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Original Article

Does kinesiotaping affect standing balance in healthy individuals? A pilot, double-blind, randomized-controlled study

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ABSTRACT

Objectives: This study aims to investigate the immediate and short-term effects of kinesiotaping (KT) on balance, when applied to the ankles of healthy individuals.

Patients and methods: In this pilot, double-blind, randomized, sham-controlled study, a total of 24 healthy male individuals (mean age 31.8 years; range, 22 to 40 years) were randomized into two groups as KT and sham between January 2014 to March 2014. The KT group had a therapeutic KT application which could provide the ankle stability. The control group had a prespecified sham application. Balance testing was done before, immediately after and 24 hours after the application of KT. Anteroposterior, mediolateral, and overall stability indexes (APSI, MLSI, and OSI, respectively) were measured and given in relative treatment effect (RTE).

Results: There was no statistically significant interaction between the intervention and time for all stability indexes. The main effects were evaluated. The main effect of time showed a significant difference in terms of RTE and mean ranks at all time points for the MLSI and OSI (p=0.034 and p=0.009, respectively). The KT of ankle had an immediate positive effect on standing balance of healthy individuals which did not sustain after 24 hours. The main effect of group showed that there was a significant difference in the RTE levels between the intervention groups for all indexes. Based on the rank means, the KT group had a better stability than the sham group for all indexes.

Conclusion: Our study results suggest that KT of ankle has an immediate positive effect on standing balance of healthy individuals by increasing mediolateral stability of the ankle.

Keywords: Balance, kinesiotaping, postural stability.

Kinesiotaping (KT) has recently gained so much popularity and a growing number of physicians has started using it to alleviate musculoskeletal symptoms. The KT was originally developed by Kenzo Kase in 1976. The tape has almost the same thickness as epidermis. It is made of polymer elastic strand wrapped by cotton fibers and can be stretched longitudinally.[1] Kinesiotaping is also used to increase sensory inputs through proprioception feedback and relieving abnormal muscle tension in healthy athletic individuals.[2-4] The effects of KT on ankle proprioception and stability have been investigated in previous studies.[5-8] However, these studies are limited with controversial data.[9-12] Repeated application of KT in a patient with chronic ankle instability has been shown to be effective in improving balance.[13] In basketball players with chronic ankle sprain, KT did not improve or inhibit balance.[14] Application of KT did not cause a significant change in balance of healthy individuals.[15]

In the present study, we hypothesized that balance would improve immediately with the prescribed application of KT, compared to the sham application, and this effect would sustain after 24 hours. Therefore, we aimed to evaluate the immediate and short-term effects of KT on balance of healthy individuals.

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PATIENTS AND METHODS

In this pilot, double-blind, randomized, sham-controlled study, a total of 30 healthy male volunteers aged between 18 to 40 years were screened for eligibility by physical examination and history. Individuals with any lower extremity fractures, knee or ankle ligamentous injury, conditions affecting balance, knee, hip or spinal osteoarthritis, lower extremity or back surgery, polyneuropathy or neurological deficits were excluded. Finally, a total of 24 healthy male individuals (mean age 31.8 years; range, 22 to 40 years) were included between January 2014 to March 2014. A written informed consent was obtained from each participant. The study protocol was approved by the Ethical Commitee of Ankara University Faculty of Medicine (No. 05-213-14). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Randomization was performed using the block randomization method with a block size of four was used to allocate the individuals equally to two groups using the Random Allocation Software (RAS) as KT and sham (control) group. To conceal the randomization sequence, an independent researcher who was blind to the baseline data carried out the procedure using a computer software. The researcher who was blinded to the allocation procedure did the balance testing of all individuals, before (T0), immediately after (T1), and 24 hours after the application of KT (T2). The individuals were also blinded to the type of intervention. The study flow chart is shown in Figure 1.

