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Original Article

Improvements in strength and functional performance after Kinesio taping in semi-professional male soccer players with and without functional ankle instability

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ABSTRACT

Objective: The objectives of this study were to compare the immediate effects of two methods of Kinesio taping on muscle strength, functional performance, and balance in athletes with and without functional ankle instability (FAI).

Methods: The present study investigated the effects of distal taping (muscle application over peroneus longus) and proximal- distal taping (muscle application over gluteus medius and peroneus longus) on the strength of evertor and hip abductor muscles, side hop test, figure of 8 hop test, and star excursion balance test in semi-professional male soccer players with and without FAI (n = 15 in each group). A Multifactorial repeated measure ANOVA was used for comparison.

Results: There were significant differences for factor effect in all outcome measures ($P < 0.05$), except for the figure of 8 hop test. No significant differences for group effects and group by factor interaction effects ($P > 0.05$) was observed except for the side hop test.

Conclusion: Kinesio taping had immediate effects on improving strength, performance and balance. However, there were no differences on the method of application. Clinicians can consider the application Kinesio taping during the rehabilitation process of athletes with FAI, to improve balance and strength. The long-term impacts of taping on the functional, balance and strength measures should be investigated in future studies.

1. Introduction

Lateral ankle ligament injuries are one of the most common injuries in the human musculoskeletal system [1]. Almost half (49.3%) of the ankle sprains occur during sports activities [2] and it has a high rate in American football and basketball (1.34 per 1000 people [3]. The general incidence rate of it is 2.4 per 1000 people-hours in sports teams [4]. Following an initial sprain, 73% of patients experience at least one sprain and 59% of patients develop prolonged disabilities. Between 30% and 70% of the primary sprains result in the development of chronic ankle instability (CAI) [2]. Ankle sprains are reported as being the most common injury in soccer [5] with the incidence rate of 2.52 per 1000 person-hour [6].

Many studies have examined the lower limb muscular strength in patients with CAI. Several studies have identified muscle weakness in evertor and invertor muscles, as well as the hip stabilizer muscles like the gluteus medius muscle [7–9]. While strengthening exercises are among the most common rehabilitation protocols for patients with CAI, there are also some evidence on the impacts of Kinesio taping on muscle tone and activation.

Kinesio tape was developed by Dr. Kenso Kase in Japan more than 25 years ago. This technique, in theory, is used as an alternative method to support fascia, muscles and joints. However, unlike the rigid athletic tape, Kinesio tape does not limit the range of motion and also, reduces recovery time by reducing pain and inflammation [10]. This taping method was used during the Olympic Games in Seoul in 1988. Since

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then, Kinesio taping was considered as an effective intervention, especially in athletes to support the fascia, muscles, and joints [10]. In addition to the clinical benefits associated with Kinesio tape, Kase also suggested that Kinesio tape may be used to regulate the muscle tone; this claim is supported by "augmented muscle activity" reports following the application of Kinesio tape aligned with the muscle orientation, from the origin to insertion [11]. However, the exact physiological mechanisms are not described so far. Several studies have suggested different theories on the mechanisms of muscle activation after the application of Kinesio tape such as increased motor neurons recruitment [11]. A study by Sihlali theorized that Kinesio tape may improve muscle tone by activating more muscle spindles through sensory-motor pathways. That is, via a sensory-motor mechanism, Kinesio tape stimulates the mechano receptors in the skin and, by reflex action, causes changes in the muscle tone [12].

There are several studies on the effect of taping (rigid athletic tape, Kinesio tape) with different methods on functional performance (FP) and postural control in subjects with CAI, but the results of these studies are controversial and there is not enough evidence to support the therapeutic impact of Kinesio Tapping. For instance, in a study by Baldrige and Nakajima, the application of Kinesio taping in young healthy individuals did not change their performance in vertical jump test, but improved the postural control in different directions [13]. However, another study by Belford showed that postural stability was not influenced significantly after Kinesio taping intervention in elite soccer players with CAI [14].

