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Original Article

The Effect of Kinesio Taping Applied to Quadriceps and Gastrocnemius Muscles on Speed, Agility and Flexibility: A Cross-Sectional Study

Tolga Hanayoğlu[1], Sema Can[2]

[1]Yozgat Bozok University of Vocational School of Health Services, Yozgat, Turkey;
[2]Hitit University, Faculty of Sport Sciences, Department of Coaching Training, Çorum, Turkey

Abstract

Objective: This study aims to examine the effect of kinesio tape (KT) applied to different parts of the body on speed, agility and flexibility. **Method**: 32 male volunteers aged 18-38 years participated in the study. KT was applied to the quadriceps and gastrocnemius muscles of the athletes at 4 different times with intervals of one week. As measurements, 30-meter sprint test, agility T test and sit and reach test for flexibility were performed. Independent samples T-Test and Mann Whitney U test, repeated measures analysis of variance and the Friedman test were used for statistical analysis. **Results**: No significant difference was found between the speed, agility and flexibility values of KT applied to quadriceps and gastrocnemius muscles ($p>0.05$). It was found that there was an increase in agility performance in both muscle groups in the 48th hour measurements after the KT application, it increased speed performance only in gastrocnemius muscle ($p<0.05$) and did not increase flexibility performance in both muscle groups. There was no statistically significant improvement in the 30th minute and 24th hour measurements ($p>0.05$). **Conclusion**: It can be suggested that applying KT to quadriceps and gastrocnemius muscles with 25-50% tension for 48 hours is effective in improving the agility performance.

Keywords: Kinesio Tape, Muscle, Performance, Soccer, Sport

Introduction

Soccer refereeing is an athletic effort that requires the high level of physical fitness[1]. However, it is a type of activity that demands the highly level of performance, and it is reported that a referee covers approximately 10 km during the match. In addition, speed and agility are some of the most important parameters that certainly a referee should have them. Besides, speed and agility provide the considerable effect on the referee performance[2-4]. It is recommended to evaluate physical parameters separately in soccer players[5].

As the non-surgical treatment methods, KT is mostly used in the field of health, however, it is recently performed commonly in the field of sports[6]. The purposes of taping include protection from sports injuries, reducing pain and oedema[7,8] etc. There are many studies investigating the effect of KT on the rehabilitation of injuries[9]. Also, in recent years, a large number of studies have been conducted to investigate its effect on the performance of athletes with different results[6,10,11]. In a meta-analysis of KT applications, 8 of 19 studies reported that KT applied in healthy individuals was effective on muscle strength, while 11 studies reported that KT had no or minimal effect on muscle strength[12]. In a meta-analysis examining the effects of KT on lower limb muscle strength, long jump and vertical jump performance, 37 studies were reviewed, and it was found that it can improve lower limb muscle strength in individuals with muscle fatigue and chronic musculoskeletal diseases. Another study reported that taping was not effective in improving ankle functional performance[13]. Güven and Aktaş[14] stated that KT applied to the ankle has an effect on speed and agility. As a result of 15 studies, it was found that taping was effective on athlete performance in only two

The authors have no conflict of interest.

Corresponding author: Assoc. Prof. Sema Can (Ph.D), Hitit University, Faculty of Sport Sciences, Department of Coaching Training, Turkey
E-mail: semacan@hitit.edu.tr

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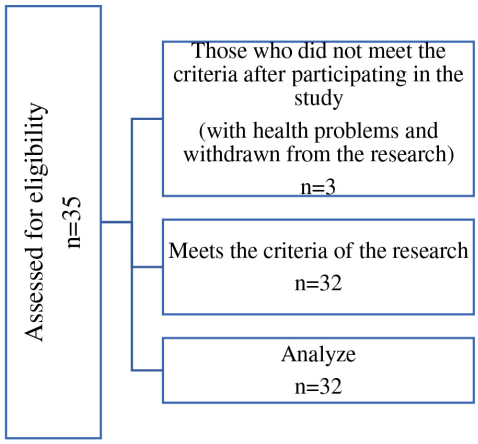

Figure 1. The flow chart of the study.

Figure 2. Kinesio Taping M. Quadriceps and M. Gastrocnemius.

studies, while 13 studies did not find a significant effect[15].

