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RESEARCH ARTICLE

WHICH KINESIO TAPE® APPLICATION AFFECTS STATIC BALANCE: COMBINATION OF CORRECTION AND FACILITATION TECHNIQUES VS FACILITATION TECHNIQUE IN HEALTHY SUBJECTS? A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Purpose: This study aimed to explore whether the correction on the retinaculum of the ankle with facilitation on the peroneal muscle or the facilitation technique on the peroneal muscle had an immediate effect on static balance in healthy subjects.
Material and Methods: Sixty healthy individuals were investigated. Individuals were randomly separated into 3 groups. KT was applied using the facilitation technique on the peroneal muscle, or the facilitation technique on the peroneal muscle, and the correction technique on the retinaculum of the ankle. No KT was applied to the control group. The standing stork test was used to evaluate static balance with opened and closed eyes.
Results: There was no difference in static balance between the groups with opened and closed eyes before and after KT application ($p>0.05$). There was no difference in static balance before and after KT application with opened and closed eyes in the KT-2 group ($p>0.05$). However, there was a significant difference in static balance before and after KT application in the KT-1 group with closed eyes ($p<0.05$).
Conclusion: Applying the facilitation technique on peroneal muscles improved static balance when eyes were closed. No effect was observed when the correction and facilitation techniques were used together on the ankle. Many KT techniques on the ankle are not required to improve static balance; they can even affect static balance negatively.

Keywords: ankle, balance, Kinesiotape®, static balance, standing stork test

INTRODUCTION

The sensory cortex innervation area of the foot and ankle is more extensive than in the hand and wrist. The ankle is important in respect of proprioception; therefore, the ankle joint is called a sense organ (1). Proprioception is the awareness of the position and movement of body parts, and allows them to be coordinated appropriately, maintaining the continuation of static and dynamic posture (2). Proprioception is important for the control of movement and is transmitted by mechanoreceptors to the central nervous system (3). Mechanoreceptors, more precisely proprioceptors, are located in tendons, muscles, ligaments, and joint capsules (4). Mechanical changes on mechanoreceptors cause activation of proprioception and the central nervous system (5). Therefore, proprioception is closely related to balance (3). Balance is the ability to integrate the vestibular, visual, and somatosensory systems of the body in the central nervous system (6) to maintain the center of gravity in a vertical position (7). In this way, postural stability can be preserved (8). Postural stability is associated with balance, musculoskeletal injuries, and poor postural control (9). The ankle is closely related to postural stability against gravity during standing or movement (10), and this is very important during sports that require force and contact especially (11).

Kinesio Tape (KT) is a derivative of adhesive tape first applied by Kenzo Kase in 1973. It is a type of tape that stretches up to 55-60% of its length and does not stretch transversely. It is used to reduce pain, edema, and muscle spasms, increase lymphatic circulation, correct mechanical problems, and stimulate mechanoreceptors (12). KT activates muscles firing early (13), improves static and dynamic balance (14), reduces the risk of overuse syndromes and injuries (15), positively affects functional reach performance and static mono pedal leg balance (16), improves proprioception, and provides ankle stability (17). In addition, KT ensures that the relevant body parts are positioned at a more optimal level, and that forces are transmitted and absorbed correctly by activating the muscles early (18, 19).

In the literature, there are many KT application studies evaluating the effect on the ankle for different purposes and at different times after the application. Tekin et al. used a correction technique on the ankle joint with a tension of 50% and distal part of the peroneal muscle group with a tension of 0%. After 10 minutes from the application, KT was seen to improve the dynamic balance performance but not the static balance (14). Huzmeli et al. used KT on the medial-lateral sides of the calf and tibialis anterior muscles. After 45 minutes from the application, KT was found to affect positively the functional reach and single-leg balance parameters (16). The aim of the present study was to discover whether the KT correction technique on the retinaculum of the ankle with facilitation technique on the peroneal muscle or the facilitation technique on the peroneal muscle alone had an immediate effect on static balance in healthy subjects.

