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ORIGINAL ARTICLE

Effects of kinesiology taping on delayed onset muscle soreness: a randomized controlled pilot study

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Purpose: The aim of this study was to determine the effects of kinesiology taping on delayed onset muscle soreness.
Methods: Twenty non-athletic volunteers were assigned randomly in two groups, kinesiology taping (N=10) and placebo kinesiology taping (N=10). Participants performed 100 consecutive drop-jumps from a platform 0.60 m in height to induce muscle damage. Kinesiology tape was applied with fan technique on quadriceps femoris muscle in kinesiology taping group while the tape was applied without any technique and no tension in placebo kinesiology taping group. Muscle tenderness was measured using digital algometry at musculotendinous junction and mid-belly of quadriceps femoris muscle. Performance was determined using one leg hop test. Blood samples were obtained for the analysis of serum creatine kinase and myoglobin levels. All measurements recorded before, immediately after, 48 hours, and 72 hours after exercise.
Results: Changes in mid-belly of quadriceps femoris muscle tenderness was determined higher in the placebo kinesiology taping group than kinesiology taping group between 48 h after-immediately after exercise ($p<0.05$). No significant differences were identified between the groups for one leg hop performance, serum creatine kinase, and myoglobin levels ($p>0.05$).
Conclusion: Although kinesiology taping reduces mid-belly of quadriceps femoris muscle tenderness after exercise that induced delayed onset muscle soreness, it has no effects on activity, performance, serum creatine kinase and myoglobin level.
Keywords: Athletic tape, Creatine kinase, Myoglobin.

Gecikmiş kas ağrısında kinezyolojik bantlamanın etkileri: randomize kontrollü pilot çalışma

Amaç: Bu çalışmanın amacı gecikmiş kas ağrısında kinezyolojik bantlamanın etkilerini araştırmaktı.
Yöntem: Yirmi sağlıklı sedanter birey kinezyo bantlama (N=10) ve plasebo kinezyolojik bantlama (N=10) olmak üzere iki gruba ayrıldı. Katılımcılarda 0.60 m yüksekliğindeki platformdan 100 ardışık aşağı atlama yöntemi ile kas hasarı oluşturuldu. Kinezyolojik bant, kinezyolojik bantlama grubunda quadriceps femoris kasına fan tekniği ile uygulanırken plasebo kinezyolojik bantlama grubuna ise teknik ve gerim olmadan uygulandı. Kas hassasiyeti dijital algometre ile quadriceps femoris muskulotendinöz bölge ve kas gövdesinden ölçüldü. Performans tek ayak sıçrama testi ile değerlendirildi. Kan örnekleri serum kreatin kinaz ve miyoglobin düzeyleri analizi için alındı. Bütün değerlendirmeler egzersiz öncesi, egzersizden hemen sonra, 48 ve 72 saat sonra yapıldı.
Bulgular: Egzersizden hemen sonra ile 48 saat arasındaki quadriceps femoris kas gövdesi hassasiyetindeki değişim plasebo kinezyolojik bantlama grubunda kinezyo bantlama grubundan daha yüksek belirlendi ($p<0.05$). Tek ayak sıçrama performansı, serum kreatin kinaz ve miyoglobin düzeylerinde gruplar arasında bir fark belirlenmedi ($p>0.05$).
Tartışma: Bu çalışmada, kinezyolojik bantlamanın egzersize bağlı gecikmiş kas ağrısında quadriceps femoris kas gövdesi hassasiyetini azaltmasına rağmen, aktivite, performans, serum kreatin kinaz ve miyoglobin düzeylerinde etkisi olmadığı bulundu.
Anahtar kelimeler: Atletik bant, Kreatin kinaz, Miyoglobin.

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Delayed-onset muscle soreness (DOMS) is the pain and stiffness felt in muscles several hours to days after unaccustomed or strenuous exercise can appear in athletic and non-athletic population.[1-4] The soreness is felt most strongly from 24 to 72 hours after the exercise.[3] A number of theories have been proposed to explain the mechanism of DOMS such as lactic acid accumulation, muscle spasm, connective tissue damage, muscle damage, inflammation, and enzyme efflux.[4,5] However, none of these theories can explained completely the mechanism of DOMS yet. DOMS is characterized by muscular pain, tenderness, edema, decreased muscle force production, reduce range of motion, and discomfort experienced.[3,5,6] Numerous treatment strategies have been introduced to help relieve the severity and symptoms of DOMS. Some of the proposed treatments include pre and post-exercise stretching,[7,8] pharmacological treatments using non-steroidal anti-inflammatory drugs,[9-11] nutritional supplements,[12,13] massage therapy,[14,15] continuous compression,[16] and ice-water immersion.[17] However, an effective treatment for DOMS has not been established yet.