The aim of this study therefore, was to assess the impact of Kinesio taping over (1) peroneus longus muscle (distal approach), and (2) over gluteus medius and peroneus longus (proximal- distal approach) on dynamic balance, muscle strength, and functional performance, in semi-professional male soccer players. The application of Kinesio taping over these muscles was hypothesized to improve the selected outcome measures in athletes with and without FAI.

2. Methods and material

This study was performed at the Biomechanic Laboratory of the School of Rehabilitation, Tehran University of Medical Sciences. The study was approved by Ethics Committee at the Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1396.4225) and Iranian Registry of Clinical Trials (IRCT20171028037057N1).

2.1. Participants

This study was part of a larger project that investigated the influence of Kinesio taping on athletes with and without FAI. Fifteen participants with FAI (15 males; age, 23.07 ± 4.76 years old; weight, 70.80 ± 8.90 kg; height, 179.53 ± 4.39 cm; BMI, 21.90 ± 2.43 kg/m2) and 15 healthy controls (15 males, age, 23.73 ± 4.95 years old; weight, 75.87 ± 6.07 kg; height, 177.07 ± 5.51 cm; BMI, 24.25 ± 2.27 kg/m2) volunteered in response to the public announcement. All participants read and signed the informed consent form and completed the initial assessment of their demographic data via a questionnaire and measurements of their weight and height.

Participants were recruited from semi-professional male soccer players and were divided into the FAI or the control group based on the following inclusion criteria. Participants were allocated to the FAI group if (1) their age ranged between 18 to 32 years old; (2) had a history of at least one ankle sprain on one side in the past 6–12 months and at least two episodes of a "giving way" sensation; and (3) had decreased function due to their history of ankle sprains by scoring 90% on the Foot and Ankle Ability Measure (FAAM) and 80% on the FAAM-Sport [15]. Participants were included in the control group if (1) their age ranged between 18 to 32 years old; (2) they had no history of ankle sprains or no feeling of ankle joint instability on either side. All the participants exercised regularly; three sessions a week with each session lasting at least for 2 h. Participants were excluded if they had balance impairments or neurological disorders, a history of lower extremity surgery or fracture, and skin allergy to Kinesio taping.

2.2. Intervention

The experiment time for each participant was before doing daily workouts and one week before participating in a sports competition. The data collection was performed on two separate occasions, at one-week interval. The sequence of interventions was randomized during the first session, using concealed opaque envelops with a red or blue card inside. The red card was allocated to the distal application of Kinesio taping and the blue card was allocated to the proximal- distal application of the Kinesio tape on the first sessions. In the next session, the intervention method was the opposite of the first session. The outcome measures were assessed on both sessions, before and 30 min after the tape application.

At the start of each session, the examiner asked the participants to do the stretching and warm-up exercises for lower extremities to prevent the possible injury during the test. A certified Kinesio taping practitioner administered all interventions. The kinesiology tape (Red Kinesio Tex Tape, Tmax, South Korea) was used for all interventions. For participants with FAI, the Kinesio taping was applied on the affected side. The tested side in the control group was matched with the participants with FAI.

In the distal Kinesio tape application, I-strip Kinesio tape was applied on the peroneus longus muscle in the long sitting position. The anchor of the Kinesio tape was attached to the head of fibula, and the end of it was attached to the plantar surface of the first metatarsal bone without tension. The base was attached to the pathway of peroneus longus with 35% tension and at the same time therapist asked the participants to do the plantar flexion and inversion in order to apply stretch on the tissue (Fig. 1A) [16].

In the proximal- distal Kinesio tape application, in addition to the peroneus longus application, the gluteus medius application was used. Two I- strip were used. The first third of the first I-strip attach to the posterior iliac crest without tension to provide an anchor. Then the examiner asked the participant to flex the adducted hip and apply the base of it with approximately 35% tension. Consequently, with the leg in its original position, the end of the tape was attached without tension at the greater trochanter. Afterward, the second I-strip was applied in the same way beginning at the anterior iliac crest (Fig. 1B) [17].

