Kinesio taping effect on quadriceps strength and lower limb function of healthy individuals: A blinded, controlled, randomized, clinical trial

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Abstract

Objectives: To analyze kinesio taping (KT) effect on quadriceps strength and lower limb function over a 7-day period.

Design: Blind randomized clinical trial.

Setting: Hospital’s Physical Therapy Department.

Participants: Sixty healthy individuals (30 men and 30 women) were randomly distributed into three groups: Control – without KT application; Placebo – placebo KT application and Experimental - A KT application designed to stimulate quadriceps femoris activity.

Main outcome measures: The quadriceps strength was measured using a manual dynamometer whereas lower limb function was assessed using the Single Hop Test for Distance. Evaluations occurred at five time-points: baseline; immediately, 3 and 5 days after KT application; and 72 h post KT withdrawal.

Results: There was no significant interaction between time-points and groups for muscle strength: dominant (P = 0.13) and non-dominant (P = 0.41) and lower limb function: dominant (P = 0.09) and non-dominant (P = 0.53); but lower limb function within-group comparisons showed improvements in all groups at the evolution of all time-points analyzed for both limbs (P = 0.001). This is possibly due to a learning effect as the participants became more familiar with executing the assessment tests.

Conclusion: KT did not improve quadriceps strength and lower limb function of healthy individuals and its application with these objectives should be reconsidered.

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1. Introduction

The search for resources to promote performance enhancement has been the focus of several studies. Kinesio taping (KT), an adhesive taping with characteristics claimed to be similar to the elasticity and movement of human skin falls within this context (Lins, Neto, Amorim, Macedo, & Brasilieiro, 2013).

KT exhibits several positive effects when applied, including: pain and edema reductions; lymphatic flow improvement by increased interstitial space; muscle and joints support; muscle spasms reduction and articular misalignment correction (Kalron & Bar-Sela, 2013; Kase, Walls, & Kase, 2003). In addition, KT can be used for five days without reaplication because it is latex free taping and has cotton fibers that allow fast drying. These characteristics mean the claimed effects of this technique may last longer than other bandage or tape methods (Akbas, Atay, & Yuksel, 2011; Briem, Eythordottir, Magnúsdóttir, Palmarsson, Rúnarsdóttir, & Sveinssson, 2011; Chen, Hong, Lin, & Chen, 2008; Fu, Wong, Pei, Wu, Chou, & Lin, 2008; Kalron & Bar-Sela, 2013; Thelen, Dauber, & Stoneman, 2008).

There are some studies reporting modulations on muscle strength and motor function after KT application (Fu et al., 2008; Lins et al., 2013; Stupik, Dwornik, Bialoszewski, & Zych, 2007; Vercelli et al., 2012). The continuous stretch applied on the skin under the adhesive taping might activate the mechanoreceptors, which in turn could stimulate modulatory mechanisms within the
central nervous system and therefore increase muscular excitability (Gómez-Soriano et al., 2014).

However, these KT positive results are related to short-term effects at very specific evaluation methods; studies with small number of participants and results influenced by proposed tests familiarization. Therefore these results do not provide clinical and therapeutic implications, and moreover produce no consensus about the best KT application techniques and lack of information about long-lasting effects to attain these benefits (Aktas & Baltaci, 2011; Gómez-Soriano et al., 2014; Yeung et al., 2014).

Thus, the aim of the present study was to analyze KT effects on quadriceps femoris strength and lower limb function of healthy individuals over a 7-day period, in order to provide results that examine these KT muscular applications in clinical practice.

2. Methods

This blinded, controlled, randomized, clinical trial was approved by the Ethics Committee of Universidade Nove de Julho (UNINOVE) — protocol number 456.617.

2.1. Participants

Initially, one hundred and fourteen healthy individuals were pre-selected at the institutions whose authors have ties. Healthy men and women, who did not practice regular physical activity; with availability to participate in all assessments proposals; without history of allergy to bandages and derivatives; and who read, understood and signed the statement of informed consent, were included in the present study. The exclusion criteria were previous surgery and/or history of lumbar spine fracture; neurological abnormalities; history of anterior pain in the knee and muscle injuries in the lower limbs in the previous 12 months (Huang, Hsieh, Lu, & Su, 2011).

Finally, a convenience sample of sixty individuals (30 men and 30 women), aged between 20 and 40 years old (mean ± SD age, 24.2 ± 2.4 years old; height, 169 ± 5.0 cm; weight, 68.6 ± 11 kg) met the eligibility criteria and were recruited.

