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Effects of the Application Direction of Kinesio Taping on Isometric Muscle Strength of the Wrist and Fingers of Healthy Adults — A Pilot Study

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Abstract. [Purpose] The purposes of this study were to investigate the immediate and delayed effects of two directions of Kinesio taping (KT) on maximal isometric strength of the wrist and finger muscles of healthy adults and compare their differences. [Subjects] Nineteen healthy junior college students participated in this study. [Methods] The inhibition and facilitation KT techniques were separately used to tape on the dominant and non-dominant forearms of the participants, respectively. Maximal isometric strength of wrist extension, middle finger extension, and grip of both hands were measured before taping, immediately after taping, and after 24 h of taping (with the tape in situ). [Results] Compared with the baseline, the average maximal isometric strength of middle finger extensors increased considerably after application of the facilitation technique. No significant time effect was observed for measurement of middle finger extension strength on the dominant side or for wrist extension and grip strength on both sides. Significant differences between both taping techniques were observed for wrist and middle finger extension strength immediately after taping, and for middle finger extension after 24 h of taping. [Conclusion] The results suggest that the application direction of KT may have different effects on isometric muscle strength. Future studies involving a larger sample of subjects and a sham condition are warranted to confirm our findings.
Key words: Kinesio taping, Isometric muscle strength, Upper extremity

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INTRODUCTION

Kinesio taping (KT) has become increasingly popular in the fields of sports medicine and rehabilitation. KT is a special therapeutic tape that was developed by the Japanese chiropractor Kenso Kase in the mid-1970s[1)]. KT is made of elastic cotton fiber and acrylic adhesive in a wavy pattern. The distinctive design of KT allows for a longitudinal stretch of 55–60% of its original length and evaporation of body moisture. Additionally, compared to traditional non-elastic tape, the heat-activated adhesive and skin-like thickness of KT permits for longer wear and smoother body movement.

KT can be applied to increase proprioception, reduce pain and edema, relieve muscle spasms, and strengthen weak muscles[2)]. Despite its widespread use, evidence supporting the claimed effects of KT remains limited and controversial[3–6)]. Williams et al.[1)] conducted a systematic review to evaluate the effects of KT in the treatment and prevention of sports injuries. They reviewed only studies that included a comparison group (placebo taping or no taping) and reported a musculoskeletal outcome. The results of magnitude-based inferences show that, although the findings were not definitive, KT may be beneficial in improving strength.

One of the possible mechanisms by which KT application can facilitate muscle strength is through the pulling on the fascia by the elastic qualities of KT[7)]. When KT is applied from the origin to the insertion of muscle, the applied tape recoils in the same direction as muscle contraction. Consequently, the KT application may assist with muscle contraction and improve muscle strength. In contrast, when KT is applied in the opposite direction, from muscle insertion to origin, the tape produces a pulling force opposite to the direction of muscle contraction and may reduce tension in the muscle. However, among the KT studies included in the systematic review of Williams et al.[1)], the application direction of KT was inconsistent in the studies reporting positive outcomes for muscle strength.

Fu et al.[8)] and Vithoukla et al.[7)] applied KT to the quadriceps from origin to insertion, and observed that isokinetic strength increased substantially immediately after KT application. Lee et al.[9)] applied the tape to the forearm in the same direction and observed a significant increase in maximal isometric grip strength. However, Hsu et al.[10)] applied KT to the lower trapezius of athletes with shoulder impingement in the opposite direction and also observed an increase in maximal isometric strength. Other studies[11, 12)] have applied the tape from muscle insertion to origin to increase muscle strength and obtained non-significant results. The methodology and results of these studies have raised questions regarding the effect of the application direction of KT as described by Kase et al.[2)].

To our knowledge, only one study has investigated the immediate effects of different directions of KT application on muscle strength. Vercelli et al.[13] applied one of three types of KT (facilitation, inhibition, or sham) on the anterior thigh of the dominant side of 36 healthy participants in three sessions. Maximal isokinetic strength of quadriceps muscles, distance of single-leg triple hop, and changes in a global rating scale were assessed in each session. The results showed no significant change in muscle strength or performance among any of the three KT applications, and the changes in muscle strength were unrelated to the type of KT application. Possibly, the width of the tape did not fully cover the large mass of the quadriceps muscle sufficiently to influence the muscle strength. Additionally, only the immediate effect was assessed. Therefore, the purposes of this study were to investigate the immediate and delayed effects of two directions of KT application on maximal isometric strength of the wrist and finger muscles of healthy adults and compared their differences.

SUBJECTS AND METHODS

A single-group repeated measures study design was used in this study. The independent variable was taping technique — facilitation or inhibition. The dependent variables were maximal isometric strength of wrist extension, middle finger extension, and grip.