Interventions

A standard 2-inch (5 cm) Kinesio® Tex (Kinesio Holding Corp., Albuquerque, NM, USA) tape was used for all applications in both groups. A certified

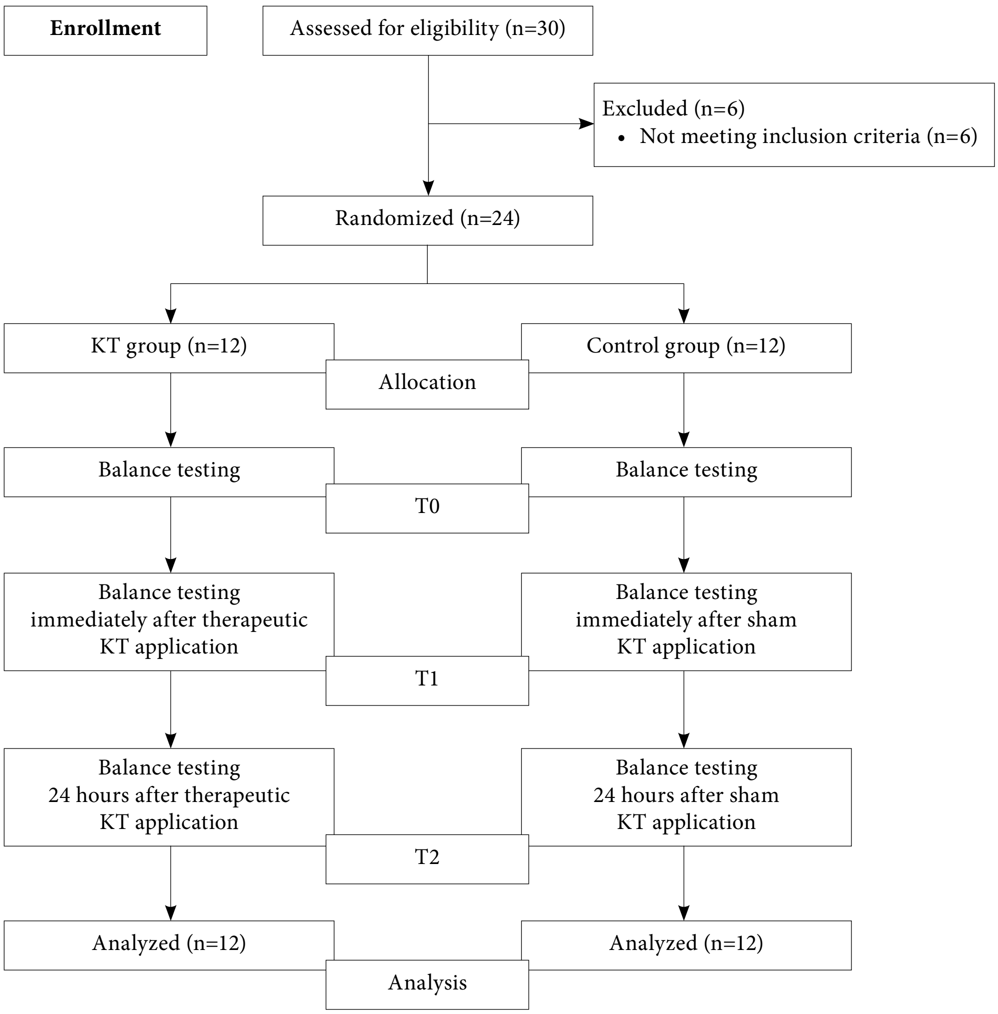

Figure 1. Study flow chart. KT: Kinesiotaping

KT practitioner did the all taping procedures. The KT was applied bilaterally to the ankle joints. To ensure blinding of the assessor, taping procedure was done in a separate room and individuals wore their socks after the application. The tape remained in place for 24 hours duration and individuals were instructed to participate in their normal daily activities, except for shower.

The experimental group received a therapeutic KT application (Figure 2). Three "I" strips were applied to the both ankle joints for joint stability with the subject's ankle at 90 degrees. The KT was applied according to the procedures recommended by the website of http://www.kttape.co.uk/instructions/ankles-and-feet/Ankle-Stability (last accessed on June 28th, 2018).

The first strip was anchored 5 cm above the ankle. Then, the tape was applied down the outer ankle, across the bottom of the heel, and up the inner side of the ankle. The last 5 cm of the tape was laid without stretch (Figure 2a-c).

The second strip was anchored along the instep of the foot. Then, the tape was laid around the back of the heel and across the arch with 50% stretch. The last part of the tape was laid down without stretch on inside of foot (Figure 2d-f).

The third strip was anchored same style along the outside of the foot. The tape was laid the around the back of the heel and across the arch with 50% stretch. The last 5 cm of the tape was laid down without stretch on inside of foot (Figure 2g-i). The layout of three strips together are shown in Figure 2j-l.

