

Immediate Effect of Kinesio Taping on Muscle Response in Young Elite Soccer Players

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Context: Kinesio taping (KT) is a new taping technique increasingly used in sports medicine to improve muscle performance; however, its real effect is not entirely known. **Objective:** To assess the immediate effects of KT on muscle performance in young healthy elite soccer players. **Design:** Crossover study. **Setting:** University laboratory. **Participants:** Eighteen young elite soccer players voluntarily participated in the study (mean \pm SEM: age 18.20 ± 2.45 y, height 1.76 ± 3.56 m, body mass 65.25 ± 3.76 kg, body-mass index 20.12 ± 1.25 kg/m²). **Interventions:** Each subject completed 2 different protocols, with and without KT. Interventions were performed in a random order, with a washout period between conditions of 1 wk. **Main Outcome Measures:** Outcome measures included tensiomyographic response in the vastus lateralis and vastus medialis, power output with 30 and 50 kg, countermovement jump, and 10-m sprint. **Results:** Data showed no significant differences for any of the outcomes analyzed between interventions. **Conclusions:** KT does not produce a short-term improvement in muscle performance in young elite soccer players.

Keywords: tensiomyography, muscle performance, leg-extension muscles

It has been demonstrated that elite soccer players not only require sport-specific technical and tactical skills, but explosive strength and speed are also essential for optimal performance.^{1,2} Consequently, in recent years there has been a heightened focus on designing and implementing training methods and techniques to improve these aspects of athletic performance. In the field of sports medicine, the application of different types of tape has been used for many years to prevent injury, but more recently taping techniques are being used to increase muscle performance. The proposed physiological basis of traditional tape and taping techniques was that taping the skin would stimulate cutaneous mechanoreceptors and therefore enhance the delivery of sensory input from the periphery to the central nervous system. This increased sensory input would then result in greater information integration and a significant improvement in proprioception and muscle performance.³⁻⁸ However, it should be taken into account that joint movement might be limited.^{9,10}

In recent years, the use of a new form of cotton tape with acrylic adhesive, known as kinesio tape (KT), has proliferated. This tape differs from traditional tape due to its elasticity—it can be stretched to up to 120% to 140% of its original length before being applied to the

skin.¹¹ Another difference from traditional tape is that KT can provide a pulling force to the skin and supposedly increase the distance between the fascia and the soft tissue under the areas where it is applied.¹² In addition, KT does not restrict joint movement in the same way that traditional taping does and can be worn for longer periods of time without the need for reapplication.^{13,14}

It is also argued that KT can be used not only to increase muscle performance¹⁵ but also to normalize muscle function, to increase lymphatic and vascular flow, to diminish pain, and to aid in the correction of possible articular malalignments.^{13,16} While KT techniques are frequently applied to patients with musculoskeletal system disorders, especially in the field of sports injuries,¹⁷ most of the supposed effects are hypothesized, and there is no evidence in the literature supporting the effects of KT taping.

The real effects of KT on muscle performance are still being investigated; several authors have hypothesized that the KT facilitates immediate increases in muscle strength by producing a concentric pull on the fascia, which may then stimulate increased muscle contraction,¹⁸ or that KT improves muscle alignment, which may contribute to marginal increases in muscle strength.¹⁹ Slupik et al²⁰ demonstrated an increase in peak torque (24 h) and electromyographic activity (72 h) in the vastus medialis of healthy individuals after application of KT tape. Huang et al²¹ investigated the effect of elastic taping on the triceps surae during a maximal vertical jump. They observed that vertical ground-reaction force and electromyographic

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activity of the gastrocnemius medialis increased when KT was applied, although the height of jump remained constant. Hsu et al¹⁹ observed an incremental increase in lower trapezius muscle strength after a taping application. Lee et al²² showed greater grip strength after applying KT to the flexor muscles than that of the untaped muscles. In contrast, Fu et al²³ demonstrated that concentric and eccentric muscle strength of the quadriceps and hamstrings were not affected by KT in healthy people. Similarly, Chang et al¹¹ evaluated the effects of KT on maximal grip strength of the dominant hand in healthy college athletes and did not find any significant effect.

