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Effect of kinesiotaping on subtalar evertor and invertor muscle strength in healthy individuals

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Abstract

Introduction. To date, no study has examined the effect of ankle kinesiotaping on eccentric versus concentric subtalar evertor and invertor strength nor compared its effect between evertors and invertors. This study examined the effect of kinesiotaping on peak subtalar evertor and invertor eccentric and concentric torques assessed at 120°/sec. Eccentric versus concentric torque in both muscle groups as well as evertor versus invertor torque at both modes of muscle contraction were examined.
Methods. A group of 30 healthy individuals (24 males and 6 females) with mean age 21 ± 2.73 years, height 1.73 ± 0.08 m, and weight 75 ± 6.20 kg were tested. They were randomly tested with kinesio tape use and without. The kinesio tape was applied on the tibialis anterior, tibialis posterior, peroneus longus and peroneus brevis muscles. The peak torques were assessed using a Biodex isokinetic dynamometer.
Results. 2×2×2 Repeated Measures ANOVA revealed that the peak torque was significantly higher with kinesio tape use compared with no tape for both eccentric and concentric evertors, and eccentric invertors ($p \leq 0.009$). The eccentric peak torque was significantly higher than the concentric for both evertors and invertors with kinesio tape use, and evertors with no tape ($p \leq 0.001$). Finally, the invertor concentric torque was significantly higher than the evertor torque with no tape use ($p < 0.001$).
Conclusions. Ankle kinesiotaping improves both evertor and invertor torques, with the eccentric torque being significantly improved compared with the concentric. No significant effect on evertors versus invertors was found. This suggests kinesio tape use for managing musculoskeletal disorders caused by impaired subtalar muscle strength as lateral ankle sprains.
Key words: ankle, isokinetic, strength, subtalar, taping

Introduction

Taping has recently attracted attention as a popular means of rehabilitation and/or performance enhancement in sport. Depending on the technique used, it helps in movement facilitation, movement restriction, and/or joint stabilisation [1]. Two types of taping techniques are normally used: elastic and non-elastic.

Kinesio Tape (KT), is a well-known form of elastic tape that can be stretched up to 60% of its initial length [2]. Its popularity and widespread use increased with its use by many professional athletes at the 2008 Olympic Games [3]. Unlike-conventional athletic tape, KT has the privilege of being elastic, thereby providing less muscular and blood flow restriction. In addition, it limits the amount of skin irritation that often occurs with conventional athletic tape use. This is because it is latex-free; it uses heat-activated adhesion to adhere to the skin [2].

In addition to being superior to the conventional athletic tape, KT has emerged as an option for treating athletic injuries over the past two decades. Murray [4] stated that KT has a facilitatory effect on cutaneous mechanoreceptors. The increased cutaneous feedback enhances proprioception and facilitates motor function [5]. It reduces congestion by improving blood and lymphatic fluid flow. It reduces pain by stimulating the neurological system. Finally, it helps in correcting mal-aligned joints by reducing muscle spasm [2].

Strong and efficient ankle and foot muscles function to correct abnormal alignment, control joint motion, maintain stability, and absorb shocks [6]. The latter reported that with inefficient muscles, ankle and foot mal-alignment causes muscle fatigue, with additional stresses being imposed on the supportive connective tissue. Consequently, excessive kinematic compensatory movements can occur, which may be accompanied by pain and/or muscle spasms.

Lateral ankle sprain is one of the clinical conditions that is caused by inefficient, weak muscles that cannot control segment mal-alignment. Normally, the evertors contract eccentrically to counteract the external inversion torque. When the evertors are weak, the foot goes into excessive inversion, thus imposing excessive stresses on the lateral ligaments, especially the anterior talo-fibular ligament, which may be torn if these stresses exceed its ultimate strength [7].

Many studies were conducted on ankle/subtalar joint muscle function in patients with ankle instability, with a diversity of findings being reported. Researchers reported deficits in eccentric inversion [8–10], eccentric eversion [8, 9], and concentric eversion [11] torques.

In an attempt to explore the facilitatory/inhibitory effect of KT on muscle function, many studies were conducted, with contradictory findings being reported. Many researchers found no significant effect of KT on peak isokinetic muscle torques [12, 13]. However, others found that KT increased the peak torques significantly [14–16]. Regardless of the lack of consensus on the effect of KT on muscle strength, it should be noted that all these studies were not conducted on subtalar muscles.