Gastrocnemius and quadriceps muscles, which are among the large muscle groups of the lower extremities, have an important role in sprint performance and power transfer[16]. Accordingly, it was aimed in this study to investigate the effects of KT on speed, agility and flexibility by applying it to different muscle groups in different time periods.

Materials and Methods

Participants

This research is a cross-sectional study. The study population consisted of soccer referees in Yozgat region of Turkey, and the sample consisted of 32 male amateur soccer referees (age: 25.60±5.60 years, training age: 10.20±5.10 years, competitive/referee experience: 5.30±4.20 years, body mass index (BMI): 22.80±2.20 kg/m2). The sample size of 32 participants for our study was determined through a power analysis conducted at a significance level (α) of (0.05) and statistical power level of (0.95). Three of the 35 participants were not included in the study because they fulfilled at least one exclusion criterion. All of the participants were soccer referees who did regular running training 3 days a week. The referees fulfilled the following inclusion criteria: a background of at least 4 years of systematic training and competitive experience, absence of any lower-extremity surgery in the past years, the previous 3 months with the absence of musculoskeletal injury, and non-allergy to KT.

Study design

The measurements were performed by a physiotherapist in a closed room. The expert physiotherapist conducted standardized training on test methods before measurements to ensure that all subjects have equal test conditions. Participants were given 10 minutes for individual warm-up before the performance measurements (jogging and stretching).

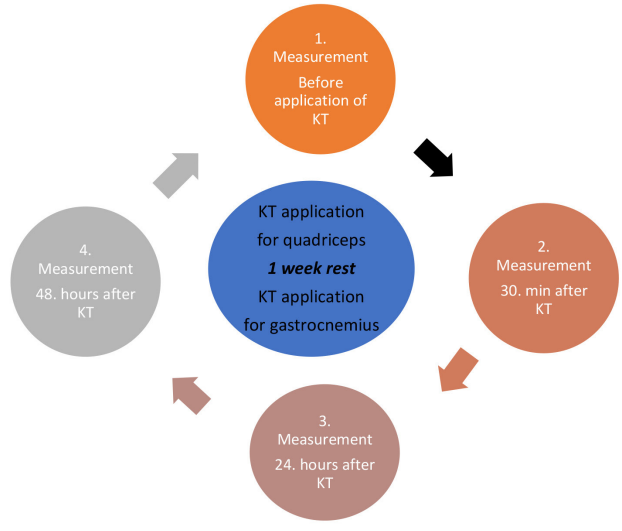

Figure 3. Research Protocole.

Anthropometric Measurements

Height and body weight

The participants were weighed with light clothes and without shoes. The height was determined using a fixed wall-scale measuring device to the nearest 0.1 cm. The weight was

Table 1. The anthropometric and physical properties of participants.

	Mean ± SD	Median [Min – Maks]
Age (year)	25.60 ± 5.60	23.00 [18.00 – 38.00]
Training year (year)	10.20 ± 5.10	10.00 [2.00 – 22.00]
Referees (year)	5.30 ± 4.20	4.00 [1.00 – 21.00]
Height (m)	1.80 ± 0.10	1.80 [1.60 – 1.90]
Body weight (kg)	72.40 ± 8.80	72.50 [55.00 – 90.00]
BMI (kg/m^2)	22.80 ± 2.20	22.40 [19.00 – 26.90]

BMI: body mass index, SD: standart deviation, Min: minimum, Maks: maksimum.

determined within 0.1 kg for each subject using an electronic scale calibrated before each measurement session. The BMI was calculated as weight in kg divided by weight in meter squared[17].

Motoric tests

30 m Sprint Test

The sprint running speed performances of the participants were measured with a Sinar branded telemetry system, a two-gate photocell stopwatch placed at 0 and 30 meter with an accuracy of 0.01 seconds. The participants were given sufficient time for warm-up and stretching exercises before the measurements and were asked to start the test at maximum speed when they were ready[18].

Flexibility

Flexibility were evaluated using the "sit and reach" test. The participants sat with their knees straight and feet flat against the front end of the box test. The participants were asked to lean forward at the hips in a slow, keeping the knees straight, steady movement, and sliding the hand up the box ruler as far as they could go, extending as far as they could and the results were recorded. The test was repeated twice times. The best result was recorded[19].

Agility

T-test is a protocol that consists of 4 contact points, 10 m long and 10 m wide. The participant was asked to move in different directions and in different ways between the 4 contact points and to complete a series in the shortest time. Photocell was placed in the place where the same start and finish and test protocol were repeated twice[20].

