Research, Society and Development, v. 11, n. 1, e11311124198, 2022
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i1.24198

Effect of the kinesio taping application method for the activation and strength of gastrocnemius muscles in healthy adults

Efeito do método de aplicação da kinesio taping na ativação e força do músculos gastrocnêmicos em adultos saudáveis

Efecto del método de aplicación kinesio-taping para la activación y resistencia de músculos gastrocnemios en adultos sanos

Received: 12/01/2021 | Reviewed: 12/12/2021 | Accept: 12/20/2021| Published: 01/03/2022

Rafaéle Gomes Correa
ORCID: https://orcid.org/0000-0002-4706-0516
Universidade Norte do Paraná, Brazil
E-mail: rafagc88@hotmail.com
Rubens Alexandre da Silva
ORCID: https://orcid.org/0000-0001-6879-436X
Universidade Norte do Paraná, Brazil
E-mail: rubens_dasilva@uqac.ca
Débora Alves Guariglia
ORCID: https://orcid.org/0000-0002-3774-1211
Universidade Estadual Norte do Paraná, Brazil
E-mail: debora.guariglia@uenp.edu.br
Marieli Ramos Stocco
ORCID: https://orcid.org/0000-0003-2041-3817
Universidade Norte do Paraná, Brazil
E-mail: stoccomarili@gmail.com
Márcio Rogério de Oliveira
ORCID: https://orcid.org/0000-0002-8315-5117
Universidade Norte do Paraná, Brazil
E-mail: marcio.doliveira@educadores.net.br
Rodrigo Antônio Carvalho Andraus
ORCID: https://orcid.org/0000-0002-3849-0872
Universidade Norte do Paraná, Brazil
E-mail: rodrigo.andraus@unopar.com.br

Abstract
The objective of this study was to verify the effect of kinesio-taping (KT) application of the origin for muscle insertion (O>I) and insertion for muscle origin (I>O) in healthy participants, through surface electromyography and peak torque of gastrocnemius muscles. A total of 69 participants with an average age of 22.9±5.2 years were evaluated, 41 women with an average age of 22.0±5.1 years, BMI 25.1±4.6 kg/m2, and 28 men with an average age of 22.0±5.1 years, BMI 23.1±3.3 kg/m2, randomized under three conditions: O>I, I>O and no KT (control), repeated three times with five-minute rest between sessions. The peak torque of the gastrocnemius lateral (GML) and medial (GMM) muscles was evaluated at speeds 30º/s 60º/s 120º/s and muscle activity through surface electromyography. Repeated-measurement ANOVA showed effect only on the variable speed (F=767,1; p<0.001) and the variables condition (F=0.010; p=0.990) and interaction (F=0.199; p=0.892) were not significant. In electromyography, Root mean Square (RMS) did not differ in the conditions evaluated, presenting standard behavior without significant differences. The KT application regardless of being O>I or I>O muscular, did not alter the muscle recruitment or contribute to the increase in peak torque performance during the three speeds.
Keywords: Athletic tape; Electromyography; Muscle strength dynamometer; Muscle strength; Torque.

Resumo
O objetivo deste estudo foi verificar o efeito da aplicação de kinesio-taping (KT) da origem para inserção muscular (O>I) e da inserção para origem muscular (I>O) em participantes saudáveis, por meio de eletromiografia de superfície e pico de torque de músculos gastrocnêmios. Foram avaliados 69 participantes com idade média de 22,9±5,2 anos, 41 mulheres com idade média de 22,0±5,1 anos, IMC 25,1±4,6 kg/m2 e 28 homens com idade média de 22,0±5,1 anos, IMC 23,1±3,3 kg/m2, randomizado em três condições: O>I, I>O e sem KT (controle), repetido três vezes com cinco minutos de repouso entre as sessões. O pico de torque dos músculos gastrocnêmio lateral (GML) e medial (GMM) foi avaliado nas velocidades 30/s 60/s 120/s e atividade muscular por meio da eletromiografia de superfície. A ANOVA

de medidas repetidas mostrou efeito apenas na variável velocidade (F=767,1; p<0,001) e as variáveis condição (F=0,010; p=0,990) e interação (F=0,199; p=0,892) não foram significativas. Na eletromiografia, o Root mean Square (RMS) não diferiu nas condições avaliadas, apresentando comportamento padrão sem diferenças significativas. A aplicação do KT independentemente de ser O>I ou I>O muscular, não alterou o recrutamento muscular nem contribuiu para o aumento do desempenho de pico de torque durante as três velocidades.
Palavras-chave: Dinamômetro de força muscular; Eletromiografia; Fita atlética; Força muscular; Torque.

Resumen
El objetivo de este estudio fue verificar el efecto de la aplicación de kinesio-taping (KT) del origen para la inserción muscular (O>I) y la inserción del origen muscular (I>O) en participantes sanos, mediante electromiografía de superficie y torque pico de músculos gastrocnemio. Se evaluaron un total de 69 participantes con una edad promedio de 22,9±5,2 años, 41 mujeres con una edad media de 22,0±5,1 años, IMC 25,1±4,6 kg/m2 y 28 hombres con una edad media de 22,0±5,1 años. IMC 23,1±3,3 kg/m2, aleatorizado en tres condiciones: O>I, I>O y sin KT (control), repetido tres veces con cinco minutos de descanso entre sesiones. El torque máximo de los músculos gastrocnemio lateral (GML) y medial (GMM) se evaluó a velocidades de 30º/s 60º/s 120º/s y actividad muscular mediante electromiografía de superficie. El ANOVA de medición repetida mostró efecto solo en la variable velocidad (F=767,1; p<0.001) y las variables condición (F=0.010; p=0.990) e interacción (F=0.199; p=0.892) no fueron significativas. En electromiografía, Root mean Square (RMS) no difirió en las condiciones evaluadas, presentando comportamiento estándar sin diferencias significativas. La aplicación de KT, independientemente de ser O>I o I>O muscular, no alteró el reclutamiento muscular ni contribuyó al aumento del rendimiento de torque máximo durante las tres velocidades.
Palabras clave: Cinta atlética; Dinamómetro de fuerza muscula; Electromiografía; Fuerza muscula; Torque.