The studies that addressed the ankle joint with KT use were limited to examining ankle proprioception [17], myoelectric activity of the triceps surae during maximal vertical

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jump [18], and functional performance in athletes with ankle sprain [19] in addition to one study that examined ankle plantarplantar flexor and dorsiflexor strength [20]. To date, it appears that no study examined the effect of KT on subtalar joint muscle strength except that conducted by Aly et al. [21]. Studying the effect of KT on subtalar evertor and invertor strength may help manage ankle instability, in which these muscles are affected most. Diminished peroneal muscle strength, specifically, has been theorised to cause impaired dynamic stability with consequent functional ankle instability [22]. Although Aly et al. [21] were the first to examine the effect of KT on evertor and invertor strength, they did not examine its effect on eccentric versus concentric contraction, nor did they compare its effect between the evertors and invertors. So, this study was conducted to examine the effect of KT on peak subtalar evertor and invertor isokinetic torques, measured both concentrically and eccentrically at 120°/s. Its effect on eccentric versus concentric torque in both muscle groups and its effect on evertor versus invertor strength at both modes of muscle contraction were examined. We hypothesised that KT use will have no effect on peak torques compared with no tape, no effect on the mode of muscle contraction (eccentric versus concentric), and no effect on the muscle group (evertors versus invertors).

Subjects and methods

The study was conducted at the Isokinetic Laboratory, Faculty of Physical Therapy, Cairo University. An announcement was made for the college students and the study was conducted on a voluntary basis. About 45 volunteered to participate, of which 30 students only (24 males and 6 females) met the inclusion and exclusion criteria and completed the whole study testing. Their age, weight, and height ranged from 18–25 years, 65–85 kg, and 1.6–1.8 m, respectively. They had no history of any previous or current ankle injury, deformity, or surgery. They were checked for any ligamentous laxityor joint motion limitation. They declared experiencing no episodes of pain at the time of the study and/or one year prior to participation in the study. All participants had at least grade four evertor and invertor muscle strength (assessed manually). Individuals with any neurological deficits were excluded from the study. Participants should not have been involved in any form of training at the time of the study. The procedures of this study were approved by the Institutional Ethical Review Board.

The Biodex System 3 multi-joint testing and rehabilitation system (Biodex Medical System, Shirley, NY, USA) was used to assess the peak subtalar invertor and evertor isokinetic torques with KT use and with no tape. The torques were assessed at two contraction modes: eccentric and concentric at 120°/s. A 2-inch Kinesio tape Gold® was used for ankle taping. Three colours of tape were used: dark pink for the tibialis posterior, light blue for the peroneus longus and brevis, and black for the tibialis anterior. Different colours were used to facilitate muscle identification (Figure 1).

Upon arrival at the laboratory, a brief orientation session about the study, its procedures, aim and significance was provided for each participant. Once each participant agreed to participate voluntarily, a consent form was filled in. The specified inclusion and exclusion criteria were verified by the same examiner for all participants. Participants were tested under both conditions (KT use and no tape) in a random order. Prior to tape application, the participant's skin was shaved and cleaned thoroughly using alcohol to remove any form of oils. Oils interfere with the ability of tape to adhere to the skin, which may affect the duration of tape application together with its mechanical effectiveness [2]. Tape application was carried out, by an experienced physiotherapist, in accordance with KenzoKase's Kinesio taping Manual.

With the aim of muscle facilitation, the muscles on which the tape was applied were initially stretched. Then, a Kinesio 'I'' strip was applied, starting from the origin to the insertion of the examined muscles (tibialis anterior, tibialis posterior, peroneus longus and peroneus brevis). This application increases the muscle contraction force and improves muscle strength [2]. The KT was applied 20 minutes prior to testing to allow the adhesive material to become fully activated. This 20-minute rest period before testing was also needed to avoid tape loosening.

For isokinetic testing, the participant was allowed to sit on the adjustable seat of the Biodex isokinetic dynamometer system with the seat back tilted 70°. The limb support pad was adjusted on the side to be tested and a pad was placed under the distal aspect of the thigh of the tested limb and secured with a strap. The knee of the tested limb was positioned in 80°–110° flexion, with the participant's leg kept parallel to the ground. This position was described by the Biodex isokinetic manual for ankle/subtalar joint isokinetic muscle testing. The tested dominant foot was securely placed in the inversion/eversion footplate attachment. A pair of shoulder straps was then placed around the chest to secure the trunk.