Kinesio taping application

KT was applied first to the quadriceps muscle group and then to the gastrocnemius muscles at different time intervals by an expert physiotherapist with 25-50% tension. Participants were asked to shave the area where the KT would be applied and Y-shaped taping was applied using muscle technique to stimulate the muscles while doing the KT[21] (Figure 2).

KT was applied from the origin to the insertion to stimulate the muscle and support its function. No stretching was applied to the beginning and ending parts of the KT. Two 5 cm wide KT strips were applied to the cleaned skin, one for each muscle. The tape's endpoint was rounded to prevent the edges from peeling and to increase the tape application length. The measurements were made for both muscle groups at a total of 4 different time periods before the application (1st measurement) and at 30 minutes (2nd measurement), 24 hours (3rd measurement) and 48 hours (4th measurement) after the application. In the 1st week, taping was applied to the quadriceps muscle group and measurements were performed. After one week of rest, the same protocol was applied to the gastrocnemius muscle in the 2nd week. Before the measurements, 10 minutes was given for individual warm-up. The same person took part in the measurements in both muscle groups.

Statistical Analysis

In summarizing the data obtained from the study, descriptive statistics were given as mean ± standard deviation, median, minimum and maximum depending on the distribution for continuous (numerical) variables. The normality of the numerical variables was checked by Shapiro-Wilk, Kolmogorov-Smirnov and Anderson-Darling tests. In the comparison of two independent groups, Independent Samples T-Test was used when the numerical variables were normally distributed, and Mann Whitney U test was used when the numerical variables were not normally distributed. Repeated measures analysis of variance was used to analyze the differences between the values measured at different times (before the application and at 30th minute, 24th hour and 48th hour after the application) and showing normal distribution, and Friedman Test was used to evaluate the statistical differences between measurements that did not show normal distribution. The Durbin-Conover test was used to find out the differences between the measurements. Statistical analyses were made using "Jamovi project (2020), Jamovi (Version 1.6.16.0) [Computer Software]

Table 2. The speed, agility, and flexibility values of applying at different times.

	Quadriceps		Gastrocnemius		*p - value**
	Mean+SD	Median (min-max)	Mean+SD	Median (min-max)	
Speed					
Before application	4.44 ± 0.34	4.30 [4.02 – 508]	4.51 ± 0.35	4.46 [4.03 – 5.22]	0.432* (Cohen's d=-0.536)
30. min	4.43 ± 0.32	4.34 [4.02 – 5.01]	4.48 ± 0.32	4.42 [4.08 – 5.08]	0.564* (Cohen's d=-0.331)
24. hours	4.44 ± 0.32	4.37 [4.05 – 5.11]	4.45 ± 0.32	4.33 [4.03 – 5.12]	0.825* (Cohen's d=-0.085)
48. hours	4.42 ± 0.31	4.37 [4.05 – 5.02]	4.42 ± 0.32	4.29 [4.02 – 5.05]	0.925* (Cohen's d=0.019)
p - value*	0.100**** (η^2=0.010)		**0.003**** (η^2=0.122)**		
Agility					
Before application	10.11 ± 0.51	9.91 [9.51 – 11.22]	10.20 ± 0.56	9.96 [9.46 – 11.25]	0.413* (Cohen's d=-0.676)
30. min	10.12 ± 0.54	9.87 [9.53 – 11.21]	10.15 ± 0.55	9.92 [9.52 – 11.25]	0.672* (Cohen's d=-0.272)
24. hours	10.08 ± 0.50	9.88 [9.49 – 11.13]	10.11 ± 0.54	9.91 [9.48 – 11.33]	0.877* (Cohen's d=-0.192)
48. hours	10.02 ± 0.50	9.81 [9.52 – 11.05]	10.06 ± 0.55	9.89 [9.42 – 11.38]	0.872* (Cohen's d=-0.228)
p - value*	**<0.001**** (η^2=0.255)**		**<0.001**** (η^2=0.421)**		
Flexibility					
Before application	28.45 ± 5.67	29.20 [17.7 – 38.1]	28.80 ± 6.04	28.65 [16.6 – 39.6]	0.812** (Cohen's d=-0.271)
30. min	28.82 ± 5.69	28.90 [17.2 – 39.4]	28.78 ± 5.92	28.60 [18.1 – 38.7]	0.978** (Cohen's d=0.036)
24. hours	28.77 ± 5.66	28.55 [18.4 – 38.4]	28.65 ± 5.79	28.75 [17.3 – 39.2]	0.934** (Cohen's d=0.068)
48. hours	28.99 ± 5.40	29.60 [18.9 – 37.5]	28.52 ± 5.99	28.45 [18.6 – 38.8]	0.743** (Cohen's d=0.275)
p - value*	0.052*** (η^2=0.079)		0.407*** (η^2=0.031)		