It seems that KT in soccer players is being used without knowing its real effects on muscle performance. The aim of this study was therefore to determine the immediate effects of KT on strength, jump ability, speed, and muscle contractile properties in young elite soccer players.

Materials and Methods

Participants

Eighteen elite soccer players voluntarily participated for the study (mean \pm SEM: age 18.20 ± 2.45 y, height 1.76 ± 3.56 m, body mass 65.25 ± 3.76 kg, body-mass index 20.12 ± 1.25 kg/m²). All subjects had a similar training volume (minimum 4 d/wk and maximum 5 d/wk), which included 2-hour sessions per day. Each subject was randomly assigned to 1 of 2 different experimental conditions, 1 with KT (KTi) and 1 without KT (NKTi). The rest period between experimental conditions was 1 week to avoid carryover effects from previous sessions. All sessions were conducted under the same conditions (24 h without physical activity and at the same hour of the day). Each participant was informed about the study procedure with its possible benefits and risks, and each gave signed written consent. The study was approved by the local ethics committee.

Procedures

Each testing session consisted on the following actions: application (or not) of KT on the rectus femoris of the dominant leg, assessment of muscle contractile properties of the vastus lateralis and vastus medialis using tensiomyographic response (TMG), standardized warm-up, and performance tests.

KT Technique. Standard 2-in (5-cm) black KT (Cure Tape, FysioTape BV, Enschede, The Netherlands) was used. The tape was applied by an experienced physiotherapist following the Y-shaped KT technique proposed by Kase et al¹³ and Fu et al²³ for the rectus femoris. Participants lay in supine position with the hip flexed 30° and the knee flexed 60°. The tape was applied from a point 10 cm below the anterosuperior iliac spine, bisected at the junction between the quadriceps tendon and the patella, and circled around the patella, ending

at its inferior side. The first 5 cm of tape were not stretched and acted as the anchor. The portion between the anchor and superior patella was stretched to 120% using a reference scale. The remaining tape around the patella remained unstretched. Figure 1 shows the KT technique used.

TMG. The TMG technique is based on measuring skeletal-muscle contractile response to a low-level electrical stimulus.²⁴ This technique produces radial displacement of the muscle belly in response to an electrical stimulus conducted through the underlying muscle tissue.²⁵ The radial displacement of the muscle belly can be measured with a displacement sensor (TMG System 100, TMG-BMC Ltd, Slovenia). Displacement-time-curve recordings allow muscle contractile properties to be assessed, obtaining different parameters that can inform about muscle tone.²⁴

Maximal radial displacement (Dm), time from the onset of electrical stimulus to 10% of Dm, time from 10% to 90% of Dm in the ascending curve (Tc), time between 50% of Dm on both sides of the curve (Ts), and time from 90% to 50% of Dm on the descending curve (Tr) were determined. Reliability of TMG has been established according Tous-Fajardo et al.²⁴

During each protocol, TMG analysis of the vastus lateralis and vastus medialis was performed. Radial displacements were measured under static and relaxed conditions, with the participant in the supine position and the knee joint fixed at an angle of 120° (180° corresponding to full extension of the knee). The measured limb was positioned on a triangular wedge foam cushion to keep a fixed knee angle. A digital displacement transducer (GK 40, Panoptik d.o.o., Ljubljana, Slovenia) that incorporates a spring of 0.17 N/mm was set perpendicular to the muscle belly to acquire radial displacement. Sensor location was determined anatomically according to Delagi et al²⁶ and marked with a dermatological pen. Two square (5 \times 5 cm) 2-mm-thick self-adhesive electrodes (Compex Medical

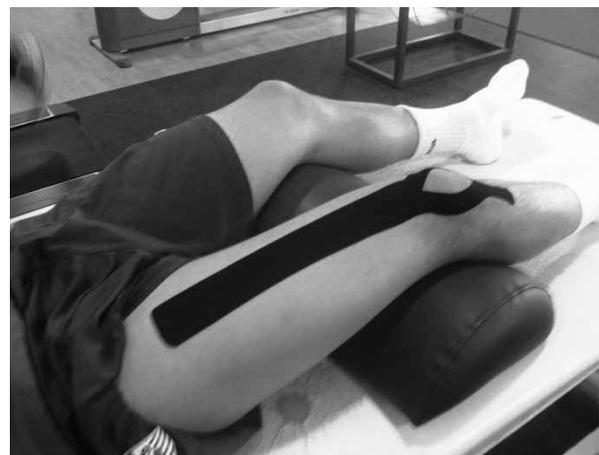


Figure 1 — The taping method and subject posture employed when applying Kinesio taping.