2.2. Procedures

At Irmandade da Santa Casa de Misericórdia de São Paulo — Physical Therapy Department; all participants were submitted to initial anamnesis to collect personal data: name; age; weight; height; dominant lower limb; address and telephone number. Next, they carried out the baseline assessments of strength and function. The same evaluator, who knew nothing about the individual allocation, performed all assessments.

After the anamnesis and the baseline assessments for strength and function, the individuals were randomly allocated, through a pre-selected at the institutions whose authors have ties. Therefore these results do not provide clinical and therapeutic implications, and moreover produce no consensus about the best KT application techniques and lack of information about long-lasting effects to attain these benefits (Aktas & Baltaci, 2011; Gómez-Soriano et al., 2014; Yeung et al., 2014).

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After the anamnesis and the baseline assessments for strength and function, the individuals were randomly allocated, through a draw with sealed envelopes, into three groups: control group (CG) — with no KT application; placebo group (PG) — with a placebo KT application on quadriceps femoris (bilateral); and the experimental group (EG) — with KT application on the quadriceps femoris (bilateral) in an attempt to stimulate it. Ten men and ten women were placed in each of the three groups and although they knew their condition were told not to report anything to the evaluator and the other study participants about its group allocation.

2.3. KT application

In the EG, KT was applied in a standardized manner (origin to insertion), from a point 10 cm below the anterior superior iliac spine to the superior pole of the patella, without any tension. The individual was then asked to perform maximal knee extension and the KT was divided so that it could be adjusted around the medial and lateral patella edges, finishing at the anterior tuberosity of the tibia, again without tension (Akbas et al., 2011; Briem et al., 2011; Chen et al., 2008; Fu et al., 2008; Kase et al., 2003; Thelen et al., 2008; Vercelli et al., 2012) (Fig. 1).

At the PG, two horizontal strips of 10 cm were applied 10 cm below the anterior superior iliac spine and 5 cm above the patella base, respectively, without any tension (Thelen et al., 2008) (Fig. 1). In the CG, no KT was applied.

The KT was standardized for the groups that received it and black Kinesio Tex™ was used. The same researcher, who has experience in clinical KT application, always applied the adhesive taping. Prior to the KT being applied, the skin was shaved and cleaned with an antiseptic. All KT were applied to the individuals in dorsal decubitus position, keeping the knee flexed and beyond examination table lateral limits, with the hip in a neutral position.

2.4. Assessments

Strength and function assessments were performed, always in the same order, starting with the dominant limb and followed by the non-dominant limb, at the following time-points in all groups: baseline (72 h before KT application); immediately after KT application; on the third and fifth days after KT application; and 72 h after removing the adhesive taping. Therefore, the individuals used the KT or placebo KT for five consecutive days.

All individuals were told to maintain their activities of daily living while using the adhesive taping. The individuals in the CG were assessed at the same time-points intervals as the other groups and received the same instructions.

A pilot study was conducted prior to the present one, with five healthy individuals who did not practice regular physical activity (10 lower limbs evaluated: 5 dominant and 5 non-dominant). The aim of this pilot study was to assess the reliability and validity of the manual dynamometer when assessing the quadriceps strength. The participants were tested according to the protocol described below and the results demonstrated excellent reliability and an interclass correlation coefficient (ICC) of 0.96 for the quadriceps femoris manual dynamometer.

The quadriceps femoris strength (voluntary maximal isometric contraction) was assessed by a manual dynamometer (Lafayette Instrument Company, Lafayette, IN) (Deones, Wiley, & Worrell, 1994; Dolak, Silkman, Mckeon, Hosey, Lattermann, & Uhl, 2011; Magalhaes, Fukuda, Sacramento, Forgas, Cohen, & Abdalla, 2010; Piva, Goodnite, & Childs, 2005). The participant was positioned in the leg extension chair with the hip at 90° flexion and 0° rotation and the knee at 60° flexion. A three-point belt stabilized the trunk and hip. In all assessments, the individuals were told to cross their
arms over their thorax (Deones et al., 1994; Dolak et al., 2011; Piva et al., 2005; Reinking, Pugliese, Worrell, Kegerreis, Sayers, & Farr, 1996; Vasconcelos et al., 2009).

The dynamometer was positioned in the tibia anterior region, 2.5 cm from the medial malleolus. A nylon belt was used, positioned perpendicularly to the application of strength to stabilize the dynamometer and to resist the force generated by the participant’s lower limb (Dolak et al., 2011) (Fig. 2).

