Journal of Bodywork & Movement Therapies 25 (2021) 212–217

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

Prevention and Rehabilitation

Effect of two Dynamic Tape™ applications on the electromyographic activity of the gluteus medius and functional performance in women: A randomized, controlled, clinical trial

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A R T I C L E I N F O

Article history:
Received 14 July 2020
Received in revised form
14 October 2020
Accepted 13 November 2020

Keywords:
Bandages
Electromyography
Athletic performance
Rehabilitation

A B S T R A C T

Introduction: Dynamic Tape™ (DT) is a biomechanical tape that is used to directly manage load, modify movement patterns, and assist functioning. However, no studies have evaluated its effectiveness in increasing gluteus medius (GM) muscle activation and improving functional performance.
Objective: To investigate the effect of two forms of DT applications on the electromyographic (EMG) activity of the GM muscle and lower limb functional performance.
Methods: Thirty-three, healthy, recreationally active women were randomly assigned into two groups: 1) submitted to the DT application on GM muscle that adhered to the stretching method for Kinesio Tape® application (KG, n = 17) and 2) submitted to the DT application on GM muscle that adhered to the stretching method suggested for DT (DG, n = 16). The EMG evaluation of GM was performed at rest, in maximum voluntary isometric contraction, and in the single-leg squat, drop landing, and jump landing + maximum vertical jump tests. Functional performance was evaluated using the triple hop test and the 6-m timed hop test.
Results: No significant changes in GM activation or functional performance were found, regardless of the stretching method used. No significant intergroup differences were observed ($\alpha = 5\%$).
Conclusion: DT did not increase GM activation in functional activities, and it did not improve functional performance in the lower limbs in healthy women, regardless of the form of application used.

1. Introduction

Functional bandages are commonly used in sports as well as many clinical situations to prevent and treat injuries and to provide joint protection and support during movement (Christou 2004; Williams et al., 2012). Among the different types of functional bandages, Kinesio Tape® (KT) is noted for having been an industry pioneer. KT was developed by Kenso Kase in the 1970s; since then, it has been used to treat a variety of lesions (Castro-Sánchez et al., 2012; Taylor et al., 2014; Zübeyir et al., 2012).

In 2009, Ryan Kendrick, an Australian physiotherapist, developed the Dynamic Tape™ (DT) functional bandage. While the principles that were used to develop DT and KT are similar, their mechanical properties are different. Due to its elastic (elongation capacity greater than 200%) and multidirectional (elongation occurs in all directions) nature, DT is a biomechanical tape that has properties which involves deceleration, absorption of loads, and assistance with movement in its primary mode of action (McNeill and Pedersen 2016). In addition, the reasoning and method of applying the functional bandage also differs between the KT and DT

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https://doi.org/10.1016/j.jbmt.2020.11.018
1360-8592/

models. The KT is usually applied with the tape stretched with the body part lengthened to use the proposed tape convolution effect in order to maximize KT's tissue lifting. In DT application, the technique to maximize load absorption is to put the tape on with the body part shortened and with a degree of stretch in the tape (McNeill and Pedersen 2016). Thus, while the KT is applied with the muscle lengthened (generally), the DT is applied with the muscle shortened.

In theory, functional bandages may stimulate or inhibit muscle action, depending on how they are applied to the target structure (MacGregor et al., 2005). A recent review (Reneker et al., 2018) points to the lack of convincing evidence that KT (the most studied bandage) improves sports performance skills. Moreover, to date, limited evidence supports its use for increasing muscle strength (Christou 2004; Fukui et al., 2017; Kim et al., 2015) for ensuring joint stability (Christou 2004; Hosp et al., 2017; Kim et al., 2015) and for improving lower limb athletic performance (Ward et al., 2014).

It should be noted, however, that the effect of functional bandages has been investigated almost exclusively when they are applied to the knee and ankle muscles. The effect of functional bandages on the hip muscles, in particular on the gluteus medius (GM) muscle, has not been well investigated. Maguire et al. (2010) found that the application of functional bandaging in GM can favor hip abduction activity in hemiparetic individuals, increasing their gait velocity. Miller et al. (2013) found that KT may facilitate GM activation and improve postural stability in women with patellofemoral pain syndrome (PFPS). However, none of these studies used DT as an intervention taping method.