2.3. Outcome measures

The outcome measures included hip abductors and ankle evertors muscle strength using hand-held dynamometry, functional performance using side hop test, and figure of 8 tests, and dynamic balance using star excursion balance test (SEBT) in the anterior, posteromedial, and posterolateral directions. Participants were allowed to practice the tests up to 3 times [18]. When participants became familiar with the tests, they performed 3 repetitions for each test. There was a thirty-seconds of rest period between each repetition, and a one-minute rest interval between the different tests.

2.3.1. Isometric muscle strength

The Micro Manual Muscle Tester (North Coast Medical Inc., US) was calibrated and the hip abductors and ankle evertors isometric muscle strength were measured. To measure the hip abduction isometric muscle strength, participant was positioned in the supine position with the head and neck supported by a pillow, hands across their chest, hip in neutral position, and knees in extension. The dynamometer was placed above the lateral malleolus and after counting down to 3, the participant directed the maximal isometric abduction force into the dynamometer and held the contraction for 5 s. The examiner used standardized verbal encouragement during these tests.

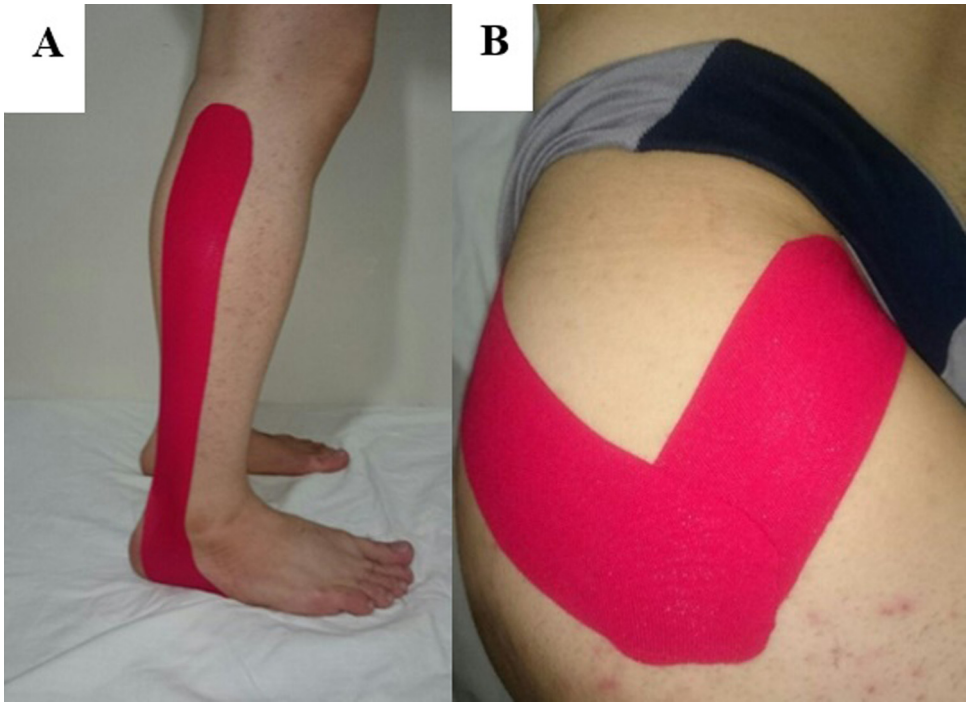

Fig. 1. (A): distal Kinesio tape application on peroneus longus muscle, (B): Proximal application of Kinesio tape on gluteus medius muscle.

