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Prevention and Rehabilitation

Kinesiology tape increases muscle tone, stiffness, and elasticity: Effects of the direction of tape application

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ABSTRACT

The claim that the effects of kinesiology tape are different depending on the direction of tape application needs to be clearly ascertained. This study aimed to determine the immediate effects of two forearm kinesiology tape applications on muscle tone, stiffness, and elasticity of young individuals. Thirty-nine participants (15 men and 24 women) were randomized (1:1:1) to: the facilitatory group, receiving kinesiology tape applied from origin to insertion; the inhibitory group, receiving kinesiology tape applied from insertion to origin; or, a control group, without any intervention. The mechanical properties – tone, elasticity, and stiffness – of the forearm muscles were measured with a handheld mechanical impulse-based myotonometric device before and 30 min after the kinesiology tape application. Only the application of kinesiology tape from origin to insertion significantly increased muscle tone [16.6 (2.5) to 17.4 (3.5) Hz, $p = 0.036$], stiffness [318.3 (52) to 355.0 (87) N/m, $p = 0.004$], and elasticity [0.98 (0.1) to 1.10 (0.1), $p = 0.023$]. No changes were observed in both inhibitory kinesiology tape and the control group. In conclusion, kinesiology tape application has different effects depending on the direction of the taping application. The facilitatory tapping increased muscle tone, elasticity, and stiffness.

1. Introduction

Kinesiology tape (KT) application is a technique commonly used during sports practice, as well as during the rehabilitation of musculoskeletal and sports injuries; however, there is insufficient evidence to support its widespread use (Williams et al., 2012; Kalron and Bar-Sela 2013; Morris et al., 2013; Mostafavifar et al., 2013; Csapo and Alegre 2015; Hanson et al., 2019; Cheatham et al. 2021).

There is a wide list of benefits associated with KT, including amelioration of proprioception, pain, blood and lymphatic circulation, inflammation, muscle function, and injury prevention (Kase et al., 2003, Bassett et al., 2010; Berezutsky 2019; Hanson et al., 2019; Yam et al., 2019). It was also suggested that the KT could have either facilitatory or inhibitory effects on muscle function depending on the direction of the taping application (Gusella et al., 2014, Choi and Lee, 2018). Yet, previous studies showed contrasting results in this regard, with a substantial number of studies reporting no facilitatory or inhibitory effects of KT on handgrip strength (Cai et al., 2016, MacPhail et al., 2018), isokinetic muscle strength (Vercelli et al., 2012; Gomez-Soriano et al., 2014; Poon et al., 2015), and electromyographic activity (Correia et al., 2016, Yoosefinejad et al., 2017; MacPhail et al., 2018). However, Sartre et al. (2013) showed that inhibitory taping application decreased the electromyographic activity at rest while Tsai, Chu et al. (2018) and Mostaghim et al. (2016) showed improvements in muscle performance with facilitatory KT application. Hence, the purpose of this study was to determine the immediate effects of two forearm KT applications (facilitatory or inhibitory) on muscle tone, stiffness, and elasticity assessed with a non-invasive myometer, in young adults. It was hypothesized that there would be an improvement in muscle performance with facilitatory KT application.