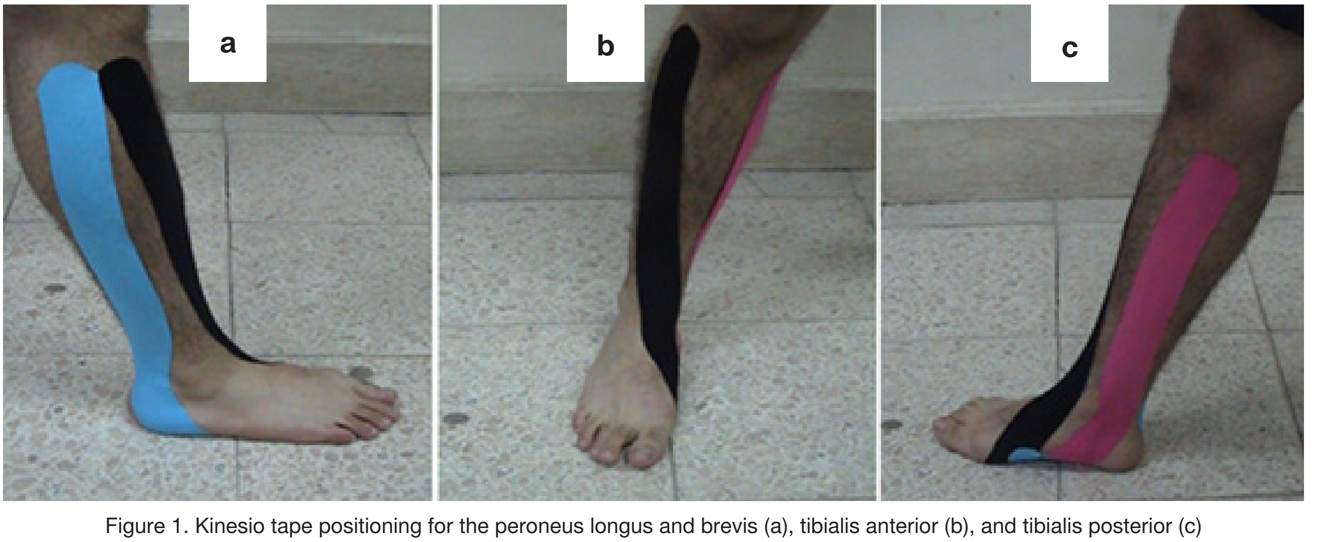

Figure 1. Kinesio tape positioning for the peroneus longus and brevis (a), tibialis anterior (b), and tibialis posterior (c)

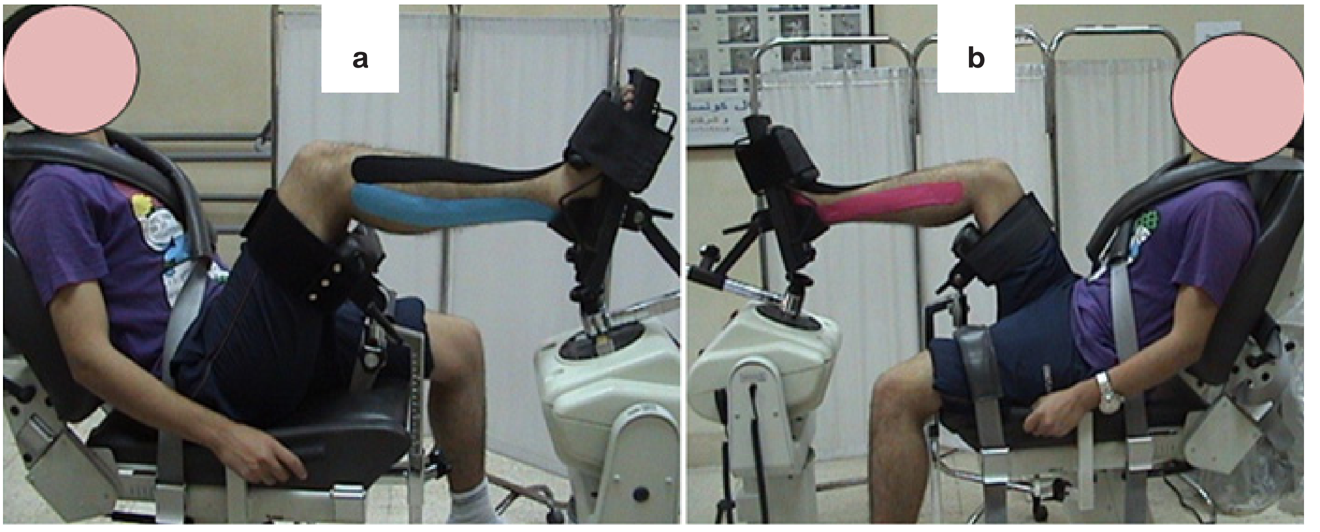

Figure 2. Isokinetic testing of subtalar evertors (a), and invertors (b)

The untested lower limb was placed in a rest position and secured by a strap. The participant was asked to grip the stabilisation handles on either side of the chair for extra support (Figure 2).

To become familiar with isokinetic testing and reduce the practice effect during actual isokinetic testing, each participant performed one practice series of three sub-maximal repetitions of subtalar eversion and inversion. Then, each participant performed warm-up exercises before being isokinetically tested. These warm-up exercises involved five minutes of stationary bicycling followed by flexibility exercises for subtalar eversion/inversion and ankle dorsiflexion/plantar flexion. A 1-minute rest period was then provided before actual testing. Three trials of isokinetic testing were then recorded, with each trial involving five repetitions.

Subtalar invertor isokinetic torque was tested first, followed by subtalar evertor torque. Initially, each participant performed five repetitions of subtalar inversion in the eccentric/concentric mode. The staring position was maximum subtalar inversion, then the foot moved towards maximum eversion by eccentric contraction of the invertors and returned to the starting position using concentric contraction of the invertors. This was followed by a 2-min rest period prior to subtalar evertor isokinetic testing. Subtalar evertor testing followed the same procedure as that used for invertor testing, but in the opposite direction. The staring position was subtalar eversion, then the foot moved towards inversion by eccentric contraction of the evertors and returned to the starting position using concentric contraction of the evertors. The dynamometer axis was aligned in line with the axis of the ankle joint. Verbal encouragement was given repetitively during testing to maximise the participant's effort.