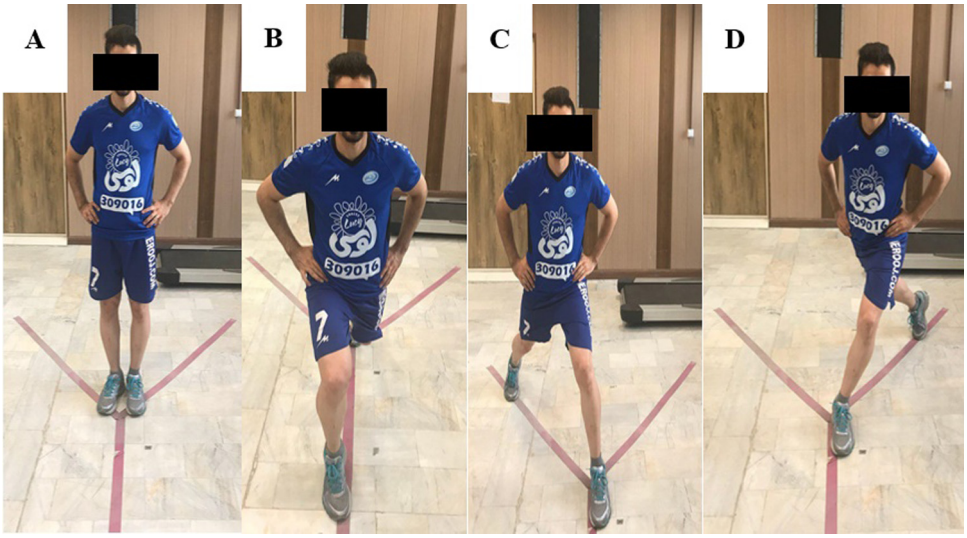

Fig. 2. Star excursion balance test (SEBT); (A): Start position, (B): Anterior reach, (C): Posteromedial reach, (D): posterolateral reach.

To measure the ankle eversion muscle strength, participant was positioned in supine position with the head and neck supported by a pillow, hands across their chest, and their feet over the edge of the bed. The examiner stood beside the tested foot. The pelvis and lower limbs were stabilized by a non-elastic belt to prevent unwanted motion. The foot on the tested side was positioned in 10-° plantar flexion. The dynamometer was placed on the outer edge of the foot, just below the fifth metatarsal and after counting down to 3, the participant directed the maximal eversion force into the dynamometer and held the contraction for 5 s [18]. The examiner used standardized verbal encouragement during these tests. The generated force in isometric muscle strength tests was reported in Newtons.

2.3.2. Functional performance tests (FPT)

2.3.2.1. Side hop test. For this test, two parallel lines (30 cm apart) were marked on the ground using tapes. Participants were asked to hop over both lines and return to the start position, repeatedly for 10 times. The total time for hopping the route (about 6 m) was recorded in seconds and used for analysis [19].

2.3.2.2. Figure of 8 hop test. For this test, the distance of 5 m was plotted with two cones. Participants were asked to hop the figure-8 path twice as fast as possible. The total time for hopping the route was used for evaluation [19].

Side hop test and figure- 8 hop test were performed three times and the best performance (minimum test time) was taken for analysis. If participant touched the tapes on the floor or the cone, the non- tested foot hit the ground, or if the participant left the designated path, the test was considered fail and was repeated again [19].

2.3.3. Dynamic balance

2.3.3.1. Star excursion balance test (SEBT). Participants stood in the

center of a circle, which consists of three radii at 135° in the anterior (ANT), posteromedial (PM), and posterolateral (PL) directions. These three directions are the best directions to assess and detect the "reach deficit" associated with CAI [19]. The examiner asked the participant to look straight forward and stand on one leg and reach as far as possible with the opposite foot. The point of reach was marked and the distance from the center of the circle to the marked point was measured. Then, the participant returned to the starting position while marinating balance (Fig. 2). The test was considered as fail if the participant touched the line at any time during the test, or lost his balance, or the stance foot was raised from the center of the circle. The reach distance was measured in centimeters and was normalized by dividing by the length of the lower limb (the distance between the anterior superior iliac spine (ASIS) and the inner end of the medial malleolus) and multiplied by 100 [19]. This test was performed three times in each directions and the average of the three repetitions was taken for analysis.

