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THE EFFECT OF KINESIO® TAPE ON VERTICAL JUMP AND DYNAMIC POSTURAL CONTROL

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ABSTRACT

Introduction and Background: Ankle injuries are one of the most common injuries among physically active individuals. The role of prophylactic ankle taping and bracing has been studied extensively. Kinesio® Tape (KT) is a somewhat new type of taping technique gaining popularity as both treatment and performance enhancement tool. However, there is limited research on the effect of KT on functional performance.

Purpose: The purpose of this study was to determine whether the application of Kinesio Tex® Tape had an effect on vertical jump and dynamic postural control in healthy young individuals.

Methods: 52 healthy subjects free of ankle or lower extremity problems (28 males and 24 females; age: 22.12 ± 2.08 years; height: 170.77 ± 8.69 cm; weight: 69.90 ± 12.03 kg) participated in the study. Subjects were randomly assigned to either the experimental group (KT with tension) or the control group (KT without tension). Vertical jump was measured using the VertiMetric device and dynamic postural control was assessed using the Star Excursion Balance Test (SEBT) under three conditions: (1) without taping; (2) immediately after taping; (3) 24 hours after taping with the taping remaining in situ.

Results: Three-way repeated measure ANOVA was conducted in order to identify differences between the experimental and the control group during the three conditions. Overall, there were no differences between groups in vertical jump maximum height, vertical jump average height, or the SEBT scores for the three time periods (pre-test, post-test, 24hrs-post-test). However, the main effect of KT was moderated by a significant gender interaction, resulting in a statistically significant effect of KT for the SEBT scores in the posterior-medial direction, $F(1.72, 82.57) = 4.50$, $p = 0.018$ and the medial direction, $F(1.75, 83.81) = 4.27$, $p = 0.021$. Follow-up analyses indicated that female subjects in the KT group had increased SEBT scores between three time periods when compared to the placebo group.

Discussion: KT application on the ankle neither decreased nor increased vertical jump height in healthy non-injured young individuals, but did increase dynamic postural control in females for certain directions. Additional study is warranted using different measures of balance to further investigate the effect of KT on dynamic postural control.

Level of Evidence: 2b

Key Words: Dynamic postural control, Kinesio taping, vertical jump

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The protocol for this study was approved by the Institutional Review Board of California State University, Long Beach.

INTRODUCTION

Ankle injuries are one of the most common injuries in the athletic population, accounting for up to 20% of injuries.[1] It is estimated that more than 25,000 ankle sprains occur each day in the United States.[1] Among ankle injuries, 33-73% are ankle sprains.[1] The high incidence of ankle injuries has led to the design of numerous support systems for the ankle joint.[3,4] The majority of ankle stabilizers were developed to support the joint and to limit inversion and eversion of the foot, without compromising normal joint mechanics.[2] Prior to the creation of ankle braces, traditional ankle taping technique using porous adhesive tape was used as an ankle stabilizer.[3] Ankle braces are constructed with thermoplastic polymer material (e.g., semi-rigid style) or are constructed with nylon material (e.g., lace-up style).[4]

Many researchers have investigated the use of such prophylactic devices as ways to prevent ankle injuries.[4-8] Meta-analysis conducted by Cordova et al[6] showed general effectiveness of the ankle tape and braces to provide mechanical support in preventing ankle sprains. In a systematic review, Dizon and Reyes[7] also showed a reduction of ankle sprain by 69% with the use of ankle brace and 71% with the use of ankle tape among previously injured athletes. The effects of ankle stabilizers on lower-extremity functional performance have also been investigated in both injured and uninjured subjects.[4-12] Anecdotally, those who are involved in the athletic community have argued that ankle stabilization inhibits athletic ability, thus not being able to run as fast or jump as high.[8] Several researchers[9-12] have investigated the effect of external ankle stabilization devices on lower-extremity functional performance but have not reached a consensus. Some authors found decreases in vertical jump and multidirectional agility test scores when using various forms of ankle support while no significant effect was found in others.[9-11] A meta-analysis conducted by Cordova et al found a negative effect of lace-up style braces on sprint speed.[12] However, on subjects who were not elite athletes, the average effect of external ankle support on sprint, agility, and vertical jump performance were trivial.

The effect of ankle stabilizers on proprioception is also a controversial topic. Some researchers believe that taping and bracing enhances proprioceptive activity due to increased stimulation of the cutaneous mechanoreceptors.[13] However, results of the findings vary, with some studies showing improved proprioceptive activity[14] while others showed no change or worse activity with tape and brace.[15,16] Meta-analysis conducted by Raymond et al[17] concluded that the ankle brace or ankle tape had no effect on proprioceptive activity in participants who have functional ankle instability.

Kinesiotaping method is a somewhat new type of taping technique in which one uses Kinesio Tape (KT). It was originally created by a Japanese chiropractor, Kenzo Kase in 1980 and has gained popularity in the clinical setting. The tape is approximately the same thickness as the epidermis, made of polymer elastic strand wrapped by 100% cotton fibers, which allows for fast evaporation of body moisture and drying.[18] The tape uses no latex and the adhesive properties are 100% acrylic which has heat-activated glue. The tape is lightweight and thin in order for it to feel like part of the body. It is able to stretch 140% of its resting length and can stay on the body for about 3-5 days including in the shower without compromising the adhesive quality.[19] According to the manufactures of the tape, KT is hypothesized: to provide a positional stimulus through the skin; to align fascial tissues; to create more space by lifting fascia and soft tissue above area of pain/inflammation; to provide sensory stimulation to assist or limit motion; and to assist in the removal of edema by directing exudates toward a lymph duct.[19,20] How the tape is applied determines the function it will provide. Therefore, practitioners need to identify which of the functions KT needs to serve and thus apply the tape accordingly.

