

Effects of Kinesio Tape on kinesiophobia, balance and functional performance of athletes with post anterior cruciate ligament reconstruction: A Pilot Trial

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Abstract

Background : This study aimed to investigate the effects of Kinesio Taping on Kinesiophobia (fear of re-injury), balance and functional performance in athletes after anterior cruciate ligament reconstruction.

Methods: This randomized, placebo-controlled clinical trial was performed on 20 athletes with anterior cruciate ligament reconstruction (mean age 32.35 ± 6.25 years) at the time of return to sport. The participants were selected using purposive sampling approach and they were randomly assigned to kinesio tape group (n=10) or placebo kinesio tape group (n=10). While subjects under taped, the following outcomes were measured at baseline, ten minutes after the intervention, and two days later. Kinesiophobia, balance, strength, functional / agility performance was assessed by Tampa Scale, Y balance test (YBT), single leg hops and 10-yard extremity functional test, respectively. Data were analyzed using the repeated measure analysis of variance (RMANOVA) in the SPSS v.23. Results: Two days after Kinesio taping, the difference between the scores obtained in the first and the second measurements for all variables in the kinesio tape group was not significantly different rather than placebo kinesio tape group (all $P > 0.05$). The difference between scores of the third and the first measurements of all variables was also not significantly different in the kinesio tape group compared to the placebo kinesio tape group (all $P > 0.05$). In the kinesio tape and placebo kinesio tape groups, RMANOVA indicated that the differences in all variables scores were significant over time ($P < 0.001$), Sidak post-hoc test indicated that the differences between the first and the second measurements, as well as between the first and the third measurements were significant ($P < 0.001$). Conclusion: This study gives no support for any beneficial effect of kinesio taping on reduction of kinesiophobi or improvement of balance score and functional performance in athletes with post anterior cruciate ligament reconstruction. Trial registration: This study was registered in the Iranian Clinical Trial Center with the code IRCT20190130042556N1, <https://www.irct.ir/trial/37312>, registered 12 February 2019.

Background

Anterior cruciate ligament (ACL) trauma is one of the most common knee injuries in professional athletes [1, 2]. The anterior cruciate ligament plays an important role in the stability of the knee joint during running, exercises and movement of lower extremity. Also it prevents forward movement of the tibia in relation to the femur [2]; therefore, trauma which is happened by an injury to the ligament can cause static and dynamic knee instability, reduce the range of motion, decrease balance, and ultimately decrease professional activity [2, 3]. Pain, swelling, and movement limitations, such as reduction in knee range of motion, strength, and knee function, are other common outcomes after anterior cruciate ligament reconstruction [4].

Kinesiophobia (fear of movement\re-injury) is the most common factor of disability to return to sport, feeling of instability or uncertainty and ultimately disability to get the pre-injury activity levels after anterior cruciate ligament reconstruction [4]. According to the results of the previous case studies, the prevalence of Kinesiophobia as a psychological factor that causes athletes doesn't return to pre-injury levels after anterior cruciate ligament reconstruction is reported between 7 % to 30 % [5, 6].

Recently, Kinesio Taping has been recommended as a noninvasive procedure in the early phase of ACL reconstruction and returning to activity. Because of it is easy to use this method rather than other therapeutic modalities such as TENS, cold therapy, aquatic therapy and manual therapy. Moreover, this treatment is used as a factor for sports' injuries prevention, movement pattern improvement, and increased athletes' performance [2, 7].

Up to now, normalization of muscular function, increasing lymphatic and vascular flow, reduction of pain, contribution to correcting joint malalignments, supporting joints and improvement of proprioception have been introduced as benefits of Kinesio Taping [8, 9]. There are many theories that justify the effects of kinesi taping on muscle activation and joint control, that Kinesio Taping can stimulate superficial (cutaneous) receptors and modify the motor unit recruitment [7, 10].

As anterior cruciate ligament reconstruction changes sensory and motor components of the knee, Kinesio Taping may also be effective in increasing neuromuscular control of the knee and be a supportive treatment along with other rehabilitation interventions [2, 10].