1. Introduction

The therapeutic elastic bandage technique (BET) consists of an intervention where, a type of elastic and adhesive tape known as Kinesio Taping® (KT) is applied to the skin providing a tension force that is produced by its stretch (Choi & Lee, 2018).With the KT application some results such as: 1- Neuromuscular optimization and coordination, 2- Alignment and reduction of joint instability, 3- Increase of muscle activation and strength, 4- Favor of static and dynamic functionality, are expected (Chang, et al., 2010; Fratocchi, et al., 2013; Simon, et al., 2014; Wong, et al., 2012). However, there is still a lack of consensus on what is expected and observed in this technique.

The KT has been used in the search for improved performance (Huang, et al., 2011), injuries prevention (Chen, et al., 2013), rehabilitation (Rojhani-Shirazi, et al., 2015) and pain relief (Song, et al., 2015). Two theories are used to justify its benefits (Cai, et al., 2016): the first explains the skin 'lifting effect' that is pointed out as a mechanism capable of increasing the blood and lymphatic fluids circulation , the second says that KT is capable of pressing and lengthening the skin surface and thus stimulating cutaneous mechanoreceptors that in turn increase the somatosensory stimuli (Yeung & Yeung, 2016) and, therefore, it is capable of facilitating the muscle contraction and increase strength (Choi & Lee, 2018; Ridding, et al., 2000).

However, its effects remain conflicting in the literature in order to clarify its real benefits. The directions that KT can be applied (origin-insertion or insertion-origin) generate controversy in the literature, some authors report an increase in strength, torque and muscle activation regardless of the direction that KT was applied (Choi & Lee, 2018; Serrão, et al., 2016; Vercelli, et al., 2012). The KT technique efficiency on muscle strength development and activation should be determined by tests that are capable of providing objective measures that are reliable and reproducible. In this case, isokinetic dynamometer and electromyography are effective tests that can evaluate muscle torque and activation respectively.

The objective of this study was to verify the effect of two forms of kinesio-taping application (from muscle origin, to muscle insertion and from muscle insertion, to muscle origin) in healthy participants, on muscle activation, and peak torque of gastrocnemius muscles. It is believed that many controversial results observed in the literature are caused by the diversity of techniques and management during the BET application (origin-insertion or insertion-origin), in addition to the investigation of healthy muscles, necessary to better understand the KT action mechanisms, without suffering changes caused by other mechanisms that may happen in individuals with pathologies. Thus, being able to verify whether the practice of applying BET is efficient in improving performance in healthy people, as has been observed in the practice of sports and leisure. As a hypothesis of the study, it is believed that the BET (through KT) can contribute with the performance, but the way in which it is applied (from origin to insertion or from insertion to origin) does not interfere with neuromuscular activation and peak torque.

2. Methodology

Study Place

The study was carried out in accordance with Resolution 466/12 of the National Health Council and was initiated after the approval of the Ethics in Research Committee of the institution under opinion No 3.059.113, and it happened in partnership with Universidade Pitágoras UNOPAR -Londrina-PR and the Multi-User Laboratory of Biomechanics of the Human movement of Universidade Estadual do Norte do Paraná (UENP), Jacarezinho-PR.

Sample size calculation

The sample size was calculated using the mean values of torque peak strength in the plantar flexion of O>I application condition (84.1 Nm and DP=44.2 N.m) and the I>O condition (mean 67.9 Nm and DP=26.2 N.m) previously collected in a pilot study of a sample containing 8 participants. Considering an alpha of 0.05, a power (1-beta) of 0.80 and an effect size of 0.42, the sample size was estimated at 68 participants, by the GPower program (Faul, et al., 2007).

Participants

For the sample selection, the inclusion criteria adopted were: age group between 18 and 35 years; individuals without lower limb injury (MMII), without gait dysfunction, and who presented a readiness for physical activity verified by the PAR-Q questionnaire. Therefore, in order to promote the sample homogeneity, volunteers presenting degenerative muscle diseases; use of analgesics, anti-inflammatory or muscle relaxants in the last week and history of trauma in the lower limbs were excluded from the study.

The sample consisted of 69 participants with mean age 22.9±5.2 years, of which 41 women aged 22.0±5.1 years, weight 60.0±10.2 kg, height 1.61±0.06 cm and 28 men aged 22.0±5.1 years, weight 75.0±16.8 kg, height 1.74±0.06 cm. Everyone consented to be part of the study and signed the Written Informed Consent Form (FCLE).

Study design

All participants carried out evaluations under all the proposed conditions. The order of application of the conditions was randomized for each individual, through opaque and sealed envelopes that were listed and drawn by a blind evaluator. The Conditions were tested with rest intervals of 5 min.