3. Statistical analysis

All data were analyzed using Statistical Package for the Social Sciences (SPSS) software version 19. A one- sample Kolmogorov–Smirnov test was employed to check normal distribution of all variables ($P > 0.05$). For comparison of anthropometric data between athletes with and without FAI, independent t- test was employed. Multifactorial 2 (FAI and control groups) * 2 (Kinesio taped and non- Kinesio taped legs) * 2 (distal and proximal- distal Kinesio tape applications) * 2 (before and after intervention) repeated measure ANOVA was used. Each test consisted of three within- subjects (leg, intervention, and time of assessment) and one between- subject (group) factors. Repeated measurement assumption was check out. When the spherity assumption was rejected, the Greenhouse–Geisser test was employed. In the face of the significant difference, Bonferroni post- hoc tests were used to determine the difference is related to which test conditions. In all statistics test, P-value were considered less than 0.05.

4. Results

The Kolmogorov–Smirnov test revealed normality of all data ($P > 0.05$). There were no significant differences between the FAI and control groups in regard to anthropometric data ($P > 0.05$) (Table 1).

The main significant effects in factor were detected for hip abductors muscle strength ($F = 3.56$, $P = 0.005$), ankle evertors muscle strength ($F = 1.50$, $P = 0.000$), SEBT- ANT ($F = 4.30$, $P = 0.002$), SEBT- PM ($F = 2.54$, $P = 0.045$), and SEBT- PL ($F = 7.43$, $P = 0.000$). Also repeated measure ANOVA exhibited significant effects in group ($F = 5.42$, $P = 0.027$), and group by factor interaction ($F = 2.63$, $P = 0.026$) for strength of ankle evertors (Table 2).

The average ankle evertors muscle strength increased after Kinesio tape application. Also, the mean difference value indicated that control group had higher evertor muscles strength than athletes with FAI (mean difference = 1.453, standard error = 0.624, $P = 0.027$).

Due to the non- significant results of the main effects for figure of 8 hop test, Bonferroni post- hoc test was not applied.

However, the factor effect ($P = 0.045$) on the mean value of SEBT-PM was significant, but after checking the post- hoc test, no significant difference were observed in the different test conditions, which can be due the close significance to 0.05 and the small effect size (0.083).

5. Discussion

The aim of the present study were to compare the effects of two methods of Kinesio taping over (1) peroneus longus, (2) gluteus medius and peroneus longus muscle) on muscle strength, functional performance, and balance in semi-professional male soccer players with and without FAI. The main findings of this study were that the application of Kinesio taping improved the strength of the hip abductor and ankle evertor muscles, the performance in SHT and SEBT in anterior and posterolateral directions immediately. But we found no differences between the methods of application.

These findings are consistent with findings of previous studies. Elshemy et al. compared the effect of Kinesio taping with proprioceptive exercises on the dynamic position sense of ankle joint, and the concentric strength ratio of eversion to inversion in children with FAI. Post-treatment results revealed the effectiveness of Kinesio tape on improving the dynamic position sense of ankle and the concentric strength ratio of eversion to inversion [20]. Halim-Kertanegara et al. showed that taping enhances perception of stability, confidence, and assures a person in performing dynamic tasks. However, these improvements in perception and self-efficacy did not lead to general improvements in performance [21]. Evidence suggest that mechanisms provided by Kinesio tape are different from the mechanisms involved in traditional taping [20]. In addition to being structurally supportive like the sport athletic tape, it is suggested that Kinesio tape may modifying muscle function by increasing the generated tension demonstrated by electromyography or isokinetic dynamometer testing; improving blood and lymphatic flow; reducing the pain through the neurologic suppression; and correcting of the condition of the subluxed joints by reducing the normal muscle tone, helping to return the function of the fascia and muscle. Another mechanism proposed by Murray is that Kinesio tape may provide rapid sensory- motor feedback through a direct connection between the skin and tape and improves the proprioception by increasing the stimulation of cutaneous mechanoreceptors [22]. Another important factor might be that Kinesio taping may improve self- confidence and sense of stability leading to the better performance.