Kinesiology taping (KT) for lymphatic drainage is an alternative choice in the field of physical therapy. According to the manufacturers of KT, the tape causes micro convolutions or folds in the skin, which causes a lifting of the skin away from the tissue beneath. This lifting effect facilitates a release the pressure on tender tissues underneath and provides space for lymphatic fluid movement. It is claimed that this can help relieve pain and muscle spasm, decrease edema, improve joint motion and muscle force.[18] When considering these effects of KT, it can reduce inflammation and the symptoms associated with DOMS. However, to our knowledge, there is no study investigating the effects of KT on DOMS.

The aim of this study was to investigate the effects of KT on DOMS. It was hypothesized that, compared with placebo KT, KT would reduce the severity and duration of the symptoms associated with DOMS.

METHODS

Twenty healthy non-athletic volunteers were assigned randomly in two groups, KT (mean age 21.5±1.1 years) and placebo KT (mean age 22.5±2.5 years) groups. Subjects' characteristics were recorded. Body mass index (BMI) was calculated. Subjects were identified as inactive according to the minimal activity guidelines released by the American College of Sports Medicine (less than 30 minutes of moderate physical activity as five times a week).[19] Exclusion criteria included history of vascular disease, pregnancy, recent injury or surgery to their lower extremity, neurological impairments and regular use of pain and inflammation medications. The Institutional Review Board at the Gazi University approved the study and subjects provided written informed consent prior to participation.

The muscle damaging protocol

Participants completed 100 consecutive drop-jumps from a platform 0.60 m in height to induce muscle damage. Upon landing, participants were encouraged to immediately jump vertically with maximal force. Five sets of 20 drop-jumps were performed with 10 s interval between each jumps and 2 min rest were given between sets. This protocol was determined as a reliable method in DOMS.[20-22]

Interventions

KT was carried out immediately after damaging exercise protocol. In KT group the first fan tape anchor was started from near the inguinal fold with no tension and cross over the anterior aspect of the thigh. The second fan anchor strip was started from as high up on the medial side of the thigh with no tension (as patient comfort will allow) and cross over the lateral aspect of the thigh. The tails of the tape were applied to the anterior, medial, and posterior aspects of the thigh with 5-15% tension. The fan strips were created a crisscross pattern over the anterior aspect of the thigh.[18] In placebo KT group a single "I" strip was applied with no tension to the lateral edge of the thigh. The tapes were left on the subject's skin for the next three days in both groups.

Outcome measures

All outcome measures were recorded before, immediately after, 48 and 72 hours after exercise protocol.

Muscle tenderness

Muscle tenderness was assessed using a digital algometry (Lafayette® Instrument

Corp., USA). It was measured from two reference points marked on the thigh along a line drawn from the anterior superior iliac spine to the superior pole of the patella. One of the reference points was at the midpoint of this line (representing the mid-belly quadriceps femoris muscle) and the other at 5 cm above the superior pole of the patella (representing the musculotendinous junction).[17] The pressure was applied until the participants to start complain of pain. Reference points were marked with ink to ensure that repeated measurements from the reference points. Measurements were recorded as kg/cm^2.

One leg hop test

In the one leg hop test, participants required to stand on one leg to be tested, to jump off and to land on that leg without losing balance. Three hops (with 60 sec rest between hops) were performed and the distance hopped was measured with a standard tape measure.[23] Mean value of distance was recorded as centimeter.

Blood analysis

Serum creatine kinase (CK) and myoglobin levels were used as a marker of muscle damage.[17,24] A 5 ml sample of venous blood was collected from the cubital fossa region of dominant arm of participants. The blood was allowed to clot for 30 min at room temperature and centrifuged for 10 min to obtain serum. Serum CK activity was determined spectrophotometrically by using a commercially available kit (Abbott® Laboratories, Chicago, IL, USA). Normal reference range of serum CK is 30-200 U/L for men and 29-168 U/L for women. Myoglobin concentration was also measured using a commercially available kit (Abbott®Axsym System, USA). Normal reference range of myoglobin is <154 ng/mL for men and <140 ng/mL for women.