The eccentric/concentric mode of isokinetic testing was selected because this mode was found to provide a more functional testing compared with isolated eccentric or concentric modes [23]. This stretch-shortening cycle 'SSC' when tested using an isokinetic dynamometer provides a better reflection of how each muscle group performs during functional activities [23], as these activities (as walking or running) involve a continuous series of SSC. In addition, it was found that a concentric contraction that is preceded by an eccentric one produces average torques that are 100% greater than concentric contractions that are done in isolation [24].

Data analysis

Initially, and prior to data analysis, the data were screened and the outliers were removed, assuring that the normality assumption was not violated. Hence, three-way repeated measures ANOVA (2×2×2 Repeated Measures ANOVA) was conducted with the alpha level set at 0.05. To determine the source of statistical significance, subsequent multiple pairwise comparison tests with Bonferroni adjustment of the alpha level were conducted. Three independent variables were tested; two conditions of tape use (KT use vs no tape), mode of muscle contraction (eccentric vs concentric), and muscle group (evertors vs invertors). One dependent variable was tested: peak muscle torque. Eccentric and concentric peak torques of each of the evertors and invertors with and without KT use were recorded and used for data analysis. Peak torques were normalised to body weight (Nm/kg).

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Ethical Review Board (decision number: P.T.REC/012/003134).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Regarding the patients' demographic data, the mean ± *SD* age, weight, and height were 21 ± 2.73 years, 75 ± 6.2 kg and 1.73 ± 0.08 m, respectively. The mean ± *SD* values of the peak subtalar invertor and evertor isokinetic torques are presented in Table 1.

The three-way repeated measures ANOVA was significant for the tape ($p < 0.001$), mode ($p < 0.001$), and muscle group ($p = 0.016$) effects. The interactions were also significant; tape*mode ($p = 0.003$), tape*muscle group ($p = 0.02$), mode*muscle group ($p < 0.001$) except for the tape*mode* muscle group interaction, which was not significant ($p = 0.7$). The subsequent multiple pairwise comparison tests, conducted with Bonferroni adjustment of the alpha level, showed that the peak torque was significantly higher with KT use compared with no tape for both eccentric and concentric evertors, and eccentric invertors ($p \leq 0.009$). The eccentric peak torque was significantly higher than the concentric for both evertors and invertors with KT use, and evertors with no tape ($p \leq 0.001$). Finally, the invertor concentric torque was significantly higher than the evertor torque with no tape use ($p < 0.001$, Tables 2–4).

Table 1. Descriptive statistics of the peak subtalar invertor and evertor torques assessed eccentrically and concentrically with and without kinesio tape use at 120°/s

Presence of kinesio tape	Mode of muscle contraction	Muscle group	Peak torques (Nm/kg) Mean ± *SD*
Kinesio tape	Concentric	Evertors	25.26 ± 6.71
		Invertors	27.42 ± 6.57
	Eccentric	Evertors	33.09 ± 9.51
		Invertors	30.63 ± 6.1
No tape	Concentric	Evertors	20.93 ± 5.76
		Invertors	25.72 ± 6.29
	Eccentric	Evertors	24.83 ± 6.58
		Invertors	26.42 ± 7.49

Discussion

Comparing the effect of kinesiotaping on subtalar eccentric versus concentric torque, our findings showed that the peak eccentric torques were significantly higher than the concentric for both evertors and invertors with KT use. This finding was also found with no tape use, however, the increase in the invertor torque with no tape was not statistically significant. As a starter, eccentric muscle contraction is well known to producee greater muscle output than concentric and isometric contractions. The 'cross-bridge' theory [25] has long provided an accepted explanation for the increased force in eccentric contraction as opposed to concentric and isometric ones. This theory states that muscle force is the resultant of multiplying two items; the number of attached cross bridges and the amount of average force per cross bridge. At any given speed of muscle contraction, both items are predicted to be greater in eccentric contraction [26].

