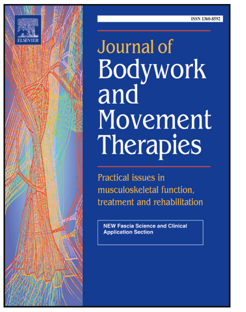
Journal Pre-proof



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

Mário Lopes, Rui Torres, Dalila Romão, Maria Dias, Sara Valério, Luís Espejo-Antúnez, Rui Costa, Fernando Ribeiro

PII: S1360-8592(22)00003-1

DOI: https://doi.org/10.1016/j.jbmt.2022.01.003

Reference: YJBMT 2383

To appear in: *Journal of Bodywork & Movement Therapies*

Received Date: 18 May 2021

Revised Date: 29 November 2021

Accepted Date: 15 January 2022

Please cite this article as: Lopes, Má., Torres, R., Romão, D., Dias, M., Valério, S., Espejo-Antúnez, Luí., Costa, R., Ribeiro, F., Kinesiology tape increases muscle tone, stiffness, and elasticity: Effects of the direction of tape application, *Journal of Bodywork & Movement Therapies* (2022), doi: https://doi.org/10.1016/j.jbmt.2022.01.003.

Credit Author Statement

Mário Lopes, Fernando Ribeiro, Rui Torres, Luis Espejo-Antúnez: Conceptualization, Methodology, Software. Mário Lopes, Fernando Ribeiro, Rui Torres, Luis Espejo-Antúnez: Data curation, Writing- Original draft preparation. Dalila Romão, Maria Dias, Sara Valério, Rui Costa,: Visualization, Investigation. Fernando Ribeiro: Supervision.: Fernando Ribeiro: Software, Validation.: Mário Lopes, Fernando Ribeiro, Rui Torres, Luis Espejo-Antúnez: Writing- Reviewing and Editing.

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

Authors

Mário Lopes[1], Rui Torres[2,3], Dalila Romão[4], Maria Dias[4], Sara Valério[4], Luís Espejo-Antúnez[5], Rui Costa[1], Fernando Ribeiro[1]

[1] Institute of Biomedicine and School of Health Sciences, University of Aveiro, Aveiro, Portugal

[2] Vale do Sousa Higher School of Health, Polytechnic Health School of the North, CESPU, Gandra PRD, Portugal

[3] Physiotherapy department, School of Heath, Polytechnic Institute of Porto, Center for Rehabilitation Research - Center of Human Studies and Human Activity, Porto, Portugal

[4] School of Health Sciences, University of Aveiro, Aveiro, Portugal

[5] Department of Medical-Surgical Therapy, Faculty of Medicine, University of Extremadura, Badajoz, Spain

Corresponding author:

Mário Lopes, PhD, School of Health Sciences, University of Aveiro - Building 30, Agras do Crasto - Campus Universitário de Santiago, 3810-193 Aveiro, Portugal. **E-mail:** mariolopes77@ua.pt

Key words: facilitation; kinesiotape; inhibition; mechanical properties.

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

Key words: facilitation; kinesiotape; inhibition; mechanical properties.

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 minutes 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.

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, Whatman et al. 2012, Kalron and Bar-Sela 2013, Morris, Jones et al. 2013, Mostafavifar, Wertz et al. 2013, Csapo and Alegre 2015, Hanson, Ostrem, and Davies 2019, Cheatham, Baker, and Abdenour 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, Wallis et al. 2003, Bassett, Lingman et al. 2010, Berezutsky 2019, Hanson, Ostrem, and Davies 2019, Yam, Yang 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, Bettuolo 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, Au et al. 2016, MacPhail, Au et al. 2018), isokinetic muscle strength (Vercelli, Sartorio et al. 2012, Gomez-Soriano, Abian-Vicen et al. 2014, Poon, Li et al. 2015), and electromyographic activity (Correia, Lopes et al. 2016, Yoosefinejad, Motealleh et al. 2017, MacPhail, Au 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, Jahromi 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.

Methods

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.

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 Figure 2. The institutional review board approved the study; written informed consent was obtained, and all procedures were conducted according to the Declaration of Helsinki.