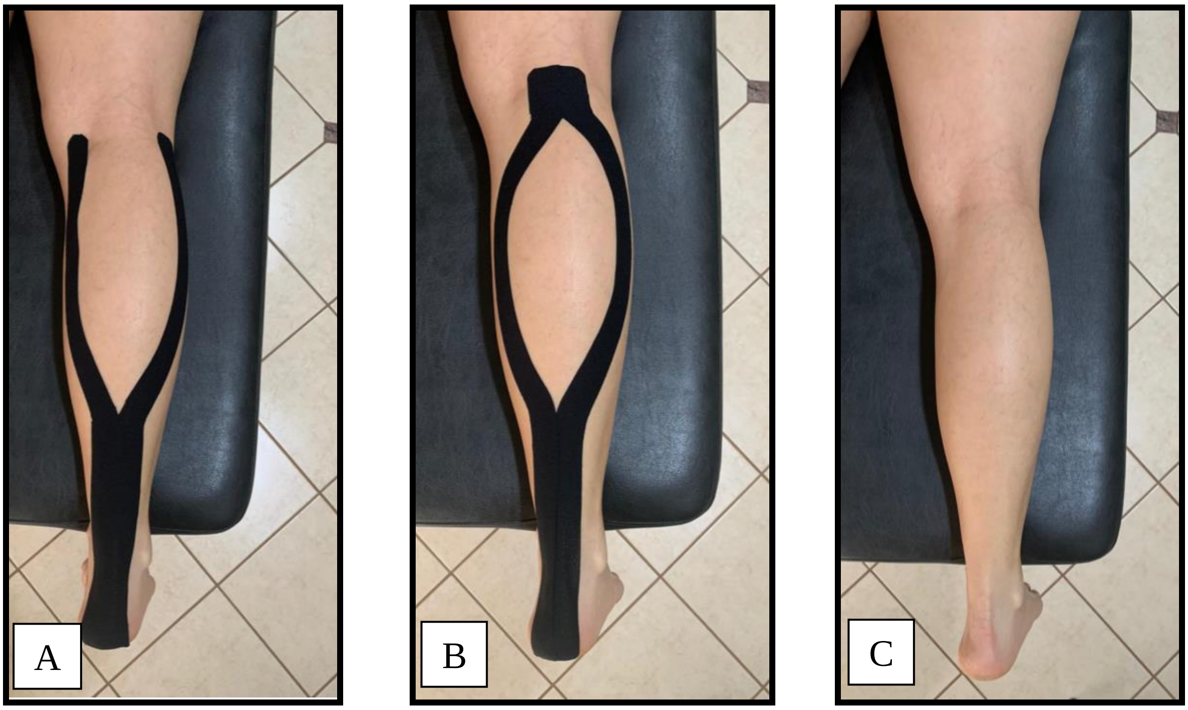
Procedures

The peak torque of the medial and lateral gastrocnemius muscles of the participants was evaluated using the isokinetic dynamometer, the participants were submitted to three types of evaluation: A - KT application in the direction from muscle insertion to muscle origin, B - KT application in the direction from muscle origin to muscle insertion and C - Control, without KT application. Each evaluation was repeated three times with five-minute rest between sessions. The KT used in the study was TMAX® brand, which was always applied by the same professional qualified for the method application.

KT Application

For the KT application, all the participants were asked to remain in a stretcher in the prone position, with the ankle in neutral position (90º). The KT application was performed using two application models: A - insertion-origin (I>O) and B - origin-insertion (O>I). In the first model (I>O), the tape was laid from the calcaneus tuberosity by means of the tendon calcaneus to lateral and medial epicondyle of the femur. In the second model (O>I) the tape was applied from the popliteal fossa to the calcaneus tuberosity by means of the calcaneus tendon, both models were applied by the Y technique, without the KT tension (Figure 1), the KT application was always performed on the right lower limb, according to the study by Bastos (2014), that found no significant difference when KT is applied to the dominant or non-dominant lower limb. The KT application was always performed by the same skilled professional and 8 years of experience with the technique.

Figure 1 – KT application model: (A) inhibitory stimulus - from the calcaneus region (posterior), to the lower femur region (lateral and medial), (B) excitatory stimulus - from the lower femur, to the calcaneus region (posterior) and (C) without KT (control).



Source: Authors.

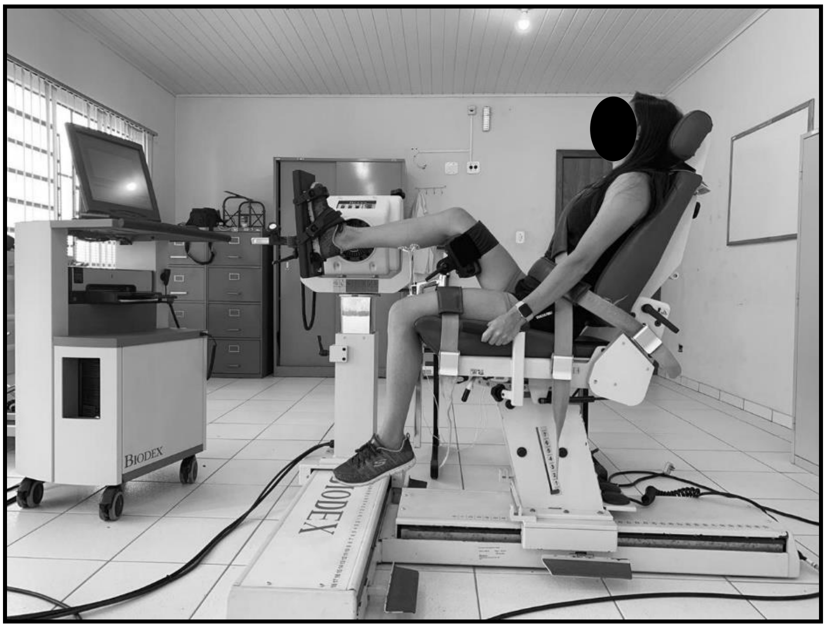
Muscle Torque Evaluation (isokinetic)

The isokinetic dynamometer brand Biodex System 4® was used to evaluate the immediate effect of isokinetic muscle strength. The equipment provides constant speed and resistance while articulating within a predetermined range, so it can draw a curve that displays muscle torque throughout the test. The torque peak is identified by the highest point of the curve. Additionally, previous studies attest to the high reliability of the isokinetic dynamometer test and retest (intraclass correlation coefficient, 0.82–0.95) (Feiring, et al., 1990; Sole, et al., 2007). Before starting the tests, the subjects underwent low-intensity warm-up on the stationary bicycle for five minutes (Simão, et al., 2004). The medial and lateral gastrocnemius muscles torque was evaluated in angulations of 30°/s, 60°/s and 120°/s for each of the applied KT interventions (O>I - KT application in the direction origin-insertion, I>O - KT application in the direction from insertion to origin and without KT).

The speeds stipulated for the evaluations in the isokinetic are suggested and described in the Biodex® manual for the plantar flexion and dorsi flexion evaluations, establishing concrete relation with the objective of this study of torque strength evaluation and was this study is evaluating the gastrocnemius muscle which in turn is a dynamic muscle, working separately, gastrocnemius has a short predominance in the amount of type II fibers, with glycolytic characteristics, that is, they play a greater role of strength than resistance, having thus the capability to develop a greater tension in a short period of time. As a function of its characteristics, the gastrocnemius muscle has been widely investigated because it has ease of application, allow high control of variables, besides showing good metabolic responses (Moret, et al., 2013).

