NO EFFECT OF KINESIOLOGY TAPE ON PASSIVE TENSION, STRENGTH OR QUADRICEPS MUSCLE ACTIVATION OF DURING MAXIMAL VOLUNTARY ISOMETRIC CONTRACTIONS IN RESISTANCE TRAINED MEN

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ABSTRACT

Background: Kinesiology Tape (KT) is widely used in sports rehabilitation and by those performing physical activity, however, there is no consensus in the scientific literature about its effectiveness on performance, strength or muscle activation.

Purpose: The purpose of this study was to measure the acute effects of KT in static rest, and during knee extension maximal voluntary isometric contraction (MVIC) performance in resistance trained men.

Study Design: Observational, descriptive, comparative.

Methods: Eighteen young, healthy, trained males (age: 25 ± 6 years, height: 176.0 ± 5 cm, and mass: 81.8 ± 8.0 kg) volunteered to participate. Initially, they were in a relaxed sitting position of 90 degrees knee flexion with their limb supported by the machine lever arm to measure passive tension of the tissues of the knee joint. Then, they performed three MVIC trials of five seconds each with a three-minute rest between trials, in four randomized experimental conditions, with 10-min rest between conditions: (a) control, no taping; (b) Knee Sleeve; (c) KT; and (d) sham. During all MVICs, peak force, impulse, and muscle activation of the vastus lateralis (integrated electromyography [IEMG] and median frequency) were measured.

Results: Repeated measures ANOVAs revealed no statistical differences between conditions for passive tension ($p > 0.05$), peak force ($p > 0.05$), impulse ($p > 0.05$), IEMG ($p > 0.05$), or median frequency ($p > 0.05$).

Conclusion: KT does not influence passive tension during static position at 90 degrees of knee flexion. KT does not affect quadriceps activation or force production during a maximal voluntary isometric contraction in the same position.

Level of Evidence: 3a

Keywords: Electromyography, force, kinesiology tape, muscle performance, quadriceps.

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All authors report no conflicts of interest.

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INTRODUCTION

Kinesiology Tape (KT) is a method introduced by Kase et al.¹ in 1973, and has been widely used in sports rehabilitation and by those who participate in physical activity. It has been claimed that KT might enhance normal functional movements, decrease pain, and decrease swelling,² additionally, several researchers have investigated its use to increase performance, strength or muscle activity.³⁻²⁴

Previous authors have attempted to verify the effect of KT on force,^{6,9,11,12,18,21,25-27} torque,^{4,5,10,17,28} and muscle activation.^{6,18,22-24,29,30} Some researchers have observed a significant increase in a specific performance,³⁻²¹ and muscle activity,^{6,22-24} while others have shown no significant effect.²⁹⁻³⁸ The aforementioned studies illustrate that there is no consensus in the scientific literature about the efficacy of KT in performance, strength and muscle activation. Furthermore, these studies provide conflicting results due to differences in population as well as methodology (inclusion of the sham or control group), KT application (direction, pattern of application, tension), muscles evaluated, and tests performed. Additionally, to the best of authors' knowledge, no study has verified the passive tension provided by KT, which might explain improvements in total amount of force that is produced by subjects in some studies. In this case, the passive tension of the KT is the additional force produced by the material properties, and might be added to the contractile force to produce improvement in performance.³⁹⁻⁴² Therefore, the purpose of this study was to measure the acute effects of KT in static rest, and during knee extension maximal voluntary isometric contraction (MVIC) performance in resistance trained men. The null hypotheses of the present study are: (1) KT will not affect passive tension during static rest; and (2) KT will not affect muscle activation or force output during an MVIC.

METHODS

Subjects

The number of participants was determined by using a pilot study conducted previously, with individuals with the same characteristics used in the present study, based on a significance level of 5% and a power of 80% derived from the peak force on MVIC test.⁴³ Eighteen young, healthy, resistance

trained males (age: 25 ± 6 years, height: 176.0 ± 5 cm, and total body mass: 81.8 ± 8.0 kg) volunteered to participate. They had 5 ± 2 years of experience resistance training, at least three times a week. They had no previous surgery on their lower limbs (specifically in the knee joint) and no history of injury with residual symptoms (pain, "giving-away" sensations) in the lower limbs within the prior year. This study was approved by the Methodist University of Piracicaba research ethics committee (#65/2015) and all subjects read and signed an informed consent document.