Nineteen junior college students, 11 females and 8 males (mean age 18.9 ± 0.5 years, mean height 166.7 ± 8.2 cm, mean body weight 59.5 ± 12.0 kg) participated in this study. None of the participants had any musculoskeletal complaints within the past 6 months. Prior to commencing the study, each participant was informed of the procedures in accordance with the institutional ethical standards of the Ethics Committee on Human Experimentation and the Helsinki declaration of 1975.

Two taping techniques were separately used to tape the forearms of each participant. Grip strength is typically greater in the dominant hand; therefore, we decided to apply the inhibition technique (KT−) on the dominant side and the facilitation technique (KT+) on the non-dominant side. To eliminate the potential influence of stretch tension, the same stretch tension (110%) was used for both techniques by standardizing the length of the tape. For each participant, the distance between the lateral epicondyle of the humerus to the wrist joint line was measured and then divided by 1.1. The calculated distance was used to prepare the appropriate length of the strip from a roll of tape. The first 5 cm of the tape, which acts as the anchor, was applied to the skin without any stretch tension, and the remainder of the tape was stretched to cover the length of the targeted muscles.

For the inhibition technique, we followed the protocol for lateral epicondylitis of the elbow as suggested by Kase et a.l[2]. A Y-shaped tape (a single strip being cut down in the middle to produce 2 tails) was applied to the dorsal surface of the hand and forearm and wrapped around the wrist extensor muscles, starting from the heads of the metacarpals and ending at the lateral epicondyle of the humerus. During the application, the wrist, forearm, and elbow were maintained in full flexion, full pronation, and full extension, respectively. An I-shaped tape (a single strip) was used for the facilitation technique. The tape was applied on the same muscle group, but from origin to insertion. The joint position and tension of the tape during application of the facilitation technique were the same as those for the inhibition technique.

Measurements included maximal isometric strength of wrist extension, middle finger extension, and grip. All measurements were performed on the dominant and non-dominant hands of the participants in a random order at three time points: before taping, immediately after taping, and after 24 h of taping with the tape in situ. To minimize measurement errors, the same physical therapist performed all measurements. Additionally, each measurement was repeated three times, and the mean value of the three measurements was used in the analysis.

Maximal grip strength was measured using a Jamar dynamometer (Sammons Preston, IL, USA). This instrument is the most widely used, and has excellent concurrent validity with known weights ($r > 0.96$) and moderate to excellent test-retest reliability ($r > 0.80$)[14]. We followed the standard testing position as described in the literature[15]. Each participant sat on a straight back chair with both feet on the floor. The arm to be tested was held against the body with the elbow flexed at 90° and the forearm and wrist in the neutral positions. The participants were instructed to grip the handle of the dynamometer as tightly as possible for 3 s.

Maximal isometric strength of the wrist and middle finger extensors were measured using a hand-held dynamometer (MicroFet2; Hoggan Health Industries Inc., UT, USA). This instrument has been used to measure the maximal isometric strength of wrist flexion[16] and has excellent test-retest reliability (intraclass correlation coefficient = 0.878)[17]. For measurement of wrist extension, the participants rested their elbows on the table while seated, and placed the dorsal surface of the wrist on a dynamometer that was positioned on the table and stabilized by the investigator. The participants were instructed to maintain the elbow at approximately 90°, close to the trunk, and to apply a downward force on the stationary dynamometer by extending the wrist for 3 s. For measurement of middle finger extension strength, the participants placed their forearms on the table with their palms facing downward. Each participant was instructed to extend the middle finger for 3 s against a dynamometer that was positioned over the middle phalange of the middle finger and stabilized by the investigator.

All data were analyzed using the IBM SPSS statistics software package (Version 19). The normality assumption for parametric statistical analysis was tested using the Shapiro-Wilk test and the values of skew and kurtosis were calculated. Data are presented as means and standard deviations (SDs).

Differences in the original data of each dependent variable were examined using one-way repeated-measures analysis of variance (ANOVA). Mauchly's test of sphericity was performed and the Greenhouse–Geisser correction was used if the sphericity assumption was violated. Post-hoc pairwise comparisons with the Bonferroni correction were used in the case of a significant main effect.