It is known that women tend to present altered and/or diminished neuromuscular control strategies during tasks involving changes of direction and jump landings. Women demonstrate greater hip adduction and medial rotation excursions during these activities (Baldon et al., 2012; Boling and Padua 2013; Myer et al., 2006). Considering the role of hip abduction in controlling hip and knee movements, it is important to verify the influence that a specific intervention on this musculature would have on the biomechanical characteristics of the limb during activities that mimic functional gestures related to knee injuries (Baldon et al., 2012).

Thus, the present study aimed to evaluate the effect of using DT on GM electromyographic activity and lower limb functional performance in healthy, recreationally active women, by applying the bandage in two different ways: 1) with stretching that is similar to the application of KT and 2) with stretching specifically suggested for DT. It was hypothesized that the application of DT would promote improved GM activation and enhance lower limb functional performance. Furthermore, it was hypothesized that the DT mode of application could be decisive in promoting both effects.

2. Methods

This single-blinded, controlled, randomized, clinical trial was approved by the Ethics Committee of Federal University of Alfenas (UNIFAL-MG) – protocol number 637.839/2014, and registered at *Registro Brasileiro de Ensaios Clínicos* (RBR-3fs2dm). Thirty-three healthy, recreationally active, university educated women ranging in age between 18 and 28, participated in this study, after reading and signing an informed consent form. The recreationally active condition was defined as anyone participating in aerobic or athletic activity at least three times per week for 30 min (Baldon et al., 2012). Other inclusion criteria were: a) the absence of pain or any signs of musculoskeletal dysfunction in the lower limbs (Hosp et al., 2017); b) no history of surgery and/or orthopedic dysfunction in the lower limbs in the previous year (Hosp et al., 2017); c) the absence of cardiovascular or respiratory disease that impeded the performance of the movements under study (Chappell et al., 2002); d) the absence of systemic or vestibular disease that affected balance (Rozzi et al., 1999); e) the absence of peripheral or central metabolic or neurological disease (Hosp et al., 2017); and f) no history of allergic reaction to the application of elastic bandages (Lins et al., 2013). Exclusion criteria were: a) the inability to perform any of the assessment and/or intervention procedures; b) the presence of significative musculoskeletal pain or discomfort during the performance of any evaluation and intervention procedures, which management depends on medical and/or physiotherapeutic treatment; c) the presence of allergic reaction to the DT application; d) unavailability of schedules to carry out all stages of evaluation and intervention; and e) the presence of any other reason that leads to withdrawing the informed consent.

The study's sample was randomly divided into two groups: Kinesio Group (KG, n = 17) and Dynamic Group (DG, n = 16). The KG participants were submitted to the DT application on the GM muscle that adhered to the KT stretching method (Miller et al., 2013). The DG participants were submitted to the DT application on GM muscle that adhered to the DT stretching method (McNeill and Pedersen 2016). The participants were blinded to the characteristics of the group to which they were assigned. As seen in Fig. 1, there was no sample loss in the present study.

The KG and DG participants underwent the evaluations with and without the presence of bandages. Both evaluations were carried out on the same day, in a random order defined by a simple draw. The participants rested for 30 min after the first evaluation, and then they repeated the entire procedure.

2.1. Procedures

DT was applied by the same researcher with the purpose of increasing GM muscle activation. For the KG participants, the application procedure used two bandage strips. With the participant in lateral decubitus, with the lower limb in the neutral position, the investigator applied the first third (base) of the posterior band to the region of the posterior superior iliac spine, without tension, in order to provide an anchor that did not cross the target tissue (Miller et al., 2013). The participant then flexed and actively adducted her hip to allow for application of the middle third of the posterior band, with approximately 50% of tension to be applied to the greater trochanter of the femur. Finally, the participant returned to the neutral hip position to apply the final third of the posterior band, without tension, to the greater trochanter region. The same procedure was used to apply the anterior band of the bandage (second strip), starting from the anterior superior iliac spine and ending in the region of the greater trochanter of the femur (Miller et al., 2013).