Although KT has been widely used in rehabilitation protocols and prevention of sports injuries by people in the healthcare field such as physical therapists and athletic trainers,[21] scientific evidence for the efficacy of KT is somewhat limited. One of the well documented effects of KT is on decreasing pain symptoms for patients.[18,20-23] Several randomized double-blinded trials have been conducted to demonstrate the efficacy of KT in pain reduction. For example, Gonzalez-Iglesias and his colleagues[18] examined the efficacy of KT on patients with acute

whiplash-associated disorders (WADs). Patients reporting neck pain as a result of motor vehicle accident within 40 days of injury compared to the sham group. Injury numerical pain rating scale (NPRS) and cervical range of motion measurements were compared. The results showed that the KT group had a significantly greater improvement in both measurements following tape application and at the 24hr follow-up. However, the authors cautioned that the improvements were small and may not be clinically meaningful. In another randomized control trial, Castro-Sanchez and colleagues[22] investigated the effect of KT on adults with chronic non-specific low back pain compared to sham tape. Several outcome measures were used, including disability, pain, kinesiophobia, trunk flexion range of motion, and isometric endurance of trunk muscles. As a result, the KT group had significantly reduced disability and back pain at week one, but only the decrease in pain was maintained four weeks later. Trunk muscle endurance was also significantly better at week one and at week four. However, similar to study by Gonzalez-Iglesias et al,[18] the effect of pain decrease was small and may not be clinically worthwhile. In another randomized clinical trial, Thelen and colleagues[20] investigated the effect of KT compared to the sham tape on subjects with shoulder pain due to rotator cuff tendinitis. Results showed an immediate statistically significant difference in pain-free range of motion for shoulder abduction, but the difference between the groups no longer existed by day three. In addition, no other differences between the groups regarding range of motion, pain, or disability scores were found. Kaya and colleagues[21] investigated the short-term efficacy of the use of KT compared to conventional physical therapy modalities on reducing pain and disability in patients with shoulder pain due to rotator cuff problems. The Disability of Arm, Shoulder, and Hand (DASH) scale and visual analog scale (VAS) were used to assess function and pain. The rest, night, and movement median pain scores were significantly lower for the KT in the first week, but no differences were found for the second week. Thus, the KT may have a more immediate effect than other physical therapy modalities.

However, not all studies demonstrated positive effects of KT. In a randomized clinical trial, Saavedra-Hernandez and colleagues[23] compared the effectiveness of cervical spine thrust manipulation to application of KT on individuals with mechanical neck pain. Neck pain, disability, and cervical range of motion data was collected at baseline and at one week after intervention. Results indicated that the application of KT and cervical spine thrust had similar effects for the reduction of pain and disability. Statistically, there was a significant decrease in pain and disability after treatment when compared to baseline tests. In addition, patients experienced similar improvements with cervical range of motion for flexion, extension, and lateral flexion.

With regard to performance enhancement, the effect of KT is even more limited and mixed.[24-38] Application of KT had no effect on ankle proprioception when measured by reproduction of joint position sense (RJPS) on healthy individuals,[24] maximal grip strength in healthy subjects,[25] nor maximal quadriceps strength immediately after tape application.[26] Fu and colleagues[27] also showed KT, when placed on healthy athletes, does not influence muscle strength. Merino-Marban and colleagues[28] evaluated the acute effects of KT on hamstring muscle extensibility on healthy individuals and found no significant effect. On the other hand, some researchers showed that KT application was more effective in increasing isokinetic knee extension peak torque and single leg hop distance than knee brace and KT plus knee brace.[29] KT had a significant effect on the eccentric muscle strength in healthy adults,[30] increased recruitment of motor units in the vastus medialis oblique muscle and increased peak torque measured by electro-myography (EMG) in healthy subjects,[31] and improved explosive power of gluteus maximus among male athletes.[32] Jung-Hong and colleagues[33] found that the application of KT to the flexor muscles of the dominant hand significantly increased grip strength among healthy adults. The authors suggested that KT may have provided cutaneous stimulation to the skin during flexion, therefore stimulating the afferent receptors of the skin, thus affecting muscle activity of the flexor muscles.

The inconsistency among studies may be attributed to how the experiments were conducted. For example, KT may have a different effect on eccentric muscle contraction and concentric muscle contraction. Vithoulk and colleagues[30] compared the effect of KT

on healthy female individuals on peak muscle torque of the dominant knee extensors by using isokinetic dynamometer for concentric and eccentric strength. Results indicated a statistically significant increase in eccentric isokinetic exercise of the quadriceps muscle under the KT condition compared to the no-tape and sham condition. However, no difference was found for concentric muscle strength. Vercelli and colleagues[26] only examined concentric muscle strength and did not find any effects related to KT.

KT may also have an increased effect over time. For example, Slupik and colleagues[31] found increased recruitment of muscle's motor units, 24 hours after placement of KT on the quadriceps muscle. The tape was intended to increase the tone of the medial head of the quadriceps muscle, thus started at the origin of the vastus medialis muscle ending at the muscle's insertion at patellar ligament. Transdermal EMG was used to assess the bioelectrical activity of the muscle, measuring the peak torque of the vasus medialis oblique (VMO) muscle. There was lack of increase in peak torque after 10 minutes of KT, which corresponds to a study done by Taiwanese researchers[27] noting no significant increase in muscle strength after 12 hours. However, there was a high increase in peak torque 24 hours following KT application. Both studies suggest that there may be a gradual increase in muscle tone several hours after tape placement. The effect was maintained for another 48 hours after removal of the tape.