MATERIAL AND METHODS

Ethical Consideration

The current study was designed as a randomized controlled trial (RCT). The Istanbul University Clinical Research Ethics Committee approved the study protocol (Date: 26.11.2010, Decision Number: 2010/692-184). The participants were informed about the scope and procedures of the study and were provided with written informed consent before participating in the study. The Helsinki Declaration was abided by throughout the study.

Subjects

Individuals who had no pain, history of neurological or systemic disorders, or surgical operations were accepted. Individuals who had pes cavus or third-degree pes planus deformities, body mass indexes above 30 kg/cm2 or under 18 kg/cm2, or who participated in sports at least three days a week regularly were excluded.

All individuals were divided into three groups (KT-1, KT-2, and Control groups) by the lottery method; a simple randomization procedure. The groups were defined as the facilitation technique on peroneal muscle (KT-1 group), correction technique on retinaculum of the ankle with facilitation technique on peroneal muscle (KT-2 group), and no application (Control group). While the facilitation technique is used over the muscle from origo to insertion, the correction technique is used over ligaments (12). Since gender could directly affect the results of evaluations, the number of men and women was evenly distributed between the groups.

Evaluation

The age, gender, size, body weight, and dominant leg kick side were recorded for each volunteer. Pes cavus is evaluated according to the scaphoid tubercle of the navicular bone above the line. The line is determined by drawing with a pencil from the center of the medial malleolus to the center of the metatarsophalangeal joint of the thumb. It is decided visually whether there would be a pes cavus or not. Third-degree pes planus is defined as ground contact of the scaphoid tubercle (20). If the subject matched the study criteria, the evaluation continued by measuring static balance with the standing stork test with eyes open and eyes closed before and after KT application on the dominant ankle.