For the DG participants, the application procedure was performed with the individual in the same position previously described for the KG participants, but maintaining the maximum abduction position of the hip throughout the placement of the bandage, with the target muscle in the shortening position. According to the manufacturer's recommendations, the bandage was applied with a light stretching tension throughout its length (McNeill and Pedersen 2016), as seen in Fig. 2.

2.2. Electromyographic assessment

A surface electromyographic (EMG) assessment of the GM muscle was conducted during rest, at maximal voluntary isometric contraction (MVIC), and during three functional tasks (described later). The EMG data were obtained using an EMG-8000C electromyography (EMG System do Brazil, São José dos Campos, Brazil).

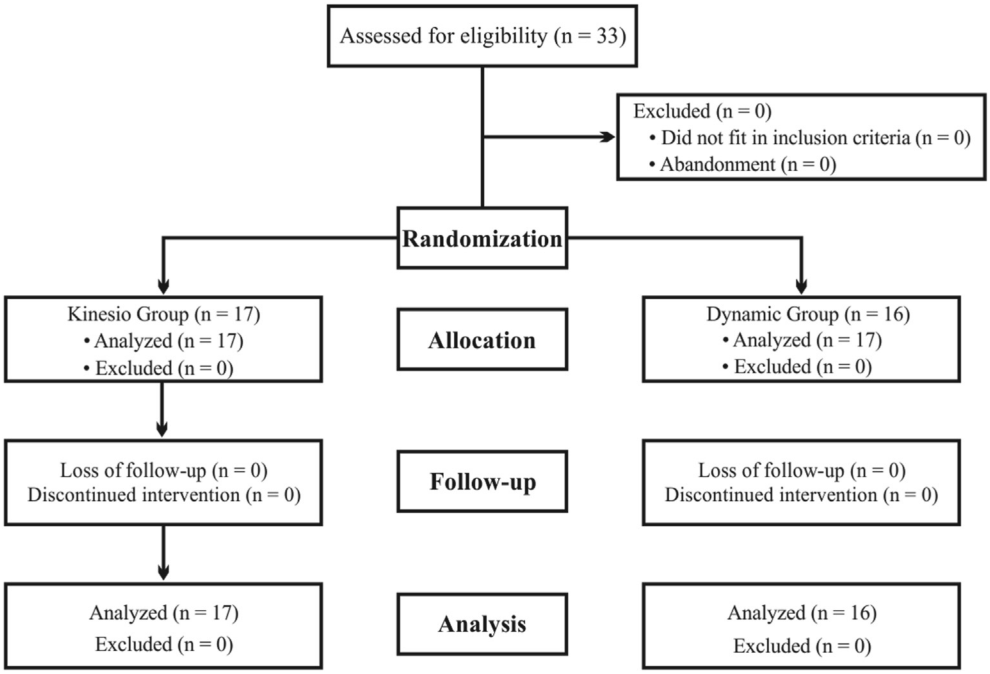

Fig. 1. Study flow diagram.

The signal acquisition mode was calibrated at a sampling frequency of 2000 Hz. The EMG system had a common mode rejection >100 dB, an input impedance of 1 MΩ, and gain set to 1000. The electrodes used to obtain the EMG data were 2-cm round Ag/AgCl with an inter-electrode distance of 2 cm. The electrodes were adhered to the dominant limb following the SENIAM guidelines. To reduce signal noise, the ground electrode was placed on the lateral malleolus (Hermens et al., 2000).

Initially, all the participants underwent an EMG assessment in the resting condition to verify the basal state of muscle activation in a supine position. Next, MVIC data were collected during the manual muscle strength test with the participants in a side-lying position with 20° of hip abduction in the dominant limb. Three EMG signals were acquired during the MVIC test for each participant. Each maximum contraction was performed for 5 s, with a 30-s interval between contractions.

Fig. 2. Application of Dynamic Tape™ in gluteus medius muscle (DG).

The following functional tasks were chosen for the dynamic EMG evaluation: the single-leg squat task, the drop landing task, and the jump landing + maximum vertical jump task, according to previous descriptions (Baldon et al., 2012; Boling and Padua 2013; Homan et al., 2013). For all of the tests, the participants completed three valid task attempts. A 30-s rest interval was provided between each attempt.