Procedures

Prior to data collection, subjects were asked to identify their preferred leg for kicking a ball, which was then considered their dominant leg.⁴⁴ All subjects were right-leg dominant. Subjects attended one session in the laboratory, and they reported to have refrained from performing any lower body exercise other than activities of daily living for at least 72 h prior to testing.

Subjects performed a general warm-up of lower body cycling for five minutes at a cadence of 70 rpm at one kilopound prior to testing. Dominant leg knee strength was measured with MVIC testing, completed while seated on a leg extension machine (Leg Extension Machine, Riguetto, Brazil), and positioned at 90° of knee flexion with the limb (lateral femoral condyle) in alignment with the mechanical axis of the equipment. Hips were positioned at 90° of hip flexion, arms crossed over their chest, and trunk was secured to the chair by belts. A strap was also placed across their pelvis to minimize hip movement. The machine lever arm was connected perpendicularly to a load cell (EMG832C, EMG system do Brasil, São José dos Campos, Brazil), which was interfaced with a computer for recording, sampling at 2 kHz. Then, a specific warm-up of five submaximal unilateral isometric knee extension contractions were performed. After a 10-minute rest, all subjects performed three MVIC trials of five seconds each with three-minute rest between trials. Prior to MVIC measurement subjects were required to remain relaxed with their limb supported by the machine lever arm, and the force measured in this condition was considered the passive tension of the knee joint. The passive tension was measured in all

conditions. After that, all subjects were instructed to initiate each MVIC as hard and fast as possible. Consistent standardized verbal encouragement was given during all tests. All tests were performed at the same hour of the day, between 9 AM and 12 PM, and by the same researcher.

Surface Electromyography (sEMG): Participants' skin was prepared by shaving hair at the site of electrode placement and cleaned with alcohol. Bipolar passive disposable dual Ag/AgCl snap electrodes were used which were 1-cm in diameter with 2-cm center-to-center spacing. They were attached on the dominant limb over the longitudinal axis of the Vastus Lateralis (VL) at two thirds the distance between the anterior superior iliac spine and the superior aspect of the lateral side of the patella, according to the SENIAM/ISEKI protocol.⁴⁵ The sEMG signal of the VL was recorded by an EMG acquisition system (EMG832C, EMG system do Brasil, São José dos Campos, Brazil) sampling at 2KHz using a commercially designed software program (EMG system do Brasil, São José dos Campos, Brazil), and synchronized with the load cell. The sEMG activity was amplified (bi-polar differential amplifier, input impedance = 2M Ω , common mode rejection ratio > 100 dB min (60 Hz), gain x 20, noise > 5 μ V), and analog-to-digittally converted (12 bit). A ground electrode was placed on the right patella.

All MVICs and sEMG data were analyzed with a customized Matlab routine (MathWorks Inc., USA). MVIC data were filtered using a fourth-order Butterworth filter with a 10 Hz cutoff frequency. Peak force was defined as the maximal value of each MVIC, after removing the passive tension of the knee joint. Impulse was measured as the integrated MVIC during the first two-seconds of the contraction. For the temporal analysis, the digitized sEMG data were band-pass filtered at 20-400 Hz using a fourth-order Butterworth filter with a zero lag. For muscle activation, the root mean square (RMS) (150ms moving window) was calculated during the first two-seconds of the MVIC and integrated (IEMG) for each trial. For the frequency analysis, the digitized sEMG data were band-pass filtered at 20-400 Hz using a fourth-order Butterworth filter with a zero lag, the first 500-ms of the sEMG data was removed, and then the next 1-s of the data was analyzed with a short-time

Fourier transformation, and the median frequency (MF) of the spectrum was computed.