The individuals were positioned sitting on the dynamometer chair brand Biodex® with their back tilted back, the trunk and thighs were fastened by belts and the ankle was fixed in the torque meter. Regarding the dynamometer positioning, the following was adopted: guidance = 90 °, tilt = 0 ° (axis direction), seat orientation: 90 °, trunk tilt with the seat back: 70 °, knee flexion: 30 °, and ankle in neutral position, the axis passing through the body of the talus, fibular malleolus and through or just below the tibial malleolus. Participants in the study were verbally stimulated during the tests to encourage them to use their maximum muscle strength. Muscle torque was measured at angular velocities of 30°/s, 60°/s and 120°/s during the five plantar flexion and dorsiflexion movements. Individuals rested for five minutes after the measurements for a given angular velocity were completed. This rest period was adopted based on the time of adenosine triphosphate (ATP) resynthesis, and the five minutes were considered adequate for the complete recovery of ATP stocks (Baker, et al., 1993).

Figure 2 – Positioning for isokinetic evaluation of torque peak strength of gastrocnemius muscles (medial and lateral).



Source: Authors.

Surface electromyography (EMG)

To identify the muscle activity during the 9 evaluations performed with the tests on the Biodex® isokinetic dynamometer, surface electromyography was used (miotool 200/400 of myotec®). Electromyographic signals were collected at a frequency of 2000 Hz. The active bipolar electrodes standard distance of (10mm) were positioned on the belly of the gastrocnemius muscle in the medial and lateral portions, following the muscle fibers direction. Trichotomy and site cleaning were performed with alcohol (70%) to decrease skin impedance. In addition, in order to verify the signal quality of the electrode positioned, the individual was requested to perform the ankle plantar flexion movement. For the maximum pressure in this position, it is necessary to apply the pressure against the forefoot as well as against the calcaneus. The use of electrodes followed the guidelines of the Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM).

Electromyographic signals were initially softened with a low pass filter and high pass with a cut-off frequency from 20 to 450 Hz. The signals were normalized by the electromyographic activity peak during the task itself, considering the average of the highest RMS values of each series obtained during the test. After the first and last contraction was withdrawn, an activation percentage average of the 5 intermediate repetitions was performed. For the analyzes, each of the RMS values obtained during the five plantar flexion and dorsiflexion movements and their mean were considered. Thus, activation percentage values were obtained for medial and lateral gastrocnemius muscles during plantar flexion and plantar dorsiflexion movement at different speeds.

Data Analysis

For the statistical analysis, Shapiro Wilk test was initially used to verify the data distribution. Mean and standard deviation were used to describe the numerical data that presented normal distribution, whereas absolute and relative frequency were used to describe categorical data. Comparisons between experimental conditions (O>I origin – insertion, I>O insertion - origin and control - without KT) and speeds tested at isokinetic 30º/s, 60º/s, 120º/s, were performed by the ANOVA repeated measures test. To determine the effect of the three conditions studied on muscular electrical activations, considering the differences between genders, mixed ANOVA test was used for repeated measures.

Additionally, 5 activations were selected regarding 5 plantar flexions performed during the isokinetic dynamometer evaluation, and comparisons throughout the activations and between the experimental conditions and the same were analyzed again by mixed ANOVA for repeated measures, with Greenhouse-Geisser correction when necessary. For all analyzes, the significance of $p<0.05$ was adopted and the statistical program used was SPSS 21.0.

3. Results

Table 1 shows the general characteristic of the sample investigated, from which it is observed that the majority of the 69 volunteers were composed by female participants. There were no differences between age and BMI between genders, but differences between weight and height were found (Table 1).

Table 1. General characteristics of the participants.

Variables	Total	Male	Female	P
N total	69 (100%)	28 (41%)	41 (59%)	------
Age (years)	29.9 (5.2)	24.2 (5.1)	22.0 (5.1)	0.083
Weight (Kg)	67.3 (15.4)	75.0 (16.8)	60.0 (10.2)	**<0.001**
Height (cm)	1.66 (0.09)	1.74 (0.06)	1.61 (0.06)	**<0.001**
BMI (Kg/m^2)	23.9 (4.0)	25.1 (4.6)	23.1 (3.3)	0.06

Note: P = difference between sexes. Variables categories are described in absolute (relative) frequency. Numerical variables are described in average (standard deviation). Source: Authors.

In the isokinetic test evaluation, presented in Table 2, no differences were observed among the experimental conditions (O>I, I>O and control) at the peak torque at the speeds investigated.

The repeated-measured ANOVA analysis showed an effect only on the speed variable ($F=767.1$; $P=<0.001$), whereas the condition variable ($F=0.010$; $P=0.990$) and interaction ($F=0.199$; $P=0.892$) were not significant.

Table 2. Peak torque at speeds 30º/s 60º/s e 120º/s among the experimental conditions during the plantar flexion.

Speeds	Control	O>I	I>O	p-Value
30º/s (N.m)	114.6 (37.2)	114.0 (38.4)	114.3 (39.8)	0.951
60º/s (N.m)	88.2 (30.8)	90.5 (30.9)	89.1 (31.4)	0.818
120º/s (N.m)	61.0 (22.6)	61.5 (23.5)	61.6 (22.1)	0.779

Note: O>I: KT applied in the direction from muscle origin to muscle insertion; I>O: KT applied in the direction from muscle insertion to muscle origin; Control: No KT application; the values are mean and (standard deviation) and $p<0.05$. Source: Authors.

The evaluation of muscular electrical activity of GML and GMM muscles during the isokinetic dynamometer test at the three speeds were presented in Table 3. It was observed that the data maintained the same patterns regardless of sex; therefore, the sexes were grouped in table 3 and presented together. There was a significant difference between the conditions only for the medial gastrocnemius muscle evaluated with RMS 120º/s (p=0.047). However, comparisons by pairs showed that there is no significant difference between control vs O>I (p=0.912), control vs I>O (p=0.054) and I>O vs O>I (p=0.427), that is, it was possible to observe that RMS does not differ among the experimental conditions in the muscles investigated.