In the single leg squat task, the participants remained in unipodal support, with the contralateral limb without ground support and with the upper limbs crossed in front of the chest (Baldon et al., 2012). The participants then performed a single leg squat until they reached approximately 75° of knee flexion (target angle), after which they returned to the initial position. The time of execution of the single leg squat was standardized as 2.00 ± 0.30 s, which was controlled using a digital chronometer.

For the drop landing task, the participants remained in bipodal support on a 30 cm high platform, with their feet apart at shoulder width and with their upper limbs hanging at their sides. They then stepped anteriorly with the non-dominant lower limb (dominant limb remained in support) and landed in bipodal support on a mark that was 30 cm from the platform (Munro et al., 2012).

For the jump landing + maximum vertical jump task execution, the participants were placed in bipodal support on the same platform that was used in the drop landing task. The participants jumped from the platform in the anterior direction in order to reach a mark distant to 50% of their height from the platform; they then executed a maximum vertical jump (Boling and Padua 2013; Homan et al., 2013).

Raw data were smoothed with EMGLab software (EMG System do Brazil, São José dos Campos, Brazil), using a high pass and a low pass Butterworth digital filter with a cut-off frequency of 20 Hz and 500 Hz, respectively; a notch filter (60 Hz) was used to control electrical interferences. To analyze the muscle activation, Root Mean Square (RMS) and peak of muscle activation data were processed, excluding the first and last seconds of contraction, totaling 3 s. EMG data were normalized to MVIC.

2.3. Functional performance evaluation

The functional performance evaluation was conducted during two functional tests: the triple hop test and the 6-m timed hop test, which measure agility, strength, and functional stability. Before performing the functional tests, the participants underwent a warm-up on a treadmill for 5 min at 5.0 km/h, as well as stretching of the quadriceps, hamstrings, and triceps surae muscles for 30-s in three sets for each muscle group (Baldon et al., 2012).

To measure the performance in the triple hop test, each participant started the test with simple support on the dominant limb, with the foot immediately behind the starting line. The participants performed three consecutive maximum jumps with the dominant limb, and they maintained their balance on the last landing for at least 2 s before placing their contralateral limb on the ground (Baldon et al., 2012).

For the 6-m timed hop test, each participant started the test with support on the dominant limb, with the foot immediately behind the starting line. The participants performed consecutive jumps toward the defined distance (6 m), as quickly as possible, and they crossed the finish line without decelerating at any time during the test (Baldon et al., 2012).

The upper limbs were positioned behind the body to avoid any balancing contribution during the activity, increasing functional demand in the lower limb (Baldon et al., 2012). Three valid attempts were performed for each test. The average distance obtained during the triple hop test (m) and the mean time obtained in the 6-m timed hop test (s) were used for the statistical analyses.

The EMG electrodes were kept in the same place during the rest period in order to guarantee that the second evaluation used the same positioning that was used in the initial evaluation.

2.4. Statistical analyses

All statistical analyses were performed using SPSS software (v. 20.0, IBM, New York, NY, USA). The normality and homoscedasticity of the data were analyzed using the Shapiro-Wilk W test and Levene's tests, respectively. Anthropometric and demographic data were compared using the Student's t-test for independent samples. To analyze the parametric data, Student's t-test for dependent samples was used to verify the effects of DT application (pre- and post-application) in each group. To analyze the non-parametric data, the Wilcoxon signed-rank test was used for intragroup comparisons. Delta values (Δ) were obtained in each group, demonstrating the effect of each intervention. The comparisons between the effects of the interventions (intergroup analysis) were obtained using the Mann-Whitney *U* test. A preset alpha level of 0.05 was used for all of the statistical tests.

3. Results

The anthropometric characteristics between groups were similar for all of the variables, indicating that the samples are comparable (Table 1).

Table 1
Means and standard deviations for demographic and anthropometric data between groups.

	KG (n = 17)	DG (n = 16)	*p*-value
Age (years)	22.05 ± 2.86	23.56 ± 2.65	.130
Body mass (Kg)	60.60 ± 8.73	58.28 ± 6.70	.320
Height (m)	1.64 ± 0.04	1.62 ± 0.04	.400
BMI (Kg/m^2)	22.49 ± 2.65	20.89 ± 1.48	.340

KG – DT application that adhered to the stretching method for KT.
DG – DT application that adhered to the stretching method suggested for DT.
BMI – Body mass index.