*p<0.05; *. Mann-Whitney U test; **. Independent Samples T-Test; ***. Analysis of variance in repeated measures; ****. Friedman test.*

Table 3. Multiple comparisons of changes in KT over time.

Time Zones	Quadriceps	Gastrocnemius	
	Agility	Speed	Agility
Before application - 30. min	0.378	0.112	0.005
Before application - 24. hours	0.187	0.011	<0.001
Before application - 48. hours	<0.001	<0.001	<0.001
30. min - 24. hours	0.029	0.328	0.186
30. min - 48. hours	<0.001	0.025	<0.001
24. hours - 48. hours	0.003	0.199	0.002

p<0.05; Durbin-Conover test.

(Retrieved from https://www.jamovi.org) and JASP (Version 0.14.1.0) (Retrieved from https://jasp-stats.org) and the significance level was taken as 0.05 (p-value) in statistical analyses. Cohen's d and partial eta squared (η^2) coefficients were calculated for the effect size. Cohen's d effect size classification was taken as insignificant (<0.2), small (0.2-0.59), medium (0.60-1.19), large (1.20-1.99), very large (2.0-3.99) and near perfect (>4.0)[22]. Partial eta squared effect size classification was taken as small (0.0099), medium (0.0588) and large (0.1379)[23].

Results

In Table 2, the differences between the speed, agility and flexibility values measured at different times of the taping applied to the quadriceps and gastrocnemius muscles of the study participants were statistically analyzed. According to this analysis, there was no statistically significant difference between the mean values of speed, agility and flexibility obtained before the application and at 30th minute, 24th hour and 48th hour after the application in terms of quadriceps and gastrocnemius muscles to which KT was applied (p>0.05). Coefficients of effect sizes (Cohen's d) are categorized as insignificant and small. It was found that the difference between the agility values of KT applied to the quadriceps muscle before the application and at 30th minute, 24th hour and 48th hour after the application was statistically significant (p<0.001). The effect size eta squared coefficient is classified as large (η^2=0.255). There was no statistically significant difference between the speed and flexibility values