Despite the widespread use of Kinesio Taping, the effects of this method in post-operative ACL reconstruction in athletes are still unclear and little evidence exists for the effects and mechanism of it at this stage [7, 11-14]. Recently, different studies about the effects of kinesi tape on various problems; such as sports injury, pain reduction, decreased range of motion, and muscle force have shown conflicting results and also there are different ideas about Kinesio tape's effectiveness [7, 11, 15]. However, to the best of our knowledge, no study was found about the effects of the knee Kinesio Taping on fear of movement, as a psychological factor in athletes who has done ACL reconstruction in phase of return to exercise. Therefore, additional studies are required to evaluate the effectiveness of this method.

The main reason of this study is considering the effects of knee kinesi tape on fear of movement and performance of athletes, who have undergone ACL reconstruction and are in the return to exercise phase.

Methods

Study design and participants

This double-blind randomized controlled trial with parallel groups was conducted in the physiotherapy clinic of Kermanshah Sports Medicine Federation, Kermanshah, Iran.

After obtaining approval from the Ethics Committee of Shiraz University of Medical Sciences with the code of IR.SUMS.REHAB.REC.1397.017 and registration of the trial in the IRCT website under the code of IRCT20190130042556N1, sampling was conducted from January until April 2019.

The inclusion criteria allowed subjects aged 18-45 years, who had history of ACL reconstruction surgery in the last 6-12 months, those who were scared to move on the basis of the Tampa questionnaire > 37, were athlete on the basis of the Tegner questionnaire (scores > 5 from the Tegner questionnaire), had full range of motion of hips, knees and wrists and had normal gait.

Subjects with severe pain, swelling and range of motion limitation in the knees, dizziness and involvement of the vestibular system, limiting physical activity (e.g. major orthopedic, neurological or rheumatologic problems in the lower extremities, history of previous surgery in the lower extremity and difference in leg's length) were excluded. A trained physiotherapist interviewed the eligible participants for confirmation of the criteria.

As no related study on main outcomes was found; therefore, the sample size was estimated based on a pilot study. In the beginning of the study, pilot information (means and standard deviations of Kinesiophobia as the main outcome measure) was obtained using a preliminary sample of participants. The sample size was calculated as 10 participants in each group to have a statistical power of 80%. Eligible participants were randomly allocated to kinesio tape (n=10) and placebo kinesio tape groups (n=10) with randomized block procedure of block size two using the Random Allocation Software (RAS) version 1.0.0. Random allocation of participants was performed by a statistician not involved in the sampling process. The participants and assessor were blinded to the patients' allocations (Figure 1).

Before any intervention, the study goals and the methods were explained for and written consents were obtained from all participants.

Interventions

Treatment group: To apply the kinesio tapes in the intervention group, 5-centimeter kinesio tape length with 50% elongation was attached from the origin to the insertion of the quadriceps muscle, and then it has splitted to two tails and comes down of two sides of the patella. Then we used a tape in (I) shape, which was sized to extend from the tuberosity of tibia up to 5-centimeter above the femoral condyles in order to modify knee movements and stimulate surface receptors. By flexing the knee at 80 to 90 degrees, we opened the tape from the middle and put on the tibia tuberosity in full tension. Then the stretch of the tails was reduced to about 50 percent to attach them to the femoral condyles (Figure 2).

Control group: In this group, taping was the same as the treatment group without tension in the tape (Figure 3).

Outcome measures

All the outcome's measures were evaluated by a blinded assessor, at the baseline, ten minutes after the intervention and on the second KT treatment day. At each assessment point, Kinesiophobia (Primary outcome), balance, stability and functional performance were measured by Tampa scale, Y balance test (YBT), single leg hop and 10-yard extremity functional test (secondary outcomes), respectively.

Tampa Scale for Kinesiophobia (TSK)

Tampa scale was used to measure the degree of fear of movement (kinesiophobia). This scale was designed by Corey et al. in 1990. It consists of 17 items that every item was scored from 1 (strongly disagree), 2 (disagree), 3 (agree) to 4 (strongly agree). The overall scores were calculated between 17 to

68. The high score shows the greater fear of movement due to pain perception. In this calculation, the score of 37 is the border line of high and low scores. The Persian version of this questionnaire was developed and validated by Jafari et al. (2010) [16].