Data analysis

All statistical analysis were performed using SPSS (Statistical Package for Social Sciences) Version 15.0 (SPSS®, Inc, Chicago, IL, USA). Descriptive statistics were presented as means and standard deviation. The Mann-Whitney test was used to analyze the differences between KT and placebo KT groups at each time point during the study. Friedman test was used to evaluate the changes in the each variables among the time periods of the study for separate each group. If there was a significant difference between time periods, we used the Wilcoxon Signed Rank Test with Bonferroni correction. Statistical significance was set at $p<0.05$.

RESULTS

There were no significant differences in age, height, weight, and BMI between the KT and placebo KT groups ($p>0.05$) (Table 1).

Significant increases in serum CK and myoglobin levels were identified in both groups immediately after exercise indicating the presence of DOMS ($p<0.05$). Supporting the presence of DOMS, an increase muscle tenderness and a decrease in one leg hop test was identified in both groups ($p<0.05$) (Table 2). When compared muscle tenderness changes between the groups, there was only significant increase in mid-belly of quadriceps femoris muscle in placebo KT group between 48 hours after-immediately after exercise ($p<0.05$) (Table 3). No significant differences were observed between the groups for other outcome measures ($p>0.05$) (Table 3).

Table 1. Demographic characteristics of participants.

	Kinesiology Tape (N=10) X±SD	Placebo Kinesiology Tape (N=10) X±SD	p
Age	21.5±1.1	22.5±2.5	0.556
Height (cm)	170.4±8.6	171.9±7.1	0.705
Body weight (kg)	70.4±15.1	65.3±9.6	0.520
Body mass index(kg/m^2)	24.0±2.9	22.0±2.5	0.151
Gender (Female/Male) (n)	6/4	5/5	

Table 2. Comparison of muscle tenderness, one leg hop test, and blood analysis results before, after, 48 h, and 72 h between the groups.

	Group	Before	After	48 h	72 h	p §
Muscle tenderness at musculotendinous junction (kg/cm2)	KT	13.0±2.4[a]	10.8±1.5[b,c]	10.6±2.2[b]	11.5±2.4[c]	<0.001
	Placebo KT	12.5±2.2[a]	11.3±1.6[b]	10.7±1.3[b]	10.5±2.2[b]	<0.001
	p#	0.496	0.650	0.821	0.326	
Muscle tenderness at mid-belly of muscle (kg/cm2)	KT	10.7±2.0[a]	9.1±1.1[b]	8.9±2.3[b]	9.6±1.9[b]	<0.001
	Placebo KT	11.1±2.0[a]	9.5±1.6[b]	7.4±3.0[b]	9.5±1.6[b]	<0.001
	p#	0.762	0.677	0.174	0.821	
One-leg hop (cm)	KT	147.2±29.7[a]	141.4±30.0[a,b]	134.8±25.1[b]	142.2±30.8[a,b]	0.001
	Placebo KT	161.2±35.2[a]	154.0±36.5[b]	151.5±36.1[b]	151.7±36.1[b]	0.001
	p#	0.326	0.496	0.364	0.705	
Creatine Kinease (U/l)	KT	106.6±43.2[a]	124.2±49.4[b]	138.9±38.7[a,b]	128.5±28.7[a,b]	0.043
	Placebo KT	78.3±26.9[a]	92.4±33.2[b]	101.8±40.5[a,b]	99.5±33.0[a,b]	0.032
	p#	0.151	0.140	0.041	0.014	
Myoglobin (ng/mL)	KT	25.8±4.7[b]	70.3±25.0[a]	32.6±12.8[a,b]	29.1±8.4[b]	0.002
	Placebo KT	27.2±5.3[b]	59.2±26.7[a]	26.4±5.4[b]	27.1±10.9[b]	<0.001
	p#	0.520	0.257	0.272	0.940	

KT= Kinesiology Tape. The same letters in each row indicate no significant difference. (Wilcoxon test with Bonferroni correction were used and statistical significance was set at p<0.013). # Mann-Whitney U test. §Fridman test for before, after, 48 h and 72 h measurements.

Table 3. Comparison of differences in muscle tenderness, one leg hop test, and blood analysis results ΔAfter-Before, ΔAfter-48 h and Δ72 h–48 h in two groups.