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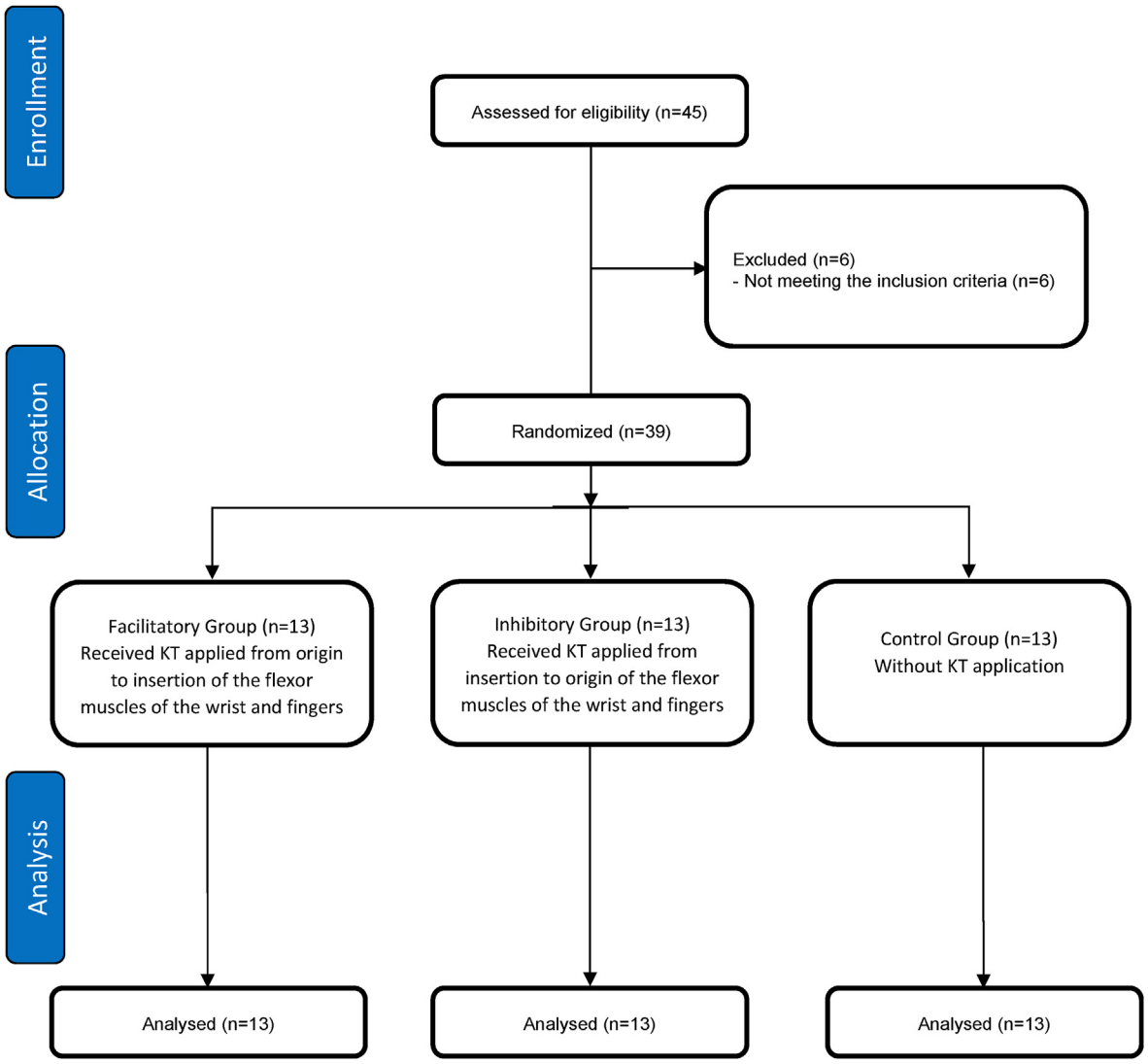

Fig. 1. Flow chart.

2. Methods

2.1. Participants

Forty-five physically active young, healthy, adults were recruited through verbal advertisement and social media in the University of Aveiro, Portugal. Young adults (age ≥18 years old), both sexes, and without cervical/upper limb pain were included. Exclusion criteria: past or present upper limb or cervical injury; previous upper limb or cervical surgery; skin disease or skin conditions precluding tape. From the 45 participants who were assessed for eligibility, six were excluded because they met at least one exclusion criterion.

2.2. Ethical consideration and randomization

Thirty nine participants (15 male and 24 female), with an age range between 18 and 33 years were eligible for study participation and randomized (block randomization, 1:1:1) to 1 of 3 groups: the facilitatory group (n = 13), which received KT applied from origin to insertion of the flexor muscles of the wrist and fingers; the inhibitory group (n = 13), which received KT applied from insertion to origin; and the control group (n = 13), without KT application. The randomization was performed by allowing the participant to pick up a number out of a hat. The flow diagram is displayed in Fig. 1. The institutional review board approved the study; written informed consent was obtained, and all procedures were conducted according to the Declaration of Helsinki.

2.3. Procedures

At baseline and 30 min after the KT application, the mechanical properties of the forearm muscles were measured in the dominant upper limb. We selected a short period of the tape application (30 min), to specifically determine the immediate effects of the KT.