SA, Ecublens, Switzerland) were placed symmetrically 5 cm (± 3 cm) to the sensor tip. A TMG-S1 (EMF-Furlan and Co, d.o.o., Ljubljana, Slovenia) stimulator was used.

Regarding electrical stimulation procedures, pulse duration was 1 millisecond and the amplitude was set at 100 mA. None of the participants reported discomfort during electrical stimulation.

Warm-Up. After TMG analysis, all subjects performed a 5-minute warm-up (3 min at 60 W + 2 min at 80 W) at 60 rpm on a cycle ergometer (C3 Advanced, Life Fitness, EEUU) followed by 10 repetitions with 20 kg in a half-squat exercise. After a standardized warm-up, power output, countermovement jump, and speed at 10 m were assessed in this order, with a rest period between tests of 3 minutes.

Power Output. Participants adopted a half-squat position with shoulders touching the bar, and the starting knee angle for movement execution was set at 90°. From this position, participants performed a concentric activation of the leg-extensor muscles until reaching full extension at 180°. They were given instructions to perform a purely concentric action from the starting point, keeping shoulders at an abducted position of 90° to ensure consistency of shoulder and elbow joints during the movement execution.²⁷ Such movement was performed on a Multipower (Smith Machine, Life Fitness, EEUU) using 2 different loads (both 30 and 50 kg are the most common loads used in daily training) to estimate maximal power output. A linear encoder (T-Force, T-Force System, Ergotech, Spain) was used, which has a microprocessor that works internally with a 10- μ s resolution. The optical transducer signal interrupts the microprocessor at each 0.07-mm displacement, which lets us perform kinematic analysis. The rest period between repetitions was 90 seconds.

Countermovement Jump. Lower body explosive-strength characteristics, expressed as elevation of the body's center of gravity (vertical jump), were assessed using an infrared-ray platform built into the Opto Jump System (Opto Jump, Microgate, Italy) according to Cronin and McLean.²⁸ The test starts with a preparatory movement of knee extension going down to 90° knee flexion and, without pausing, jumping upward as high as possible. The jump was performed without the use of the arms; participants were asked to keep their hands on their hips. Elevation of the center of gravity (height in meters) above ground level was calculated for both tests, as was flight time (t_v) in seconds, applying the laws of ballistics:

$$H = t_v^2 \times g/8$$

where H is the height (m) and g is the gravitational acceleration (9.81 m/s²). Participants performed 2 jumps separated by 90 seconds. The mean score was used for statistical analysis.

10-m-Sprint Test. Participants' running speed was evaluated with a 10-m sprint effort using dual-beam

electronic timing gates (Ergo Timer, Globus, Italy) and methods previously described.²⁹ Participants were instructed to run as quickly as possible along the 10-m distance from a standing start. They started from a stationary, upright position with the front foot on the 1-m point in front of the line with the start gate. Speed was measured to the nearest 0.01 second, with the mean score from 2 trials used as the speed score. Two minutes of rest between the 2 trials was given.

Reproducibility of Variables

Tests were repeated on 3 different days (Monday, Wednesday, and Friday) in the week before training. The intraclass correlation values (interday) were power = .94, countermovement jump = .95, and sprint test = .92.

Statistical Analyses

Means and standard errors of the mean (SEM) were calculated for each variable. Normality was checked using the Kolmogorov-Smirnov test, and all variables were normally distributed. One-way analysis of variance (ANOVA) was performed to check differences between interventions (KTi and NKTi). Statistical significance was set at $P < .05$.

Results

In relation to physical-performance tests, the application of KT lead to 0.45% \pm 1.43% and 0.74% \pm 2.29% increases for power output with 30 kg and 50 kg, respectively; an increase of 1.97% \pm 1.57% for the countermovement-jump test; and an increase of 0.10% \pm 0.66% for the 10-m-sprint test. However, these differences did not reach statistical significance, as shown in Figure 2.

