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The protective role of kinesio taping on lateral epicondyle pain and handgrip strength performance during the tennis tournament of college players

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Abstract

Objectives: The purpose of this study is to investigate the protective role of kinesio taping on pain and handgrip strength performance during the tennis tournament of college players.

Methods: Participants were equally divided into three groups (the first group Kinesio Taping Group (KTG): 14 females and 15 males, the second group Placebo Taping Group (PTG): 15 females and 16 males, and the third group No Taping Group (NTG): 15 females and 14 males tennis players). Forty-three females and forty-six males volunteers (age 21.5 ± 3.7 years, body mass 69.7 ± 13.2 kg and height 167.8 ± 11.9 cm) were recruited to participate in this study.

Results: Pain pressure threshold values were significantly decreased after second, third, and fourth days of female tennis players (except KTG; p=0.076, p=0.029, p=0.018 respectively). Also, values of pain pressure threshold was significantly decreased second, third and fourth days of male tennis players (except KTG; p=0.128, p=0.023, p=0.001 respectively). Dominant handgrip strength values were significantly reduced after second, third, and fourth days of female tennis players (except KTG p=0.066, p=0.031, p=0.016 respectively). Besides, values of handgrip strength was significantly decreased second, third and fourth days of male tennis players (except KTG p=0.058, p=0.012, p=0.012 respectively).

Conclusions: Our findings indicate that the application of kinesio taping on the wrist extensors, extensor carpi radialis brevis and longus muscles have an effect on dominant muscle strength and pain pressure threshold without placebo effect.

Keywords: *Pain, kinesio taping, placebo, strength, tennis elbow*

Introduction

Lateral Epicondyle (LE) is a common type of overuse injury seen among tennis

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players. LE is frequently ascribed to work related repetitive strain injuries but it is also a specific sports injury (Gellman, 1992). Pain on the lateral epicondyle, which is irritated by recreational activities that include clinching actions of the hand, such as holding tools, shaking hands, and lifting a kettle, generally signals that the individual has a condition entitled lateral epicondylalgia, epicondylitis, or what is mostly known as tennis elbow. Its prevalence has been declared to be 3% in the general population, 15% in repetitive hand task occupations, and 50% in tennis players (Coombes, Bisset, & Vicenzino, 2009; Goel, Bathilaya, & Reddy, 2015). Handgrip strength (HGS) and pressure pain threshold (PPT) are outcome measures that are responsive to detect changes in LE (Shiri, Viikari-Juntura, Varonen, & Heliövaara, 2006). Some studies proposed that taping assists in pain management, affect joint range of motion, decreases the effects of inflammation, off-loads pain producing tissues, and provides protection and support during movement (Goel, Bathilaya, & Reddy, 2015; Vicenzino, Brooksbank, Minto, Offord, & Paungmali, 2003). Sports therapy management of LE typically involves manipulation and exercise or use of adhesive tape (Almekinders & Temple, 1998). Also, KT is an adhesive tape, implemented in varying cases of stretch to the skin, particularly designed to copy the physical features and characteristics of human skin. It has nearly the similar elasticity as skin, weight and thickness and is breathable and comprises neither medical materials nor latex. One of its primary differences compared to traditional tapes is that it activates the region over which it is applied instead of restricting movement resulting in proprioceptive and nociceptive stimulation. KT is frequently used modality in clinical practice for the prevention and treatment of musculoskeletal conditions (Nirschl, 1977). It was used by 25% of hand therapists to organize acute LE as suggested by a current rehearse study (Gogia, 2013). Popularity of KT is the raise in terms of sports performance, particularly requiring repetitive, high-intensity muscular effort, and eccentric loading (O'Sullivan, & Bird, 2011). Kase, Wallis, & Kase, (2003) claimed the possible beneficial effects when KT is applied, included the following: *"(1) improve the contraction ability of the muscle; (2) use the elasticity to create skin folds resulting in increased the space underneath the skin to improve circulation of blood and lymph; (3) activate neurological suppression in order to reduce pain and increase joint range of motion; and (4) adjust mal-alignment of muscle, myofascia and joint"* (Fu et al., 2008; Chang, Chou, Lin, Lin, & Wang, 2010). However, the effect of KT on various sports and especially tennis effects has not been demonstrated and there is a lack of evidence to demonstrate effectiveness of the methods. Despite a lack of clinical data to reinforce KT