The mechanical properties – tone, elasticity, and stiffness – of the flexor muscles of the wrist and fingers were measured using a handheld mechanical impulse-based myotonometric device (MyotonPro, Myoton AS, Tallinn, Estonia) with the participant in supine, with their upper limb externally rotated and the forearm in supination (Fig. 2). The selected measurement site was the most prominent point in the muscle belly, identified during an isometric muscle contraction. Three consecutive measurements, in multi-scan mode comprising 10 mechanical taps 1 s apart, were performed and the average was taken for analysis. This device has

Fig. 2. Assessment of the mechanical properties of the flexor muscles of the wrist and fingers with the MyotonPro.

proven to be valid and reliable (Bizzini and Mannion 2003; Zinder and Padua 2011, Aird et al., 2012) and provides measures of (i) muscle tone in resting state, which is indicated by the oscillation frequency (Hz); (ii) elasticity, which represents the capacity to recover the muscle shape after a contraction, indicated by the logarithmic decrement of a muscle's natural oscillation; and (iii) stiffness (N/m), i.e. the muscle resistance to contraction (Aird et al., 2012). Furthermore, myotonometric stiffness measurements in muscles at rest can be reliably accomplished with 10 records/mechanical taps (Marusiak et al., 2018).

The KT conditions were "facilitatory application" and "inhibitory application". Standard blue (5 cm) KT (CureTape, FysioTape B. V., SW Enschede, Netherlands) was applied from the origin to the insertion of the flexor muscles of the wrist and fingers in the facilitatory group, and from the insertion to the origin of the same muscles in the inhibitory group, as previously reported (Kase et al., 2003, Chang et al., 2010). The Y-strip was applied with 20% stretch tension. The same instructor, qualified to apply KT, applied all taping in a standardized manner, after cleaning the participants' skin. The tape was applied from the origin to the insertion with the aim of muscle activation and in the opposite direction with the aim of muscle inhibition (Kase et al., 2003). The control group did not receive any tape.

Table 2
Effects of KT application in muscle tone, elasticity, and stiffness [median (interquartile range)].

	Muscle tone (Hz)	Elasticity	Stiffness (N/m)
Control Group			
Baseline	16.7 (2.9)	0.99 (0.2)	305.3 (59)
30-min after	16.3 (3.2)	0.96 (0.1)	313.7 (61)
Change (%)	−2.2 (4.8)	−0.69 (8.9)	−0.7 (12.1)
Facilitatory Effect Group			
Baseline	16.6 (2.5)	0.98 (0.1)	318.3 (52)
30-min after	17.4 (3.5)‡	1.10 (0.1)‡	355.0 (87)‡
Change (%)	2.8 (5.8)**	5.3 (12.7)**	6.5 (9.6)*
Inhibitory Effect Group			
Baseline	17.2 (3.2)	1.02 (0.2)	312.7 (36)
30-min after	17.3 (3.0)	0.99 (0.1)	332.3 (72)
Change (%)	−0.4 (5.4)	−3.69 (13.4)	3.3 (11)

‡ significantly different from baseline, $p < 0.05$; *significantly different from control group, $p < 0.05$; **significantly different from control and inhibitory groups, $p < 0.05$.

2.4. Statistical analysis

All analyses were conducted with SPSS version 24.0 (SPSS Inc., Chicago, IL, USA). The normality of the data distribution was tested with the Shapiro-Wilk test. Muscle tone, elasticity, and stiffness data were not normally distributed. Data are expressed as mean ± SD (age, height, weight, body mass index) or median (interquartile range) (muscle tone, elasticity, and stiffness). Kruskal-Wallis Test was performed for comparisons between groups in muscle tone, elasticity, and stiffness, while one-way Anova was used for comparisons in age, height, weight, and body mass index; Mann-Whitney *U* test or Bonferroni test were used for the post hoc analysis, respectively for Kruskal-Wallis Test and one-way Anova. Wilcoxon signed-rank test was used to test baseline to post-intervention differences within groups in muscle tone, elasticity, and stiffness. A value of $P < 0.05$ was used to determine statistical significance.

3. Results

Overall, there were no significant differences among groups in the characteristics of the participants, namely age, body weight, and body mass index (Table 1). There were no differences between groups at baseline in muscle tone, stiffness, and elasticity (Table 2).

The inhibitory KT application did not change the mechanical properties of the flexor muscles of the wrist and fingers, while the facilitatory application increased muscle tone ($p = 0.036$), stiffness ($p = 0.004$), and elasticity ($p = 0.023$). No changes were observed in the control group (Table 2).

4. Discussion

The main findings of the present study indicate KT had a different effect on the mechanical properties of the muscles depending on the direction of taping application. Only the facilitatory application changed the mechanical properties of the flexor

Table 1
Characteristics of the participants (mean ± SD).