Control group

The control group received a sham KT application. Ankle position was hold at minimally plantar flexion during taping. A "I" strip was placed from the anterior mid foot, not stretched and attached to the midline of the anterior leg.

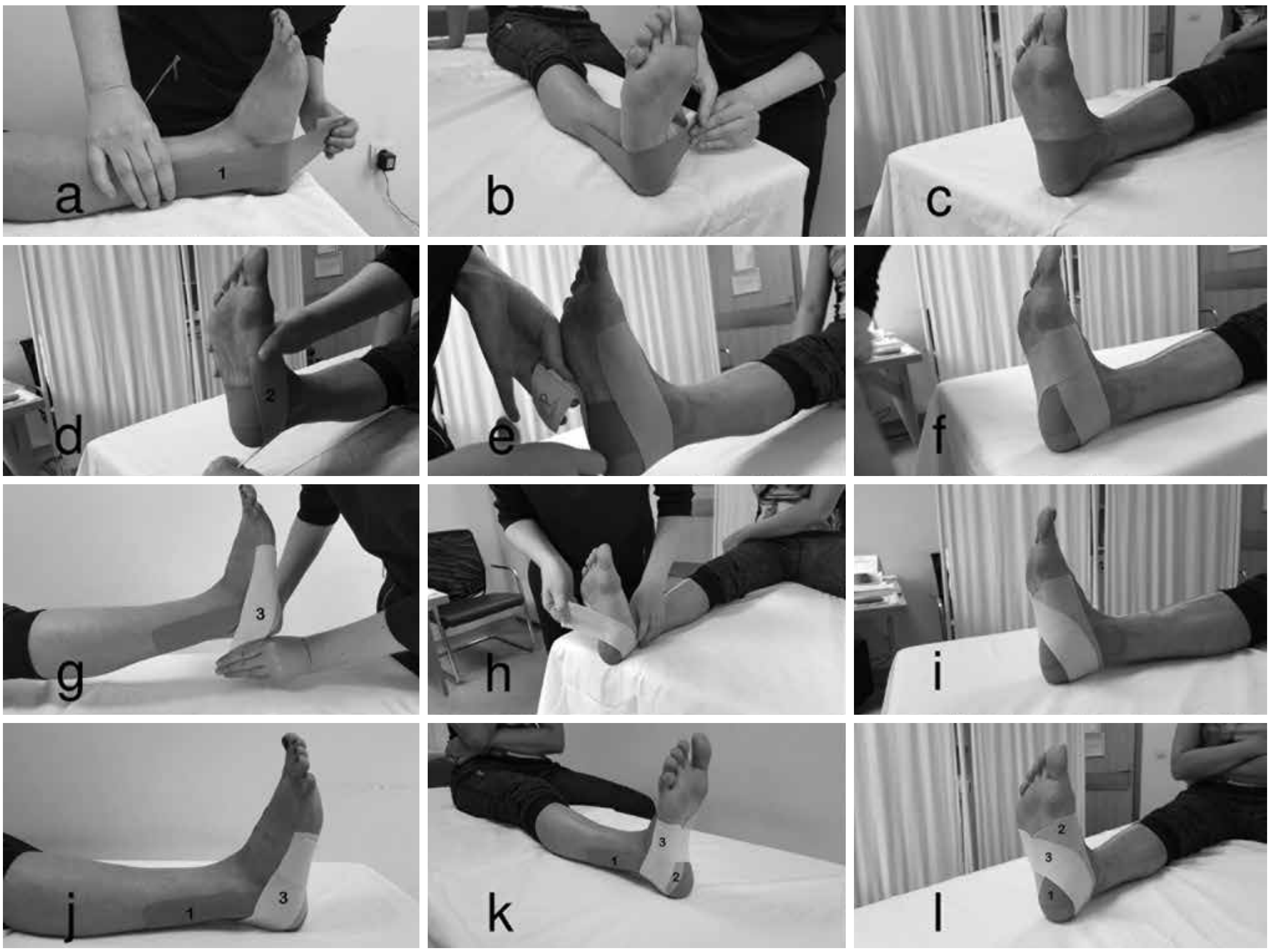

Figure 2. Therapeutic kinesiotaping technique of ankle.