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application on tennis elbow, the mass of anecdotal proof has prevailed over scientific evidence (Bassett, Lingman, & Ellis, 2010; Thelen, Dauber, & Stoneman, 2008). Prior controlled and randomized controlled studies utilized kinesio tape application without any additional tension, or kinesio taping on irrelevant position as their placebo condition (Gonzalez-Iglesias, Fernandez-de-Las-Penas, Cleland, Huijbregts, & Gutierrez-Vega, 2009; Fratocchi et al., 2013; Williams, Whatman, Hume, & Sheerin, 2012). But, it is disputable that placebo kinesio taping can still supply therapeutic results. Additionally, in the literature, it is emphasized that KT might have placebo effects on the participants (Beedie & Foad, 2009). Therefore, it is very important to determine the placebo effect in terms of this study. So, the kinesio taping effect mechanism can be determined as correct.

To our knowledge, there are limited studies examining the effects of KT during a sport competition. Also, there are no studies investigating the effects of KT on HGS and PPT during tennis tournament. Based on the data in the literature, it is found that a prolonged tennis match could induce muscle fatigue. So, our hypothesis is that KT group could be less affected in HGS performance and PPT values compared to placebo and no taping group. Therefore, the purpose of this study is to evaluate the effects of KT application on elbow on pain, and handgrip strength performance during the tennis tournament of college players.

Methods

Participants

The experimental study design was used, including about 110 amateur tennis players from different universities of Turkey during inter-universities tennis tournament. Participants were included in the experimental trial if their age were 18 years or older and they were willing to take part in the research. Primary demographic data were gathered through utilizing a self-administered survey. The sample of the study consist of forty-three females average age 22.10±4.50 years, average height 166.20±5.75 cm, average weight 63.55±6.20 kg and forty-six males of whose average age 23.70±4.85 years, average height 177.10±12.45 cm and average 71.90±11.20 kg. They were informed in detail about the nature of the experiment, the importance of study and its possible risks. All participants were provided with a written informed consent prior to participation in the study. The major inclusion criteria were as follows: (a) having *"Tegner Activity Levels"* 7 level (Tegner & Lysolm, 1985), (b) being physically healthy, (c) not having any chronic injuries or disease, (d) not having upper extremities injuries within the last years. Principal excluding criteria were included: (a) having any injuries at during tournament, (b) missing to measurements of days and times, (c)

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doing any strength exercise, (d) use of anabolic substances, and (e) removing the tape during study. The study was approved by Malatya Clinical Studies Ethical Committee and conducted in conformity to the Declaration of Helsinki for Medical Research involving human participants.

Measure Procedures

Following signing of the informed consent forms background information and anthropometric measurements were done. Then participants were randomly divided into three groups: Kinesio Tape Group (KTG=14 females and 15 males), Placebo Tape Group (PTG=15 females and 16 males) or No Tape Group (NTG=15 females and 14 males tennis players). Each participant was evaluated for PPT and HGS, prior to taping, and consecutive tournament each day. Result measure tests were performed four times on each participant. The first baseline evaluation (1st day) took place during the first meeting (09.00 a.m.), after confirmation. The second evaluation (2nd day) was measured after one day and at the same time. The third evaluation (3rd day) was performed after two days and at the same time. The last evaluation (4th day) was measured after the last day and at the same time. No specific advice on dietary habits was given to any of the participants during the tournament period. All tennis players were wished to not alter their dietary habits during of the tournament.

Taping Technics

A single expert certified in the KT method conducted the taping, and fawn Kinesio Tex Gold tape was used (Kinesio Holding Corporation, Albuquerque, NM). For wrist flexors/extensors, the participants were required to keep the wrist in a hyperextended/hyperflexed position with the elbow in full extension and supination/flexion and pronation. A roll of tape was cut into a strip and then cut down the middle of the strip to produce a "Y – strip". The proximal head of the Y-strip was applied to the distal of wrist palmar and dorsal side, the tails were along the ulnar and radial wrist flexors and wrist extensors lateral epicondyle, respectively, with natural stretch tension (Lemos, Pereira, Protássio, Lucas, & Matheus, 2015). The PTG received the same tape application, but no tension was added as the tape was applied (0% of stretch). The placebo tape was a common Cadu Medi non-woven adhesive tape (T&G Healthcare Co. Ltd., China). Participants were instructed not to remove the tape during the study. The NTG only performed the HGS, PPT assessment and did not receive any taping (Lemos, Pereira, Protássio, Lucas, & Matheus, 2015).