Table 3 - Mean (standard deviation) of RMS values among the experimental conditions in medial and lateral gastrocnemius muscles.

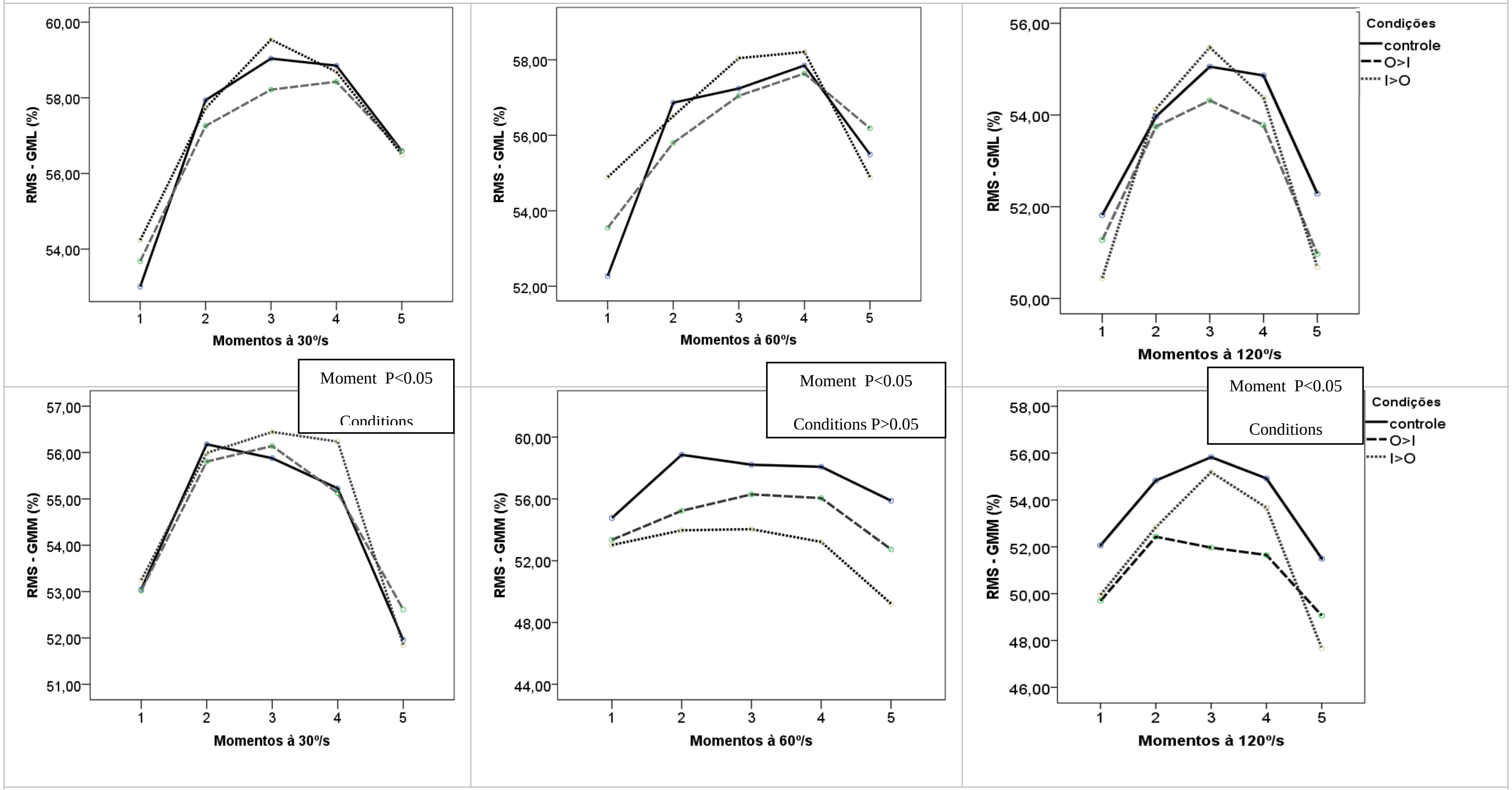
	RMS (%)	Control	O>I	I>O	P conditions	Effect size condition
	30º/seg	56.9 (6.6)	56.8 (5.9)	57.3 (6.2)	0.683	0.006
Gastrocnemius Lateral	60º/seg	56.8 (5.8)	56.9 (5.7)	56.5 (6.7)	0.694	0.006
	120º/seg	53.5 (6.1)	52.8 (7.2)	53.0 (7.1)	0.400	0.017
Gastrocnemius Medial	30º/seg	54.4 (7.8)	54.5 (8.2)	54.7 (7.3)	0.875	0.002
	60º/seg	57.1 (14.8)	54.7 (7.7)	52.6 (7.7)	0.128	0.036
	120º/seg	53.8 (6.8)	52.6 (7.8)	51.8 (7.6)	**0.047**	0.058

Note: O>I: KT applied in the direction from muscle origin to muscle insertion; I>O: KT applied in the direction from muscle insertion to muscle origin; Control: No KT application. Source: Authors.

In Figure 3, a similar behavior is observed between the tests. Thus, regardless of the tested speed or investigated musculature (medial or lateral gastrocnemius), no differences were observed among the experimental conditions (O>I, I>O and control) and in the interaction among the experimental conditions and the moments (repetitions). Significant differences were found only among the test moments (1,2,3,4,5). Additionally, the effect sizes of the conditions studied varied between 0.002 to 0.058.

(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i1.24198

Figure 3 - RMS of the 5 activations regarding plantar flexions performed during the isokinetic test.



Note: RMS = Root mean square; GMM = Medial Gastrocnemius; GML = Lateral Gastrocnemius; O = Origin; I = Insertion; M = moment; C = Experimental condition; I = Interaction between the moment and experimental condition. Source: Authors.