Testing procedures

Each participant's height and weight were recorded and body mass index (BMI) values were calculated. Balance measurements were made using a Stabilometer, Biodex™ Balance System (Biodex Medical Systems, Inc., Shirely, NY, USA). A dynamic postural stability test was performed in a double-leg standing position with eyes open. Each test included three trials which lasted 20 sec with a 10 sec rest period between them. A mean score was calculated from three trials. All participants were given a practice trial lasting 20 sec to familiarize with the test. During the dynamic postural stability test, three indexes were calculated: *(i)* anteroposterior stability index (APSI), *(ii)* mediolateral stability index (MLSI), and *(iii)* overall stability index (OSI). The OSI indicates the total variation in plate deviation (sway) from the horizontal plane. The APSI and MLSI indicate the deviation of the plate (sway) from the horizontal position in the sagittal and frontal planes, respectively. Since the values obtained during measurements indicate the amount of sway from the horizontal position, lower scores show better balance.

Statistical analysis

Non-parametric tests were used for hypothesis testing due to small sample size and skewed data distribution. The baseline demographic characteristics of the patients in each group were compared using the Mann-Whitney U test. Data were expressed in mean ± standard deviation (SD), median (min-max), number and frequency, or mean ranks and relative treatment effects (RTEs), where appropriate. Since the measures of three time points for each patient were dependent, we used a robust rank-based non-parametric method proposed by Bruner and Puri[16] for the analysis of longitudinal data in the factorial setting. The RTEs were given in this method as descriptive point estimators. 95% confidence intervals (CIs) of RTEs were also used for post-hoc inferences. If the related 95% CIs did not overlap, we concluded that there was a significant difference between the time points or subgroups. The RTE was defined as the probability that a randomly chosen observation from time point and/or group under consideration tended to results in a larger value than the randomly chosen observation from the whole dataset independently from time point and/or group under consideration.[17] The F1-LD-F1 design was used to analyze the repeated measurements from two groups of patients. We tested three hypotheses of no time, no group, and no time and group interaction effects. If the null hypothesis of no effect is true, all groups and/or time points should have an RTE of 0.50. When interaction was found to be significant, the trend in the observations through time points was considered different between the groups. When the time effect was significant, changes at different time points were tested by ignoring the group effect. When the group effect was significant, the significance of inter-group differences was considered by ignoring the time effect. All analyses were performed in R v.3.0.1 (R development team) and "nparLD" library used for non-parametric repeated F1-LD-F1 designs.[18,19] All statistical analyses were performed using the RStudio Version 0.96.122. (RStudio: Integrated Development for R. RStudio, Inc., Boston, MA, USA). A p value <0.05 was considered statistically significant. For the evaluations of the results, time and group-based charts including RTEs and related 95% Cis were given.

RESULTS

Baseline sociodemographic characteristics of the participants were similar between the groups (Table 1).

There was no significant interaction between the intervention and time on anteroposterior stability (Fn=0.718, p=0.481) (Table 2, Figure 3). Therefore, the main effects were evaluated (Table 3). The main effect of time did not show a significant difference in terms of RTEs and mean ranks at all time points (Fn=2.223, p=0.110). However, the main effect of group showed

Table 1. Baseline demographic characteristics of individuals

	KT group (n=12)			Sham group (n=12)			
Characteristics	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	p
Age (year)	31.3±6.2	31.5	22-40	32.3±5.8	34	23-40	0.563
Weight (kg)	73.1±13.1	72	52-95	77.5±9.4	77	60-92	0.370
Height (cm)	170.8±9.0	171	155-190	174.3±5.5	174.50	165-186	0.193
Body mass index (kg/m^2)	24.9±3.3	24.59	20.20-31.02	25.5±2.9	25.84	20.28-30.04	0.644

KT: Kinesiotaping.

Table 2. Intervention, time, and the interaction terms of intervention versus time for the tests

	Treatment (Group)		Time		Interaction	
	F_n	*p*	F_n	*p*	F_n	*p*
Anteroposterior stability index	8.588	0.003	2.223	0.110	0.718	0.481
Mediolateral stability index	29.947	<0.001	3.393	0.034	0.309	0.730
Overall stability index	14.841	<0.001	9.238	0.009	0.803	0.669

F_n: ANOVA type statistic; F1-LD-F1 design was used to test the significance of terms group, time, and group versus time interaction.