Pain Pressure Threshold

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PPT was obtained by applying the 1-cm^2 rubber probe tip of a digital algometer to the most palpably tender site over the lateral epicondyle with arm in 30° of abduction, elbow in 90° of flexion; and with forearm, wrist, and hand supported. PPT is defined as the pressure at which the participant first felt pain. The pressure is applied at the rate of 5N/sec and player is instructed to say, "stop". It was measured 3 times, with 20 sec rest interval between each measurement. For analysis, mean value (in kg/cm^2) of the 3 efforts was noted (Gogia, 2013). At this study, quantitative sensory pain was measured with the aid of a digital pressure algometry (Chatillon DFE- 100, Digital Force Gauge/AMETEK). Intra-class correlation coefficient (ICC) for lateral epicondyle PPT was 0.90 (1^{st} day= 0.90, 2^{nd} day= 0.91, 3^{rd} = 0.89, and 4^{th} day= 0.90).

Handgrip Strength

HGS was measured with the aid of a hydraulic hand dynamometer (Baseline Hydraulic Hand Dynamometer, Irvington, New York, USA). All participants were evaluated in the standardized testing position recommended by the American Society of Hand Therapists. Participants were seated with their shoulder adducted and neutrally rotated, elbow twisted to 90°, forearm in neutral position and wrist between 0° and 30° dorsiflexion and between 0° and 15° unlar deviation. The participants performed the handgrip movement with maximum effort, only during exhalation and after a verbal cue given by the examiner: "one, two, three, go". Three measurements were made for dominant hand, a rest interval of 60 seconds was provided between trials in order to avoid muscle fatigue during the assessment. The average of the three trials was calculated for each hand (Lemos, Pereira, Protássio, Lucas, & Matheus, 2015; Fess, 1992). Intra-class correlation coefficient (ICC) for HGS was 0.92 (1^{st} day= 0.90, 2^{nd} day= 0.92, 3^{rd} = 0.92, and 4^{th} day= 0.95).

Statistical Analysis

The sample size of the study was determined by GPOWER 3.1 trial version (power 80%, two-sided significant level, 5%). The sample size was found that must be at least twelve (12) people for each group. Statistical analyses were conducted with the aid of a package program (SPSS, version 17.0). Data are presented as mean ± standard deviation. Statistical analysis procedures started with "*Kolmogorow Smirnov*" (for sample size bigger than fifty participants) tests within normality analysis in order to test whether data were homogenous. As variances show a normal distribution, the testing times of groups were analyzed by repeated-measures "*ANOVA test 3 X 4 (group x times)"* analysis was used to test for

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significant differences between groups. A significance level $p<0.05$ was used in all statistical analyses.

Results

In total 110 study participants consented for the study. Twenty-one participants meet at least one of the exclusion criteria and where immediately excluded from the study before randomization. Therefore, 89 participants were randomly allocated into three groups. The rest of the sample (forty-three female age 22.10±4.50 years, height 166.20±5.75 cm, weight 63.55±6.20 kg and forty-six male of which age 23.70±4.85 years, height 177.10±12.45 cm and weight 71.90±11.20 kg respectively) completed the test successfully. There were no significant differences between the groups at baseline (Flow chart was presented at Figure 1).