Regarding the TMG measurements, Table 1 shows results for all outcomes in both the KTi and the NKTi protocol. The ANOVA test for interprotocol comparison showed no significant differences for the vastus lateralis and vastus medialis in any of the variables considered.

Discussion

The aim of this study was to determine the short-term efficacy of KT on muscle performance in young elite soccer players. Our results demonstrate that muscle response, jump ability, 10-m sprint, and power output do not significantly change after the application of KT. These findings may be important, as many athletes, both amateurs and professionals, are using this kind of tape based on the premise that it will improve their performance.

Regarding the muscle response, to our knowledge no studies have analyzed the TMG response after different tape treatments. In the field of sport rehabilitation few studies have analyzed TMG parameters to provide useful information about muscle activation.³⁰ However, our study has shown that Dm (which could be equated to

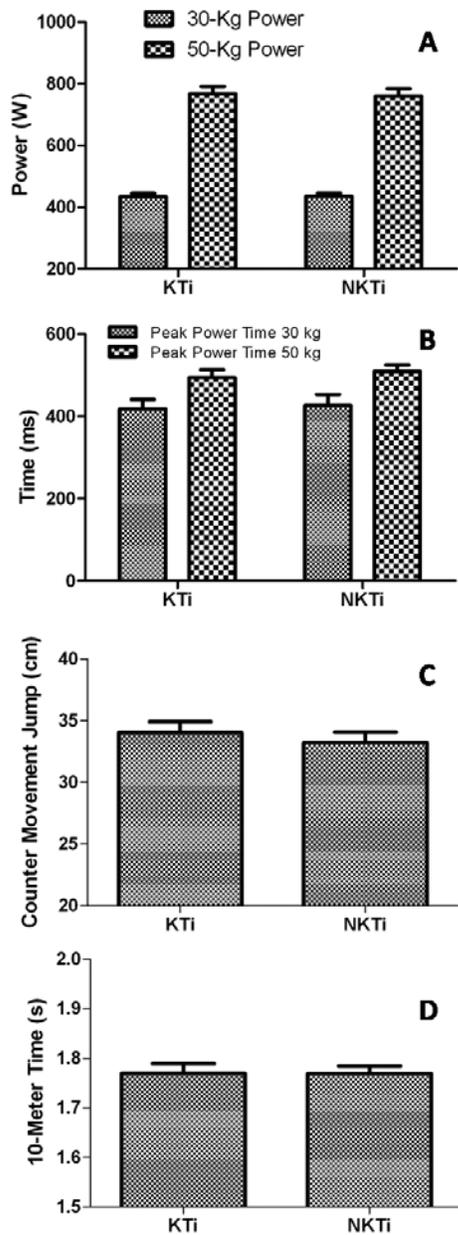


Figure 2 — Interprotocol comparison for (A) power output, (B) peak power time, (C) countermovement jump, and (D) 10-m time. Abbreviations: KTi, kinesio taping; NKTi, no kinesio taping.

electrically evoked peak twitch torque) is representative of muscle tone and contractile force.^{25,31} Contraction-time parameters such as Ts and Tr show the largest influence on muscle activation and fatigue rate,³⁰ or Tc, which is related to muscle-composition parameters such as fiber-type distribution^{32–34} and speed of force generation.³⁴ In the current study, TMG analysis of the vastus lateralis and vastus medialis of the dominant leg showed

no statistically significant differences between the two interventions in Dm, Tc, Ts, and Tr. These results indicate that there was no effect of KT on muscle contractile properties.

These results contrast with those reported by Slupik et al,²⁰ who showed an increase in muscle tone when KT was applied to support the muscle and suggested that it may be due to a reflex effect on the nervous system. This effect may be due to an increase in the number of motor units recruited during maximal contraction, an increase in muscle tone generated by individual units, or the joint effect of both mechanisms. Morrissey³⁵ and Sijmonsma,¹⁴ argue that when the tape is applied in the direction of muscle fibers the muscle tone might increase, and therefore it may facilitate the strength of the underlying muscle. However, in the current study all TMG parameters showed no significant effects when the KT was applied; it is therefore apparent that there is no clear relationship between increased muscle tone and KT.