Y Balance Test (YBT)

This test which is a modified type of Star Excursion Balance Test (SEBT) [17] consists of three tapes in three directions for measurement; anterior, posterior-lateral and posterior-medial. They are stuck to the ground. The posterior tape is positioned 135 degrees from anterior one, and the two posterior tapes are positioned 90 degrees to each other. For evaluation, the subject was in standing position in the middle of these three lines on one leg without shoes. His foot positioned in the center of the intersection of three tapes, and the big toe positioned along the line drawn in the anterior direction. While maintaining single leg stance, the person was asked to move his foot forward as far as possible along these three directions in relation to the stance foot. The distance has been measured by reading the tip of the foot on the meter. The person repeated the process three times for each direction, and the highest score was recorded during the test. After three attempts, if the subject could not perform the test correctly, the test was repeated until could do it at least once. If the subject could not do the test properly with six attempts in each direction, it was rejected in that direction. The test results were normalized in all three directions by dividing the distance to the leg length in cm and then multiplied by 100 to obtain the percentile of the length of the lower limb.

(see Formula 1 in the Supplementary Files)

Single Leg Hop Test

This test is one of the valid functional tests for evaluating the knee, which was used to evaluate the objective performance of the athletes. To perform this test, the subject was asked to stand behind a line then positioned both hands to the back of the body and while maintaining single leg stance, tried to jump and land on the same foot, as far as he could. The test was repeated three times for each foot and the distance from the tip of the toe in the start line to the base of the toe after landing was measured and recorded with one-millimeter precision. The maximum jump record was taken for each individual subject. Results were also normalized based on each person's leg's length [18].

Level of Functional Activity

10-Yard Lower Extremity Functional Test

Starting was line A, subject sprinted ten yards forward to line B then back pedal to line A. Next, subject will side shuffle to line B then side shuffle back to line A. After than subject will carioca to line B and also carioca back to the line A. Finally, subject will sprint through the line B. The subject must make sure to touch each line with his foot (Figure 4). The administrator measured the time. Normal range of records for this test for males has reported 17-20. and for females has reported 19-23 seconds [19].

Data analysis

SPSS software version 23.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analyses. Kolmogorov–Smirnov test was applied to determine normality of the distribution of the quantitative data.

Comparisons of baseline characteristics were performed using independent samples chi-squared test and t-test for qualitative and quantitative data, respectively.

The between-group differences for kinesiophobia, functional performance (Single Leg Hop and 10-Yard test and balance performance) throughout the study were assessed by analysis of Covariance (ANCOVA). Repeated measures ANOVA (RMANOVA) was used to compare differences in outcome measures before, ten minutes and two days after the intervention in each group. Mauchly's test was used to evaluation the assumption of sphericity. All significance was set at $P < 0.05$.

Results

No significant differences were observed for age, height, weight, time of surgery and Tegner score between the two groups. These data are presented in table 1.

In the kinesio tape group, the changes in all study variables (TSK: $F=34.50$; $df= 2$; $P<0.001$, Single Leg Hop: $F=50.75$; $df=2$; $P<0.001$, 10 Yard test ($F=12.61$; $df=2$; $P<0.001$) and YBT scores were significant over time (all $P < 0.05$). Sidak post-hoc test indicated that the differences between the first and the second measurements, as well as between the first and the third measurements and between the first and the third measurements were significant (all $P < 0.001$).

Likewise, for athletes in the placebo kinesio tape group, the results revealed significant changes in the mean value of the TSK ($F=13.41$; $df= 2$; $P<0.001$), Single Leg Hop ($F=21.48$; $df =2$; $P<0.001$), 10 Yard Test ($F=41.85$; $df=2$; $P<0.001$) and YBT scores over time (all $P < 0.05$), (table 2). Sidak post-hoc test indicated that the differences between the first and the second measurements ($P < 0.001$) as well as between the first and the third measurements ($P = 0.001$) were significant; but the difference between the second and the third measurement was not significant in terms of TSK scores ($P > 0.05$).

Although the decrease of TSK score in the kinesio tape group was much more than the decrease in the placebo kinesio tape group, there was not a statistically difference between the two study groups ($P > 0.05$).

Regarding YBT scores, no significant differences between groups for before or after intervention's measures were observed ($P > 0.05$). Likewise, significant statistical changes were not observed between two study groups in terms of Single Leg Hop, and 10 Yard test scores at two days after the Kinesio Taping (all $P < 0.05$) (table 3).