A property called residual force enhancement (RFE), which is present in skeletal muscles, can also help explain why the eccentric torques exceeded the concentric ones. RFE refers to the increase in muscle force that follows active muscle stretch 'eccentric contraction' [27]. RFE increases with increasing the stretch magnitude [27, 28] without being dependent on the stretch speed [27]. It occurs due to the presence of elastic structural elements within the skeletal muscles. These

Table 2. Multiple pairwise comparison tests of concentric versus eccentric subtalar evertor and invertor torques with and without kinesio tape use assessed at 120°/s

Kinesio tape use	Muscle	Mode (I)	Mode (J)	Mean difference (I–J)	Sig.	95% Confidence interval for difference	
						Lower bound	Upper bound
Kinesio tape	Evertors	Concentric	Eccentric	–7.83	0.000*	–10.04	–5.63
	Invertors	Concentric	Eccentric	–3.21	0.001*	–4.96	–1.46
No tape	Evertors	Concentric	Eccentric	–4.73	0.000*	–5.88	–3.59
	Invertors	Concentric	Eccentric	–0.7	0.34	–2.16	0.77

* significant at $p \leq 0.05$

Table 3. Multiple pairwise comparison tests of kinesio tape versus no tape use for concentric and eccentric subtalar evertor and invertor torques assessed at 120°/sec

Muscle	Mode	Kinesio tape (I)	No tape (J)	Mean difference (I–J)	Sig.	95% Confidence interval for difference		Cohen's *d* effect size
						Lower bound	Upper bound	
Evertors	Concentric	Kinesio tape	No tape	5.16	0.001*	2.43	7.9	0.69
	Eccentric	Kinesio tape	No tape	8.27	0.000*	4.67	11.86	1.01
Invertors	Concentric	Kinesio tape	No tape	1.7	0.11	–0.41	3.81	0.26
	Eccentric	Kinesio tape	No tape	4.21	0.009*	1.12	7.31	0.62

* significant at $p \leq 0.05$

Table 4. Multiple pairwise comparison tests of peak subtalar evertor versus invertor torques assessed eccentrically and concentrically with and without kinesio tape use at 120°/s

Kinesio tape use	Mode	Muscle group (I)	Muscle group (J)	Mean difference (I–J)	Sig.	95% Confidence interval for difference	
						Lower bound	Upper bound
Kinesio tape	Concentric	Evertors	Invertors	–2.17	0.11	–4.86	0.53
	Eccentric	Evertors	Invertors	2.46	0.095	–0.45	5.38
No tape	Concentric	Evertors	Invertors	–5.63	0.000*	–7.52	–3.73
	Eccentric	Evertors	Invertors	–1.59	0.078	–3.37	0.19

* significant at $p \leq 0.05$

elements become involved upon active muscle stretch 'eccentric contraction', producing extra force during and after this stretch.

In 2002, this property was experimentally studied on actively stretched cat soleus muscles, and it was referred to as the ''passive force enhancement'' theory. The researchers, Herzog and Leonard [28], suggested that some of the force produced during active muscle stretch, eccentric contraction, and most of the force that persists after stretch is due to titin engagement; a structural protein found in the sarcomeres. Titin increases muscle force by increasing its own stiffness. Titin stiffness is increased through binding with calcium while being stretched in the presence of calcium and through binding with actin [26].

Comparing the effect of KT use versus no tape on the eccentric torques of the evertors and invertors, it was found that the torques were significantly higher with KT use than with no tape. This may be attributed to the way the KT is applied on the involved muscles. When the KT is applied, it is placed in a somewhat elongated, stretched position. Approximately 40–60% additional tension is applied to the elastic cotton strips of the KT with the target muscle being initially stretched. This passive tension in which the KT material is placed could be considered as additional energy added to the eccentric muscle energy, eliciting improved effort [29].

In 2010, Collado et al. [30] suggested that using the eccentric mode of muscle contraction for evertor muscle reinforcement restores muscle strength in injured evertors following ankle sprain. When they used this mode, they noticed that the evertor strength increased during both concentric and eccentric contractions, showing statistical significance during the concentric contractions. However, when they used the concentric mode for evertor muscle reinforcement, there were significant strength deficits in the rehabilitated injured evertors during both concentric and eccentric contractions. Although Collado et al. [30]did not use KT for muscle reinforcement, it is anticipated that using the eccentric mode for muscle reinforcement in the presence of KT would add to the evertor strength, resulting in better muscle performance. This anticipation is strongly supported by the findings of our study, where the peak torques were significantly increased when the evertors/invertors were tested eccentrically with KT use.

Despite the lack of consensus on invertor muscle involvement in lateral ankle sprain, with many researchers reporting significant reduction in invertor eccentric strength [8, 10, 31], and others not [22], the significant improvement in invertor eccentric torque with KT use reported in our study could provide a beneficial mechanical effect. Normally, invertor eccentric contraction is required to control the lateral displacement of the tibia over the weight-bearing foot. The lack of ability to control this displacement and the resulting excessive postural sway outside the base of support and the consequent rise of the medial border of the foot off the ground upon reaching the end range of closed-chain eversion causes the foot to go into rapid inversion, predisposing it to lateral ankle sprain [31]. Thus, improving invertor eccentric torque with KT use may help reduce sprain incidence.

The beneficial effect of KT use in improving eccentric muscle strength is further approved by the findings reported by Vithoulka et al. [15]. When compared with no tape and placebo tape, KT was able to produce a significant increase in eccentric muscle torque. Again, Vithoulka et al. [15] examined the quadriceps muscles, not subtalar muscles.