Another reason for the mixed results may be that the effects of KT may be so subtle that it can only be observed in cases where movement disorder is present and not among healthy individuals.[34] Yasukawa and colleagues[34] conducted a pilot study to evaluate the use of KT on upper extremity functional motor skills of children admitted into the acute rehabilitation program. The Melbourne Assessment, which was developed to measure function in children with cerebral palsy, was used as an outcome measure. The study showed improvement of the scores immediately following taping and three days following taping. In another study of individuals with acute lateral patellar dislocation, KT was successful in promoting beneficial effect of decreasing pain and enhancing quadriceps activity and weight bearing stability during functional activity of an individual.[35] Lastly, Hsu and colleagues[36] studied the effect of KT on scapular kinematics and muscle performance among baseball players with shoulder impingement syndrome. EMG results of the reference voluntary contraction (RVC) showed that KT group had increased muscle activity of the lower trapezius at 60-30° of arm lowering phase, as well as increase in strength of the lower trapezius. However, even within symptomatic patients, the effect of KT is not concrete. Brein et al[37] found that KT did not alter muscle activation or improve sense of stability with athletes who had ankle instability compared to non-elastic tape condition when athletes were tested for sudden ankle inversion perturbation.

As can be seen, the evidence for the efficacy of KT is controversial. A meta-analysis conducted by William and colleagues[38] concluded that there is little quality evidence to either support nor oppose the use of KT over other methods for prevention of sports injuries. They searched electronic databases including SPORTDiscus™, Scopus, MEDLINE, ScienceDirect and sports medicine websites and found 97 articles. However, only ten met their inclusion criteria for the meta-analyses and the vast amount of evidence that confirmed positive usage of KT was from case studies and anecdotal support.[38] They concluded that a well-designed experimental research in order to assess the efficacy of KT is warranted. Therefore, the purpose of this study was to investigate the effects of KT on functional performance in healthy individuals, specifically by applying KT to the ankle and measuring vertical jump height and dynamic postural control. Immediate and delayed effects of KT were examined, which may be relevant to clinical application.

METHODS

Participants

College students from the Department of Kinesiology were asked to participate in this study. Fifty-four subjects initially volunteered for the study and were randomized into the real KT (n = 27) and the sham KT (n = 27) intervention. Two subjects were removed from the study since the tape came off for one individual and another acquired an injury unrelated to this study. As a result, data was collected from 52 individuals, (28 males and 24 females; mean ± SD, male age: 21.78 ± 1.75 years; female age: 22.50 ± 2.39 years; male height: 175.35 ± 7.55 cm; female height: 165.41 ± 6.71 cm; male weight:

76.93 ± 10.51 kg; female weight: 61.70 ± 7.82 kg) who were randomized into the real KT (n = 27; 17 males and 10 females) and the sham KT (n = 25; 11 males and 14 females) intervention. Subjects were excluded who reported trauma in the lower limbs within the previous 6 months, ongoing concussion symptoms, vestibular problems, or a head cold that may have affected their balance. Subjects were first interviewed and received pre-participation orthopedic ankle exam by a certified athletic trainer (ATC) in order to rule out any abnormalities (e.g., congenital deformities, neurological deficits) that may affect the experimental data. The orthopedic examination included stress tests to determine ligamentous stability as well as tests for active range of motion, passive range of motion, and manual muscle testing. Assessment of cutaneous sensation and circulatory tests were also conducted. Approval for the study and the use of human subjects was obtained from the host institution's Institutional Review Board. All subjects signed the informed consent form prior to participating in the study.

Kinesio Tape Application

Following baseline examination, the participants were randomly assigned to either the KT group (experimental group) or the sham-KT group (control group). The experimental group was taped by the Kinesio Tex® Tape with tension, while the sham-KT group was taped with Kinesio Tex® Tape but without any tension. The tape was just laid on their skin instead of being stretched and applied. The subjects were allowed to choose their dominant ankle to be taped. All the taping procedures were completed by a certified athletic trainer who utilizes KT regularly in the clinical setting in order to warrant consistency throughout the study.

Kinesio Tex® Tape (Kinesio Holding Corporation, Albuquerque, NM) was used in this study. The tape is waterproof, porous, and adhesive. The participants were instructed that they were allowed to exercise and shower with the tape on. The width of the tape was 5 cm and the thickness was 0.5 mm. Same tape was used for both the experimental group and the control group.

All participants were taped for a lateral ankle sprain in accordance to Kenzo Kase's Kinesio taping manual.[19] Tendon correction techniques was applied to the ankle and the surrounding muscles including the anterior tibialis to assist in active dorsiflexion and inversion, the gastrocnemius-soleus complex to assist in active plantar flexion, and the peroneus brevis and longus to assist in active ankle eversion. The three tendon correction techniques assist in all of the major movements of the ankle, and since lateral ankle sprain is one of the most commonly seen ankle injuries, this particular taping method was chosen for this particular experiment.

Each participant sat on the taping table in a relaxed position with ankle in slight plantar flexion. For the experimental group, the first strip (I strip) was applied on the anterior midfoot without tension, then stretched approximately 140% of its maximal length and attached just below the anterior tibial tuberosity over the tibialis anterior muscle. The second strip (Y strip) was applied on the lateral side of the ankle/lower leg without tension, then stretched approximately 140% of its maximal length and attached just below the fibula head over the peroneus longus and brevis muscle. A Y-strip refers to a tape that has a portion cut down in the middle to produce two tails. The third strip (Y strip) was applied on the posterior side of the ankle/lower leg, then stretched approximately 140% of its maximal length and attached just below the knee joint over the gastrocnemius muscle (Figure 1). The control group received the same KT application, but with no tension.