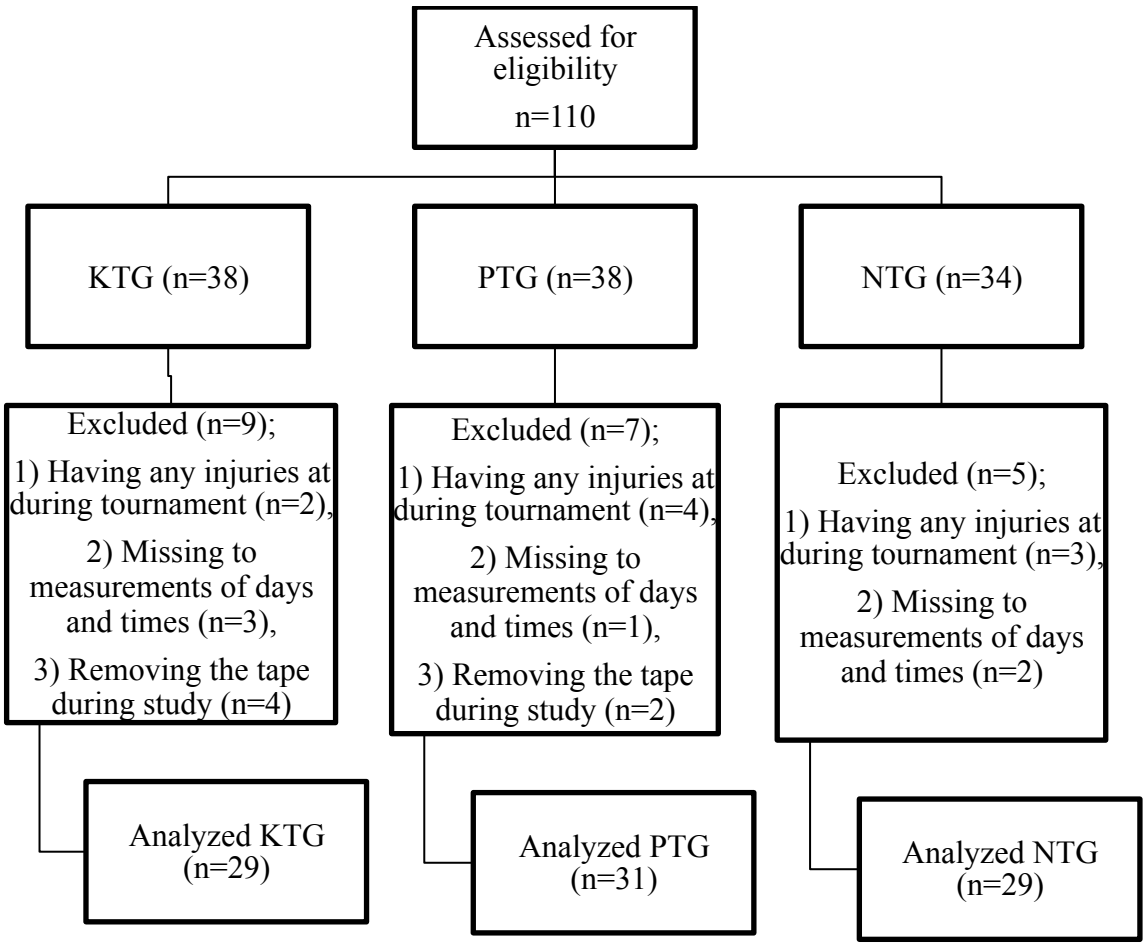

Figure 1. Flow chart showing participant selection and randomization

In post-hoc analysis significant differences were found between the times of the KTG group versus PTG, and NTG. The analysis of the data regarding the different PPT values assessment times among the groups revealed that there were significant differences among the

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groups (except KTG). PPT values were significantly decreased after second, third, and fourth days of female tennis players (except KTG; p=0.076, p=0.029, p=0.018 respectively). Also, values of PPT were significantly decreased second, third and fourth days of male tennis players (except KTG; p=0.128, p=0.023, p=0.001 respectively, Table 1). In addition to, there were significant difference values of PPT found that between KTG versus PTG and KTG versus NTG (for females: p=0.016, p=0.005, for males: p=0.011, p=0.001 respectively). However, there was no significant difference in PPT values between PTG versus NTG (for females: p=0.416, males: p=0.211, respectively).