Significant differences were observed in the maximal

Table 1. Maximal isometric strength (kg) over time of facilitation and inhibition Kinesio taping techniques

Outcome	Technique	Before taping	Immediately after taping	After 24 h of taping
Wrist extension	KT−	8.3 ± 3.1	7.6 ± 3.0	7.9 ± 3.1
	KT+	7.3 ± 2.3	7.8 ± 2.6	7.5 ± 2.4
Middle finger extension	KT−	2.1 ± 0.5	2.1 ± 0.5	2.0 ± 0.4
	KT+	1.8 ± 0.3	2.0 ± 0.3	2.1 ± 0.3
Grip	KT−	32.3 ± 10.3	32.2 ± 10.2	31.1 ± 9.4
	KT+	28.2 ± 7.9	28.0 ± 8.0	28.0 ± 7.7

Abbreviation: KT−, inhibition technique; KT+, facilitation technique. Values are expressed as mean ± standard deviations

Table 2. Percentage change in maximal isometric strength following application of facilitation and inhibition Kinesio taping techniques

Outcome	Technique	Immediately after taping*	After 24 h of taping†
Wrist extension	KT−	–7.8 ± 13.1	–2.5 ± 20.1
	KT+	5.7 ± 7.6	4.1 ± 17.8
	Difference	–13.5 ± 17.6	–6.1 ± 21.1
Middle finger extension	KT−	–0.4 ± 12.2	–1.8 ± 14.9
	KT+	9.8 ± 12.9	13.3 ± 17.4
	Difference	–9.6 ± 18.9	–14.5 ± 23.2
Grip	KT−	–0.2 ± 7.0	–2.4 ± 11.6
	KT+	–0.6 ± 6.9	0.2 ± 11.5
	Difference	1.2 ± 8.3	–2.0 ± 14.0

Abbreviation: KT−, inhibition technique; KT+, facilitation technique. Values are expressed as mean ± standard deviations. *Before taping vs. immediately under taping. †Before taping vs. 24 h after taping and with the tape in situ

isometric strength between the dominant and non-dominant sides before taping (wrist: z = 2.004, p = 0.045; middle finger: z = 2.983, p = 0.003; grip: t = 3.740, p = 0.002); therefore, the percentage change of each dependent variable was calculated for each participant at each time point using the before-taping measure as the baseline. A positive value indicates increased muscle strength, and vice versa. The paired t tests or an equivalent non-parametric test was conducted using the percentage change data to determine if differences occurred between the two taping techniques immediately after taping, and at 24 h after taping. The statistical significance level was chosen as $p<0.05$. The effect size (ES), based on Pearson's correlation coefficient[18], was calculated to indicate the magnitude of the observed effect.

RESULTS

The mean and standard deviation of maximal isometric strengths of wrist extension, middle finger extension, and grip are shown in Table 1. For maximal isometric strength of wrist extension, we observed a decreasing trend on the dominant side with the inhibition technique (8.3 ± 3.1 kg to 7.6 ± 3.0 kg) and an increasing trend on the non-dominant side with the facilitation technique (7.3 ± 2.3 kg to 7.8 ± 2.6 kg) immediately after taping. The degree of change had decreased after 24 h, and one-way repeated measures ANOVA indicated no significant main effect of time for either taping technique (KT−: F = 1.792, p = 0.183; KT+: F = 1.164, p = 0.311). On the non-dominant side, where the facilitation technique was applied, a significant main effect of time was observed on the maximal isometric strength of middle finger extension (F = 6.054, p = 0.006). Compared to the baseline, the average maximal isometric strength of middle finger extension significantly increased, by 0.2 kg, immediately after taping (p = 0.022, ES = 0.625) and had increased by 0.3 kg after 24 h (p = 0.025, ES = 0.618). No significant difference was observed for the measurement of middle finger extension on the dominant side, or grip strength on either side (p > 0.05).

All the average percentage changes following KT application were negative for the inhibition technique and positive for the facilitation technique (Table 2), except the negative value for grip strength immediately after application of the facilitation technique. The average percentage changes were significantly greater (13.5%) for the facilitation technique than for the inhibition technique for wrist extension immediately after taping (t = −3.127, p = 0.006). The same result was observed for middle finger extension immediately after taping (z = −2.112, p = 0.035) and 24 h after taping (t = −2.498, p = 0.025). No significant differences were observed in other comparisons (p > 0.05).

DISCUSSION

This study investigated the immediate and delayed effects of two directions of KT application on the maximal isometric strength of the wrist and fingers. Immediately after the application of the facilitation technique, the maximal isometric strength of middle finger extension significantly increased and the effect lasted for 24 h. However, no significant difference was observed in other measurements over time. The facilitation technique had a greater effect on the middle finger extensors than on the wrist extensors. The opposite was observed with the application of the inhibition technique.