Outcome Measures

Two outcome measures were utilized in this study: the single-leg vertical jump test and the dynamic postural control. To measure the single-leg vertical jump, the participants stood in the middle of the athletic training room, with their testing foot flat on the ground. The VertiMetric (Lafayette Instrument Company, Lafayette, IN) was applied to the testing leg. The VertiMetric is a wireless device that measures vertical leap and leg power. Intervisit relative reliability of the VertiMetric device ranged from 0.93 to 0.91 in a study conducted by previous investigators examining the device,[39] and ranged from 0.85 to 0.89 in this current study. The participant was then instructed to jump as high as possible, by swinging the arms to create a rapid countermovement and thrusting the arm upward to reach as high as pos-

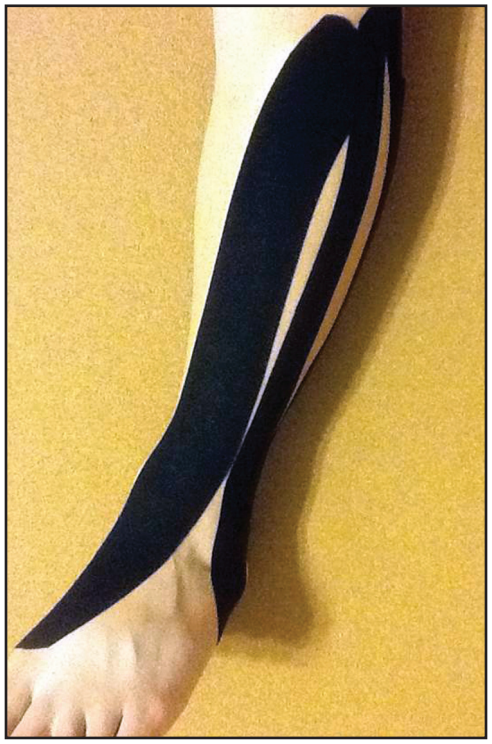

Figure 1. *Kinesio Tape Application.*

sible. They were instructed to practice a couple of times in order to familiarize themselves with the movement. Once the participants were familiar with the single leg jump, they were asked to perform 3 standing vertical jumps. They were allowed to rest between each jump as much as they needed.

The Star Excursion Balance Test (SEBT) was used to collect the participants' dynamic postural control.[40] The objective of the SEBT is to reach as far as possible with one leg while maintaining balance with the contralateral leg. The SEBT was measured in the athletic training room with 2-inch adhesive tape on the hard floor. The grid was made with 8 lines extending at 45° increments from the center of the grid. The participants stood in the center of the grid. Each line was named: Anterior (A), Anterolateral (AL), Lateral (L), Posterolateral (PL), Posterior (P), Posteromedial (PM), Medial (M), Anteromedial (AM), in accordance to the excursion direction associated with the stance leg (Figure 2). The investigator demonstrated the SEBT test, and after the demonstration, as recommended by previous researchers,[39] the participants practiced the test 3 times in 8 directions in order to familiarize themselves with the test and limit learning effect. The participants were instructed to maintain a single-leg stance in the center of the grid placed on the floor. While standing on one leg, they were instructed to try to reach the other leg as far as possible along the 8 lines and touch the furthest point possible on the line with the toes. Participants were also instructed to touch the tape with the reach foot as lightly as possible without bearing weight. Once the participant completed the toe touch on the tape they returned to a bilateral stance while maintaining equilibrium. During the test, the subjects stood on their taped leg in the middle of the grid, and extended their other leg as far as they could while maintaining balance. They were instructed to "try to reach as far as you can without losing balance, and touch with

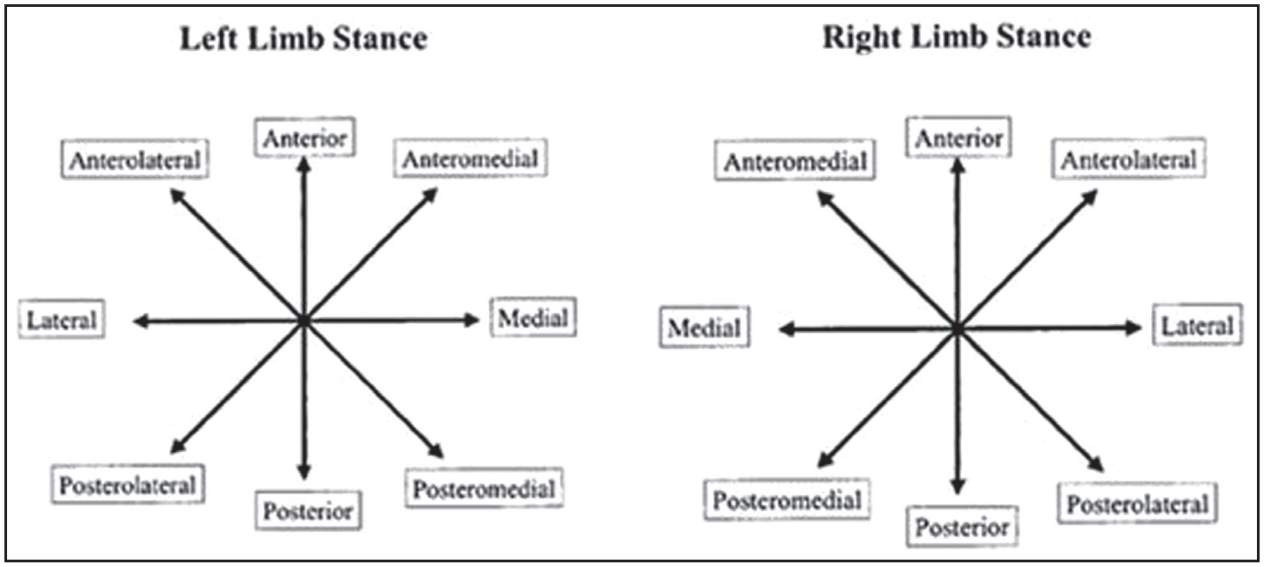

Figure 2. *SEBT Direction.*

your other foot on the tape." They performed the reach in a sequential order in either counterclockwise or clockwise directions starting from the front. If the participant was standing on his or her left leg, the test was performed in a clockwise direction. If the participant was standing on his or her right leg, the test was performed in a counterclockwise direction. However, whichever direction they start, the first line they touch is always the A, then the AL, then the L, and so on. The participants performed the test three times, touching each of the eight lines, and their mean was recorded. There was a 30 second break between each reach, or the participants were allowed a longer break if they thought necessary. The distance of each reach was divided by the length of the subject's leg, and multiplied by 100 to keep the subject's leg length from influencing the results. The test was repeated in case the following occurred: 1) the participant did not make contact with the ground with the opposite foot while standing on the stance leg, 2) the participant moved the stance leg, 3) the participant lost balance during the trial, 4) the participant failed to maintain start and return position for a full second, 5) if the investigator determined that the participant have touched the ground with the reach foot that caused the reach foot to bear weight.