Table 1. Average PPT of groups (kg/cm^2)

PPT	Time of Measure	KTG		PTG		NTG	
		F (n=14)	M (n=15)	F (n=15)	M (n=16)	F (n=15)	M (n=14)
Lateral Epicondyle	1st Day	20.3±5.3	29.1±5.8	20.2±4.8	29.5±5.2	21.0±5.5	30.5±5.8
	2nd Day	19.4±5.3	28.7±5.8	16.1±4.8[a]	23.6±5.0[a]	15.4±5.7[a]	21.0±4.9[a]
	3rd Day	18.7±5.9	27.0±4.7	14.2±4.6[a]	20.9±4.7[a]	14.1±6.7[a]	19.6±4.4[a]
	4th Day	17.5±5.1	26.3±4.2	13.7±4.1[a]	18.5±4.7[a]	13.5±4.9[a]	17.2±4.7[a]
Difference (%)	1 Δ 4	13.7	10,6	32,1[b]	37,2[b]	35,7[b]	43,6[b]

(KTG: Kinesio Taping Group; PTG: Placebo Taping Group; NTG: No Taping Group; HGS: Handgrip Strength; F: Female; M: Male; [a]: Significance level among the times; [b]: Significance level among the groups)

In post-hoc analysis significant differences were found between the times of the KTG group versus PTG, and NTG. The analysis of the data regarding the different handgrip assessment times among the groups revealed that there were significant differences between the groups (except KTG). Dominant HGS values were significantly reduced after second, third, and fourth days of female tennis players (except KTG p=0.066, p=0.031, p=0.016 respectively). Also, values of HGS were significantly decreased second, third and fourth days of male tennis players (except KTG p=0.058, p=0.012, p=0.012 respectively, Table 2). In addition to, there were significant difference in HGS values between KTG versus PTG and KTG versus NTG (for females: p=0.013, p=0.006, for males: p=0.001, p=0.001 respectively). But, there was no significant difference in HGS values between PTG versus NTG (for females: p=0.125, males: p=0.852, respectively).

Table 2. Average HGS of groups (kg)

HGS	Time of Measure	KTG		PTG		NTG	
		F (n=14)	M (n=15)	F (n=15)	M (n=16)	F (n=15)	M (n=14)
Dominant Hand	1st Day	35.7±9.4	51.5±8.7	33.9±8.7	51.8±8.4	34.0±5.5	50.8±8.5
	2nd Day	33.6±6.4	50.9±9.6	29.6±6.1[a]	42.9±9.2[a]	30.1±5.9[a]	44.5±7.7[a]
	3rd Day	32.3±5.5	48.8±8.1	27.3±5.0[a]	40.0±8.6[a]	26.5±5.7[a]	39.3±6.6[a]
	4th Day	32.5±5.0	46.8±7.7	26.5±5.4[a]	38.8±7.0[a]	24.2±4.9[a]	37.8±6.9[a]
Difference	1 Δ 4	8,9	9,1	22,4[b]	25.0[b]	28,8[b]	25,5[b]

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(KTG: Kinesio Taping Group; PTG: Placebo Taping Group; NTG: No Taping Group; HGS: Handgrip Strength; F: Female; M: Male; [a]: Significance level between the times; [b]: Significance level between the groups).

Discussion

The main purpose of this research was to examine the protective role of KT on HGS and PPT by comparing the consecutive tennis tournament days. Also, this recent study is the first research that investigates the protective role of KT application by successfully eradication of placebo effects. Our results were harmonious with our hypotheses that KTG application significantly affected both HGS and PPT values when it was compared with PTG and NTG.