Another finding of our study was that there were no significant differences between two groups in regard to functional performance tests. Several studies have demonstrated that participants with CAI have impaired functional performances during the single leg hop test, figure of 8 hop test, and side hop test but not in the up- down hop test, compared to controls [18,23].The differences between our findings and previous studies might be due to our participants being semi-professional soccer players requiring to perform these functional tasks frequently and during their trainings or sport activities. Nakajima and Baldrige [13] studied the effect of Kinesio tape on vertical jump and dynamic postural control in young people, and there was no significant difference in vertical jump height in patients with Kinesio tape application. This study demonstrates the limited effects of Kinesio tape on dynamic postural control compared to placebo group. The significant

Table 1
The results of the Independent t-test for the comparison of anthropometric data between athletes with FAI and control group (n = 15 in each group).

Variables	Mean ± SD		Range		Sig. (2- tailed)
	FAI		FAI	Control	
Age (year)	23.07 ± 4.76	23.73 ± 4.95	18–32	18–32	0.71
Weight (Kg)	70.80 ± 8.90	75.87 ± 6.07	55–91	64–86	0.08
Height (Cm)	179.53 ± 4.39	177.07 ± 5.51	171–187	169–188	0.19
BMI (Kg/M2)	21.9 ± 2.43	24.25 ± 2.27	17.36–26.88	20.09–28.38	0.06

Table 2
The before- after values of strength, functional performance, and SEBT in two different Kinesio tape applications (15 athletes with FAI, 15 healthy controls).

Variables	Distal Kinesio taping				Proximal- distal Kinesio taping			
	Kinesio taped leg		Non-Kinesio taped leg		Kinesio taped leg		Non-Kinesio taped leg	
	Before	After	Before	After	Before	After	Before	After
FAI								
Hip abductors (N)	151.60 ± 28.60	143.50 ± 24.00a	143.00 ± 29.70	NA	144.50 ± 28.40	143.40 ± 30.50	136.10 ± 28.00a	NA
Ankle evertors(N) I, II	83.90 ± 15.80b, c	86.00 ± 20.5b, d, e, f	80.20 ± 17.80d	NA	77.20 ± 18.80e, g	80.50 ± 18.60g, h	76.30 ± 14.40c, f, h	NA
Side hop test (s)	7.61 ± 2.06i, j	7.03 ± 1.43k, l, m	7.73 ± 1.73k	NA	8.47 ± 2.76i, l, n	7.76 ± 2.38m, n	8.49 ± 3.53j	NA
Figure of 8 hop test (s)	11.39 ± 1.63	11.42 ± 1.54	11.42 ± 1.88	NA	11.50 ± 1.62	11.60 ± 1.67	11.32 ± 1.68	NA
SEBT- ANT (cm)	128.79 ± 18.93o, p	129.68 ± 18.72	127.63 ± 18.52	129.54 ± 19.89q, r	122.58 ± 19.76o, q	127.08 ± 20.91	120.82 ± 20.73p, r	125.80 ± 23.07
SEBT- PM(cm)	118.39 ± 16.85	121.51 ± 15.51	121.38 ± 16.07	121.02 ± 16.67	116.62 ± 14.37	118.16 ± 16.87	115.66 ± 16.35	120.75 ± 18.45
SEBT- PL(cm)	111.07 ± 16.53S	114.42 ± 17.08t	113.03 ± 14.67	116.31 ± 13.06s, u, v, w	105.14 ± 20.75u	112.91 ± 16.21w	102.87 ± 14.65t, v	112.81 ± 15.63
Control								
Hip abductors(N)	164.00 ± 35.90	171.10 ± 33.50a	158.30 ± 34.40	NA	155.50 ± 30.70	164.20 ± 30.90	155.30 ± 30.00a	NA
Ankle evertors(N) I, II	94.80 ± 20.00b, c	105.20 ± 23.70b, d, e, f	94.80 ± 20.80d	NA	90.00 ± 15.10e, g	102.6 ± 20.70g, h	84.10 ± 19.00c, f, h	NA
Side hop test (s)	7.18 ± 1.11i, j	6.98 ± 1.14k, l, m	7.26 ± 1.13k	NA	8.08 ± 0.67i, l, n	7.55 ± 0.74m, n	8.06 ± 0.62j	NA
Figure of 8 hop test (s)	10.78 ± 1.18	10.99 ± 1.42	10.80 ± 1.03	NA	11.32 ± 0.95	11.33 ± 0.99	11.31 ± 0.94	NA
SEBT- ANT (cm)	131.18 ± 15.58o, p	131.61 ± 17.41	129.00 ± 19.40	132.76 ± 19.02q, r	127.71 ± 18.61o, q	132.50 ± 20.15	127.87 ± 18.30p, r	130.50 ± 20.18
SEBT- PM (cm)	120.99 ± 11.64	122.78 ± 12.44	120.09 ± 12.59	122.64 ± 14.99	119.57 ± 18.61	122.39 ± 20.15	118.75 ± 11.21	121.81 ± 11.30
SEBT- PL (cm)	113.97 ± 11.09S	118.84 ± 15.71t	118.05 ± 14.39	120.77 ± 12.43s, u, v, w	112.60 ± 11.16u	115.53 ± 12.09w	114.33 ± 10.20t, v	117.15 ± 13.74