Table 3. Changes in the scores of the APSI, MLSI, and OSI in terms of the RTE and mean rank for intervention according to time points

	APSI			MLSI			OSI		
	RTE	95% CI	Mean ranks	RTE	95% CI	Mean ranks	RTE	95% CI	Mean ranks
KT									
T0	0.468	0.343-0.600	34.250	0.348	0.264-0.450	7.170	0.451	0.330-0.582	8.880
T1	0.376	0.261-0.516	27.625	0.261	0.184-0.374	8.420	0.323	0.220-0.462	9.000
T2	0.281	0.197-0.401	20.792	0.318	0.234-0.425	7.920	0.262	0.189-0.366	8.040
Sham									
T0	0.664	0.535-0.764	48.333	0.767	0.674-0.830	17.830	0.739	0.653-0.802	16.130
T1	0.598	0.462-0.715	43.625	0.604	0.498-0.697	16.580	0.602	0.482-0.706	16.000
T2	0.609	0.494-0.709	44.375	0.699	0.588-0.782	17.080	0.620	0.510-0.714	16.960

APSI: Anteroposterior stability index; MLSI: mediolateral stability index; OSI: Overall stability index; RTE: Relative treatment effect (mean ranks); CI: Confidence interval; KT: Kinesiotaping; F1-LD-F1 design was used to test the significance of terms group, time, and group versus time interaction.

that there was a significant difference in RTE levels between the intervention groups (Fn=8.588, p=0.003) (Table 2). Due to a dichotomous variable, the test of the main effect of the group resulted in a comparison between two average mean rank scores and RTEs (Table 4). Based on the rank means, it was found to be 27.556 for KT the group and 45.44 for the sham group (RTEs: 0.375 and 0.624, respectively). On average, the KT group had a better stability than the sham group (Table 4).

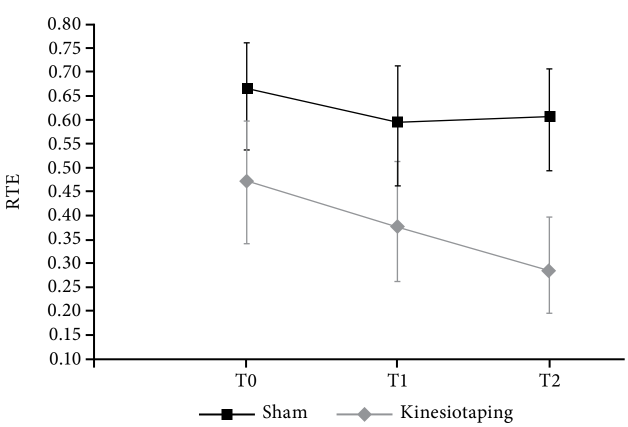

Figure 3. Intervention and time graphic for anteroposterior stability index.

RTE: Relative treatment effect (mean ranks).

In addition, there was no significant interaction between the intervention and time on mediolateral stability (Fn=0.309, p=0.730) (Table 2, Figure 4). The main effect of time showed a significant difference in terms of RTEs and mean ranks at all time points (Fn=3.393, p=0.034). The RTE decreased from 0.55 to 0.43 immediately after KT and, then, increased to 0.50 after 24 hours (Table 5). The main effect of group showed that there was a significant difference

Table 4. RTEs, mean ranks of intervention, time and main effects for APSI

Source	Rank mean	Nobs	RTE
KT group	27.556	36	0.3757716
Sham group	45.444	36	0.6242284
T0	41.292	24	0.5665509
T1	35.625	24	0.4878472
T2	32.583	24	0.4456019
KT group*t0	34.250	12	0.46875
KT group*t1	27.625	12	0.3767361
KT group*t2	20.792	12	0.2818287
Sham group*t0	48.333	12	0.6643519
Sham group*t1	43.625	12	0.5989583
Sham group*t2	44.375	12	0.609375

RTE: Relative treatment effect; APSI: Anteroposterior stability index; KT: Kinesiotaping.