Standing Stork Test

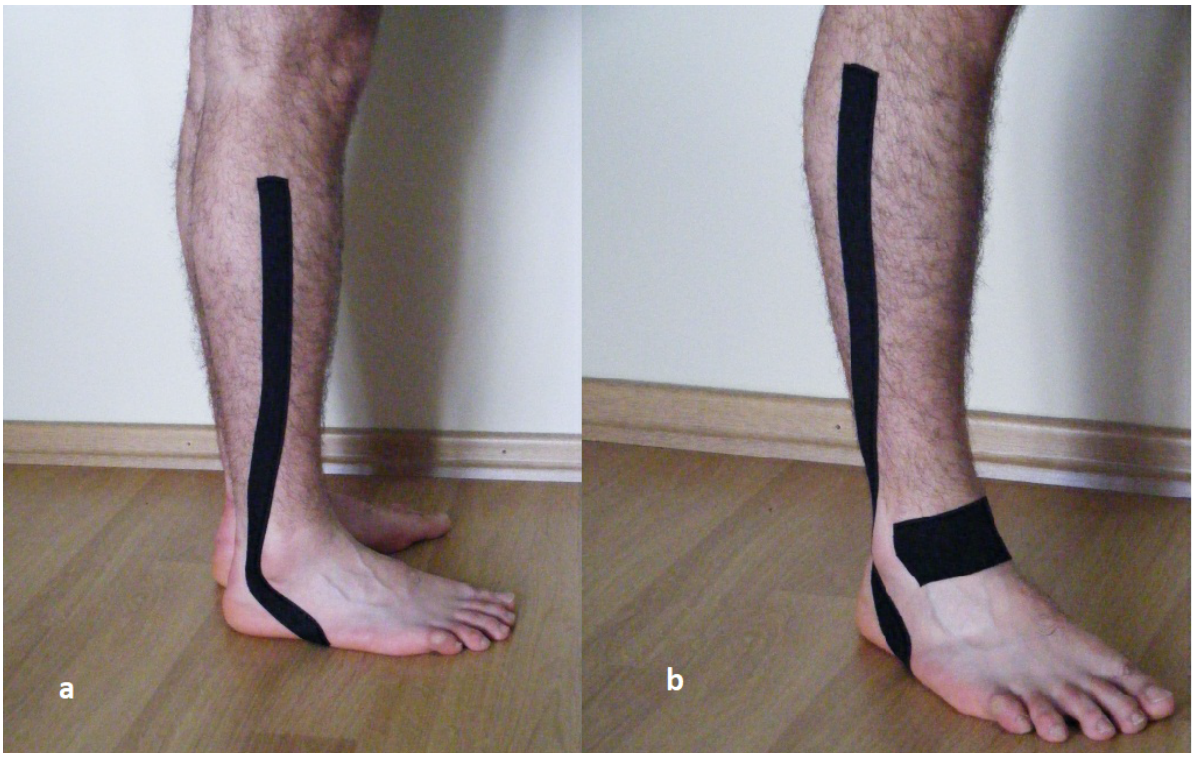

Figure 1. KT application a. The facilitation technique on the peroneal muscle (KT-1 group) b. The correction technique on the extensor retinaculum of the dominant side with the facilitation technique on the peroneal muscle (KT-2 group).

The standing stork test can be used to evaluate static balance (21). After the non-dominant foot is placed on the inside of the dominant leg, the heel of the dominant side is raised. The individual puts his hands on his buttocks and lifts the ball of his supporting foot from the floor upon the sign from the physiotherapist. The individual tries to keep this position as long as possible with the eyes open and then with the eyes closed. If the heel touches the ground or the hands are removed from the hips and/or breaks contact, or the foot disrupts contact on the inside of the other leg, the test is completed and the time is recorded. Standing Stork Test duration is classified as poor level under 5 seconds in men and 3 seconds in women during eyes open while over 50 seconds in men and 27 seconds in women is classified as excellent level (21). During the study, three trials were allowed before the time was measured. After experimenting, the participants were asked to take this position with their eyes open three times and the timing was recorded. The longest of the recorded times was included in the study. After five minutes rest, the same procedure was repeated with the eyes closed and the timing was recorded. After application of KT, the standing stork test with eyes open and closed was repeated and the effects were assessed immediately. After the application of KT, the evaluation was continued without waiting for any time. The control group was evaluated only three times at the beginning. In present study, since the immediate effect was evaluated and no application was made in control group, the participants were not re-evaluated in order not to be exposed to repeated evaluation.

In the standing stork test it was noted that healthy male and female subjects were not significantly different in respect of the period of standing on the dominant and non-dominant legs. In the present study, the dominant side was evaluated before and after the application of KT. The validity and reliability of the test has been proven, and found suitable for all ages (22).

Kinesiotape Application

Two different KT application techniques were used in this study by the same physiotherapist who was certified as a practitioner. The first technique was the facilitation technique on the peroneal muscle of the dominant side (KT-1 group), and the second was the mechanical correction technique on the extensor retinaculum of the dominant side with the facilitation technique on the peroneal muscle (KT-2 group) (Fig. 1).