In the intragroup analyses (the differences between the pre- and post-DT application), no significant differences were observed in GM activation (Table 2) or functional performance (Table 3), regardless of the DT stretching technique.

In the intergroup analyses (differences between Δ), no significant differences were found between the two forms of DT application in relation to EMG data (Table 2) and functional performance (Table 3).

4. Discussion

Functional bandages have long been used to reduce joint instability, minimize pain, increase muscle electrical activity (Maguire et al., 2010) and strengthen weakened muscles (Christou 2004). In the latter case, this outcome is theoretically supported by the concentric traction mechanism between the superficial fascia and the subcutaneous tissues promoted by the use of these bandages (Fukui et al., 2017). However, other studies note that functional bandages are not able to increase muscle activation (Lins et al., 2016; Ng and Wong 2009) or improve muscle strength (Fu et al., 2008; Serra et al., 2015; Wong et al., 2012) thus, the effects of bandage use are still questionable and should be better elucidated.

Contrary to the initial hypothesis and some of the findings reported in the aforementioned studies, the present study found that there was no increase in the EMG activation of the GM after DT use, regardless of the stretching technique. Indirectly, these findings contradict those of Maguire et al. (2010) and Miller et al. (2013), that have investigated the application of functional bandages on the GM. Those studies verified an increase in the EMG activity after KT application in individuals with stroke and in people with PFPS, respectively. Possible explanations for the results may be related to the methodological differences between the studies in relation to the sample profile (healthy participants or those with dysfunction), the method of applying the bandage and the type of bandage used (different between the studies).

Although it is not possible to state which of these factors is more important in explaining the differences in the results between the studies, the sample profile seems to be especially significant. In this sense, we highlight the findings of a recent study (Hosp et al., 2017), noting that the application of KT on knees attenuates the effects of exercise-induced fatigue on balance in healthy adults, and that this effect was more pronounced in individuals whose baseline measurement scores were low.

Another study (Zulfikri and Justine, 2017) points out that the KT application in rectus femoris, biceps femoris, and medial gastrocnemius muscles can inhibit the effects of fatigue and preserve the performance in lateral and posterior directions during the Star Excursion Balance Test. Thus, it is possible that functional bandages may present more pronounced neuromuscular effects in situations of greater impairment of muscle activation and, in theory, lower functional performance, such as is expected in neurological conditions or in fatigue situations (which were not evaluated in the present study).

In the present study, the values obtained in the functional performance tests did not change after DT use, regardless of the stretching method that was applied. These findings are indirectly in agreement with the study by Wilson et al. (2016), who did not find any improvement of balance and functional performance after KT application in the gastrocnemius muscle. Our findings are also supported by the results of Lins et al. (2016), who concluded that KT does not promote immediate or delayed effects on the performance of quadriceps in healthy women.

In time, despite the absence of statistical support, we noted a discrete increase in functional performance in the triple hop test, as

Table 2
Means and standard deviations for electromyographic activity of gluteus medius muscle pre- and post- DT application and Δ values.

	KG pre- (RMS μV)	KG post- (RMS μV)	Δ KG	DG pre- (RMS μV)	DG post- (RMS μV)	Δ DG	p-value Δ
Rest	2.03 ± 1.00	2.01 ± 0.87	−0.02 ± 0.92	2.15 ± 0.96	2.16 ± 0.96	0.01 ± 1.28	.630
Single-leg squat	32.01 ± 8.45	32.97 ± 10.10	0.96 ± 5.69	34.70 ± 12.08	34.91 ± 11.50	0.21 ± 2.45	.400
Drop landing	26.22 ± 12.30	29.04 ± 13.71	2.82 ± 5.36	24.74 ± 12.36	25.30 ± 13.43	0.56 ± 4.60	.400
Jump landing + MVJ	40.97 ± 17.92	42.97 ± 19.69	2.00 ± 9.32	33.49 ± 8.33	37.35 ± 12.79	3.86 ± 7.78	.330

KG – DT application that adhered to the stretching method for KT.
DG – DT application that adhered to the stretching method suggested for DT.
MVJ – maximum vertical jump.
Δ = difference between post-values and pre-values.