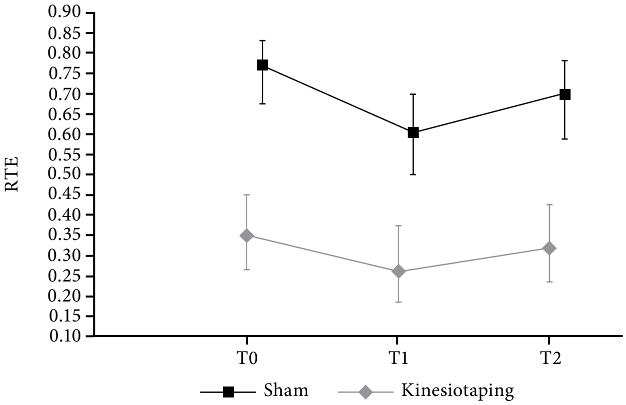

Figure 4. Intervention and time graphic for mediolateral stability index.

RTE: Relative treatment effect (mean ranks).

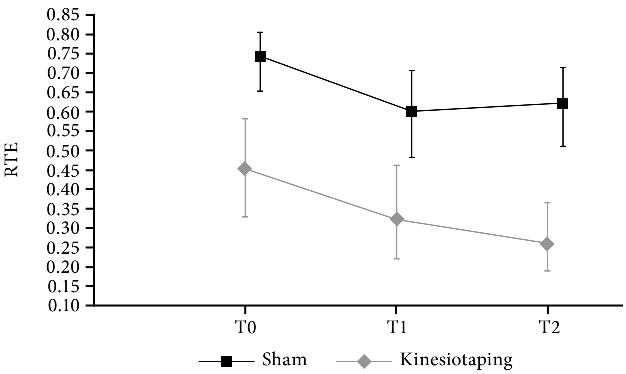

Figure 5. Intervention and time graphic for overall stability index.

RTE: Relative treatment effect (mean ranks).

in the RTE levels between the intervention groups (Fn=29.947, p<0.001) (Table 2). Based on the rank means, it was found to be 22.79 for KT the group and 50.21 for the sham group (RTEs: 0.309 and 0.690, respectively), On average, the KT group had a better stability than the sham group (Table 5).

Furthermore, there was no significant interaction between the intervention and time on overall stability (Fn=0.803, p=0.669) (Table 2, Figure 5). The main effect of time showed a significant difference in terms of RTEs and mean ranks at all time points (Fn=9.238, p=0.009) (Table 2). The RTE decreased from 0.59 to 0.46 immediately after KT and, then, decreased to 0.44 after 24 hours (Table 6). The main effect of group showed that there was a significant difference in the RTE levels between the intervention groups (Fn=14.841, p<0.001) (Table 2). Based on the rank means, it was found to be 25.40 for the KT group and 47.59 for the sham group (RTEs: 0.346 and 0.654, respectively). On average, the KT group had a better stability than the sham group (Table 6).

Table 5. RTEs, mean ranks of intervention, time and main effects for MTSI

Source	Rank mean	Number of observations	RTE
KT group	22.792	36	0.3096065
Sham group	50.208	36	0.6903935
T0	40.708	24	0.5584491
T1	31.667	24	0.4328704
T2	37.125	24	0.5086806
KT group*t0	25.625	12	0.3489583
KT group*t1	19.333	12	0.2615741
KT group*t2	23.417	12	0.318287
Sham group*t0	55.792	12	0.7679398
Sham group*t1	44.000	12	0.6041667
Sham group*t2	50.833	12	0.6990741

RTE: Relative treatment effect; APSI: Anteroposterior stability index; KT: Kinesiotaping.

Table 6. RTEs, mean ranks of intervention, time and main effects for OSI

Source	Rank mean	Number of observations	RTE
KT group	25.403	36	0.3458719
Sham group	47.597	36	0.6541281
T0	43.396	24	0.5957755
T1	33.833	24	0.462963
T2	32.271	24	0.4412616
KT group*t0	33.042	12	0.4519676
KT group*t1	23.792	12	0.3234954
KT group*t2	19.375	12	0.2621528
Sham group*t0	53.750	12	0.7395833
Sham group*t1	43.875	12	0.6024306
Sham group*t2	45.167	12	0.6203704

RTE: Relative treatment effect; APSI: Anteroposterior stability index; KT: Kinesiotaping.

There were no adverse reactions or local adverse events after the application of KT. None of the patients withdrew from the study due to adverse events.