When short-term effects of KT on muscle performance were analyzed, our results agree with those of Fu et al²³ and Slupik et al,²⁰ who did not find positive effects of KT on peak torque during isokinetic activations of the leg muscles immediately and after 10 minutes of taping, respectively. Hsu et al¹⁹ investigated the effect of elastic taping on strength of the scapular muscles in baseball players with shoulder impingement. Compared with the placebo taping, the strength of the lower trapezius had a tendency to increase after KT application, but again this response was not statistically significant. However, Huang et al²¹ showed increases in electromyographic activity and reaction force when KT was applied on the calf muscle, but jump height did not improve.

When they assessed the long-term effect of KT, Fu et al²³ found no significant increase in muscle strength 12 h after application of the tape. However, Slupik et al²⁰ showed that KT has a positive effect on muscle activity 24 and 72 hours (but not 96 h) after taping. Long-term effects were not analyzed in the current study, but it may be that KT's effects are more apparent 24 to 72 hours after its placement.

Several theories have tried to explain these contradictory results. Slupik et al²⁰ suggested that effects of KT may be due to an increased recruitment of the muscle's motor units. However, Ridding et al³⁶ and Simoneau et al³⁷ hypothesize that tactile input has been reported to interact with motor control by altering the excitability of the central neuron system. Huang et al²¹ indicate that the muscle that contributes the most during an activity may reflect larger electromyographic change with KT. In addition, Alexander et al³⁸ reported that the longitudinal strip may shorten the muscle fibers, producing a decrease in the afferent Ia discharge from the neuromuscular spindle, causing a reduction in the motor neurons of the medullar anterior horn, proved by the diminished amplitude of the H reflex observed. According to Hsu et al,¹⁹ the reason KT application could lead to the immediate marginal

Table 1 Tensiomyographic Measurements in Both Interventions

Muscle	Measure	Group		F	P
		Kinesio taping, mean ± SEM	No kinesio taping, mean ± SEM		
Vastus medialis	contraction time (ms)	24.48 ± 0.67	24.88 ± 0.75	0.560	.931
	substation time (ms)	185.38 ± 9.99	181.53 ± 11.09	0.498	.959
	relaxation time (ms)	79.46 ± 10.83	70.55 ± 13.58	0.210	.866
	maximum distance (mm)	5.20 ± 0.28	5.82 ± 0.38	0.928	.391
	delayed time (ms)	19.19 ± 0.40	20.07 ± 0.46	1.373	.277
Vastus lateralis	contraction time (ms)	20.81 ± 0.45	20.87 ± 0.98	0.169	.845
	substation time (ms)	78.24 ± 9.91	81.93 ± 11.39	0.054	.947
	relaxation time (ms)	54.47 ± 9.31	53.99 ± 9.47	0.021	.979
	maximum distance (mm)	4.09 ± 0.32	3.71 ± 0.35	0.456	.638
	delayed time (ms)	19.73 ± 0.42	19.22 ± 0.32	0.636	.536

increase in muscle strength can be explained by the results of the facilitated muscle activity and improved joint alignment.

The negative results observed in the current study may be explained by the fact that afferent stimuli generated by KT may not be strong enough to modulate muscle performance of healthy soccer players. Another possible explanation for these results may be type of tape, as was suggested by Hsieh et al.³⁹ In addition, unlike most studies in the field, in this investigation functional muscle-performance tests were used, which may be less sensitive to change (but more clinical and functionally relevant), which could explain the differences found between our results and those of others. In addition, the functional tests used higher loads, facilitating greater muscle-fiber recruitment and motor-unit synchronization, but these loads are less used in daily soccer-training routines.

Finally, our study had some limitations that should be considered. Tape localization and/or trajectories on the target limb, joint, or muscle and application technique used by the therapist can influence the effect of KT on muscle performance. In our study, a standard 2-in (5-cm) black KT was used, and an experienced physiotherapist applied it in all cases following the Y-shaped KT technique proposed by Kase et al¹³ and Fu et al.²³ However, subtle differences in tape and application used across the studies may account for some of the differences.

Conclusions

In conclusion, there is no short-term effect of KT on contractile properties and muscle performance in young elite soccer players. However, new studies are needed to confirm long-term effects of KT 24 to 72 hours after taping.

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