Table 3
Means and standard deviations for functional performance tests pre- and post- DT application and Δ values.

	KG pre-	KG post-	Δ KG	DG pre-	DG post-	Δ DG	p-value Δ
Triple hop test (m)	2.70 ± 0.38	2.73 ± 0.32	0.03 ± 0.35	2.64 ± 0.58	2.68 ± 0.49	0.04 ± 0.37	.910
Six-meter timed hop test (s)	3.33 ± 0.57	3.26 ± 0.56	−0.07 ± 0.34	3.36 ± 0.69	3.19 ± 0.38	−0.17 ± 0.43	.610

KG – DT application that adhered to the stretching method for KT.
DG – DT application that adhered to the stretching method suggested for DT.
Δ = difference between post-values and pre-values.

indicated by the Δ values, for both groups. Despite the possibility of a learning effect during the test/retest procedure, considering the care taken in relation to the familiarization procedures, as well as the randomization of the evaluation order (with and without the bandage), it is believed that this bias was reduced.

In this sense, we hypothesized that the DT bandage may have been able to promote better hip stabilization in unipodal support (even without increasing hip abduction EMG activity) during the jump performance, thereby optimizing the efficiency of the lower limb extensor muscles (especially of the quadriceps, gluteus maximus, and triceps surae muscles) in generate maximum horizontal impulsion. DT presents a recoil effect that allows a role on mechanical and deceleration, load absorption and assistance of movement (McNeill and Pedersen 2016). Therefore, we hypothesized that DT was able to assist the GM muscle to resist the hip adduction and medial rotation, as well as the pelvic contralateral drop, while maintaining a better balance, dynamic position and lower limb control. Furthermore, the DT application was only performed for the GM, even though other muscle groups are also involved in these activities (Lins et al., 2016). Thus, the application of the bandage in only one muscle may have been insufficient to significantly improve performance, perhaps requiring other, more functional forms of application (for example, using the DT applied to cross one or more joints to have a better purchase on lever arms), which will be considered in future studies.

Based on the study's results, we can state that the two forms of DT stretching that were used did not increase activation of the GM muscle and did not significantly improve functional performance in comparison to the baseline values. In addition, no differentiated effects were observed between the stretching methods (KT or DT) that were used. Thus, we can suggest that the application method used does not interfere with the activation of the GM muscle. These findings are in line with the review by Reneker et al. (2018), where the authors concluded that the application technique is unlikely to have any influence on the response obtained.

5. Conclusion

The use of DT did not increase GM activation in functional activities, and it did not improve the functional performance of the lower limb in healthy, recreationally active women, in any form of application used. Additional research is needed to better investigate the effect of functional bandages on muscle facilitation, considering more functional forms of DT application.

5.1. Clinical relevance

- The GM muscle activation was not facilitated by DT functional bandage.
- The hopping performance was not optimized by DT functional bandage.
- The stretch form used in the DT application did not produce differentiated effects.
- Clinicians should not consider using DT application in GM muscle when the objectives are exclusively to increase muscle activation or functional performance in recreationally active women.

CRediT authorship contribution statement

Roberta O. Silva: Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Filipe R. Carlos:** Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Melina C. Morales:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **Vanessa de S. Emerick:** Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Ana I. Teruyu:** Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Victória M.A. Valadão:** Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Leonardo C. Carvalho:** Data curation, Formal analysis, Investigation, Methodology, Software, Writing - review & editing. **Daniel F.M. Lobato:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors have not conflicts of interest to report.

Acknowledgements

This project was financially supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (Financial Code - 001), the Conselho Nacional de Desenvolvimento Científico e Tecnológico – Brazil (scholarship), the Fundação de Amparo à Pesquisa do Estado de Minas Gerais – Brazil (scholarship and financing – APQ-02141-15) and Federal University of Triangulo Mineiro – Brazil (grant).

References

Baldon, R.D.M., Lobato, D.F.M., Carvalho, L.P., Wun, P.Y.L., Santiago, P.R.P., Serrão, F.V., 2012. Effect of functional stabilization training on lower limb biomechanics in women. Med. Sci. Sports Exerc. 44, 135–145.