Procedures

At baseline and 30 minutes 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 minutes), 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 (Figure 1). 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 one second apart, were performed and the average was taken for analysis. This device has proven to be valid and reliable (Bizzini and Mannion 2003, Zinder and Padua 2011, Aird, Samuel 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, Samuel et al. 2012). Also, are myotonometric stiffness measurements in muscles at rest can be reliably accomplished with 10 records/mechanical taps (Marusiak, Jarocka 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, Wallis et al. 2003, Chang, Chou 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, Wallis et al. 2003). The control group did not receive any tape.

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 $P < .05$ was used to determine statistical significance.

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).

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 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 onto 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, Whatman 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 & 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^{o} 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 hours 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 minutes 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.

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.

Conflict of interest statement: none.

Acknowledgement

iBiMED is a research unit supported by the Portuguese foundation for Science and Technology (REF: UID/BIM/04501/2013) and FEDER/Compete2020 funds.

References

Aird L, Samuel D, Stokes M. Quadriceps muscle tone, elasticity and stiffness in older males: reliability and symmetry using the MyotonPRO. Arch Gerontol Geriatr 2012;55(2):e31-39

Andrýsková, Adéla, and Jung Hoon Lee. 2020. "The Guidelines for Application of Kinesiology Tape for Prevention and Treatment of Sports Injuries." Healthcare (Switzerland) 8(2):10–13. doi: 10.3390/healthcare8020144.

Bassett K, Lingman S, Ellis R. The use and treatment efficacy of kinaesthetic taping for musculoskeletal conditions: a sistematic review. N Z J Physiother 2010;38(2):56-62

Berezutsky V. Possibilities of kinesio taping to prevent injuries of professional dancers. Int J Occup Saf Ergon 2019;25(4):638-645

Bizzini M, Mannion AF. Reliability of a new, hand-held device for assessing skeletal muscle stiffness. Clin Biomech (Bristol, Avon) 2003;18(5):459-461

Cai C, Au IP, An W, Cheung RT. Facilitatory and inhibitory effects of Kinesio tape: Fact or fad? J Sci Med Sport 2016;19(2):109-112

Chang HY, Chou KY, Lin JJ, Lin CF, Wang CH. Immediate effect of forearm Kinesio taping on maximal grip strength and force sense in healthy collegiate athletes. Phys Ther Sport 2010;11(4):122-127

Cheatham, Scott W., Russell T. Baker, and Thomas E. Abdenour. 2021. "Kinesiology Tape: A Descriptive Survey of Healthcare Professionals in the United States." International Journal of Sports Physical Therapy 16(3):778–96. doi: 10.26603/001c.22136.

Choi, Im Rak, and Jung Hoon Lee. 2018. “Effect of Kinesiology Tape Application Direction on Quadriceps Strength.” Medicine (United States) 97(24). doi: 10.1097/MD.0000000000011038.

Correia C, Lopes S, Goncalves R, Torres R, Pinho F, Goncalves P, Rodrigues M, Costa R, Lopes M, Ribeiro F. Kinesiology taping does not change fibularis longus latency time and postural sway. J Bodyw Mov Ther 2016;20(1):132-138

Csapo R, Alegre LM. Effects of Kinesio((R)) taping on skeletal muscle strength-A meta-analysis of current evidence. J Sci Med Sport 2015;18(4):450-456

Gomez-Soriano J, Abian-Vicen J, Aparicio-Garcia C, Ruiz-Lazaro P, Simon-Martinez C, Bravo-Esteban E, Fernandez-Rodriguez JM. The effects of Kinesio taping on muscle tone in healthy subjects: a double-blind, placebo-controlled crossover trial. Man Ther 2014;19(2):131-136

Gusella A, Bettuolo M, Contiero F, Volpe G. Kinesiologic taping and muscular activity: a myofascial hypothesis and a randomised, blinded trial on healthy individuals. J Bodyw Mov Ther 2014;18(3):405-411

Kalron A, Bar-Sela S. A systematic review of the effectiveness of Kinesio Taping--fact or fashion? Eur J Phys Rehabil Med 2013;49(5):699-709

Kase K, Wallis J, Kase T (2003). Clinical Therapeutic Applications of the Kinesio Taping Method. Tokyo, Japan, Ken Ikai Co Ltd.