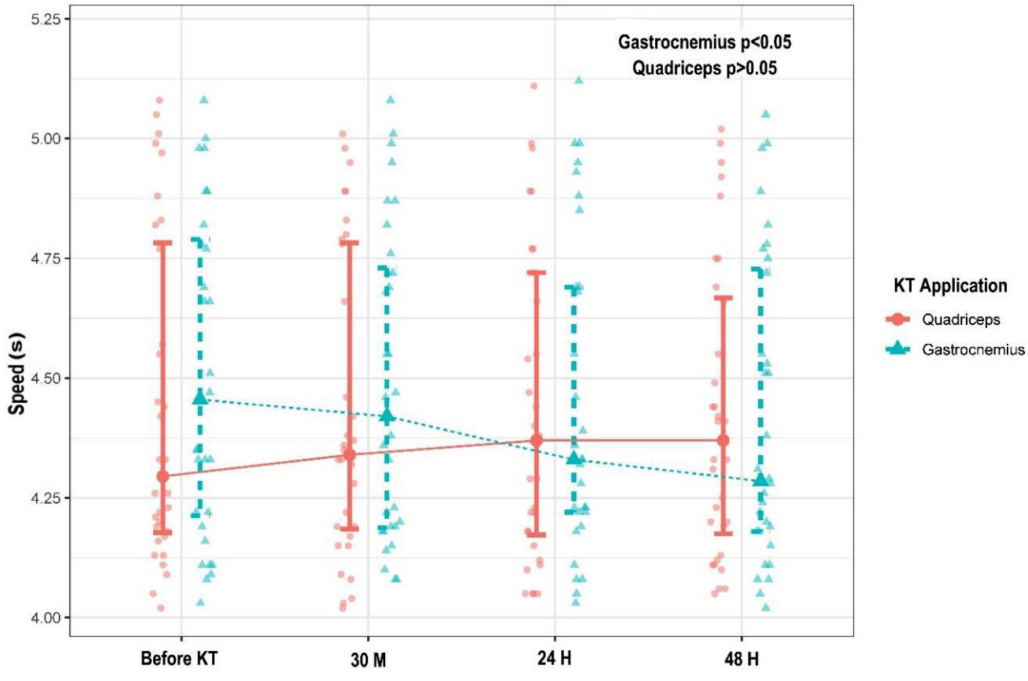

Figure 4. Multiple comparisons of changes in speed performance.

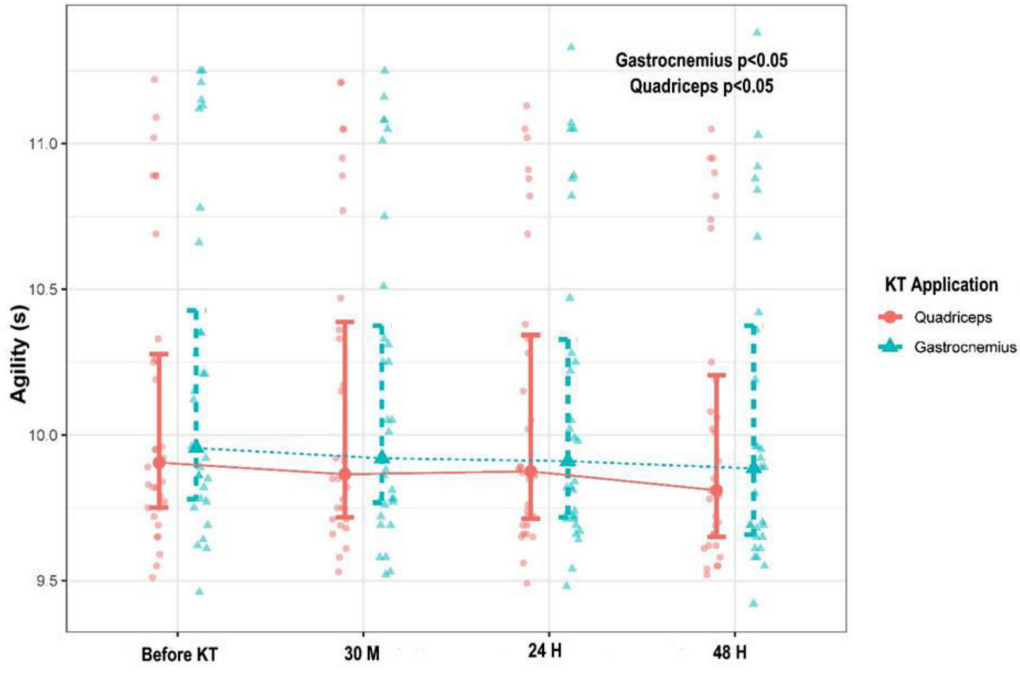

Figure 5. Multiple comparisons of changes in agility performance.