Boling, M., Padua, D., 2013. Relationship between hip strength and trunk, hip, and knee kinematics during a jump-landing task in individuals with patellofemoral pain. The International Journal of Sports Physical Therapy 8, 661–669.

Castro-Sánchez, A.M., Lara-Palomo, I.C., Matarán-Peñarrocha, G.A., Fernández-Sánchez, M., Sánchez-Labraca, N., Arroyo-Morales, M., 2012. Kinesio Taping reduces disability and pain slightly in chronic non-specific low back pain: a randomised trial. J. Physiother. 58, 89–95. https://doi.org/10.1016/S1836-9553(12)70088-7.

Chappell, J.D., Yu, B., Kirkendall, D.T., Garrett, W.E., 2002. A comparison of knee kinetics between male and female recreational athletes in stop-jump tasks. Am. J. Sports Med. 30, 261–267. https://doi.org/10.1177/03635465020300021901.

Christou, E.A., 2004. Patellar taping increases vastus medialis oblique activity in the presence of patellofemoral pain. J. Electromyogr. Kinesiol. 14, 495–504. https://doi.org/10.1016/j.jelekin.2003.10.007.

Fu, T.C., Wong, A.M.K., Pei, Y.C., Wu, K.P., Chou, S.W., Lin, Y.C., 2008. Effect of Kinesio taping on muscle strength in athletes-A pilot study. J. Sci. Med. Sport 11, 198–201. https://doi.org/10.1016/j.jsams.2007.02.011.

Fukui, T., Otake, Y., Kondo, T., 2017. The effects of new taping methods for increasing the muscle strength. J. Phys. Ther. Sci. 29, 70–74. https://doi.org/10.1589/jpts.29.70.

Hermens, H.J., Freriks, B., Sisselhorst-Klug, C., Rau, G., 2000. Development of recommendations for SEMG sensors and sensor placement procedures. J. Electromyogr. Kinesiol. 10, 361–374. https://doi.org/10.1016/S1050-6411(00)00027-4.

Homan, K.J., Norcross, M.F., Goerger, B.M., Prentice, W.E., Blackburn, J.T., 2013. The influence of hip strength on gluteal activity and lower extremity kinematics. J. Electromyogr. Kinesiol. 23, 411–415. https://doi.org/10.1016/j.jelekin.2012.11.009.

Hosp, S., Folie, R., Csapo, R., Hasler, M., Nachbauer, W., 2017. Eccentric exercise, kinesiology tape, and balance in healthy men. J. Athl. Train. 52, 636–642. https://doi.org/10.4085/1062-6050-52.3.11.

Kim, B.J., Lee, J.H., Kim, C.T., Lee, S.M., 2015. Effects of ankle balance taping with kinesiology tape for a patient with chronic ankle instability. J. Phys. Ther. Sci. 27, 2405–2406. https://doi.org/10.1589/jpts.27.2405.

Lins, C.A.A., Neto, F.L., Amorim, A.B.C., Macedo, L.B., Brasileiro, J.S., 2013. Kinesio Taping® does not alter neuromuscular performance of femoral quadriceps or lower limb function in healthy subjects: randomized, blind, controlled, clinical trial. Man. Ther. 18, 41–45. https://doi.org/10.1016/j.math.2012.06.009.

Lins, C.A.A., Borges, D.T., Macedo, L.B., Costa, K.S.A., Brasileiro, J.S., 2016. Delayed effect of Kinesio Taping on neuromuscular performance, balance, and lower limb function in healthy individuals: a randomized controlled trial. Braz. J. Phys. Ther. 20, 231–239. https://doi.org/10.1590/bjpt-rbf.2014.0161.

MacGregor, K., Gerlach, S., Mellor, R., Hodges, P.W., 2005. Cutaneous stimulation from patella tape causes a differential increase in vasti muscle activity in people with patellofemoral pain. J. Orthop. Res. 23, 351–358. https://doi.org/10.1016/j.orthres.2004.07.006.

Maguire, C., Sieben, J.M., Frank, M., Romkes, J., 2010. Hip abductor control in walking following stroke - the immediate effect of canes, taping and TheraTogs on gait. Clin. Rehabil. 24, 37–45. https://doi.org/10.1177/0269215509342335.