	Control Group	Inhibitory Group	Facilitatory Group	P value
Women/Men (n)	8/5	8/5	8/5	1.000
Age (years)	20.2 ± 1.9	21.4 ± 3.8	20.2 ± 1.4	0.429
Height (m)	1.72 ± 0.79	1.69 ± 0.88	1.68 ± 0.12	0.553
Weight (kg)	63.1 ± 8.8	66.6 ± 14.2	63.4 ± 15.4	0.756
BMI (kg/m^2)	21.3 ± 2.0	23.5 ± 3.3	22.1 ± 2.3	0.097

muscles of the wrist and fingers, increasing muscle tone, elasticity, and stiffness, confirming our hypothesis. These results seem to indicate that those who are seeking to change the mechanical properties of the flexor muscles of the wrist and fingers should disregard the inhibitory application of KT.

Our results are in line with previous studies showing that the inhibitory application of KT did not change the muscle tone. For instance, Gomez-Soriano et al. (2014) showed that the application of the tape on the gastrocnemius muscles of 19 healthy subjects did not affect healthy muscle tone, extensibility nor strength. In their study, Cai et al. (2016) recruited 39 healthy adults to test the inhibitory and facilitatory effects of KT. The authors were not able to show the inhibitory and facilitatory effects of KT reducing or increasing muscle activity or force generation. The results of the study by MacPhail et al. (2018), also showed that inhibitory KT application did not delay EMG activity, decreased maximal grip strength, or lowered perceived maximal grip strength in 60 healthy adults.

However, a systematic review (Williams et al., 2012) indicated that KT was associated with a considerable change in muscle activity over specific ranges of humeral elevation when considering only research with high methodological quality. Yeung and Yeung (2016) also showed that the direction of KT application had specific effects on muscle performance on 28 healthy volunteers with no history of knee injuries. The authors demonstrated that facilitatory KT resulted in higher knee extensor peak torque performance at an angular velocity of 60° s^{-1}, than inhibitory KT. Likewise, Tsai et al. (2018) showed that 15 University Kendo Team athletes with a faciliatory KT-Achilles taping technique, presented a shorter foot-ground contact time and a greater range of motion of the ankle when tested on a force plate compared to the moment without KT application. Additionally, Mostaghim et al. (2016) showed improvements in muscle performance and motor skills, such as maximum voluntary isometric contraction, jumping, and sprint performance, immediately and 24 h after facilitatory KT application in 44 healthy collegiate athletes. Indeed, the ability of KT to modulate the mechanical properties of the muscle is of interest, suggesting that KT could be an adjuvant tool to regulate muscle tone in cases of hypotonia. Future studies should be designed with participants with muscle tone pathologies to ascertain the potential therapeutic effect of KT on the mechanical properties of the muscle, namely tone, stiffness, and elasticity. Furthermore, if a rigorous establishment of taping rules may be established and the current techniques enhanced, treatment with KT may produce additional results as many factors can affect the expected outcome (Andrýsková and Lee 2020; Selva et al., 2019).

Some limitations need to be acknowledged. First, our sample was non-probabilistic, composed of healthy subjects, and recruited without performing a previous sample size calculation, which limits the generalization of the results. Second, the final evaluation was performed 30 min after the application of the tape. It could be important to evaluate at different periods and for a longer time after the KT application. Third, we did not eliminate the potential placebo effect of the tape. Future studies should mitigate the placebo effect by deceiving the participants.

5. Conclusion

The facilitatory application of KT increased muscle tone, elasticity, and stiffness, while the inhibitory application did not change any of the mechanical properties of the flexor muscles of the wrist and fingers. Our results suggest that facilitatory KT could be used during a short period of sport practice or as an adjuvant therapy during a rehabilitation session, aiming to acutely change the mechanical properties of the muscle.

CRediT authorship contribution statement

Mário Lopes: Conceptualization, Methodology, Software, Data curation, Writing – original draft, Writing – review & editing. **Rui Torres:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, Visualization, Investigation. **Dalila Romão:** Visualization, Investigation. **Maria Dias:** Visualization, Investigation. **Sara Valério:** Visualization, Investigation. **Luís Espejo-Antúnez:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, Writing – review & editing. **Rui Costa:** Writing – review & editing. **Fernando Ribeiro:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, Supervision, Software, Validation, Writing – review & editing.

Declaration of competing interest

None.

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