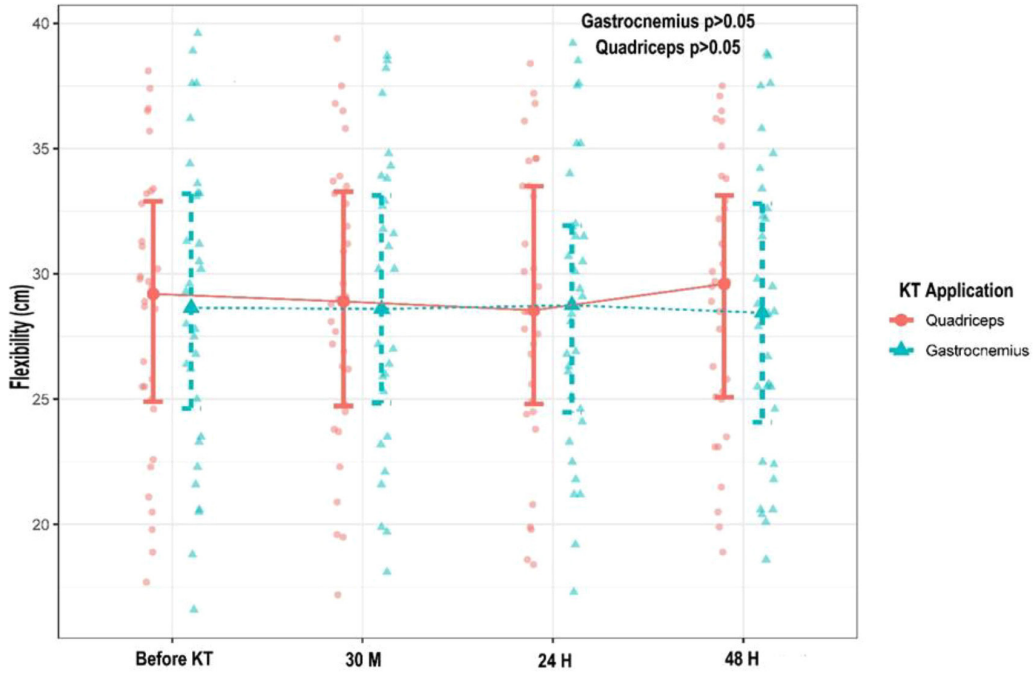

Figure 6. Multiple comparisons of changes in flexibility performance.

of kinesiological taping applied to the quadriceps muscle before the application and at 30th minute, 24th hour and 48th hour after the application (Table 2; p=0.100 and p=0.052, respectively). The effect size eta squared coefficient is categorized as small and medium (η^2=0.010 and η^2=0.079), respectively. The difference between the speed values before the application and at 30th minute, 24th hour and 48th hour after the application of kinesiological taping to the gastrocnemius muscle was statistically significant (p=0.003). The effect size eta squared coefficient is classified as medium (η^2=0.122). It was found that the difference between the agility values of kinesiological taping applied to the gastrocnemius muscle before the application and at 30th minute, 24th hour and 48th hour after the application was statistically significant (p<0.001). The effect size eta squared coefficient is classified as large (η^2=0.421). There was no statistically significant difference between the flexibility values of kinesiological taping applied to the gastrocnemius muscle before the application and at 30th minute, 24th hour and 48th hour after the application. (Table 2; p=0.407). The effect size eta squared coefficient is classified as small (η^2=0.031).

Table 3 shows that the 48th hour agility value of KT applied to the quadriceps muscle of the study participants was significantly lower than the values before the application and the agility values at 30th minute and 24th hour after the application (p<0.05). The 24th and 48th hour speed values of kinesiological taping applied to the gastrocnemius muscle were significantly lower than the values before the application (p=0.011 and p<0.001, respectively), and similarly, the 48th hour speed value was significantly lower than the 30th minute after application (p=0.025). The agility values of kinesiological taping applied to the gastrocnemius muscle in all three time periods after application were significantly lower than the values before the application (p<0.05). The values at the 48th hour were found to be lower than the agility values at 30th minute and 24th hour (p<0.001 and p=0.002, respectively).

The comparison of KT applied to the quadriceps and gastrocnemius muscles was made according to the speed performances before the application, 30 minutes after application, 24 hours after application and 48 hours after application (Figure 4).

A comparison of KT applied to quadriceps and gastrocnemius muscles was made according to agility performances before the application, 30 minutes after application, 24 hours after application and 48 hours after application (Figure 5).

A comparison of KT applied to quadriceps and gastrocnemius muscles was made according to flexibility performances before the application, 30 minutes after application, 24 hours after application and 48 hours after application (Figure 6).

Discussion

Different results have been revealed on the effects of KT on sport and performance. Although there are studies showing that KT has a positive effect on sports performance, there are also studies showing that it has no effect[24]. In this study, speed, agility and flexibility tests were performed on quadriceps and gastrocnemius muscles at 4 different times before and after the KT application and no statistically significant difference was found between them (Table 2). It was reported in a study conducted on 14 healthy young athletes that KT applied to hamstring and quadriceps muscles had no effect on muscle strength, and there was no significant difference in measurements made before taping, immediately after taping and 12 hours after taping[25]. In a study on elite weightlifters, KT and sham tape application was performed on 42 athletes and muscle strength performances were measured. KT was applied to gluteus maximus, quadriceps and gastrocnemius muscles of the athletes for 30 minutes. It was found that KT had a significant effect on horizontal jump distance but not on vertical jump height and muscle strength[26]. In a study conducted on track and field athletes, it was reported that the taping applied to different muscle groups (rectus femoris, hamstring, gastrocnemius and iliopsoas muscles) had no significant effect on performance[27]. Accordingly, this study was in parallel with the literature and no significant difference was found between them.