Not only did KT use significantly increase the evertor and invertor eccentric torques compared with no tape, it also significantly increased the evertor concentric torque. The invertor concentric torque was also increased; however, the increase was not statistically significant. The direction of KT application may provide an explanation for these findings. Despite the controversial findings reported on the effect of tape application direction (from the origin to insertion or insertion to origin of the underlying muscle) on the amount of change in peak muscle torques [13, 14, 32–34], the application of KT from origin to insertion was suggested to facilitate muscle contraction [34]. Two possible mechanisms of facilitatory muscle action were proposed. The first suggests the transmission of the KT recoiling force (pulling force) to the underlying fascia and muscles [15], this force helps in muscle contraction if both muscle contraction and KT traction power have the same direction of pull, i.e. concentric contraction [35]. The second suggests that the recoiling property of the KT stimulates the cutaneous mechanoreceptors [36], which increases motor unit excitability, thus enhancing a muscle spindle reflex, again, if both muscle contraction and KT have the same direction of pull [2].

Another possible explanation for the increased concentric torques with KT use compared with no tape is the eccentric/concentric testing mode that was used for strength assessment in the current study. As mentioned earlier, when a concentric contraction is preceded by an eccentric one, the produced concentric torque is increased 100% more than if concentric mode was used alone [24]. Using the eccentric/concentric mode in presence of KT, which provides additional elastic tension, is anticipated to augment the tension, and consequently the torque, much more than if it is not used.

As mentioned earlier, Willems et al. [11] found a significant reduction in evertor concentric torque in patients with ankle instability. Since our study reported a significant increase in peak evertor concentric torque with KT use, KT can be used in management of such cases.

As is apparent from our findings, KT was able to improve both concentric and eccentric torques of both evertors and invertors compared with no tape. The improved strength with KT use was also previously attributed to the tactile stimulation produced by its application to the skin. The increased sensory input from the tactile stimulation to the gamma motor neuron weakens the Ia inhibitory afferent stimulation, thus improving muscle contraction [37]. Moreover, it has been suggested that the convolutions created by KT application lift the skin; this fascial unloading decreases the mechanical load [2], thus improving force control.

Looking at the effect sizes of KT use compared with no tape calculated in our study (Table 3), it is apparent that the KT produced a high effect size (= 1.01) for the evertor eccentric torque and a medium effect size for both invertor eccentric (= 0.62) and evertor concentric (= 0.69) torques. This is in line with the statistically significant increase in evertor eccentric, invertor eccentric, and evertor concentric torques with KT use compared with no tape reported herein. This indicates that our statistical significance is also supported by clinical significance. As reported by Barros et al. [38], the ''effect size'' is a measure that involves the concept of clinical significance. This promotes clinical decision-making based on an evidence-based study.

Finally, with the aim of comparing the effect of kinesiotaping on subtalar evertor versus invertor torque in both eccentric and concentric contractions, no significant effect was found. Our findings showed that the concentric torque was significantly higher in the invertors compared with the evertors with no tape use. This might be attributed to different muscle group sizes. The combined physiological cross-sectional area of the invertors (tibialis posterior, tibialis anterior, flexor hallucis longus and flexor digitorum longus) is higher than that of the evertors (peroneus longus, peroneus brevis, peroneus tertius, and extensor digitorum longus), accounting for about 68.07 versus 55.86 cm^2 [39]. A muscle's size is the most important single factor that determines the produced muscle tension [40]. Moreover, the moment arm of the primary subtalar invertor (tibialis posterior) is larger than those of the primary evertors (peroneus longus and brevis) [41].

The increased invertor torque compared with the evertor is consistent with the normative findings reported by Wong et al. [42]. They found that both the absolute and relative peak torques of the invertors were consistently higher than those of the evertors in all tested participants in both males and females on both sides at all tested speeds (30°/s, 60°/s, and 120°/sec).

Our hypothesis is partially rejected, as our findings reported a significant effect of KT compared with no tape on both peak subtalar evertor and invertor concentric and eccentric torques, on the mode of muscle contraction (eccentric versus concentric) in both muscle groups, with no significant effect being found on the tested muscle group (evertors versus invertors). The findings of our study should be considered in light of a few limitations. The studied sample is a relatively young one; accordingly, the findings are to be applied in a similar age range. Our tested individuals were physically inactive; so, the findings should be considered cautiously when being applied to active individuals. Similar future studies examining the subtalar isokinetic muscle performance with KT use are to be conducted on patients with chronic ankle sprain, at different age ranges, and at different levels of physical activity. As opposed to many studies that found no significant changes in muscle strength with KT use in healthy individuals [12, 16], our study reported significant improvement. Accordingly, additional studies are required to elucidate this controversy.