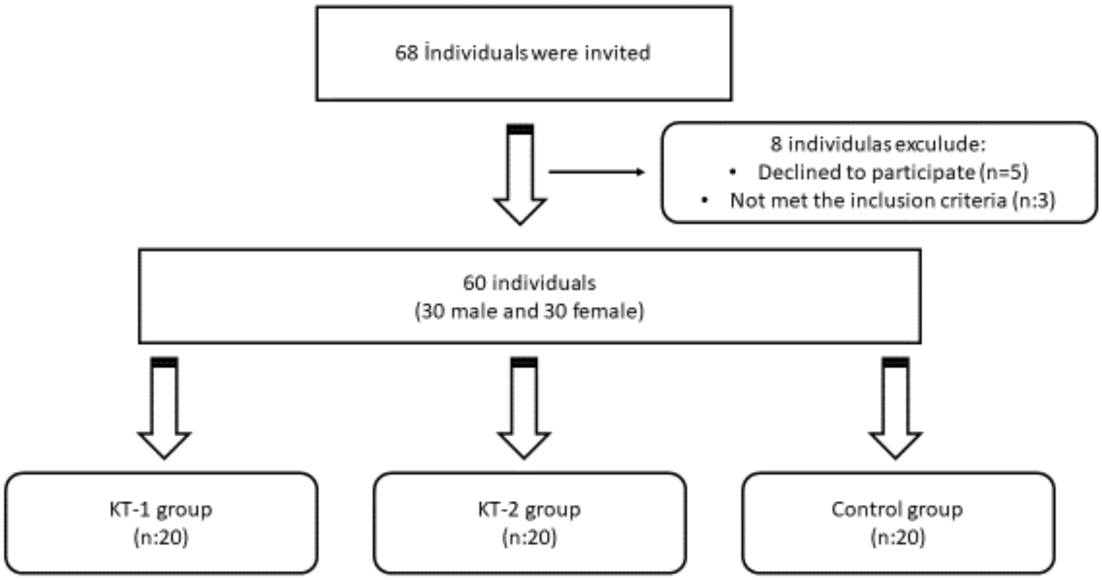

Figure 2. Consolidated standards of reporting trials (CONSORT) table

The muscle facilitation technique was applied to the peroneal muscles of the participant whose ankle was fixed in the maximum dorsiflexion and inversion in a long sitting position. In this position, KT was 2.5 cm wide, and 40 cm long with 0% tension (paper off method), and was applied in the origo-insertio direction of the peroneal muscle group, posterior to the lateral malleolus, and inferior to the fifth metatarsal head. For the correction technique; when individuals were lying on the back while knee extension and ankle dorsiflexion position, KT was 5 cm in width and 10 cm length with 100% tension was applied to the dorsal retinaculum of the ankle (12). After the application of KT, the evaluation was continued without waiting for any time in two groups (KT-1 group and KT-2 group).

Statistical analysis

Statistical analyses were performed with the IBM-SPSS for Windows version 20 software (IBM Corp., Armonk, New York, United States). Descriptive statistics were given as mean ±standard deviation for numerical data. The normal distribution of the numerical variables obtained were determined with visual (histogram) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk Tests). Age, weight, and body mass index were not of a normal distribution while height and stand stork test results were of a normal distribution. The Kruskal Wallis Test was used to compare age, weight, and body mass index, and the One Way Variance Analysis (ANOVA) was used to compare height and standing stork test results between groups. The paired t-test was used to analyze the standing stork test results with eyes open and closed before and after KT application in the KT-1 and KT-2 groups. The significance level was accepted as $p<0.05$.

RESULTS

Sixty-eight individuals were invited to participate in this study. Sixty individuals met the inclusion criteria and accepted the study. The Consolidated Standards of Reporting Trials (CONSORT) table depicts patient flow throughout the study (Fig. 2).

Sixty individuals (30 females and 30 males) were divided into three groups randomly. Each group was composed of 10 females and 10 males. The mean age, height, weight, and body mass index of all individuals were 20.73±2.4 years, 170.65±6.5 cm, 62.75±8.9 kg and 21.51±2.46 kg/m2, respectively. There were no differences in terms of demographic characteristics (age, height, weight, and body mass index) between groups (Table 1) ($p>0.05$). There were no differences in static balance between groups

Table 1. . Demographic characteristics of individuals according to groups.

Group	CONTROL (Mean ±SD)	KT-1 (Mean ±SD)	KT-2 (Mean ±SD)	p
Age (years)	20.40 ±0.568	20.65 ±0.488	21.05 ±0.583	0.745++
Weight (kg)	64.65 ±2.852	63.50 ±1.881	63.85 ±2.806	0.891++
Height (m)	1.70 ±0.014	1.69 ±0.013	1.71 ±0.014	0.565*
BMI (kg/m^2)	22.18 ±0.919	22.11 ±0.538	21.76 ±1.006	0.412++

++: Kruskal Wallis Test; *: One Way Variance Analysis (ANOVA); SD: Standard Deviation; p<0.05.

before and after KT application with eyes open and closed (p>0.05) (Table 2). There were no differences in static balance before and after KT application with eyes open in the KT-1 group, or before and after KT application with eyes opened and closed in the KT-2 group (p>0.05). However, a significant difference was found in static balance before and after KT application with eyes closed in the KT-1 group (p=0.036). The time duration of static balance was longer after KT application than before KT application in the KT-1 group (Table 2).