	Group	ΔAfter-Before	Δ48 h -After	Δ72 h – 48 h	p §
Muscle tenderness at musculotendinous junction (kg/cm2)	KT	-2.2±0.9[a]	-0.1±0.7[b]	0.8±0.2[b]	0.001
	Placebo KT	-1.2±0.6	-0.5±0.2	-0.7±0.8	0.273
	p#	0.112	0.940	0.082	
Muscle tenderness at mid-belly of muscle (kg/cm2)	KT	-1.6±0.8[a]	-0.2±1.2[a,b]	0.6±0.4[b]	0.027
	Placebo KT	-1.5±0.4[a]	-2.1±1.4[a,b]	2.1±1.4[b]	0.002
	p#	0.705	0.041	0.326	
One-leg hop (cm)	KT	-5.8±5.9	-6.6±12.0	7.4±11.9	0.061
	Placebo KT	-7.1±5.9	-2.5±7.5	0.2±7.5	0.082
	p#	0.880	0.650	0.212	
CreatineKinease (U/l)	KT	17.6±12.4	14.7±38.1	-10.4±27.8	0.273
	Placebo KT	14.1±7.3	9.4±27.8	-2.3±17.4	0.202
	p#	0.790	0.850	0.472	
Myoglobin (ng/mL)	KT	44.4±27.4[a]	-37.6±33.7[b]	-3.5±9.0[b]	0.001
	Placebo KT	32.0±25.8[a]	-32.8±25.2[b]	0.7±10.0[c]	<0.001
	p#	0.326	0.545	0.364	

KT= Kinesiology Tape. The same letters in each row indicate no significant difference. (Wilcoxon test with Bonferroni correction were used and statistical significance was set at p<0.017). # Mann-Whitney U test. §Fridman test for ΔAfter-Before, ΔAfter-48 h and Δ72 h–48 h measurements.

DISCUSSION

The findings of the study revealed that there were significant differences in both groups for muscle tenderness, one leg hop test (except KT group) and blood analysis (CK and myoglobin) measures from before to immediately after the damaging exercise. Changes in muscle tenderness (at mid-belly of quadriceps femoris muscle) between 48 h after-immediately after exercise were higher in placebo KT group.

Different exercise protocols were used to induce DOMS through the use of downhill running, resistance exercise and drop jump.[17,21,25,26] According to previous studies increase in muscle tenderness, CK, myoglobin and decrease in performance reported immediately after these exercises.[17,21,25,26] Similar decrease in performance and increase in CK, myoglobin and muscle tenderness immediately after exercises were observed in the present study. We demonstrated that drop jump protocol which used in this study is an effective method to induce DOMS.

Previous studies have demonstrated that muscle tenderness peaked at 48 h after exercise and decreased thereafter.[17,26] Highest muscle tenderness was identified at 48 h after exercise at two reference point in both groups (except placebo KT group 72 h after exercise at musculotendinous junction) and decreased thereafter in the present study. Previous study has showed that myoglobin peaked immediately after exercise and maximal CK level were observed at 48 h after exercise.[24] When taking account the markers of muscle damage parameters in this study, maximal muscle tenderness was consistent with time period of maximum level of CK. This similarity may result from coincidence or it can be a relation between CK level and muscle tenderness. Further study is needed to investigate the relation between muscle tenderness and CK level in larger sample size. When compared groups, the mid-belly of quadriceps femoris muscle tenderness was determined higher in placebo KT group. This result indicates that KT can be effective to reduce the tenderness of muscle.

A number of studies have shown that one leg hop distance was reduced after a damaging exercise.[17,27] In the current study, one leg hop distance was decreased in each time point till to 48 h in both groups. Although this decrease was found significant immediately after exercise only in placebo KT group, there were no significant differences between groups. This result reveals that despite the KT reduce the muscle tenderness, overall performance were not changed after exercise.

Previous studies have shown that serum CK and myoglobin were accepted as a marker of muscle damage and increased after damaging exercise.[17,24,28] Similarly in the current study, CK and myoglobin level was increased in both groups immediately after exercise. In the literature, it was stated that although myoglobin level peaked just after the exercise, CK take maximal level after 48 hours exercise.[24,28] Similar changes were observed in CK and myoglobin levels in this study. These results demonstrate application of KT or placebo KT has no effects on assessed blood markers.

Study limitation

This study has several limitations. Previous studies demonstrated that intensity and discomfort eventually disappear by 5-10 days post-exercise.[2,5,17] In the present study intervention and measurements ceased after 4 days; consequently, full recovery from DOMS could not be monitored. Future studies should be conducted on full recovery period to examine the effect of KT therapy on DOMS. Further study requires increased sample size.

CONCLUSION

The findings of this study revealed that although KT application reduces mid-belly of quadriceps femoris muscle tenderness after exercise that induced DOMS, it has no effects on performance, serum creatine kinase and myoglobin level.

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Conflict of interest: *None.*

Ethics approval: *Ethics approval was received for this study from the Ethics Board of Gazi University. (Date: March 3 2014. Decision number: 129)*

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