The individuals initially received standardized verbal instructions to perform maximal force during the measurements (Fu et al., 2008). A familiarization attempt was carried out, exerting voluntary sub-maximal force, followed by two standardized attempts of voluntary maximal isometric contraction for 5 s, with an interval of 30 s in between. After the assessment of muscle strength in one of the limbs, a minute long interval was allowed before assessing the contralateral limb (Deones et al., 1994; Magalhães et al., 2010).

After a 5-min interval, the Single Hop Test for Distance was performed to assess the participants’ lower limb function. The individuals were positioned on one foot, with their arms crossed in the trunk posterior region and encouraged to jump forward as far as possible while still being able to land on the lower limb in a stable manner for a minimum of 2 s. Two attempts were made and the data were used in the analysis. The participants were instructed beforehand to perform as many familiarization attempts as they deemed necessary. The test was conducted barefoot for both lower limbs and was measured the distance from hallux to hallux (Myer et al., 2011).

2.5. Data analysis

The muscle strength data were obtained from the mean of two attempts of voluntary maximal isometric contraction and given in kilograms. This was normalized for body mass using the following formula: (muscle strength kg/body weight kg) × 100 (Deones et al., 1994; Dolak et al., 2011; Reinking et al., 1996; Scoville, Arciero, Taylor, & Stoneman, 1997; Vasconcelos et al., 2009). The mean value of the two attempts at the Single Hop Test for Distance was also used in the analysis.

The Shapiro–Wilk test was used to confirm all data normality distribution. In order to assess the KT effect the comparisons between muscle strength and lower limb function data, within-group and between-groups, at the five time-points analyzed, were carried out using a separate mixed-model analysis of variance (ANOVA) for each dependent variable and lower limb (dominant and non-dominant). The assumptions required for a mixed-model ANOVA were checked. The outliers as assessed by inspection of a box plot. Homogeneity of variances was assessed by Levene’s test and the sphericity was performed by Mauchly’s test, when the sphericity was violated the Greenhouse–Geisser correction was applied. If a significant interaction was identified, the Bonferroni post hoc test was carried out to examine differences from baseline to each time point within-group and between-groups. Statistical level of significance was established a priori at 5% (P < 0.05). All the statistical analyses were conducted in IBM SPSS Statistics 20 (Statistical Package for Social Sciences version 20).

3. Results

The baseline characteristics (Table 1) between groups were similar for all variables.

Three individuals data were lost, two of which were from PG (one male, and one female), and one of which was from CG (male), due to non-comparison at one time-points assessments. Therefore, data from 57 individuals were used in the final analysis (Fig. 3).

3.1. Quadriceps strength

In dominant lower limb for quadriceps strength, there was no significant difference across the five time-points (F4, 220 = 0.425, P = 0.79) and between-groups (F2, 55 = 0.212, P = 0.80). There was also no significant interaction between time-points and groups (F8,

| Table 1 | Participants demographic data (mean ± SD). |
| Age     | Weight (kg) | Height (m) | BMI    |
| CG      | 24.8 (±4.6) | 71.5 (±16.9) | 1.7 (±0.1) | 24.5 (±4.3) |
| PG      | 24.6 (±2.6) | 68.9 (±13.1) | 1.7 (±0.1) | 23.4 (±3.0) |
| EG      | 23.1 (±0.9) | 65.4 (±9.4)  | 1.6 (±0.1) | 22.9 (±2.9) |

Fig. 2. Participants positioning during the muscle strength assessment.

Fig. 3. Fluxogram of participants’ distribution and the final data analyzed.
According to these studies, improvements in assessment execution, pain reduction and short-term evaluation could have facilitated the recruitment of motor units and consequently improved muscle strength and biomechanics.

Different theories have tried to explain the mechanisms that KT employs to increase neuromuscular recruitment, including the facilitation of neuromuscular stimulus (Konishi, 2013), activation of cutaneous receptors provided by the tactile stimulus, increase in blood flow and the consequent muscle activation generated by the improvements in interstitial space (Kase et al., 2003; Lins et al., 2013). However, these properties were not sufficient to improve the factors assessed in the present study. It is possible that the use of healthy individuals (without pain complaints or neuromuscular deficits) and the absence of taping tension at the time of application could have contributed to a reduction in the tactile stimulus and the recruitment of motor units promoted by the KT which in turn did not promote support at knee joint and hinder the improvement of lower limbs function.