Some studies have indicated that prolonged tennis playing in competitions leads to the development of muscle fatigue that may impair skilled performance on the court (Davey, Thorpe, & Williams, 2002; Brink-Elfegoun et al., 2014). Moreover, all of these studies managed performance tests during or immediately after the match. Unlike, the current study examined to effect of KT application during consecutive forth tennis days on HGS. In this respect, the study is unique in the literature. As stated by Kenzo Kase, the KT method can increase the strength of muscles. However, evidence of KT's effect on muscle strength is controversial (Kase, Wallis, & Kase, 2003). A meta-analysis (Thelen, Dauber, & Stoneman, 2008) showed that 7 out of 10 researches indicated a beneficial effect of KT application on muscle strength (Lumbroso, Ziv, Vered, & Kalichman, 2014). Similarly, Vithoulka et al. (2010) and Lemos, Pereira, Protássio, Lucas, & Matheus, (2015) reported that positive effect of KT on HGS. These results show that HGS increased with KT applications. But, this increase might be caused placebo effect of KT. Similarly; regarding the prior studies reported effects might be attributed to placebo effect. Placebo influence is a psychological phenomenon that refers to change the status and efficiency in that the hopes of the individual alter their beliefs and behavior leading to a more positive or negative consequence. In the literature, a prior study proposed that many athletes believed that placebo effects might influence (Poon et al., 2015). Therefore, we have studied to examining whether placebo effect of KT application. The study was found that no statistically significant decrease in female and male tennis players' HGS for KTG 8.9% and 9.1% (p=0.066, p=0.058 respectively). But also, we found statistically significant decrease in female and male tennis players for PTG 22.4% and 25.0% (p=0.012, p=0.031 respectively) and NTG 28.8% and 25.5% (p=0.031, p=0.012 respectively) during tournament. One of the most striking results of this research was HGS value that did not significantly decreased during tournament in the KTG. On the other hand,

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our current study proved long-term positive effect of KT application on HGS without placebo effect.

Kibler and Safran (2005) declared that tennis injuries are almost 20-45% of the upper extremity injuries. The highest frequencies in injuries were mostly lateral epicondyle (35-40%), shoulder and back pain. The primary reason for can be repetitive trauma with subsequent overload (Kibler & Safran, 2005). This is a consequence of increased frequency, intensity, duration of play, the large inherent biomechanical and physiological demands at this level of play, and also the deleterious effects of mal-adaptations in flexibility and strength that occur in areas subject to repetitive tensile overload. Kafkas et al., (2014) showed that significantly increase at values of PPT (for LE) dominant arm throughout concurrent tennis tournament days. Our study indicated that statistically significance improves with LE pain free during tournament. This research was found that no statistically significant improve in female and male tennis players' PPT for KTG 13.7% and 10.6% (p= 0.076, p= 0.128 respectively). However, we found statistically significant increase in female and male tennis players for PTG 32.1% and 37.2% (p=0.029, p=0.023 respectively) and NTG 35.7% and 43.6% (p=0.018, p=0.001 respectively) during tournament. According to the results of the meta-analysis, study regarding the effect of KT on pain intensity showed less pain (Thelen, Dauber, & Stoneman, 2008). But these studies totally measured pain intensity, and the visual analogue scale were used. However, our study measured the pain values by a pain algometry. So, our study findings are unique with regard to pain measure with algometry. In addition, one of the most interesting results of this study was PPT value that did not significantly improved during tournament in the KTG. On the other hand, our current study proved that long-term positive effect of KT application on pain pressure threshold without placebo effect. With the respect, our study findings are an original study when examining the literature.

A potential hypothesis to explain our findings is that KT may improve blood flow intra-muscularly. During the implementation of an isometric contraction above 20% of the maximum voluntary contraction, blood flow decreases to 30–40 mm Hg within the intramuscular capillaries. This continues to reduction in oxygen provision and accumulation of metabolites such as lactate and algogenic substances (Álvarez-Álvarez, San Jose, Rodríguez-Fernández, Güieta-Rodriquez, & Waller, 2014). There is some proof to demonstrate that KT can make larger peripheral blood circulation. It is presumed that the implementation of KT stimulates the autonomic nervous system leading to vasodilation of the blood vessels in the area under the tape thus improving blood circulation. An increased blood,

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and therefore oxygen provision to the muscle would improve the muscles resistance to tiredness (Kase, Wallis, & Kase, 2003).

There were some limitations of our study. Firstly, only amateur young healthy tennis players were recruited in this research. Secondly, testing over four different days may introduce measurement error, as we did not strictly control the daily match activity between testing sessions. In addition to, future studies could investigate the effect of massage treatment and different stretching exercises on PPT and HGS values.

Conclusion

The present study proved the application of KT effective in gaining long-term benefits in lateral epicondylalgia. This is the first study that a potential KT effect has been evaluated specifically on muscle strength and pain pressure threshold using an appropriate quantitative and objective methodology. Our findings indicated the application of KT on the wrist extensors, extensor carpi radialis brevis and longus muscles have effect on dominant muscle strength and pain pressure threshold without placebo effect.

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