To sum it up, the increase in both concentric and eccentric strength of both subtalar evertors and invertors with KT use reported in our study can help control excessive sudden vigorous foot movements, improve ankle/subtalar joint stability in both closed- and open-chain activities that form basic daily living activities, such as walking, running, and jumping. Thus, the incidence of ankle sprain could be reduced. This beneficial mechanical effect would be of great importance for physically active individuals and athletes, especially when proven to be elicited at a high angular velocity (120°/sec), as reported in our study, which is a basic requirement of efficient athletic performance. Rehabilitation therapists can stress improving both evertor and invertor eccentric and concentric muscle strength using KT, which in turn can help improve dynamic joint stability and reduce injury.

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Conflict of interest

The authors state no conflict of interest.

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References

1. Lees A, Asai T, Andersen TB, Nunome H, Sterzing T. The biomechanics of kicking in soccer: a review. J Sports Sci. 2010;28(8):805–817; doi: 10.1080/02640414.2010.481305.
2. Kase K, Wallis J, Kase T. Clinical Therapeutic Applications of the Kinesio Taping® Method. Tokyo: Ken Ikai; 2003.
3. 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; doi: 10.2165/11594960-000000000-00000.
4. Murray H. Kinesio Taping®, muscle strength and ROM after ACL repair. J Orthop Sports Phys Ther. 2000;30(1):A-14.
5. Osterhues DJ. The use of Kinesio Taping® in the management of traumatic patella dislocation. A case study. Physiother Theory Pract. 2004;20:267–270; doi: 10.1080/09593980490888370.
6. Neumann DADA. Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation. 3rd ed. St. Louis: Mosby, 2016.
7. Kaminski TW, Hartsell HD. Factors contributing to chronic ankle instability: a strength prespective. J Athl Train. 2002;37(4):394–405.
8. Abdel-aziem AA, Draz AH. Chronic ankle instability alters eccentric eversion/inversion and dorsiflexion/plantarflexion ratio. J Back Musculoskelet Rehabil. 2014;27(1):47–53; doi: 10.3233/BMR-130418.
9. David P, Halimi M, Mora I, Doutrellot P-L, Petitjean M. Isokinetic testing of evertor and invertor muscles in patients with chronic ankle instability. J Appl Biomech. 2013;29(6):696–704; doi: 10.1123/jab.29.6.696.
10. Goharpey Sh, Sadeghi M, Maroufi N, Shaterzadeh Mj. Comparison of invertor and evertor muscle strength in patients with chronic functional ankle instability. J Med Sci. 2007;7(4):674–677; doi: 10.3923/jms.2007.674.677.
11. Willems T, Witvrouw E, Verstuyft J, Vaes P, De Clercq D. Proprioception and muscle strength in subjects with a history of ankle sprains and chronic instability. J Athl Train. 2002;37(4):487–493.
12. Csapo R, Alegre LM. Effects of Kinesio® taping on skeletal muscle strength – a meta-analysis of current evidence. J Sci Med Sport. 2015;18(4):450–456; doi: 10.1016/j.jsams.2014.06.014.
13. Vercelli S, Sartorio F, Foti C, Colletto L, Virton D, Ronconi G, et al. Immediate effects of kinesiotaping on quadriceps muscle strength: a single-blind, placebo-controlled crossover trial. Clin J Sport Med. 2012;22(4):319–326; doi: 10.1097/JSM.0b013e31824c835d.
14. Choi I-R, Lee J-H. Effect of kinesiology tape application direction on quadriceps strength. Medicine. 2018;97(24):e11038; doi: 10.1097/MD.0000000000011038.
15. Vithoulka I, Beneka A, Malliou P, Aggelousis N, Karatsolis K, Diamantopoulos K. The effects of Kinesio-Taping® on quadriceps strength during isokinetic exercise in healthy non athlete women. Isokinet Exerc Sci. 2010;18(1):1–6; doi: 10.3233/IES-2010-0352.
16. Yam ML, Yang Z, Zee BC-Y, 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; doi:10.1186/12891-019-2564-6.
17. Simon J, Garcia W, Docherty CL. The effect of Kinesio tape on force sense in people with functional ankle instability. Clin J Sport Med. 2014;24(4):289–294; doi: 10.1097/JSM.0000000000000030.