MacPhail AJC, Au IP, Chan M, Mak DN, An WW, Chan ZY, Zhang JH, Wong K, So A, Chan N, Kwok C, Lau P, Draper D, Cheung RT. Type effect of inhibitory KT tape on measured vs. perceived maximal grip strength. J Bodyw Mov Ther 2018;22(3):639-642

Marusiak J, Jarocka E, Jaskolska A, Jaskolski A. Influence of number of records on reliability of myotonometric measurements of muscle stiffness at rest and contraction. Acta Bioeng Biomech 2018;20(4):123-131

Morris D, Jones D, Ryan H, Ryan CG. The clinical effects of Kinesio(R) Tex taping: A systematic review. Physiother Theory Pract 2013;29(4):259-270

Mostafavifar M, Wertz J, Borchers J. A systematic review of the effectiveness of kinesio taping for musculoskeletal injury. Phys Sportsmed 2013;40(4):33-40

Mostaghim N, Jahromi MK, Shirazzi ZR, Salesi M. The effect of quadriceps femoris muscle Kinesio Taping on physical fitness indices in non-injured athletes. J Sports Med Phys Fitness 2016;56(12):1526-1533

Poon KY, Li SM, Roper MG, Wong MK, Wong O, Cheung RT. Kinesiology tape does not facilitate muscle performance: A deceptive controlled trial. Man Ther 2015;20(1):130-133

Sartre A, Fabri S, Morana C. Effet du sens de pose du kinesio taping® sur les épicondyliens. Journal de Traumatologie du Sport 2013;30(3):141-145

Selva, Francisco, Alberto Pardo, Xavier Aguado, Ignacio Montava, Luis Gil-Santos, and Carlos Barrios. 2019. “A Study of Reproducibility of Kinesiology Tape Applications: Review, Reliability and Validity.” BMC Musculoskeletal Disorders 20(1):1–12. doi: 10.1186/s12891-019-2533-0.

Tsai FH, Chu IH, Huang CH, Liang JM, Wu JH, Wu WL. Effects of Taping on Achilles Tendon Protection and Kendo Performance. J Sport Rehabil 2018;27(2):157-164

Vercelli S, Sartorio F, Foti C, Colletto L, Virton D, Ronconi G, Ferriero G. Immediate effects of kinesiotaping on quadriceps muscle strength: a single-blind, placebo-controlled crossover trial. Clin J Sport Med 2012;22(4):319-326

Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. Sports Med 2012;42(2):153-164

Yam ML, Yang Z, Zee BC, Chong KC. Effects of Kinesio tape on lower limb muscle strength, hop test, and vertical jump performances: a meta-analysis. BMC Musculoskelet Disord 2019;20(1):212

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

Yoosefinejad AK, Motealleh A, Abbasalipur S, Shahroei M, Sobhani S. Can inhibitory and facilitatory kinesiotaping techniques affect motor neuron excitability? A randomized cross-over trial. J Bodyw Mov Ther 2017;21(2):234-239

Zinder SM, Padua DA. Reliability, validity, and precision of a handheld myometer for assessing in vivo muscle stiffness. J Sport Rehabil 2011;20(3):2010_0051

Figure 1. Assessment of the mechanical properties of the flexor muscles of the wrist and fingers with the MyotonPro.