Discussion

The results of the current study showed that the decrease in fear of movement and improvement of functional and balance parameters, not only occurred in the intervention but also in the placebo group. In both groups, after Kinesio Taping, athletes' performance and balance were improved and their fear of movement and injury was decreased significantly, but the results did not show a significant difference between these groups. For the variable of fear of movement and re-injury in the treatment and placebo groups, the score of Tampa Fear Scale decreased significantly compared to the pre-intervention level. Although the level of improvement and reduction of fear of movement in the intervention group was more than the placebo group, but this difference was not significant. These results showed that after ACL reconstruction, applying kinesio tape on the knees of the athletes, reduced the fear of re-injury significantly.

Patients who suffer from musculoskeletal injury are at risk of biopsychosocial impairments, and Kinesiophobia has been reported as one of a variety of biopsychosocial types [20, 21]. In patients with cruciate ligament injury kinesiophobia is more likely to occur in active individuals whose physical damage has improved physiologically but still prevents them from returning to competitive exercise or higher levels of performance [20, 21]. It has been suggested that reducing pain-related fear can lead to pain reduction, because fear of pain is more debilitating than pain itself [22, 23].

Previous studies have considered the effect of kinesi taping on kinesiophobia in patients with musculoskeletal pain. It seems that using kinesio tapes, by instilling a sense of confidence and support in the joint, makes the person ready psychologically to return to the exercise and reduces their fear of movement and injury. Perhaps, because of psychological effect of Kinesio Taping in both groups (treatment group with proper stretching and placebo one without stretching), there was little discrepancy between them, and both groups were benefited from these positive effects. This reduced fear and increased self-esteem can also be a reason for improving other individual variables such as balance, agility, and performance level.

In the Hoffman et al. study, which examined the effects of Kinesio Taping on reducing kinesiophobia in patients with musculoskeletal problems, there was much evidence to suggest that kinesiophobia was reduced by the use of Kinesio Taping in comparison with placebo Kinesio Taping, which is inconsistent with our results [24]. This difference may be due to the different kinesi taping techniques which were used in the placebo group in these studies.

The results of 10-yards lower extremity test as a criterion for evaluating athletes' agility showed that in both treatment and control groups, the test scores decreased significantly during the intervention. Since the 10-yard lower limb test score is the time taken to perform the test in seconds, its reduction is a sign of improvement of agility in athletes, and it shows that kinesotaping can play a significant role in increasing agility in athletes following anterior cruciate ligament reconstruction.

In this study, in order to evaluate the subjects' functional status, the single leg hop test was used. According to the results, the test's scores in the evaluations of immediate stage (ten minutes after the baseline) and short-term stages (two days after the baseline) were increased in both groups. In this study,

increasing the score of the single leg hop test which is jumping distance in meters, proves that the practice of Kinesio Taping can significantly improve the performance of the athletes after anterior cruciate ligament reconstruction. The main reasons for improvement in the single leg hop test are reducing pain and increasing joint proprioception, which are followed by the use of Kinesio Taping.

Oliveira et al (2014), executed a research on patients with ACL rupture after reconstruction in which neuromuscular functions of the quadriceps and balance were evaluated. They reported that there were not any changes in the performance or balance of the kinesio tape group before and after the intervention as well as the placebo group, which is inconsistent with our results. Again, it can be possible that the Kinesio Taping technique, and they're stretching rate were different in these studies [13].

Moreover, Herrington (2004), studied the effect of patellar taping on the single-leg hop test in healthy people, and he reported that no significant effect was observed. The reason for results of the Herrington's study can be attributed to the health status of the subjects. So, maybe there was no pain that the Kinesio Taping to reduce it and improve single-leg hop test [25].

Harput et al. (2016) examined the effect of the knee brace and Kinesio Tape on the level of performance of people who felt six months after ACL reconstruction are unable to return to those activities doing prior to cruciate ligament injury due to fear of movement. In this cross-sectional study, 30 persons who had operated six months ago, were participated. The inclusion criteria were to score above 37 on the Tampa Fear Scale. Participants were evaluated in three situations: Kinesio Tape, braces and no intervention. They were randomly assigned to the groups. Assessments included concentric strength of quadriceps and hamstrings (isokinetic), single-leg hop test and star excursion balance test. Based on the results, both the Kinesio Taping and the knee brace significantly improved the distance hop and balance level of the subjects. But, only the knee braces could significantly increase quadriceps and hamstring maximum torque. Also the patients reported better knee performance in brace and Kinesio Taping than the non-intervention (placebo) group. This study generally demonstrates the positive effects of brace and knee taping on reducing kinesiophobia in people undergoing cruciate ligament reconstruction. It seems that knee brace is more effective than Kinesio Tape in improving knee function [26].