PROCEDURE

Each participant had their baseline vertical jump and SEBT scores completed prior to tape application. Once their baseline measurements were taken, the participants were taped for either the "real" KT taping technique or the "sham" KT taping. Immediately after the tape application, outcome measurement was taken for vertical jump and SEBT scores. Participants were then instructed to wear the tape for the next 24 hours, and return to the athletic training room for re-evaluation. At that time, the third measurement was taken for vertical jump and SEBT scores, and after the final outcome measurement was obtained, the participants were instructed to remove the tape.

DATA ANALYSIS

Group-by-time three-way mixed model analysis of variance (ANOVA) with time as a repeated factor was used to assess the effect of KT on vertical jump and dynamic postural control. Descriptive statistics were calculated for both groups at the 3 time intervals: baseline (before taping), immediately after taping, and 24 hours after taping. Main effect analysis was applied in the cases of significant difference among the three assessments (pre-, immediately post, and 24-hours-post). When appropriate, follow-up analyses were performed using lower-order ANOVAs and independent and dependent sample t-tests with Bonferroni corrections.

RESULTS

Baseline characteristics for all outcome measures are shown in Table 1. No significant differences existed between the experimental group and the control group in vertical jump or the SEBT scores prior to tape application.

Table 1. *Baseline Characteristics between Control and Experimental Group.*

	Control Group (n = 25)	Treatment Group (n = 27)	*P* Value
Age	22.16 (1.34)	22.00 (2..62)	.781
Height	67.20 (3.40)	67.22 (3.51)	.982
Weight	150.84 (28.51)	155.22 (24.33)	.555
VJ Max	9.86 (3.06)	10.94 (2.31)	.158
SEBT_A	105.08 (10.89)	101.58 (8.04)	..106
SEBT_AL	109.98 (10.46)	107.03 (8.96)	.282
SEBT_L	114.64 (11.82)	111.31 (10.86)	.296
SEBT_PL	121.59 (11.37)	120.14 (12.44)	.662
SEBT_P	121.89 (12.13)	122.12 (13.89)	.951
SEBT_PM	112.51 (13.78)	115.57 (13.78)	.409
SEBT_M	97.69 (17.56)	93.55 (15.23)	.371
SEBT_AM	98.03 (9.56)	93.21 (9.61)	.076

Data are mean ± SD except for gender. No difference between groups

Table 2. *Multivariate Test.*

	Value	F	Hypothesis df	Error df	Sig.	Partial eta Squared
Between Subjects						
Intercept	.005	943.521	9.000	40.000	.000	.995
Control	.667	2.221	9.000	40.000	.041	.333
Gender	.470	5.016	9.000	40.000	.000	.530
Control*Gender	.806	1.068	9.000	40.000	.407	.194
Within Subjects						
Time	.310	3.833	18.000	31.000	.001	.690
Time*Control	.572	1.286	18.000	31.000	.262	.428
Time*Gender	.584	1.227	18.000	31.000	.300	.416
Time*Control*Gender	.436	2.232	18.000	31.000	.024	.564

Table 3. *Epilson Correction Greenhouse Geisser for Vertical Jump and SEBT Scores.*

	Type II SS	df	Mean Square	F	Sig.	Partial Eta Squared
VJ	.332	1.508	.220	.067	.888	.001
SEBT_A	60.769	1.463	41.530	1.331	.265	.027
SEBT_AL	146.974	1.978	74.298	2.599	.020	.051
SEBT_L	221.511	1.480	149.698	1.084	.327	.022
SEBT_PL	45.364	1.826	24.841	.949	.384	.019
SEBT_P	124.173	1.853	67.017	2.181	.123	.043
SEBT_PM	287.891	1.720	167.356	4.496	.018	.086
SEBT_M	263.266	1.746	150.779	4.272	.021	.082
SEBT_AM	75.011	1.560	48.099	1.193	.300	.024

A 3-way analysis of variance (ANOVA) with repeated measures (time [pre vs. post vs. 24hr post] x control [tension vs. no tension] x gender [male vs. female]) was used to determine the differences between groups (Table 2). When appropriate, follow-up analyses were performed using lower-order ANOVAs and independent and dependent sample t-tests with Bonferroni corrections. Mauchly's test indicated that the assumption of sphericity had been violated, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = 0.732-0.989) (Table 3).

Data analysis revealed a significant interaction between gender and control. This suggested that the effectiveness of the KT depended upon the gender of the subject. Within subject analysis revealed that there was a statistically significant effect of time, Wilks' Lambda = 0.310, F (18, 31) = 3.833, p = 0.001, a significant effect of time x control x gender, Wilks' Lambda = 0.436, F (18, 31) = 2.232, p = 0.024.

