closed for 20 seconds. The examiner counted the errors as the participant balanced. Possible errors were (1) lifting hands off the iliac crest; (2) opening eyes; (3) stepping, stumbling, or falling; (4) moving the hip into more than 30° of flexion or abduction; (5) lifting the forefoot or heel; and (6) remaining out of the testing position for more than 5 seconds. To be eligible for the study, all participants had to demonstrate at least 14 errors on the BESS.

According to a systematic review by Bell et al,[21] the reliability of the BESS ranges from moderate to good. The same systematic review concluded that the BESS has moderate to high criterion-related validity (depending on testing conditions) and high content validity for identifying balance deficits.[21] Our examiner's reliability for BESS total score was intraclass correlation coefficient (2,k) = 0.99.

Kinesiology Tape. We used Kinesio Tex Tape (Kinesio Products, Albuquerque, NM). Although a variety of taping techniques have been developed for the ankle, little consistency exists in the published research regarding applying KT to the ankle. The taping technique used in this study was created in conjunction with the instructor of the KT Certification class. The taping technique consists of 4 strips of tape, with the lengths depending on the size of the participant. To begin, the participant was asked to lie prone on a treatment table with the foot hanging off in a relaxed, resting plantar-flexed position. The taping procedure was applied by the same certified athletic trainer to ensure consistency throughout the study. When the tape was applied to the skin, the paper backing was removed at one end, making that the anchor. The anchors at the beginning and end of each strip of tape were laid on the skin with no tension.

Moderate tension (20%–35%) was provided when applying each strip of tape to the participant's skin. After the tape was applied, it was rubbed, creating friction and heat to activate the adhesive and properly adhere it to the skin (Figure 1). The first strip of tape was placed approximately from the origin to the insertion of the posterior tibialis muscle. This strip began around the inner posterior borders of the tibia and fibula and extended over the muscle to around the medial malleolus. The participant then lay supine on the treatment table for the remainder of the taping procedure. The second strip was placed approximately from the origin to the insertion of the anterior tibialis muscle. It extended from around the upper two-thirds of the lateral surface of the tibia to the dorsum of the foot around the first cuneiform and first metatarsal bones of the foot. The third strip was extended approximately from the origin to the insertion of the peroneus longus muscle. This strip began around the head of the fibula, ran on top of the lateral malleolus, and then continued and wrapped under the plantar aspect of the foot, ending around the base of the first metatarsal. The fourth strip began just anterior to the lateral malleolus, extended under the plantar aspect of the foot, and was pulled up the transverse arch of the foot.

Statistical Analysis

We used 3 repeated-measures analyses of variance, 1 for each dependent variable, to determine if the KT had an effect on BESS errors. The 3 dependent variables were total of the flat conditions, total of the foam conditions, and the total BESS score. Each analysis included 1 within-subject factor, time at 3 levels (pretest, 48 hours post–tape application, and 72 hours post–tape removal), and 1 between-subjects factor, KT group and control group. A Tukey post hoc test was conducted on all significant differences. The a priori α level was set at $P < .05$ for all analyses.

RESULTS

For the overall total BESS scores, interpretation of the repeated-measures analyses of variance revealed a significant interaction between the groups and the test times ($F_{2,56} = 6.16$, $P = .004$, $\eta_p^2 = 0.18$, power = 0.87; Figure 2). Specifically, we found no difference in total scores between the KT and control groups at the pretest ($P = .86$) but we did find a difference between the groups at 48 hours post–application of the tape (mean difference = 4.7 ± 1.4 errors, $P < .01$; 95% confidence interval [CI] = 2.0, 7.5) and at 72 hours post–removal of the tape (mean difference = 2.3 ± 1.1 errors, $P = .04$; 95% CI = 0.1, 4.6). We also found an improvement in balance scores in the KT group between