Experimental Conditions: Subjects performed MVICs in four randomized experimental conditions, with 10-min rest between conditions: (a) control, no taping (Figure 1a); (b) Knee Sleeve (Figure 1b); (c) KT (Figure 1c); and (d) sham (Figure 1d).

Knee Sleeve application: A knee sleeve (CORFLEX, Manchester, NH) was placed without any pressure on the knee joint.

KT application: The KT (Muscle Sports Tape, China; color: black; maximum rupture tension: 30 ± 3 MPa; maximum strain tension: 120 ± 5 MPa) was applied with a Y-shape over the quadriceps according to Fu et al.,⁴⁶ by the same researcher. While subjects were seated with their hip flexed at 90° and the knee extended, tape was applied from a point 10 cm inferior to the anterior superior iliac spine bisected at

Figure 1. Experimental Conditions: (a) control; (b) knee sleeve; (c) Kinesiology Tape (KT), and (d) sham.

the junction between the quadriceps femoris tendon and the patella, and circled around the patella, ending at its inferior side. The first five cm of tape was not stretched and acted as the anchor. The portion between the anchor and superior patella was stretched to 120%. The remaining tape around the patella remained unstretched (Figure 1d).

Sham application: The KT was applied in the same pattern as KT condition, however, the tape was not stretched (Figure 1d).

Statistical Analyses

Normality and homogeneity of variance within the data were confirmed by the Shapiro-Wilk and Levene's tests, respectively. Repeated measures ANOVAs were used to test differences between conditions for all dependent variables. Post-hoc comparisons were performed with the *Bonferroni* test. Cohen's formula for effect size (*d*) was calculated, and the results were based on the following criteria: trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0), and very large (>2.0) effects.⁴⁷ An alpha value of 0.05 was used to determine statistical significance.

RESULTS

Test-retest reliability was calculated by intraclass correlation coefficient (ICC) and ranged between 0.82 and 0.97, and for all dependent variables.

There were no statistical differences between conditions ($p > 0.05$) for passive tension, MVIC peak force, impulse, IEMG, or median frequency (Table 1). The effect sizes ranged between 0.10 and 0.55 (trivial-small) for all dependent variables.

DISCUSSION

The main findings of the present study confirmed the null hypotheses, that there was no significant difference between all experimental conditions, (including the control condition) for passive tension during the rest condition. KT is elastic cotton strips with an acrylic adhesive, and involves application of the tape while applying additional tension (~40%) to the tape and/or with the target muscle in a stretched position.^{48,49} In general, when the knee is flexed against an external resistance plus elastic adhesive (i.e. KT), the elastic material is stretched during the knee flexion phase, returning this energy during the knee extension phase. This potential accumulation of energy is purported to be transferred to the muscle, and added to the strength performance of the movement in the concentric phase.⁵⁰ This additional effect on strength is known as passive tension of the material.³⁹⁻⁴² To the best of authors' knowledge, this was the first study to analyze passive tension during the rest condition with the knee flexed. This might help to evaluate any significant additional aid in performance that occurs from the KT. The effects of KT have been based on fascia

Table 1. Descriptive data for all dependent variables across all conditions. Reported as Mean $\pm$ standard deviation [95% Confidence Interval].