In our study, the comparison between the time after Kinesio Taping and baseline (immediate and short-term evaluations) showed a significant improvement in both treatment and control groups in all three directions of balance. Generally, in both groups and in all directions, the trend of the balance of the athletes' changes at times was similar and increasing.

These results were inconsistent with the results of the Oliviera's study, which has reported that Kinesio Taping did not significantly change the balance level of those people who were undergoing anterior cruciate ligament reconstruction. The reason for this discrepancy in the results of these two studies could be attributed to the way of evaluation of level of balance in participants. Unlike the present study, which used a modified star excursion test, Oliviera et al, chose a baropodometric method to assess their patients' balance. Also, the evaluations of the Oliviera study were done just after Kinesio Taping and if longer-term evaluations were made, it may be obtained other results. In addition, in the current study, the

kinesio tape was applied to the knee joint which could provide more mechanical support and stability than the method of Kinesio Taping in Oliviera's study that only taped the quadriceps. This mechanical stability can increase the balance in subject [13].

The results of the present study regarding of the balance variable are also in line with the results of the study by Harput et al., who reported a significant effect of kinesio tape on balance level and star excursion test score after anterior cruciate ligament reconstruction [26].

In spite of the contradictory results in various studies, still the main finding is the positive effect of kinesio tapes on improving physical abilities. In the post-operative phase of ACL reconstruction, although it was sensitivity of the time and tissue regeneration was required, but applying this technique and inducing skin irritation can improve the index of the treatment process.

Limitations

Limitations of current study include the low number of subjects and the sexually unbalanced distribution of athletes (ratio 2 to 18) due to the limited community available, and also, lack of consideration of the long-term effect of kinesi taping due to the impossibility of long-term follow-up of samples and the limited time for evaluations (the limitation of design time) is another limitation of the current study.

Conclusion

This study gives no support for any beneficial effect of kinesio taping on reduction of kinesiophobia or improvement of balance score and functional performance in athletes with post anterior cruciate ligament reconstruction.

To evaluate the longevity of these therapeutic effects, similar studies with longer-term follow-up in combination with other therapeutic and rehabilitation interventions are suggested.

List Of Abbreviations

ACL: Anterior cruciate ligament; RMANOVA: Repeated measures ANOVA; SEBT: Star Excursion Balance Test; TSK: Tampa Scale for Kinesiophobia; YBT: Y Balance Test

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of Shiraz University of Medical Sciences (IR.SUMS.REHAB.REC.1397.017) and participants provided written informed consent for participation in this study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyses during the current study are available from the corresponding author on reasonable request.

Competing interests

The author(s) declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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No funding was obtained for this study.

Authors' contributions

MGh contributed in original idea and protocol, conception of the work, conducting the study, data analysis, revising the drafting and editing of the manuscript. FK contributed in conception of the work and data analysis. MM contributed in data analysis, wrote and drafting/editing of this manuscript. AM contributed in conception of the work, wrote and editing of this manuscript. M-BSh contributed in original idea and protocol, conception of the work, data analysis, revising the drafting of the manuscript. All authors approval of the final version of the manuscript.

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Tables

Table1. Demographic characteristics of the groups

Variables	Kinesiotape group (n=10)	Placebo kinesiotape (n=10)	p-value
Age(year)	32.00(5.98)	32.70(6.82)	0.810 [#]
Height (cm)	177.40(5.13)	179.60(5.87)	0.384 [#]
Weight (kg)	77.30(11.61)	83(9.83)	0.342 [#]
BMI (kg/m ²)	24.47(2.64)	25.41(2.57)	0.772 [#]
Time of surgery (month)	10.70(1.70)	10.20(2.14)	0.571 [#]
Tegner Score	7.3(1.49)	6.5(1.58)	0.260 [#]
Gender (male/female)	9/1	9/1	1 [*]