DISCUSSION

The aim of the present study was to discover whether the KT correction technique on the retinaculum of the ankle with facilitation technique on the peroneal muscle or the KT facilitation technique on the peroneal muscle alone had an immediate effect on static balance in healthy subjects. The primary finding of the present study was that the facilitation technique was applied to the peroneal muscle improved static balance during eyes closed. But it did not affect static balance during eyes opened. The second finding of the present study was that the correction technique on the retinaculum of the ankle with facilitation technique on the peroneal muscle did not affect static balance during eyes opened or closed. Finally, there were no differences between the facilitation technique on the peroneal muscle and the correction technique on the retinaculum of the ankle with the facilitation technique on the peroneal muscle statistically. Although there was no statistically significant difference, the static balance duration was observed to increase in facilitation technique on the peroneal muscle more than the correction technique on the retinaculum of the ankle with the facilitation technique on the peroneal muscle.

When visual input is cut or altered, the somatosensory system tries to support proprioceptive feedback with the vestibular system to maintain balance (23). Proprioception is important to control movement and is transmitted by mechanoreceptors to the central nervous system (3). These mechanoreceptors are in muscles, joint capsule tendons, ligaments, and skin (24). KT application can stimulate proprioception in healthy individuals (25). Stimulating proprioception could modulate sensorimotor integration and motor facilitation of ankle muscle (26). In the present study, the facilitation technique used to stimulate muscle mechanoreceptors (12), affected static balance positively in the facilitation technique on the peroneal muscle alone during eyes closed. Activation of ankle mechanoreceptors can improve balance ability with the correct KT application on the ankle. Postural stability can be maintained with improved balance (3), and so injuries that may occur during force and contact in sports can be avoided (11).

In the present study, the facilitation technique of KT on peroneal muscles affected static balance when the eyes were closed, but the correction technique on the retinaculum of the ankle with facilitation technique on the peroneal muscle did not affect static balance positively. KT induces an illusory perception of movement (16). For this reason, using several KT applications together on ligaments and muscles around the ankle might interrupt sensorimotor integration. An extreme mechanoreceptor stimulation around the ankle might adversely affect static balance. A similar result to the present study was found by Tekin et al. They used a correction technique on the ankle joint from the sole of the lateral to the medial malleolus with a tension of 50% and the distal part of the peroneal muscle group with a tension of 0%. In the result of their study, the correction technique of KT did not affect static balance with opened or closed eyes (14). These results can be explained since the correction technique can be used

Table 2. Static balance before and after KT application with eyes opened or closed in groups and between groups.

		KT-1 (Mean ±SD)	KT-2 (Mean ±SD)	CONTROL (Mean ±SD)	p^{++}
Eyes opened time (s)	Before application	5.25 ±4.35	4.01 ±3.01	3.50 ±1.47	0.208
	After application	6.15 ±5.41	4.40 ±2.68		0.067
	p^{*}	0.130	0.560	-	-
Eyes closed time (s)	Before application	1.67 ±0.65	1.73 ±0.47	1.68 ±0.41	0.993
	After application	2.19 ±0.87	1.85 ±0.77		0.079
	p^{*}	0.036	0.225	-	-

++: One Way Variance Analysis (ANOVA); *: Paired t test; s: second; SD: standard deviation; p<0.05.

to correct a misalignment (12). Therefore, the changing of the alignment after the correction technique and the deterioration of the stimulus coming from the ankle might disrupt the mechanoreceptors' ability to adapt to the new situation and prevent the muscles from responding quickly. Since the individuals in both studies (the present study and the study of Tekin et al.) did not have a misalignment, the correction technique might have negatively affected the balance. However, contrary to these results, static balance had been seen to affect positively when only the facilitation technique on the peroneal muscle was used during closed eyes. Proprioception stimulated by KT application can modulate sensorimotor integration and motor answer of ankle muscles (26). In this way, the ankle muscles may have been able to react more quickly to the instantaneous changes that occur during static balance and to maintain the equilibrium. When visual information is removed or altered, the sensorimotor system must compensate using proprioceptive feedback and information from the vestibular system to maintain balance (23). It is highly likely that this positive effect could not be achieved with opened eyes owing to visual stimulation being more dominant than proprioceptive sense during balance.