4. Discussion

The objective of the present study was to evaluate the KT effect on peak torque torque strength and neuromuscular activation on medial and lateral gastrocnemius muscles in healthy individuals. And as the main results, our data do not show significant difference, therefore denoting, that application (O>I and I>O) did not show alterations in muscle activity and peak torque in the population and musculature investigated, However, a tendency of variation in the medial gastrocnemius muscle was observed evaluated with RMS 120 º/s in the KT applications.

In addition to these findings, studies evaluating other muscle groups are found in the literature, both investigating the acute effect of KT application, Choi and Lee, (2018) verified that when applied KT to the rectus femoris, vastus medialis and vastus lateralis of quadriceps muscle, there was an increase in muscle torque, regardless of the tape application direction. Where as Lemos, et al. (2018) in healthy individuals, without any type of dysfunction or injury, does not influence the femoral rectum strength and knee ROM.

The applications directions in facilitation or inhibition, as well as the different amounts of tensions evaluated in this study, did not generate any change in the torque measurements investigated. This pattern remains in different populations studied and different muscle groups (Choi & Lee, 2018; Lemos, et al., 2018).

So far, no studies have been found that investigated muscle strength and activation in lateral and medial gastrocnemius investigating the outcome of the KT use, due to the fact that this muscle exhibits glycolytic characteristics, and predominance of type II fibers, thus developing the capacity to develop great tension in a short period of time (Moret, et al., 2013).

These findings refute the theories of Kase, et al. (2013) about the KT ability to increase the number of motor units during muscle contraction and to produce a greater muscle strength. Additionally, the differences highlighted by the same authors in the form of application (origin>muscular insertion or insertion>muscular origin) and its effects of activation and/or relaxation were also not observed in the analyzes performed.

On the other hand, some studies in the literature have pointed to the KT effects on some variables investigated being dependent on the form of application (Fukui, et al., 2017; Hosseini, et al., 2019). When evaluating these contradictory results, it is possible to note that it may be associated with the muscle group investigated, since these authors evaluated different regions than those adopted in the present study.

Fukui, et al., (2017) evaluating the gluteus maximum, demonstrated that the way in which the KT is applied interferes with the muscle strength capacity performed, and when applied from I>O there is an improvement in muscle strength.

There are also controversies in the literature regarding the KT use in upper limbs. Fratocchi, et al. (2013) and Kennan, et al., (2017) evaluated peak torque with isokinetic dynamometer in MMSS, the first identified an increase in peak strength of those who used KT, whereas the second did not obtain results indicating an increase in the participants' strength.

One important factor to consider is the tension in tape application, a study carried out on tape property and the tension effect showed that the tension only causes a statistically significant effect when the voltage in the load cell is above 75% stretch, however, this study was carried out by evaluating the tape properties and not the tape application on the human skin, nor by investigating outcomes in humans (Morini Junior, et al., 2020), however no studies have been found that investigated the different tensions and the possible effects of this variable on humans, since there is a very large divergence of materials, therefore, it was opted for not exerting tension in the KT application in the present study..

Another factor relevant to the interpretation of the KT effects is the previous time of the KT application, Soares, et al., (2018) in their study, evaluated the vastus medialis oblique, the vastus lateralis oblique and the vastus lateralis longus muscles. To perform the isokinetic strength test, a dynamometer was used 60°/s before and 24 hours after the KT application. After the tests, the authors reached the conclusion that the time of 24 hours was not enough to improve peak torque, maximum repetition, fatigue, antagonist/agonist ratio, deceleration time and time to reach torque.

However, Soares, et al., (2018) had already tested several periods after the KT application: 1- before application, 2- right after application, 3- after 24 hours, 4- after 48 hours and 5- after 72 hours. Similarly, the technique was not capable of improving isokinetic strength and electromyographic activity of the vastus lateralis muscle (same muscle evaluated by Soares, et al., (2018). Therefore, the authors suggested that KT does not promote immediate and late changes over any of the variables analyzed (Lins, et al., 2016).

In the study by Limmer, et al., (2020) when the acute KT effect was evaluated in climbing athletes, no significant differences were observed in the parameters of peak grip strength, fatigue index, finger waiting time, distance and rise time, or maximum blood lactate values after climbing. The participants' climbing ability with KT did not show any difference in the strength and resistance of the fingers flexor muscles, nor did the performance parameters of the sports climbing such as distance, time and maximum blood lactate values after the ascent.

Another very important issue is the understanding of KT and its mechanism in cases where it changes strength. Some authors hypothesized that KT indirectly could be interfering with neuromuscular activation, but the present study corroborates with Mak, et al., (2019), in which electromyographic activity does not change with KT, even presenting changes in maximum grip strength (wrist flexor muscles). There seems to be a "facilitator" effect of using KT related to some indirect work mechanism capable of inducing force increase in some muscle groups.

And since the KT use does not cause changes in neuromuscular activation, it is refuted that the theories that the placement of the KT application with the objective of inhibiting (insertion-origin) or facilitating (origin-insertion) muscle function does not seem to alter the magnitude of electromyographic activity of the vastus lateralis, vastus medialis and femoral biceps muscles during squat exercise. Additionally, the perceived effort was also not affected regardless of the direction that KT was applied (Serrão, et al., 2016).

Based on the findings of Dos Santos Glória, et al., (2017), that used the evaluations with EMG and isokinetic dynamometer as well as in this research, did not find any significant difference for the activation of the femoral straight muscle and also has no effect on the muscle torque peak, in activity or jumping performance among soccer players.

Despite the evidence observed herein that the KT use does not cause changes in strength and activation, it is essential to consider the population investigated, that are healthy individuals. Some reviews indicate when it comes to individuals who present muscular fatigue or chronic musculoskeletal diseases, the use of KT promotes greater effects compared to other types of treatment (bandages, bands, adhesive plasters and adhesives) for the increase of the lower limbs strength (Mostafavifar, et al., 2013; Mine, et al., 2018; Yam, et al., 2019).

Previously, Williams, et al., (2012) had already developed a systematic review seeking to answer the same questions reported above, analyzing the KT effects on healthy and injured people. Similar to later published studies, the author concluded that KT could have a "small" positive effect on the strength of an injured area, but additional studies would still be necessary to confirm the hypothesis.