An additional univariate test was used as the sphericity had been violated, which showed statistically significant differences between the groups for the SEBT scores in the posterior-medial direction F(1.72, 82.57) = 4.50, p = 0.018 and in the medial direction, F(1.75, 83.81) = 4.27, p = 0.021. When independent t-tests were conducted, for PM direction, there was a significant difference between the SEBT scores for the control group (−2.720 ± 7.063) and the KT group (4.475 ± 5.123); t(22) = 2.741, p = 0.012 during the post to 24 hours post time period. Similarly, for the M direction, there was a significant difference between the SEBT scores for the control group (−4.144 ± 6.226) and the KT group (4.045 ± 3.841): t(22) = 3.677, p = 0.001 during the post to 24 hours post time period. No significant difference between the experimental group and control group was found for pre-post time period (Table 4) (Figure 3, 4).

DISCUSSION

Numerous researchers have reported the effect of KT for function, pain, and ROM in the past.[18,20-37] However, the results are mixed and further investigation was warranted. The purpose of this study

Table 4. *Mean difference between Gender x Time x Group.*

		Male Control	Tx	Female Control	Tx
VJ Max	Pre	11.464 (.679)	12.171 (.546)	8.600 (.602)	8.860 (.712)
	Post	11.355 (.612)	11.700 (.492)	8.536 (.542)	8.410 (.642)
	24hr	11.645 (.694)	11.988 (.559)	8.307 (.616)	8.590 (.728)
SEBT_A	Pre	107.795 (2.906)	102.221 (2.337)	104.739 (2.576)	100.761 (3.047)
	Post	112.795 (2.527)	106.286 (2.033)	110.318 (2.240)	106.563 (2.651)
	24hr	113.032 (2.699)	105.265 (2.171)	108.666 (2.393)	108.390 (2.831)
SEBT_AL	Pre	111.973 (2.933)	108.445 (2.360)	108.414 (2.600)	104.626 (3.077)
	Post	112.211 (3.205)	112.076 (2.578)	115.342 (2.841)	110.692 (3.361)
	24hr	118.638 (2.826)	111.850 (2.273)	113.817 (2.505)	112.207 (2.964)
SEBT_L	Pre	117.745 (3.436)	111.195 (2.764)	112.212 (3.045)	111.505 (3.603)
	Post	120.795 (3.418)	119.372 (2.750)	117.277 (3.030)	117.280 (3.585)
	24hr	133.471 (5.481)	119.781 (4.409)	118.969 (4.858)	118.510 (5.748)
SEBT_PL	Pre	122.839 (3.658)	119.276 (2.942)	120.616 (3.242)	121.619 (3.836)
	Post	127.736 (3.423)	128.227 (2.753)	127.663 (3.034)	127.324 (3.590)
	24hr	129.953 (3.425)	128.068 (2.755)	126.813 (3.036)	126.866 (3.592)
SEBT_P	Pre	122.946 (4.011)	122.943 (3.227)	121.074 (3.556)	120.722 (4.207)
	Post	126.963 (4.071)	130.249 (3.274)	127.661 (3.608)	124.976 (4.269)
	24hr	130.877 (3.481)	128.696 (2.801)	125.184 (3.086)	125.851 (3.651)
SEBT_PM	Pre	112.837 (4.025)	117.435 (3.238)	112.250 (3.568)	112.408 (4.222)
	Post	119.176 (3.981)	123.004 (3.202)	119.125 (3.529)	118.138 (4.175)
	24hr	122.398 (3.539)	121.463 (2.847)	116.405 (3.137)	122.615 (3.711)
SEBT_M	Pre	98.088 (5.043)	93.602 (4.057)	97.379 (4.471)	93.484 (5.290)
	Post	100.498 (4.796)	98.257 (3.858)	102.431 (4.251)	101.928 (5.030)
	24hr	105.482 (4.406)	100.788 (3.544)	98.287 (3.905)	105.974 (4.621)
SEBT_AM	Pre	97.399 (2.921)	91.879 (2.350)	98.528 (2.589)	95.477 (3.064)
	Post	102.764 (2.724)	97.616 (2.191)	102.495 (2.414)	100.418 (2.857)
	24hr	106.366 (2.844)	97.576 (2.287)	101.108 (2.521)	101.077 (2.983

was to investigate the effect of KT on vertical jump and dynamic postural control on healthy individuals. The results of this study added to the mixed results previous researchers have found regarding the effectiveness of KT. It was partially consistent with previous reports that showed no difference in the vertical jump height for patients with KT application.[29] Although these results contradicted the most recent study done by Mostert-Wentzel and colleagues[32] that showed increased explosive power with KT application. However, Mostert-Wentzel showed improvement for both taping conditions (experimental and placebo), thus the influence of the KT may be questioned.[32] This current study also showed a significant improvement of SEBT scores for female participants which was a contradictory outcome compared to previous study that found no significant difference in SEBT performance with tape application.[41,42]

The current study demonstrated limited effect of KT treatment on dynamic postural control compared to the placebo group. The limitations were seen within the gender, direction, and timing. The significant