DISCUSSION

Previously, athletic taping or bracing have been shown to have unfavorable effects on balance.[20] They decrease balance ability and increase postural sway by decreasing the joint mobility. However, KT differs from traditional athletic tape or bracing in a way that it is highly elastic and can be stretched to as much as 140% of its length.[4] Subsequently, it provides a constant pulling force to skin unlike athletic tape or bracing. In this pilot study, we investigated the immediate and short-term effects of KT on balance of healthy individuals.

Cortesi et al.[9] and Tamburella et al.[21] reported that there was a better control of balance after application of KT to the ankle joint. However, the aforementioned studies recruited individuals with balance impairments and did not have a control group. Akbari et al.[22] compared the effects of ankle taping and balance exercises on postural stability in healthy women and found partially supportive effects of taping on postural stability. In the current study, the application of KT increased the mediolateral stability of the ankle, compared to the sham taping.

In recent years, there has been a growing interest in KT. Accordingly, KT practitioners are faced with an uncertainty due to the increasing number of taping techniques. This is also reflected in clinical trials as non-standard KT applications. In the current taping method, three strips were used to provide ankle stability in the anterior and mediolateral planes. However, a significant improvement was observed in the mediolateral plane reflected by changes in the MLSI and OSI. This is not surprising as the positioning of the strips was rather compatible with the mediolateral stability. Therefore, modification of the current method by adding more strips or re-positioning may be necessary to improve the anteroposterior stability, as well.

The majority of clinical trials investigating the effects of KT have a single-blind study design, as blinding of individuals is difficult due to the nature of taping procedure itself. Ferrari et al.[23] did not allow wearing stockings to avoid the extra-stimulation in their study. However, all individuals wore stockings in the current study to ensure their blinding. Since the individuals in two groups wore stockings at all times during our study (T0, T1, T2), this might not have caused a bias due to possible extra-stimulation.

On the other hand, the present study did not specifically address the mechanisms underlying the positive effects of KT on balance. However, increased stimulation to cutaneous mechanoreceptors is a widely accepted mechanism. Murray and Husk[6] first described the phenomenon of increased stimulation to skin mechanoreceptors with resultant increase in proprioception. Horak et al.[24] also proposed that the information originated from the skin mechanoreceptors has an effect similar to that of joint receptors on proprioception. Consequently, the information flow to the central nervous system (CNS) increases with a more accurate control of joint movement.[25] Based on these theories, KT is thought to improve postural control and balance by conveying sensorial inputs to the CNS by skin.[12]

In general, patients are recommended to keep taping for three to five days to maintain its clinical benefits. Taping of ankle joints provided a significant improvement immediately after the procedure in the current study. This improvement, however, did not sustain after 24 hours. Shields et al.[11] evaluated the immediate and prolonged effects of KT on postural control in healthy, coper, and unstable ankles. They observed minor improvements following 24 hours of use, but not immediately after the application of KT. However, the aforementioned study had no sham group and utilized single-leg stance as the test position. In this position, maintaining the opposite, non-weight bearing lower leg in a standard location becomes a major concern. On the contrary, double-leg stance was used as the test position to avoid this difficulty in the current study.

There are some limitations to the present study, mainly due to its pilot nature. First, the study has a limited sample size. A retrospective power analysis showed that the study was underpowered. Group sample sizes of 12 and achieving 75% power to detect a difference of 0.084 in a design with three repeated measurements having a autoregressive[1] covariance structure, when the standard deviation is 0.100, the correlation between observations on the same subject is 0.500 and the alpha level is 0.05. Therefore, current results must be interpreted with caution against type II statistical error. Second, the participants were a convenience sample including only healthy male individuals with no balance impairment. Hence, generalization of the current findings to females and individuals having problems with postural control still remains limited. In the literature, it has been reported that male and females use different strategies to control the ankle joint.[26] Females are thought to have less joint stability compared to males. Since KT may have produced different results in either case, it would have been better to include both populations in the current study. Third, the taping method which we used had its major effect on the mediolateral stability, causing non-significant changes in the anteroposterior stability.

In conclusion, KT of the ankle has an immediate positive effect on dynamic standing balance of healthy individuals. The therapeutic taping method used in the current study showed its major effect on the mediolateral stability of ankle. However, further large-scale studies are needed to confirm its effects on time and to identify the most optimal taping method to maintain a better ankle stability.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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