18. Huang C-Y, Hsieh T-H, Lu S-C, Su F-C. Effect of Kinesio tape to muscle activity and vertical jump performance in healthy inactive people. Biomed Eng Online. 2011;10: 70; doi: 10.1186/1475-925X-10-70.
19. Bicici S, Karatas N, Baltaci G. Effect of athletic taping and kinesiotaping on measurements of functional performance in basketball players with chronic inversion ankle sprains. Int J Sports Phys Ther. 2012;7(2):154–166.
20. Hong S, Lee E-H, Eom H-R, Yeom C-K, Park S-Y, Jeong Y-B, et al. Effect of ankle taping on the ankle muscle strength in young healthy women. J Hum Sport Exerc. 2020;15(2):470–475; doi: 10.14198/jhse.2020.152.20.
21. Aly G, El-Hafez S, Nassif N. Effect of Kinesio taping on isokinetic parameters of ankle joint. Int J Curr Res. 2017; 9(4):49299–49307.
22. Fox J, Docherty CL, Schrader J, Applegate T. Eccentric planter-flexor torque deficits in participants with functional ankle instability. J Athl Train. 2008;43(1):51–54; doi: 10.4085/1062-6050-43.1.51.
23. Porter GK Jr, Kaminski TW, Hatzel B, Powers ME, Horodyski MB. An examination of the stretch-shortening cycle of the dorsiflexors and evertors in uninjured and functionally unstable ankles. J Athl Train. 2002;37(4):494–500.
24. Svantesson U, Ernstoff B, Bergh P, Grimby G. Use of a Kin-Com dynamometer to study the stretch-shortening cycle during plantar flexion. Eur J Appl Physiol Occup Physiol. 1991;62(6):415–419; doi: 10.1007/BF00626613.
25. Huxley AF. Muscle structure and theories of contraction. Prog Biophys Biophys Chem. 1957;7:255–318.
26. Herzog W. Why are muscles strong, and do they require little energy in eccentric action? J Sport Health Sci. 2018; 7(3):255–264; doi: 10.1016/j.jshs.2018.05.005.
27. Edman KA, Elzinga G, Noble MI. Residual force enhancement after stretch of contracting frog single muscle fibers. J Gen Physiol. 1982;80(5):769–784; doi: 10.1085/jgp.80.5.769.
28. Herzog W, Leonard TR. Force enhancement following stretching of skeletal muscle a new mechanism. J Exp Biol. 2002;205(9):1275–1283; doi: 10.1242/jeb.205.9.1275.
29. De Freitas FS, Brown LE, Gomes WA, Behm DG, Marchetti PH. No effect of kinesiololgy tape on passive tension, strength or quadriceps muscle activation of during maximal voluntary isometric contraction in resistance trained men. Int J Sports Phys Ther. 2018;13(4):661–667; doi: 10.26603/ijspt20180661.
30. Collado H, Coudreuse JM, Graziani F, Bensoussan L, Viton JM, Delarque A. Eccentric reinforcement of the ankle evertor muscles after lateral ankle sprain. Scand J Med Sci Sports. 2010;20(2):241–246; doi: 10.1111/j.1600-0838.2009.00882.x.
31. Munn J, Beard DJ, Refshauge KM, Lee RY. Eccentric muscle strength in functional ankle instability. Med Sci Sports Exerc. 2003;35(2):245–250; doi: 10.1249/01.MSS.0000048724.74659.9F.
32. Dolphin M, Brooks G, Calancie B, Rufa A. Does the direction of kinesiology tape application influence muscle activation in asymptomatic individuals? Int J Sports Phys Ther. 2021;16(1):135–144; doi: 10.26603/001c.18799.
33. Fukui T, Otake Y, Kondo T. The effects of new taping methods designed to increase muscle strength. J Phys Ther Sci. 2017;29(1):70–74; doi: 10.1589/jpts.29.70.
34. Guner S, Alsancak S, Koz M. Effect of two different kinesio taping techniques on knee kinematics and kinetics in young females. J Phys Ther Sci. 2015;27(10):3093–3096; doi: 10.1589/jpts.27.3093.
35. Kuo Y-L, Huang Y-C. Effects of the application direction of Kinesio taping on isometric muscle strength of the wrist and fingers of healthy adults – a pilot study. J Phys Ther Sci. 2013;25(3):287–291; doi: 10.1589/JPTS.25.287.
36. Yeung SS, Yeung EW. Acute effects of kinesio taping on knee extensor peak torque and stretch reflex in healthy adults. Medicine. 2016;95(4):e2615; doi: 10.1097/MD.0000000000002615.
37. Konishi Y. Tactile stimulation with kinesiology tape alleviates muscle weakness attributable to attenuation of Ia afferents. J Sci Med Sport. 2013;16(1):45–48; doi: 10.1016/j.jsams.2012.04.007.
38. Barros LAN, Ferrari-Piloni C, Torres EM, Estrela E, Valladares-Neto J. Effect size: a statistical basis for clinical practice. Rev Odonto Cienc. 2018;33(1):84–90; doi: 10.15448/1980-6523.2018.1.29437.
39. Brand RA, Pedersen DR, Friederich JA. The sensitivity of muscle force predictions to changes in physiologic cross-sectional area. J Biomech. 1986;19(8)589–596; doi: 10.1016/0021-9290(86)90164-8.
40. Gans C. Fiber architecture and muscle function. Exerc Sports Sci Rev. 1982;10:160–207; doi: 10.1249/00003677-198201000-00006.
41. Oatis CA. Kinesiology: The Mechanics and Pathomechanics of Human Movement. 2nd ed. Baltimore: Lippincott Williams & Wilkins; 2009.
42. Wong DLK, Glasheen-Way M, Andrews LF. Isokinetic evaluation of the ankle invertors and evertors. J Orthop Sports Phys Ther. 1984;5(5):246–252; doi: 10.2519/jospt.1984.5.5.246.