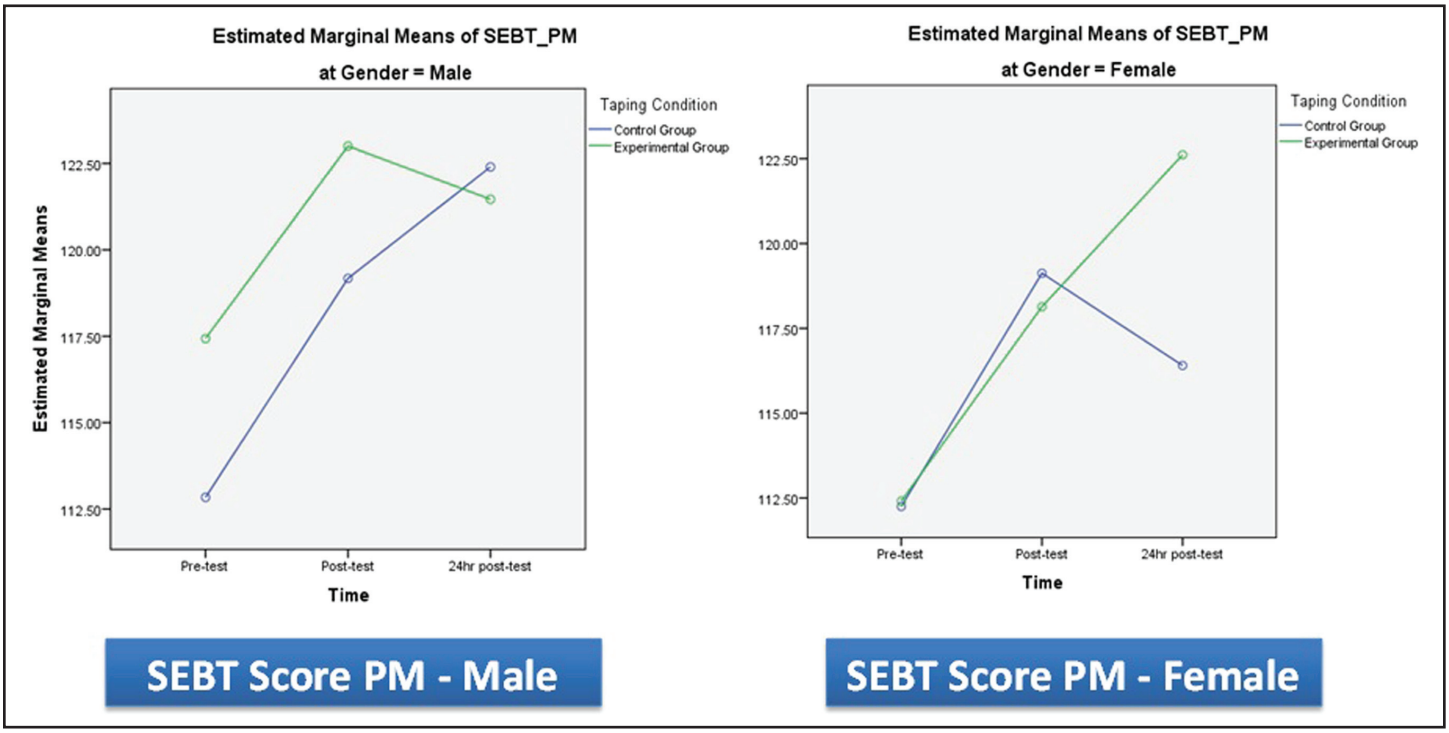

Figure 3. *SEBT Score for Posterior-Medial Direction; male vs female.*

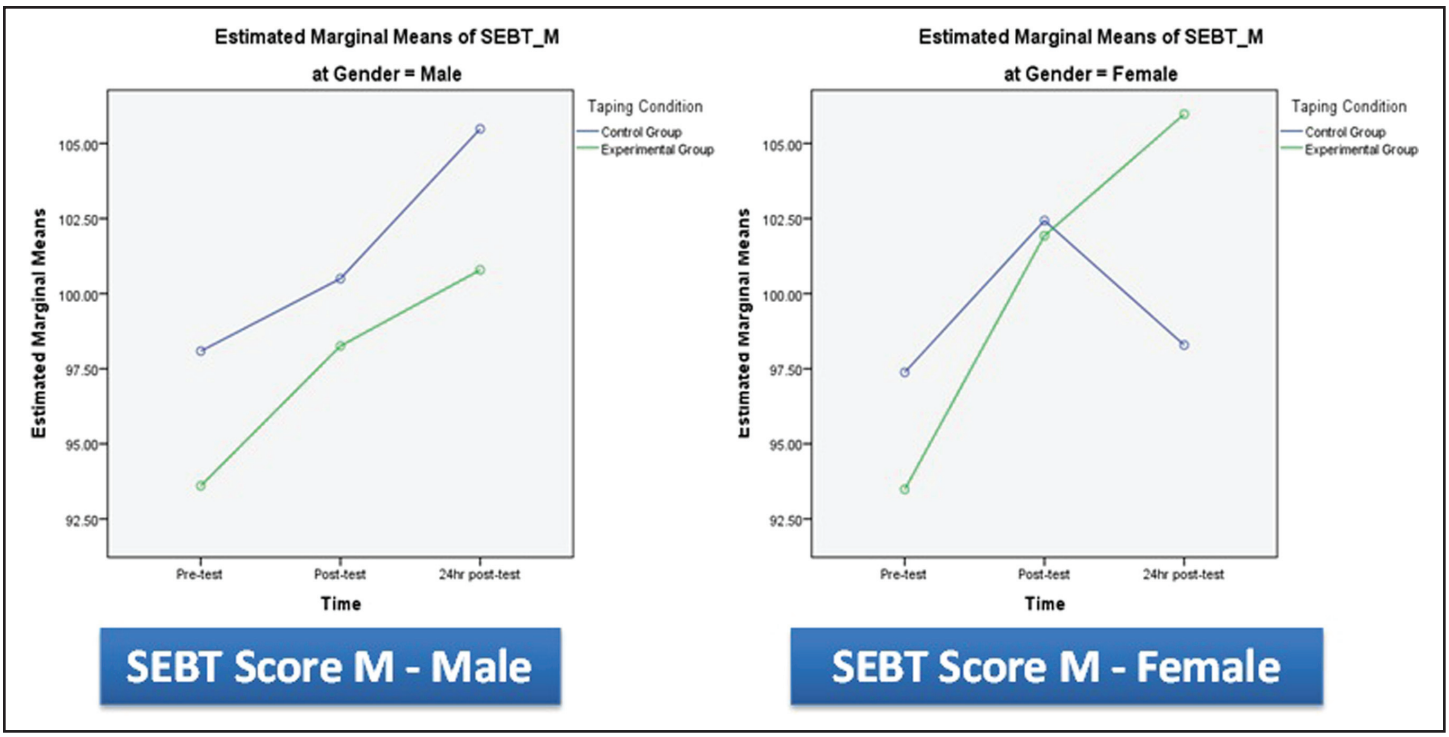

Figure 4. *SEBT Score for Medial Direction; male vs female.*

effect was only applicable for female participants, and only in the posterior-medial and medial directions of the SEBT test. In addition, the effects of the improvement in SEBT scores for the two directions were found when pre- and 24-hours post time period were compared and not for pre- and immediate-post time period. This corresponds to the previous study[31] in which they showed no significant increase of muscle peak torque 10 minutes after tape application, but increased torque after 24 hours of KT application. Therefore, these findings may indicate that the potential benefits of KT application are only available with prolonged tape application.

The physiological mechanism by which the KT may have presumed to work remains a speculation since it is beyond the scope of this study. Nonetheless, a few hypotheses will be proposed to possibly explain the difference. In this current study, the main difference between the control and experimental group was the existence of tension in the KT for the experimental group compared to the lack of tension in the control group. It is a possibility that the tension provided by the real application might have increased the neural feedback to the participants during ankle movement, facilitating increased balance. Tactile input has been shown to alter motor control by changing the excitability of the central nervous system.[43,44] This is in accordance with the claim that the tape applied with tension in the direction of the muscle fibers would facilitate the strength of the underlying muscles.[45] However, it contradicts many other studies that showed no indication that the taping influenced muscle activity assessed via electromyography[46] or by the isokinetic dynamometer.[27] One possible explanation for this is that the tactile input from the KT was not strong enough to produce increased muscle power for vertical jump, but was enough to stimulate cutaneous mechanoreceptors in order to improve muscle excitability.[47] It is possible that increased muscle excitability of the tibialis anterior may have worked to prevent excessive pronation and navicular drop, thus stabilizing the ankle when participants were reaching in the posterior-medial and medial direction. This corresponds with a study conducted to examine effects of orthotics on dynamic postural control.[48] In the study conducted by Olmsted and Hertel,[48] the SEBT scores improved for participants with orthotics in the lateral direction possibly due to heightened plantar cutaneous receptor activity, leading to enhanced neuromuscular function allowing increased stability during dynamic reaches. However, additional research is necessary to determine why in this current study, the effect of KT was only seen on posterior-medial and medial directions and not on the lateral directions. Several researchers have suggested that reaching eight directions of the SEBT is redundant and that posteromedial direction reach was the most representative of overall performance of the SEBT in healthy individuals.[49-51] In addition, for individuals with chronic ankle instability, Hertel and colleagues[51] concluded that anteromedial, medial, and posteromedial directions showed greater sensitivity to functional deficiencies of the ankle. Therefore, in this current study, the effect of KT may have been seen only in the most sensitive directions of the SEBT, posteromedial and medial, and not in any other directions. However, why the SEBT is more sensitive to these medial reach components is not clear and warrants further study.