McNeill, W., Pedersen, C., 2016. Dynamic tape. Is it all about controlling load? J. Bodyw. Mov. Ther. 20, 179–188. https://doi.org/10.1016/j.jbmt.2015.12.009.

Miller, J., Westrick, R., Diebal, A., Marks, C., Gerber, J.P., 2013. Immediate effects of lumbopelvic manipulation and lateral gluteal Kinesio taping on unilateral patellofemoral pain syndrome: a pilot study. Sport Health 5, 214–219. https://doi.org/10.1177/1941738112473561.

Munro, A., Herrington, L., Comfort, P., 2012. Comparison of landing knee valgus angle between female basketball and football athletes: possible implications for anterior cruciate ligament and patellofemoral joint injury rates. Phys. Ther. Sport 13, 259–264. https://doi.org/10.1016/j.ptsp.2012.01.005.

Myer, G.D., Ford, K.R., McLean, S.G., Hewett, T.E., 2006. The effects of plyometric versus dynamic stabilization and balance training on lower extremity biomechanics. Am. J. Sports Med. 34, 445–455. https://doi.org/10.1177/0363546505281241.

Ng, G.Y.F., Wong, P.Y.K., 2009. Patellar taping affects vastus medialis obliquus activation in subjects with patellofemoral pain before and after quadriceps muscle fatigue. Clin. Rehabil. 23, 705–713. https://doi.org/10.1177/0269215509334835.

Reneker, J.C., Latham, L., McGlawn, R., Reneker, M.R., 2018. Effectiveness of kinesiology tape on sports performance abilities in athletes: a systematic review. Phys. Ther. Sport 31, 83–98. https://doi.org/10.1016/j.ptsp.2017.10.001.

Rozzi, S.L., Lephart, S.M., Sterner, R., Kuligowski, L., 1999. Balance training for persons with functionally unstable ankles. J. Orthop. Sports Phys. Ther. 29, 478–486. https://doi.org/10.2519/jospt.1999.29.8.478.

Serra, M.V.G.B., Vieira, E.R., Brunt, D., Goethel, M.F., Gonçalves, M., Quemelo, P.R.V., 2015. Kinesio taping effects on knee extension force among soccer players. Braz. J. Phys. Ther. 19, 152–158. https://doi.org/10.1590/bjpt-rbf.2014.0075.

Taylor, R.L., O'Brien, L., Brown, T., 2014. A scoping review of the use of elastic therapeutic tape for neck or upper extremity conditions. J. Hand Ther. 27, 235–246. https://doi.org/10.1016/j.jht.2014.03.004.

Ward, J., Sorrels, K., Coats, J., Pourmoghaddam, A., Moskop, J.A., Ueckert, K., Glass, A., 2014. The ergogenic effect of elastic therapeutic tape on stride and step length in fatigued runners. Journal of Chiropractic Medicine 13, 221–229. https://doi.org/10.1016/j.jcm.2014.09.003.

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 Med. 42, 153–164. https://doi.org/10.2165/11594960-000000000-00000.

Wilson, V., Douris, P., Fukuroku, T., Kuzniewski, M., Dias, J., Figueiredo, P., 2016. The immediate and long-term effects of Kinesiotape® on balance and functional performance. The International Journal of Sports Physical Therapy 11, 247–253.

Wong, O.M.H., Cheung, R.T.H., Li, R.C.T., 2012. Isokinetic knee function in healthy subjects with and without Kinesio taping. Phys. Ther. Sport 13, 255–258. https://doi.org/10.1016/j.ptsp.2012.01.004.

Zübeyir, S., Nilüfer, K., Burcu, C., Onur, A., Bahar, K., Ufuk, Y.S., Gülden, P.M., 2012. The effect of kinesiology taping on respiratory muscle strength. J. Phys. Ther. Sci. 24, 241–244. https://doi.org/10.1589/jpts.24.241.

Zulfikri, N., Justine, M., 2017. Effects of Kinesio® taping on dynamic balance following fatigue: a randomized controlled trial. Physical Therapy Research 20, 16–22. https://doi.org/10.1298/ptr.e9887.