After 10 minutes from the applying, the using correction technique on the ankle joint from the sole of the lateral to the medial malleolus and the distal part of the peroneal muscle group was not seen to improve the static balance (14). Similar to this result, the correction technique on the retinaculum of the ankle with the facilitation technique on the peroneal muscle had not an immediate effect on static balance in healthy subjects in the present study. In another study, after 45 minutes from applying of the mechanical correction technique (with a tension of 30-40%) on the tibialis anterior muscle and mediolateral side of the calf muscle, there had been to see an improvement in static balance (16). However, in the present study, the KT facilitation technique on the peroneal muscle alone had an immediate effect on static balance during eyes closed in healthy subjects. Although the application of KT on ligaments did not improve static balance in these studies (the present study and the study of Tekin et al.), the application of KT on muscles (the present study and the study of Huzmeli et al.) improved it. Consequently, if the correct application of KT on target tissues is used, it was thought there is no need to wait for it to take effect. However, new studies that examine the time required for the correct technique to show its effectiveness are needed.

Taping improves the joint position sense in athletes (2). Therefore, taping reduces the risk of injury in players with a previous ankle injury (27). It has been reported that KT does not develop ankle proprioception (28). Examination of the study revealed that proprioception was investigated using too much KT around the ankle. In contrast to this study, an improvement in ankle proprioception after KT application was observed (29). In the present study, KT improved static balance when the eyes were closed. In light of this result, using the facilitation technique on peroneal muscles can affect balance positively and as a result it can reduce the risk of injury. However, while the facilitation technique affects balance positively, using the facilitation technique in combination with the correction technique is not effective for static balance. We propose that KT practitioners should use KT with appropriate techniques and avoid excessive taping. Using KT for the intended purpose or not using KT at all might give a better result than using too much.

Although the proprioceptive information from the ankle after KT application affected balance when the eyes are open, it may not have been effective in both the facilitation technique on the peroneal muscle alone and the correction technique on the retinaculum of the ankle with facilitation technique on the peroneal muscle since visual information did not change and visual information was more dominant in maintaining balance. The similar result observed by Tekin et al. further strengthens this hypothesis (14). Although it is not statistically significant in present study, in sports competitions, the relatively small but positive changes between before and after the application of KT can be important in terms of both preventing injuries and athlete can make a differences according to others. Therefore, it is thought that there is a need randomized controlled studies using methods such as functional MRI or electromyograms or special balance devices to research activated cortical neurons or muscles following KT application on both healthy individuals and athletes.

Strengths and Limitations

The present study had some limitations. All the individuals in the study did not have instability. The effect of KT should be investigated on athletes and individuals who have ankle instability. Using a balance platform or isokinetic equipment is important to evaluate proprioception objectively. The effects of KT on balance could be evaluated before and after a warming up program or sport. The effects of sham taping on acute/subacute/chronic subjects should be investigated and the firing time of peroneal muscles should be evaluated with EMG. Moreover, it is thought that studies examining the time required for the correct technique to show its effectiveness are needed.

CONCLUSION

KT is used very often in clinics during sports competitions, rehabilitation, protection from trauma, healing soft tissue, improving performance, and maintaining stability. However, if misused KT may have no effect or may adversely affect performance, contrary to its purpose. In this study, using the facilitation technique of KT on peroneal muscles improves static balance when the eyes are closed more effectively than using the correction with facilitation technique on the ankle. Furthermore, KT affected positively the static balance during closed eyes after using it immediately. Using KT by choosing a correct technique according to tissues provides more effective results than multiple KT applications.

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Ethical approval: The authors confirm this study meets the guidelines of the Declaration of Helsinki and after local ethical approval all subjects who accepted this study provided written informed consent. The Istanbul University Clinical Research Ethics Committee approved the study protocol (Date: 26.11.2010, Decision Number: 2010/692-184).

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