In this study, it was found that the difference between the mean/median values of agility before the application and at 30 minutes, 24 hours and 48 hours after the application of KT applied to the quadriceps muscle was statistically significant, while there was no significant difference between the speed and flexibility values (Table 2). The mean/median agility value at 48th hour after the application was found to be significantly lower than the agility values before the application and at 30th minute and 24th hour after the application ($p<0.05$) (Table 3). In many studies, it has been reported that taping has no effect on isokinetic performance[28-31], muscle strength and endurance at the end of measurements made at certain periods in KT applications to the quadriceps muscle[32-35]. As in this study, Özmen et al.[36], Şentürk et al.[37] and Karavelioğlu et al.[38] reported that the KT application to the quadriceps muscle had no effect on speed and flexibility performance. In another study, Mostaghim et al.[39] reported an increase in speed and agility performance.

It was found that the difference between the speed and agility values of KT applied to the gastrocnemius muscle before the application and 30 minutes, 24 hours and 48 hours after the application was statistically significant, while there was no significant difference between the flexibility values (Table 2). Accordingly, the speed and agility values at the 30th minute, 24th and 48th hour after the application were significantly lower than the values before the application. In the literature, it was reported that KT applications increased the peak strength of the muscle immediately and 48 hours after taping in the gastrocnemius muscle[40], effected on explosive muscle strength in the gluteus maximus muscle[41], and increased ankle range of motion and agility in the gastrocnemius muscle[42]. It is believed that the reason for the differences with the literature may be related to the application technique (tension % etc.).

In parallel with the findings of this study, it was reported that KT applied to gastrocnemius, quadriceps and hamstring muscles had no effect on flexibility[43-45]. In line with the selected test protocol, the flexibility evaluation performed on the sit and reach box is mostly aimed at evaluating the muscle group on the waist, pelvis and hip. Therefore, it can be suggested that taping in quadriceps and gastrocnemius muscle groups had no effect on flexibility. As the gastrocnemius muscle has a longer and more flexible tendon structure, it provides a wider range of motion in acceleration[46]. As a result, it can be concluded that taping to the gastrocnemius muscle is more effective than taping to the quadriceps muscle for the purposes acceleration and therefore it has no effect on flexibility.

In our study, it was found that the measurements made 48 hours after KT had a significant positive effect on agility in quadriceps muscle and speed and agility performance in gastrocnemius muscle. In a study conducted on healthy individuals, it was found that the bioelectrical effect of kinesiological taping applied to the vastus medialis obliquus muscle appeared 24 hours after application and the effect continued for 48 hours after the tape was removed[47]. In the same study, a statistically significant increase in the bioelectric activity of the muscle was found after 72 hours of KT. However, this effect was found to be lower than the effect of 24 hours KT.

Limitations

Our study had several limitations. Firstly, we did not include a placebo-taping group, which could have helped eliminate the placebo effect. Additionally, the absence of a control group and the relatively small sample size are notable limitations. It's important to note that our study included only male participants. It's worth mentioning that our study faced a challenge when tests were extended beyond three days because of the inability to restrict participants' activities between assessments, which may have affected the accuracy of our estimates. Lastly, various motoric tests could have been included in our research.

Conclusion

KT may create different responses in muscle groups. This study found that KT was effective in increasing agility performance in both muscle groups, but had no significant effect on flexibility performance. The speed performance increased with KT applied to the gastrocnemius muscle, but it was not sufficient to increase performance in the quadriceps muscle. Accordingly, it is believed that the application of KT to both muscle groups in a way to remain in the body for 48 hours will further increase the mechanism of action.

Ethics approval

The study was approved by the Ethics Committee of the Non-Interventional Research Ethics Committee of Hitit University (Approval Number: 2019-176) and received written permission from the Yozgat Provincial Referee Board. All procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki.

Consent to participate

Participants were informed and provided written consent by signing the Informed Voluntary Consent Form.

Authors' contributions

Data collection: Tolga Hanayoğlu, Analysis: Sema Can, Tolga Hanayoğlu, Writing: Tolga Hanayoğlu, Sema Can, All authors read and approved the final version of the manuscript

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