Abbreviations: NA not assessed; SEBT Star Excursion Balance Test; ANT Anterior; PM Posteromedial; PL Posterolateral.
Data were expressed as mean ± standard deviation.
a to w indicate significant results for factor effect ($P < 0.05$).Iindicates significant result for group effect ($P < 0.05$).IIindicates significant result for group by factor interaction effect ($P < 0.05$).

effect was apparent only for female participants and only in the posteromedial and medial directions of the SEBT test. Additionally, positive effects were observed in SEBT scores for the two conditions before and 24 h after application, but no significant differences were observed between the pre and post- Kinesio tape application. Therefore, these findings may indicate that the potential effects of Kinesio tape application on postural control may be observed after long-term use. One possible explanation is that tactile inputs induced by Kinesio tape were not powerful enough to increase muscle strength for vertical jump, but were sufficient to stimulate cutaneous mechanoreceptors to improve muscle excitability. This is consistent with a study that looked at the effects of orthotics on dynamic postural control. In a study by Olmsted and Hertel, SEBT scores improved in patients with external orthotics, possibly due to the increase in plantar mechanoreceptors that improve neuromuscular function, and resulting in increased dynamic stability [24].

Ankle taping is usually used by exercise instructors to prevent the occurrence and exacerbation of lateral ankle sprain. Occasionally, players with a history of previous injury may avoid ankle taping as they believe taping negatively limits and impacts their performance. Similar to our findings, studies by Ambegaonkar et al. (2011) and Verbrugge (1996) have shown that taping does not change the functional performance as measured by the Y-shaped agility test. Jeffries et al. also showed that ankle taping does not significantly change the programmed changing direction and the reactive agility and does not greatly alter the activity of the muscle complex in healthy basketballers [25].

Motte et al. examined the effects of taping on the specific patterns or reach strategies through the kinematic and kinematic 3D components in individuals with FAI during the SEBT test. No differences were observed in each of the reach directions and in each of the tested conditions (including no tape and control condition) [26]. These findings contradict with previous published results. Different methods with multiple analysis of data may explain this difference. For example, Olmsted et al. [24] did not normalize the reach distance to the length of the limbs, nor did they report that the individuals with the FAI and the control group were significantly different in height, and this is necessary to normalize the reach distance to limb length, because individuals with a longer leg are able to reach more. Without normalizing, it is not possible to determine whether there is a real difference of reach distance in these individuals or not.