Finally, as a practical application, we do not recommend the use of KT for healthy individuals when the goal is activation or relaxation, or improved strength in gastrocnemius.

5. Final Considerations

The KT tape application on the lateral and medial gastrocnemius muscles regardless of the use or direction of the application (origin > insertion or insertion > origin) did not alter the isokinetic strength or the activation of muscle fibers in healthy adults.

Therefore, it is suggested that in future studies, the tension of KT application is controlled more precisely in a clinical trial with a longer intervention time (in order to verify the chronic effect of the application of the tape), this may come to produce different results.

References

Baker, A. J., Kostov, K. G., Miller, R. G., & Weiner, M. W. (1993). Slow force recovery after long-duration exercise: metabolic and activation factors in muscle fatigue. *Journal of applied physiology*, 74(5), 2294–2300. 10.1152/jappl.1993.74.5.2294

Bastos, J. H. V. da S. (2014). Efeitos do Kinesio Taping na força muscular do Quadríceps, in Universidade Fernando Pessoa Escola Superior de Saúde, *Faculdade de Ciências da Saúde*. 52.

Cai, C., Au, I. P., An, W., & Cheung, R. T. (2016). Facilitatory and inhibitory effects of Kinesio tape: Fact or fad?. Journal of science and medicine in sport, 19(2), 109–112. 10.1016/j.jsams.2015.01.010

Chang, H. Y., Chou, K. Y., Lin, J. J., Lin, C. F., & Wang, C. H. (2010). Immediate effect of forearm Kinesio taping on maximal grip strength and force sense in healthy collegiate athletes. *Physical therapy in sport: official journal of the Association of Chartered Physiotherapists in Sports Medicine*, 11(4), 122–127. 10.1016/j.ptsp.2010.06.007

Chen, C. H., Huang, T. S., Chai, H. M., Jan, M. H., & Lin, J. J. (2013). Two stretching treatments for the hamstrings: proprioceptive neuromuscular facilitation versus kinesio taping. *Journal of sport rehabilitation*, 22(1), 59–66. 10.1123/jsr.22.1.59

Choi, I. R., & Lee, J. H. (2018). Effect of kinesiology tape application direction on quadriceps strength. *Medicine*, 97(24), e11038. 10.1097/MD.0000000000011038

Dos Santos Glória, I. P., Politti, F., Leal Junior, E., Lucareli, P., Herpich, C. M., Antonialli, F. C., de Paula Gomes, C., de Oliveira Gonzalez, T., & Biasotto-Gonzalez, D. A. (2017). Kinesio taping does not alter muscle torque, muscle activity or jumping performance in professional soccer players: A randomized, placebo-controlled, blind, clinical trial. *Journal of back and musculoskeletal rehabilitation*, 30(4), 869–877. 10.3233/BMR-160556

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, 39(2), 175–191. 10.3758/bf03193146

Feiring, D. C., Ellenbecker, T. S., & Derscheid, G. L. (1990). Test-retest reliability of the biodex isokinetic dynamometer. *The Journal of orthopaedic and sports physical therapy*, 11(7), 298–300. 10.2519/jospt.1990.11.7.298

Fratocchi, G., Di Mattia, F., Rossi, R., Mangone, M., Santilli, V., & Paoloni, M. (2013). Influence of Kinesio Taping applied over biceps brachii on isokinetic elbow peak torque. A placebo controlled study in a population of young healthy subjects. *Journal of science and medicine in sport*, 16(3), 245–249. 10.1016/j.jsams.2012.06.003

Fukui, T., Otake, Y., & Kondo, T. (2017). Os efeitos de novos métodos de bandagem projetados para aumentar a força muscular. *Journal of Physical Therapy Science*, 29 (1), 70–74. 10.1589/jpts.29.70

Hosseini, S. M., Salehi Dehno, N., Rezaiian, F., Kalantari, K. K., & Tabatabaee, S. M. (2019). Effect of kinesio taping direction on force sense in wrist flexor muscles in healthy persons. *Research in sports medicine (Print)*, 27(3), 273–282. 10.1080/15438627.2018.1549552

Huang, C. Y., Hsieh, T. H., Lu, S. C. & Su F. C. (2011). Efeito da fita Kinesio na atividade muscular e no desempenho do salto vertical em pessoas saudáveis e inativas. *BioMed Eng OnLine.* 10(70). 10.1186/1475-925X-10-70

Kase, K., Lemos, T. and Dias, E. (2013). Kinesio Taping: Introdução ao método e aplicações musculares. ANDREOLI. https://books.google.com.br/books/about/Kinesio_Taping.html?id=fjE5swEACAAJ&source=kp_book_description&redir_esc=y

Keenan, K. A., Akins, J. S., Varnell, M., Abt, J., Lovalekar, M., Lephart, S., & Sell, T. C. (2017). Kinesiology taping does not alter shoulder strength, shoulder proprioception, or scapular kinematics in healthy, physically active subjects and subjects with Subacromial Impingement Syndrome. *Physical therapy in sport: official journal of the Association of Chartered Physiotherapists in Sports Medicine*, 24, 60–66. 10.1016/j.ptsp.2016.06.006

Lemos, T. V., Júnior, J., Santos, M., Rosa, M., Silva, L., & Matheus, J. (2018). Kinesio Taping effects with different directions and tensions on strength and range of movement of the knee: a randomized controlled trial. *Brazilian journal of physical therapy*, 22(4), 283–290. 10.1016/j.bjpt.2018.04.001

Limmer, M., Buck, S., de Marées, M., & Roth, R. (2020). Acute effects of kinesio taping on muscular strength and endurance parameters of the finger flexors in sport climbing: A randomised, controlled crossover trial. *European journal of sport science*, 20(4), 427–436. 10.1080/17461391.2019.1633415

Lins, C. A., Borges, D. T., Macedo, L. B., Costa, K. S., & Brasileiro, J. S. (2016). Delayed effect of Kinesio Taping on neuromuscular performance, balance, and lower limb function in healthy individuals: a randomized controlled trial. *Brazilian journal of physical therapy*, 20(3), 231–239. 10.1590/bjpt-rbf.2014.0161