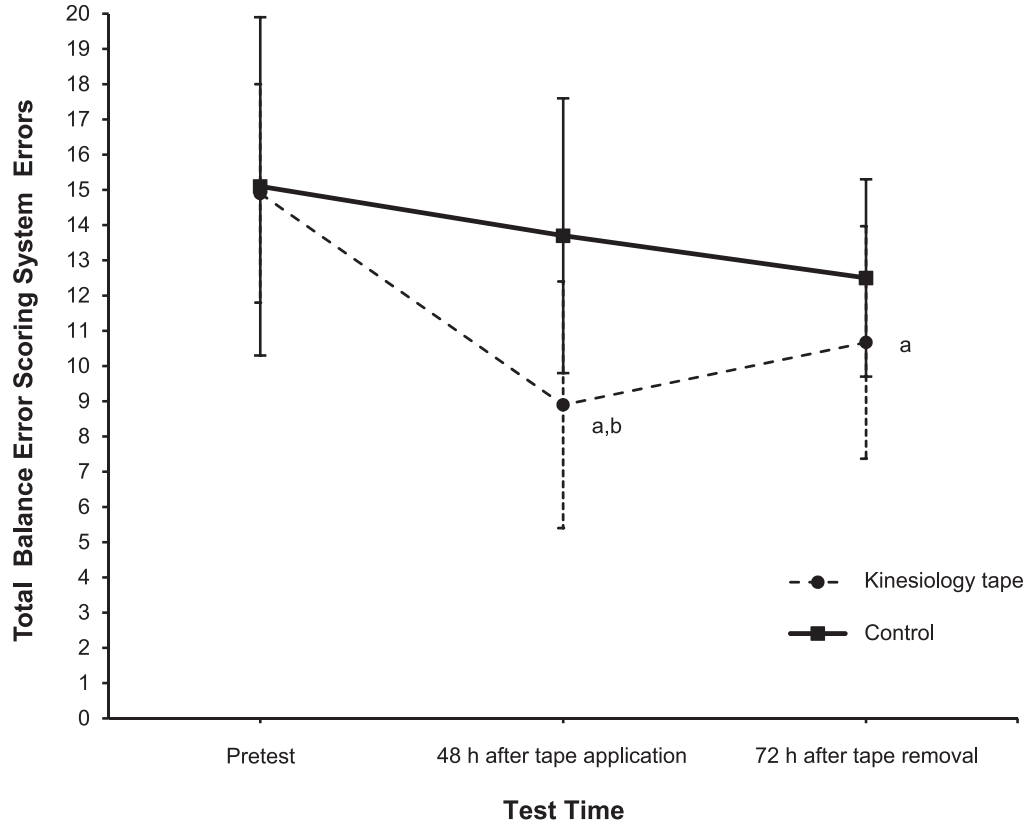

Figure 2. Total balance errors at each test time. [a] Indicates a change in balance errors from the pretest ($P < .05$). [b] Indicates a difference compared with the control group ($P < .05$).

pretest and 48 hours post–tape application (mean difference = 5.9 ± 0.9 errors, $P < .01$; 95% CI = 3.7, 8.2) and between pretest and 72 hours post–removal of the tape (mean difference = 4.7 ± 1.0 errors, $P < .01$; 95% CI = 2.3, 7.2).

When evaluating the flat and foam conditions separately, we found no group-by-time interaction for the total flat condition ($F_{2,56} = 2.75$, $P = .07$, $\eta_p^2 = 0.09$, power = 0.52) but noted an interaction between the groups and test times for the total foam condition ($F_{2,56} = 4.5$, $P = .02$, $\eta_p^2 = 0.14$, power = 0.75; Table 2).

DISCUSSION

The primary finding of this study was an improvement in balance scores after KT was applied for 48 hours to participants with CAI. Potentially one of the most clinically important findings of this study is that balance improvements were retained for 72 hours even after the tape was removed. This investigation is unique when compared with other KT studies in that it is one of the few that looked at the effects of KT on balance in participants with CAI when the tape was applied for an extended period of time. This is also one of the only studies that included a follow-up test after tape removal to see if the balance improvements were retained.

Table 2. Balance Error Scoring System Errors for Flat and Foam Totals, Mean ± SD

Variable	Pretest	48 h After Tape Application	72 h After Tape Removal
Flat total			
Kinesiology tape group	4.1 ± 1.8	2.1 ± 1.7	2.5 ± 1.8
Control group	4.5 ± 3.1	4.4 ± 2.8	3.9 ± 1.7
Foam total			
Kinesiology tape group	10.8 ± 1.8	6.8 ± 2.4[a,b]	7.6 ± 1.8[a]
Control group	10.6 ± 2.2	9.2 ± 1.4	8.5 ± 1.8

[a] Indicates a change in balance errors from the pretest ($P < .05$).
[b] Indicates a difference compared with the control group ($P < .05$).

At 48 hours after the KT was applied, errors from baseline decreased 24%; at 72 hours post–tape removal, errors decreased 18%. We suggest that the decrease in BESS errors (improvement in balance) was due to the extended period of time that the KT was applied to the skin. Unlike other types of tape, KT can be worn up to 5 days. When this tape is worn for several days (in our study, it was worn for 48 hours), we hypothesize that the cutaneous receptors and mechanoreceptors will be stimulated constantly. According to the closed-loop theory,[22] a stimulus (which could be tactile, pressure, or another type) applied to the body provides immediate afferent feedback data from the limb. The body compensates and becomes accustomed to receiving that afferent feedback from the stimulus, even after the stimulus has been removed.[8,22–24]

After a lateral ankle sprain, the ankle proprioceptors might be damaged, causing dampened feedback regarding where the limb is in space.[25] When the KT is applied to the leg, the tactile stimulus from the tape provides the feedback that has been lacking from the damaged proprioceptors. When the tape is applied for a longer period of time, there is enhanced afferent feedback, which could be retained

even after the KT is removed. This could explain why the balance improvements persisted even after the tape was removed for 72 hours. Future authors should investigate whether these balance improvements last beyond 72 hours.