In addition, Olmsted et al.' study showed that the posteromedial reach distance indicates the performance of all 8 directions of SEBT regardless of the condition of the injury [24]. Our study used the anterior, posteromedial, and posterolateral directions to reduce the time of data collection and to increase the probability of determining the differences in reach distance in athletes with FAI, but no difference in reach distance was found between two groups and could not confirm Hertel's study. Participants in the Hertel study were allowed to use their arms to balance during SEBT. However, the reach distance alone is not sufficient to determine the possible differences between individuals with and without FAI, since there is a high kinematic redundancy and variability in the human motor system. Therefore there is a need to consider other factors affecting the reach distance, liked the angular displacement and the torque of the lower limb joints to obtain a more complete picture of the involved components.

Matsusaka et al. applied a single strip of tape on the peroneal tendons over a 10-week rehabilitation period for individuals with FAI. The results showed that these individuals were able to get faster at the levels of non- injured postural sways control group (no tape) during the rehabilitation [27].

Lee et al. observed that the real ankle balance taping (ABT) compared with the non-ABT condition increased the reach distances in the anterior, posterior, medial, and posterolateral directions of the SEBT test, and significantly increased the placebo in the ABT group The anterior, posterior, and lateral tests of SEBT. The ABT method used in this study may provide greater ankle stability by adjusting the posterior glide of talus for dorsiflexion and the precise mediolateral movements of calcaneus to help inversion or eversion, which is the main cause of inversion [28].

Correia et al. evaluated the effect of two different applications of Kinesio (changing the direction of application) for twenty minutes on postural sways and latency time of peroneus longus. In this study, no significant difference was found in the EMG activity of peroneus longus muscle and the tactile effects induced by Kinesio tape to alter the muscle contraction pattern in this particular activity were not sufficient. The results of this study indicated that no facilitations or inhibitions occurred, and the Kinesio tape, regardless of its application, does not only affect muscle activity, but also does not improve postural sways [29].

Shields et al. Observed limited improvements after 24 h of Kinesio tape application, while no significant differences were observed immediately after taping or removing the tape. In addition, they showed that there are deficits in the unstable ankles compared to the two groups with healthy ankles and coper. However, the variable indicative of post-taping improvement was not the same as the one showing the instability of the ankle [30].

The initial finding of Jackson et al. was that improvement in balance scores occurred after Kinesio taping was used for 48 h in participants with CAI. One of the most important findings of this study was probably that balance recovery remained for 72 h, even after tape removal. This finding was unique in its compared to other Kinesio tape articles, as one of the few articles that describes the effects of Kinesio tape on the balance in participants with CAI when the tape is used for a long period of time. After Kinesio tape was used for 48 h, BESS errors were reduced by 24% to the baseline, 72 h after the taping, the errors fell by 18% due to the long-lasting effect of Kinesio tape on the skin. When this tape was worn for several days, cutaneous receptors and mechanoreceptors were permanently stimulated. Given the closed-loop theory, a stimulation (which can be tactile, compressive, or other types) stimulates the body and produces a quick feedback information from the organs. The body compensates or adapts by receiving the feedback from the stimulator, even after removing it [31].

The present study had several limitations. First, we just measured the immediate effects of Kinesio taping and not long-term effects. Second, we did not measure torque and just measured force as a measure of muscle strength. Future studies should investigate the long-term effects of Kinesio taping.

6. Conclusion

Based on the results our study, Kinesio taping has the potential to increase strength and better performance and balance immediately after the application. This finding might have applications for athlete's performance during their sporting performance in which they may observe immediate change after the application of Kinesio tape. However, the mechanism of these impacts are not still clear.

Clinical application

Our findings could be applicable for short-term improving of strength and functional performance in athletes with FAI, especially in sports that require sideway movements and landings.

Conflict of interest

The author declared that they have no conflict of interest.

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