Mak, D. N., Au, I. P., Chan, M., Chan, Z. Y., An, W. W., Zhang, J. H., Draper, D., & Cheung, R. T. (2019). Placebo effect of facilitatory Kinesio tape on muscle activity and muscle strength. *Physiotherapy theory and practice*, 35(2), 157–162. 10.1080/09593985.2018.1441936

Mine, K., Nakayama, T., Milanese, S. & Grimmer, K. (2018) Effects of Kinesio tape on pain, muscle strength and functional performance: a systematic review of Japanese language literature, *Physical Therapy Reviews*, 23:2, 108-115, 10.1080/10833196.2018.1447257

Morini Junior, N, Martini, SC, Lopes-Martins, RAB, Canuto, G., Silva, RR, Scardovelli, TA, Boschi, RMS e Silva, A. P. (2020). Mechanical tensile test of the body adhesive elastic tape. *International Journal of Recent Scientific Research,* 10(5), pp. 32535–39. 10.24327/IJRSR.

Moret, D. G., Castoldi, R. C., Araújo, R. G., Spagnol, A. R., Papoti, M., Filho, J. C. S. C., Malheiro, O. C. M. (2013). Análise morfológica do músculo gastrocnêmio medial de ratos submetidos a um protocolo de treinamento concorrente. *Revista Brasileira de Ciências do Esporte*, 35(3), pp. 587–597. 10.1590/S0101-32892013000300005.

Mostafavifar, M., Wertz, J., & Borchers, J. (2012). A systematic review of the effectiveness of kinesio taping for musculoskeletal injury. *The Physician and sportsmedicine*, 40(4), 33–40. 10.3810/psm.2012.11.1986

Ridding, M. C., Brouwer, B., Miles, T. S., Pitcher, J. B., & Thompson, P. D. (2000). Changes in muscle responses to stimulation of the motor cortex induced by peripheral nerve stimulation in human subjects. *Experimental brain research*, 131(1), 135–143. 10.1007/s002219900269

Rojhani-Shirazi, Z., Amirian, S., & Meftahi, N. (2015). Effects of Ankle Kinesio Taping on Postural Control in Stroke Patients. *Journal of stroke and cerebrovascular diseases: the official journal of National Stroke Association*, 24(11), 2565–2571. 10.1016/j.jstrokecerebrovasdis.2015.07.008

Serrão, J. C., Mezêncio, B., Claudino, J. G., Soncin, R., Miyashiro, P. L., Sousa, E. P., Borges, E., Zanetti, V., Phillip, I., Mochizuki, L., & Amadio, A. C. (2016). Effect of 3 Different Applications of Kinesio Taping Denko® on Electromyographic Activity: Inhibition or Facilitation of the Quadriceps of Males During Squat Exercise. *Journal of sports science & medicine,* 15(3), 403–409.

Simão, R.; Senna, G.; Nassif, L.; Leitão, N.; Arruda, R.; Priore, M.; Maior, A.S.; Polito, M. Influência dos diferentes protocolos de aquecimento na capacidade de desenvolver carga máxima no teste de 1RM. *Fitness & Performance Journal,* 3(5), pp. 261–265. 10.3900/fpj.3.5.261.p.

Simon, J., Garcia, W., & Docherty, C. L. (2014). The effect of kinesio tape on force sense in people with functional ankle instability. *Clinical journal of sport medicine: official journal of the Canadian Academy of Sport Medicine,* 24(4), 289–294. 10.1097/JSM.0000000000000030

Soares, M. S, Lopes, A. J., Vigário, P. S., Souza, M. P., Costa, H. F., Felicio, L. R. (2018). Does the Kinesio tape provide more knee extensor torque?, *Asian Journal of Sports Medicine*. In Press 9(1), p. 63946. 10.5812/asjsm.63946.

Sole, G., Hamrén, J., Milosavljevic, S., Nicholson, H., & Sullivan, S. J. (2007). Test-retest reliability of isokinetic knee extension and flexion. *Archives of physical medicine and rehabilitation,* 88(5), 626–631. 10.1016/j.apmr.2007.02.006

Song, C. Y., Huang, H. Y., Chen, S. C., Lin, J. J., & Chang, A. H. (2015). Effects of femoral rotational taping on pain, lower extremity kinematics, and muscle activation in female patients with patellofemoral pain. *Journal of science and medicine in sport,* 18(4), 388–393. 10.1016/j.jsams.2014.07.009

Vercelli, S., Sartorio, F., Foti, C., Colletto, L., Virton, D., Ronconi, G., & Ferriero, G. (2012). Immediate effects of kinesiotaping on quadriceps muscle strength: a single-blind, placebo-controlled crossover trial. *Clinical journal of sport medicine: official journal of the Canadian Academy of Sport Medicine,* 22(4), 319–326. 10.1097/JSM.0b013e31824c835d

Williams, S., Whatman, C., Hume, P. A., & Sheerin, K. (2012). Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. *Sports* medicine (Auckland, N.Z.), 42(2), 153–164. 10.2165/11594960-000000000-00000

Wong, O. M., Cheung, R. T., & Li, R. C. (2012). Isokinetic knee function in healthy subjects with and without Kinesio taping. *Physical therapy in sport: official journal of the Association of Chartered Physiotherapists in Sports Medicine,* 13(4), 255–258. 10.1016/j.ptsp.2012.01.004

Yam, M. L., Yang, Z., Zee, B. C., & Chong, K. C. (2019). Effects of Kinesio tape on lower limb muscle strength, hop test, and vertical jump performances: a meta-analysis. *BMC musculoskeletal disorders*, 20(1), 212. 10.1186/s12891-019-2564-6

Yeung SS, Yeung EW 2016 Acute Effects of Kinesio Taping on Knee Extensor Peak Torque and Stretch Reflex in Healthy Adults. *Medicine* (Baltimore) 95(4): e2615. 10.1097/MD.0000000000002615