The degree to which KT covers the targeted muscles may explain the differing results of wrist and middle finger extension for both techniques. The application of the I-shaped tape for the facilitation technique fully covered the centrally located extensor digitorum muscle in the middle of the posterior surface of the forearm; however, it may have only partially covered the laterally located wrist extensor muscles, especially in the male participants since they had larger forearms. Compared to wrist extensors, the extensor digitorum received more tactile stimulation or mechanical assistance from the tape; therefore, greater strength gain was observed in middle finger extension. Conversely, the Y-shaped tape for the inhibition technique was applied along the wrist extensor muscles, and may not have adequately covered the centrally located extensor digitorum muscle. Therefore, the inhibition technique may have a greater effect on wrist extensors than the middle finger extensors.

The findings of no significant difference in maximal isometric grip strength for both techniques may suggest the limitation of simple KT for complex movement. A powerful grip requires activation of wrist extensors to stabilize the wrist joint and allow extrinsic finger flexors to function efficiently[19]. In patients with lateral epicondylitis, or more correctly lateral epicondylagia, grip strength is often reduced because of pathological involvement of the common tendon of the wrist extensor muscles[20]. Therefore, we used the protocol for lateral epicondylitis and included measurement of grip strength. The rationale was that possible changes in wrist extension strength resulting from KT application may be accompanied by changes in grip strength. Thus, the maximal isometric grip strength results can be reasonably explained by the lack of significant changes in maximal isometric strength of wrist extension. Chang et al.[11, 16] followed a differing protocol by wrapping the Y-shaped tape along the wrist flexor muscles from insertion to origin. They also observed no significant difference. Regardless of the targeted muscle group and the application direction, the application of a single strip was insufficient to simultaneously influence agonists and synergists for gripping. In contrast, Lee et al.[9] observed a significant increase in grip strength after application of a single strip of KT on flexor muscles of the forearm from origin to insertion. A possible explanation for difference in the results of our study and the study by Lee et al.[9], is the forearm position during measurement of grip strength. We measured grip strength with the forearm in the neutral position, whereas Lee et al.[9] measured grip strength with the forearm supinated. Grip strength is stronger in forearm supination than in the neutral position[21]. Moreover, Lee et al.[9] also applied tapes to the biceps brachii.

The findings of significant average percentage change differences between both taping techniques and the positive/negative values of average percentage change after taping provide evidence that KT direction has differing effects on muscle strength. However, our findings are inconsistent with those of Vercelli et al.[13]. Both studies were performed using healthy non-athletes, and they also used similar taping techniques. The main difference between studies is the targeted muscles. We speculate that the degree to which KT covers the targeted muscles may influence the effect of KT application on muscle strength. The KT application in the study by Vercelli et al.[13] might not have sufficiently covered the large mass of quadriceps muscle, possibly reducing the magnitude of the effect, whereas the KT application used in our study easily covered the wrist and finger extensor muscles, possibly resulting in a number of significant changes.

Chang et al.[16] described the difficulty of quantifying the extent of stretch tension, regardless of whether the same physiotherapist applied the tape. To investigate the effect of the application direction of KT on muscle strength, we used the same stretch tension. On the other hand, Vercelli et al.[13] used 25–50% tension for the facilitation technique and 15–25% tension for the inhibition technique. Various stretch tensions in the tape may contribute to the conflicting results, between our study and those of Vercelli et al.[13]. However, the manner in which stretch tension influences the effect of KT on muscle strength remains unclear.

This study had a number of limitations. First, we did not include a non-taping or placebo taping condition. Although the statistical tests showed no significant main effect on the maximal isometric strength of wrist extension over time of either technique, large effect sizes ($r > 0.5$)[18] were observed immediately after taping. These changes may be clinically meaningful. It would be useful to conduct further studies that include non-taping or placebo taping conditions and use a larger sample size to verify the results of this study. Furthermore, we did not use the same shape of KT for both taping techniques. Different shapes of tape have been suggested to maximize the facilitatory or inhibitory effect of KT[22]. Vercelli et al.[13] also used different shapes of KT on the quadriceps muscle when investigating the effect of the application direction of KT on muscle strength. In the present study, we also did not measure muscle activity using electromyography (EMG). EMG data would help to substantiate the facilitatory or inhibitory effect of KT; however, the application of KT on the forearm prevented surface EMG recordings in this study. In addition, there may have been a rating bias in the present study because the same investigator applied KT and performed the measurements. Finally, participants in this study were healthy adults. Patients with muscle weakness or spasms may have differing responses to KT. Studies are warranted to investigate the effect of KT application in other populations.

The facilitation technique of KT significantly increased the maximal isometric strength of middle finger extension immediately after taping, and the effect lasted for 24 h. However, no significant effect was observed with the inhibition technique of KT. The average percentage changes in maximal isometric strength were significantly greater for the facilitation technique than for the inhibition technique in some outcome measures. The present results suggest that the applied direction of KT may have different effects on isometric muscle strength. Future studies involving a larger sample of subjects and a sham condition are warranted to confirm our findings.

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