Many researchers[11,13,14,26] found no improvement in balance after KT application. This may be because they evaluated healthy, uninjured participants and left the tape on for only a short period of time. Healthy participants may not show improved balance because they have "normal" balance abilities, and therefore, it may be difficult for any intervention to result in improvement. Participants with CAI, such as those in the current investigation, are known to have balance deficits.[4] Thus, it is more appropriate to investigate mechanisms that might improve balance in this sample of participants. In our study, we made certain that all CAI participants had balance deficits by requiring them to have at least 14 BESS errors at baseline testing. This criterion was based on 2 previous studies.[4,27] Confirming that participants had balance deficits when they began the study created the best environment to identify balance improvements.

A few investigators[8,12,15,16] have looked at the effects of KT on balance in people with CAI and, surprisingly, found no improvements. One major difference between these studies and ours is the length of time the KT remained on the skin before BESS testing. Bicici et al[15] evaluated balance immediately after KT application, whereas Hettle et al[12] left the KT on for 20 minutes. Both groups concluded that KT had no effect on balance. Shields et al[16] left the tape on for 24 hours. What is interesting about their study is that the authors identified minor balance improvements but concluded they were not clinically meaningful. This conclusion, along with our findings, suggests that KT needs to be left on for at least 48 hours to improve balance. Based on manufacturer information, KT has reportedly been left on up to 5 days.

Simon et al[8] left the KT on for 72 hours and measured changes in proprioception through ankle–force-sense testing. They found that the KT improved proprioception in the ankle-instability group. After wearing KT for 72 hours, the CAI group had similar proprioceptive function as the healthy ankle group. This additional evidence indicates that when KT is applied to the ankle for a longer period of time, ankle stability improves. These results are similar to our results, and we believe that leaving the KT on for an extended period of time constantly stimulates the cutaneous receptors and mechanoreceptors.

We also theorize that our taping technique may have contributed to the improvement in balance. Kase et al[6] proposed that pulling the tape from the origin to the insertion of a muscle facilitates muscle activation and helps the muscle work. Pulling the tape from the insertion to the origin of a muscle inhibits the muscles and tries to prevent the muscle from working. In this study, we identified the muscles in the leg that could affect balance, and we facilitated them. According to the Kinesio Taping Association,[19] facilitating muscles that are weak from a chronic condition or injury, such as CAI, increases muscle tension. The muscle fibers' and spindles' tension increases and they fire more, which might increase proprioceptive function.[6,19] However, with the amount of skin, subcutaneous fat, and fascia between the tape and the muscle, it is still unclear if the pull of the tape can really affect the muscle fibers.

A number of authors[28–31] evaluated the effects of traditional white cloth tape on ankle proprioception. One group[29] found that applying tape strips to the skin of the ankle resulted in an increase in cutaneous sensory feedback, but this study was conducted in healthy individuals who did not have decreased proprioception. Other studies[25,30,32] have looked at the effects of ankle braces on ankle proprioception. In 1 investigation,[25] when participants with ankle instability wore an ankle brace, the threshold-to-detection-of-passive-motion scores were higher than in no-tape and tape-only groups. These findings also support that theory: KT applied for an extended period of time enhanced balance.

CLINICAL IMPLICATIONS

The findings of our study can be used to treat athletes who exhibit symptoms of CAI and feel unstable while participating in physical activity. The KT can be used during the rehabilitation of individuals experiencing CAI. Using different tools may help to facilitate the rehabilitation process, especially in sports that require balancing techniques, including baseball or softball pitching, diving, gymnastics, and any other sport in which CAI's balance deficits hinder athletic performance. Clinicians can also use this information to aid patients having trouble completing activities of daily living due to balance deficits from CAI. The KT can be used on all age ranges and all sports because it is waterproof, hypoallergenic, and moveable and can be worn for long periods of time.

LIMITATIONS

One limitation was that the tape cannot be applied in identically every time it is used, although it was applied by the same clinician. Another limitation was the known learning effect with the BESS.[10,33] We attempted to prevent this by conducting 2 practice tests on the first day, so participants could become completely comfortable with the task. We think this was accomplished because the control group's balance did not improve during the study.

Areas of further research include multiple applications of the KT to the same participants to see if balance errors decrease more than with a single application. Multiple applications could include reapplying KT to the same participant after 72 hours and waiting another 48 hours to see if the BESS score would improve even more. A long-term follow-up to determine the length of time the balance improvements are retained would also be interesting. Finally, because it is theorized that when the KT is pulled from origin to insertion, muscle activation is facilitated, would the results differ if the tape is pulled from insertion to origin, thus inhibiting the muscle?

CONCLUSIONS

Balance can affect activities of daily living and sport performance in individuals with CAI. Many techniques have been used to improve balance in people with ankle instability. It appears that KT applied to the ankle for 48 hours can improve balance compared with baseline and with individuals who had CAI but no KT application. More importantly, when compared with the control group, those

balance improvements were retained after the KT had been removed for 72 hours. Even though other authors have shown no balance improvement in participants with CAI, we are the first to leave the KT on for 48 hours. Future investigators should follow these guidelines and see if these results can be reproduced.

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