Although no improvement was found in muscle strength and motor function in the present investigation, there remains a need for further studies to ascertain the different possibilities of KT application in a wide range of clinical situations and populations. This study had some limitations as it assessed only healthy individuals. Therefore, the evaluation methods used are reliable as the two methods performed to evaluate muscle strength and lower limbs function a wider variety of tests could be used to obtain more detailed and specific results.

5. Conclusion

KT did not promote long-term effects on quadriceps strength and lower limb function of healthy individuals. Therefore KT application with these objectives should be reconsidered.

Conflict of interest
None declared.

Ethical approval
Ethical Research Committee of the Universidade Nove de Julho (UNINOVE) approved under protocol number 456.617.

Funding
None declared.

Acknowledgments
We would like to acknowledge the institutions that supported this study (Irmandade da Santa Casa de Misericórdia e Universidade Nove de Julho) and also all participants.

Table 2
Data (mean ± SD) for muscle strength and lower limb function.

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<th>Follow-up</th>
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<tr>
<td></td>
<td>QS</td>
<td>LLF</td>
<td>QS</td>
<td>LLF</td>
</tr>
<tr>
<td>CG</td>
<td>46.0 (±10.7)</td>
<td>131.3 (±29.0)</td>
<td>47.8 (±11.3)</td>
<td>133.3 (±31.6)</td>
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<tr>
<td>PG</td>
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<td>48.4 (±11.5)</td>
<td>138.8 (±25.8)</td>
</tr>
<tr>
<td>EG</td>
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<td>138.9 (±30.0)</td>
<td>47.7 (±12.2)</td>
<td>139.9 (±30.1)</td>
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QS – quadriceps strength/LLF – lower limb function.

220 = 1.577, P = 0.13. For non-dominant lower limb, there was no significant difference across the five time-points (F4, 220 = 1.350, P = 0.25) and between-groups (F2, 55 = 0.095, P = 0.91). There was also no significant interaction between time-points and groups (F8, 220 = 1.033, P = 0.41) (Table 2).

3.2. Single Hop Test for Distance

The sphericity was violated and the Greenhouse–Geisser values applied for F values. In dominant lower limb for Single Hop Test for Distance, there was significant difference across the five time-points (F3.039, 167.128 = 5.476, P = 0.001) and there was no significant difference between-groups (F2, 55 = 0.367, P = 0.69), but with interaction between time-points and groups, there was also no significant difference (F8,077, 167.128 = 1.87, P = 0.09). For non-dominant lower limb, there was significant difference across the five time-points (F2.781, 152.964 = 5.69, P = 0.001) and there was no significant difference between-groups (F2, 55 = 0.291, P = 0.75), but with interaction between time-points and groups, there was also no significant difference (F5,562, 152.964 = 0.845, P = 0.53) (Table 2).

4. Discussion

The aim of this randomized, blind, clinical trial was to assess the effect of KT on quadriceps strength and lower limb function of healthy individuals over a 7-day period. KT didn’t promote modulations in both parameters analyzed in these individuals at the present investigation.

There are some previous studies reporting no improvements in muscle strength and motor function in men and women after KT application. These studies presented that KT tactile inputs were capable to stimulate cutaneous mechanoreceptors and alter motoneurons activation promoting a time required reduction to reach the maximum torque peak. In addition, the individuals assessed also exhibited an increase in the sensation of related and absolute strength. However and similar this study, this stimulus was not enough to increase muscle strength (Bicci, Karatas, & Baltaci, 2012; Chang, Chou, Lin, & Wang, 2010; Firth, Dingley, Davies, Lewis, & Alexander, 2010; Fu et al., 2008; Huang et al., 2011; Lins et al., 2013; Wong, Cheung, & Li, 2012).

On the other hand, there is research showing increases of quadriceps’ strength, lower limb functional performance as well as improvements in scapular biomechanics and lower trapezius strength. These results seem to recommend the use of KT as a treatment resource and even as a tool to assist in injuries prevention (Aktas & Baltaci, 2011; Hsu, Chen, Lin, Wang, & Shih, 2009; Osorio et al., 2013; Shaheen, Villa, Lee, Bull, & Alexander, 2013).

These studies differ from the present one because they used research designs that generate assessments execution familiarization that in turn influences muscle strength and performance results (Aktas & Baltaci, 2011). In addition, recruited amateur and professional athletes with pain complaints (patellofemoral pain syndrome and shoulder impingement syndrome) and the assessments were only conducted immediately after KT application, which prevents the inference of long-term results. According to these studies, improvements in assessment execution, pain reduction and short-term evaluation could have facilitated the recruitment of motor units and consequently improved muscle strength and biomechanics.

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