The difference in gender may be due to the fact that male and females use different strategies to control the ankle joint.[52] Researchers have suggested that when compared to male counterparts, females have a 25% greater chance of sustaining a Grade I ankle sprain.[53] Grade I ankle sprains are the most common injuries and since the ligaments connecting the ankle bones are not necessarily torn but only microscopically stretched,[54] there may not have been gross ankle instability associated with the injury. Unfortunately, the ankles of the participants in the current study were examined for gross instability only. This did not allow subtle instabilities, caused by Grade I ankle sprains, to be detected. However, based upon prior studies that showed increased ankle laxity among female participants compared to males,[49,55] females in this current study may have had increased ankle laxity as well. Therefore, it is possible that the KT provided an enhancement of stability for females, who generally have more laxity in their ankle joint. In addition, males are found to have greater active muscle stiffness compared to females[56,57] thus resulting in increased ability to resist changes in its length, suggesting increased joint stability for males. Therefore, female participants with less joint stability may have benefited

more from the tactile input of the KT. Lastly, the difference in gender may have been caused by the difference in excessive hair of the ankle area. Participants were not instructed to shave prior to the test, so since males in general have increased body hair and females in general shave their legs, the adhesiveness of KT may have been different between the two groups compromising the necessary direct contact between the tape and skin for maximum effectiveness. However, this is merely a speculation since no study to date has been conducted regarding the influence of body hair and tape effectiveness.

There are several limitations to this present study. First, the participants were a convenience sample that included only healthy individuals with no ankle injuries. The application of these present findings to individuals who actually have injuries is limited. Since the taping may have produced different results for healthy individuals and symptomatic individuals, it would have been better if both populations were included in this study. Nevertheless, the fact that there was a statistically significant increase in SEBT scores for certain directions provides impetus for future research in this area. This current study only applied tape once and the follow-up was limited to 24 hours. The effectiveness of the tape may have differed if there were multiple applications or if the follow-up was more than 24 hours. Slupik et al[31] showed maintenance of increased bioelectrical activity of the muscles for another 48 hours following tape removal. Therefore, follow-up studies lasting more than 24 hours may have been beneficial.

CONCLUSIONS

The results of this current study demonstrated statistically significant effects of KT on dynamic postural control, but the outcomes were very limited. The results showed that females had statistically significant improvement of the dynamic postural control in two directions of movement at 24-hour follow-up, but no improvement was seen in male participants or for females in any of the other directions. There was no effect of KT with regard to vertical jump between both genders. Therefore, the KT neither helped nor inhibited the movement. This study demonstrates the need for further investigation of gender differences as related to use of taping. Further research may help increase empirical evidence regarding the use of KT, and the possibility for its use in injury prevention and functional performance enhancement.

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