	Control	Knee Sleeve	Kinesiology Tape	Sham
Passive Tension (Kgf)	10.25 $\pm$ 4.0 [8.23-12.26]	8.26 $\pm$ 3.2 [6.66-9.86]	8.84 $\pm$ 3.3 [7.20-10.47]	8.41 $\pm$ 2.5 [6.89-9.39]
Peak Force (Kgf)	485.40 $\pm$ 76.0 [447.51-523.28]	469.08 $\pm$ 78.6 [429.98-508.18]	508.01 $\pm$ 92.0 [462.06-554.12]	497.31 $\pm$ 102.0 [446.60-548.14]
Impulse (Kgf.s)	85.70 $\pm$ 14.7 [78.38-93.05]	86.40 $\pm$ 16.0 [78.52-94.32]	87.10 $\pm$ 13.0 [80.33-93.61]	87.60 $\pm$ 14.0 [80.62-94.63]
IEMG (%MVIC.s)	571.90 $\pm$ 195.0 [474.79-669.11]	602.90 $\pm$ 186.5 [510.16-695.70]	600.0 $\pm$ 196.8 [503.01-698.74]	572.10 $\pm$ 157.9 [493.57-650.69]
Median Frequency (Hz)	98.70 $\pm$ 20.1 [88.74-108.74]	95.80 $\pm$ 20.2 [85.74-105.87]	100.31 $\pm$ 23.2 [88.83-111.93]	99.81 $\pm$ 17.5 [91.14-108.50]
Kgf: Kilogram-force; IEMG: Integrated electromyography; MVIC: Maximal voluntary isometric contraction; Hz: Hertz.				

traction as a main reason for an increase in muscular activation level.⁴⁹ However, the results of the present study did not show differences between experimental conditions, and thus any additional passive tension from the KT or biological tissues (i.e. tendon, ligaments or joint capsule) does not appear to be relevant.

The second hypothesis was also confirmed, as KT did not affect muscle activation or force during MVICs. Several studies have analyzed the role of KT in force production of the knee extensors.^{4,5,9,17,18,28,31,34,36-38,51,52} Csapo and Alegre,⁴⁹ in a meta-analysis, concluded that KT did not present significant effects on muscle strength, corroborating the results of this study. Additionally, Serra et al.³⁶ did not observe significant differences in maximal knee extensor isometric force when KT was compared with Micropore (sham condition). In contrast, fewer studies^{4,17,28} have reported positive effects of KT on knee extensors isokinetic torque. Possibly, such results are related to baseline/training status of the subjects, lack of a control group, or type of contraction. Vithoulka et al.⁴ investigated quadriceps isokinetic muscular strength in three conditions (control, sham and KT) of healthy women. Their results showed that the application of KT increased eccentric isokinetic peak torque. Anandkumar et al.¹⁷ studied isokinetic torque of the quadriceps in individuals with knee osteoarthritis and observed that KT increased torque production. Finally, Yeung et al.¹⁸ observed that KT shortened the time required to generate maximal torque during isometric knee extension compared to a sham, and Wong et al.⁹ reported a significantly lower time to reach peak torque, in isokinetic contractions, in KT group when compared to a control condition.

Kase has suggested that the tape might affect muscle activity (motor unit recruitment) via the stimulatory effects arising from cutaneous mechanoreceptors.¹ However, the results of the present study did not demonstrate differences between experimental conditions, indicating no change in muscular activation with or without KT exerting elastic tension on the skin. Lins et al.⁵¹ also observed no differences in the activation of vastus lateralis, rectus femoris and vastus medialis muscles, or knee flexion peak isokinetic torque at 60°/s. Additionally, neither Lins et al.,⁵¹ or Serrão et al.⁵² observed any significant differences in quadriceps muscle activation after KT application.

Median frequency can represent motor unit firing rate and might be affected by sensory influence (inhibition or excitation) such as cutaneous mechanoreceptors.^{53,54} The lack of differences between experimental conditions in the present study for median frequency appears to reinforce the absence of inhibitory or excitatory effects of KT.

The present study has some limitations. Skinfold of the sEMG detection area was not controlled, which is considered to be a low-pass filter, and there may have been some inherent differences in the stiffness of the passive tissue between subjects. The present study analyzed a healthy, non-athletic population, and these results are not generalizable to other conditions, populations, or athletes.

Future research can be conducted using isometrics and similar methods at different knee angles, in dynamic testing conditions, or with different muscles. Additionally, this study only investigated acute effects of KT and studies that span longer wear time of kinesiology tape and longer term outcomes are warranted.

CONCLUSIONS

The results of the current study indicate that KT does not influence passive tension during static position at 90 degrees of knee flexion, nor does KT affect quadriceps activation or force production during a maximal voluntary isometric contraction.

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