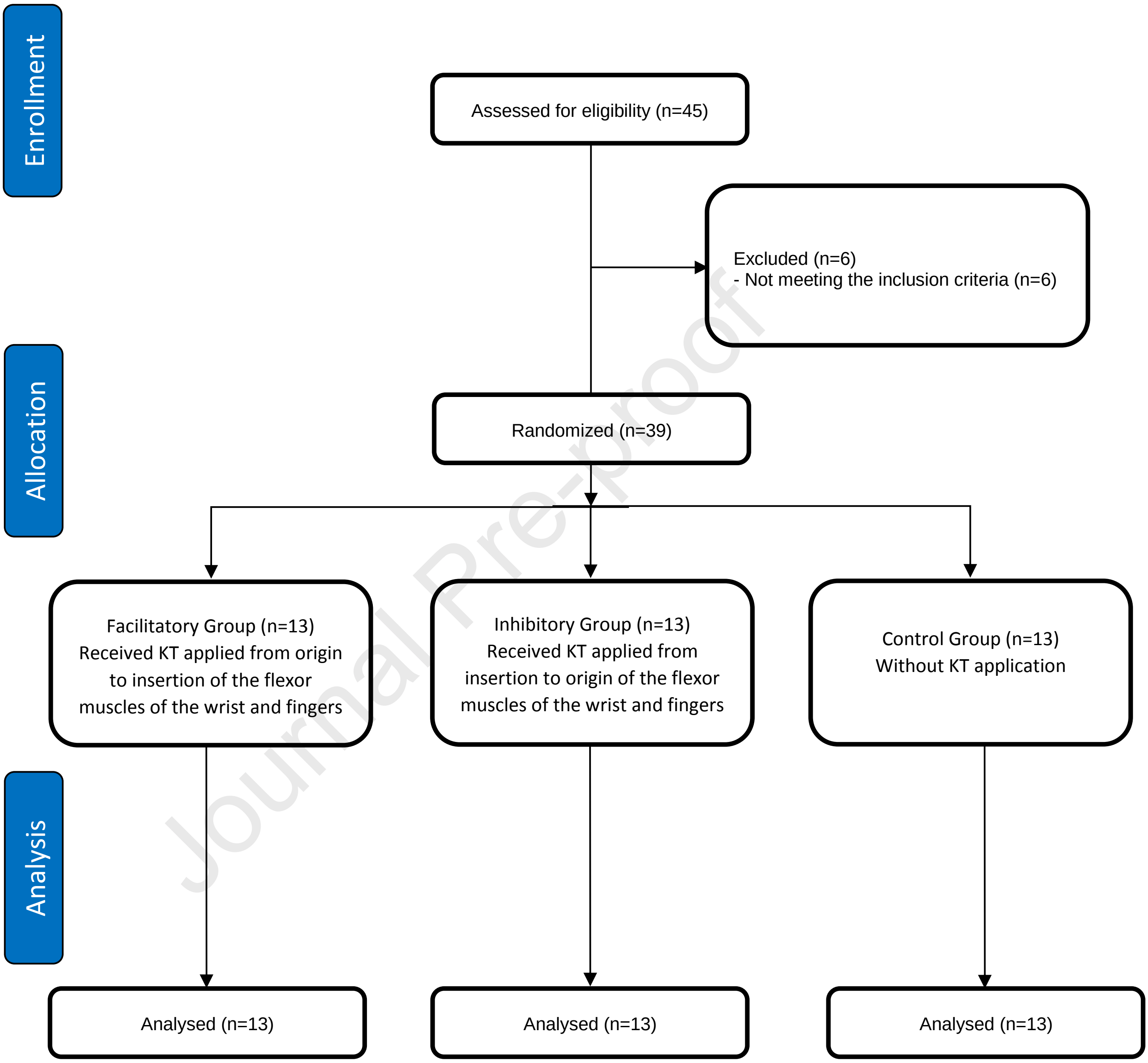


Figure 2. Flow Chart.

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

318 **Table 2.** Effects of KT application in muscle tone, elasticity, and stiffness [median

319 (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)

320 ‡ significantly different from baseline, $p<0.05$; *significantly different from control group, $p<0.05$;

321 **significantly different from control and inhibitory groups, $p<0.05$.

322

323

Conflict of interest statement

On behalf of all authors, Mário Lopes declares that there are no conflicts of interest.

The main author,

Assinado por : **MÁRIO ALEXANDRE GONÇALVES LOPES**
Num. de Identificação: BI12275040
Data: 2021.05.18 12:59:43 +0100

CHAVE MÓVEL

____

Mário Lopes