BMI: Body Mass Index/ Data are means (SD)/ [#]Based on t independent test/ ^{*}Based on chi-square test

Table2. Repeated measures ANOVA of mean and standard deviation related to kinesiophobia and functional parameters in three measurements for each group

Variables	Time of measurement period	KT group(n=10)	PKT group(n=10)
TSK	Before KT	42.40 (6.65)	44.40(6.20)
	10 minute intervention	37.90(3.87)	41.80(5.81)
	2th KT day	34.90(4.81)	39.30(2.91)
	* Repeated measures ANOVA (inter-group)	F=34.50; df=2; P<0.001	F=13.41; df=2; P<0.001
Single Leg Hop	Before KT	176.69(35.12)	175.67(31.09)
	10 minute after intervention	190.133(34.00)	189.44(24.16)
	2th KT day	197.01(44.01)	196.29(22.71)
	* Repeatd measures ANOVA (inter-group)	F=50.75; df=2; P<0.001	F=21.48; df=2; P<0.001
10 Yard Test	Before KT	26.07(4.53)	24.94(1.35)
	10 minute after intervention	24.67(3.63)	23.47(1.34)
	2th KT day	23.31(2.81)	22.97(1.27)
	* Repeated measures ANOVA (inter-group)	F=12.61; df=2; P<0.001	F=41.85; df=2; P<0.001
YBT (Anterior reach)	Before KT	100.04(10.84)	96.95(5.47)
	10 minute after intervention	105.01(8.82)	100.22(5.63)
	2th T day	105.55(8.63)	105.45(6.01)
	* Repeated measures ANOVA (inter-group)	F=14.92; df=2; P<0.001	F=27.21; df=2; P<0.001
YBT (Posteromedial reach)	Before KT	97.51(13.08)	98.57(9.38)
	10 minute after intervention	102.30(11.44)	104.85(11.23)
	2th KT day	107.37(9.24)	107.41(9.52)
	* Repeated measures ANOVA (inter-group)	F=17.79; df=2; P<0.001	F=43.31; df=2; P<0.001
YBT (Postero-lateral reach)	Before KT	92.63(9.59)	96.04(5.54)
	10 minute after intervention	99.98(8.77)	100.05(5.13)
	2th KT day	105.05(8.72)	103.39(6.97)
	* Repeated measures ANOVA (inter-group)	F=67.75; df=2; P<0.001	F=24.28; df=2; P<0.001

KT: kinesio tape; PKT: placebo kinesio tape; TSK: Tampa Scale for Kinesiophobia; YBT: Y Balance Test; Mean (SD) was reported;*P value from Greenhouse-Geisser test has been reported based on the results of Mauchly's test.

Table3. Comparison of changes in kinesiophobia and functional parameters among the 2 groups of study

Variables	Difference between stages of measurement	Mean Between-Group Difference	95% CI for Difference	#P value (between groups)
TSK	Second measurement to first measurement	-3.55	(-5.01 to 2.09)	0.254
	Third measurement to first measurement	-6.30	(-4.35 to 1.42)	0.172
Single Leg Hop	Second measurement to first measurement	13.99	(-8.76 to 19.21)	0.929
	Third measurement to first measurement	20.66	(-14.03 to 27.28)	0.939
10 Yard Test	Second measurement to first measurement	-1.43	(-2.07 to 0.86)	0.399
	Third measurement to first measurement	-2.37	(-3.42 to 1.32)	0.546
YBT (Anterior reach)	Second measurement to first measurement	4.12	(-1.88 to 6.35)	0.401
	Third measurement to first measurement	7.50	(-4.61 to 10.38)	0.728
YBT (Posteromedial reach)	Second measurement to first measurement	5.53	(-3.62 to 7.44)	0.590
	Third measurement to first measurement	9.35	(-6.44 to 12.26)	0.745
YBT (Postero-lateral reach)	Second measurement to first measurement	5.68	(-3.90 to 7.46)	0.434
	Third measurement to first measurement	9.88	(-7.71 to 12.06)	0.986

TSK: Tampa Scale for Kinesiophobia; YBT: Y Balance; Mean between-group difference and 95% CI for difference were reported/ #P value is reported based on the analysis of covariance

Figures

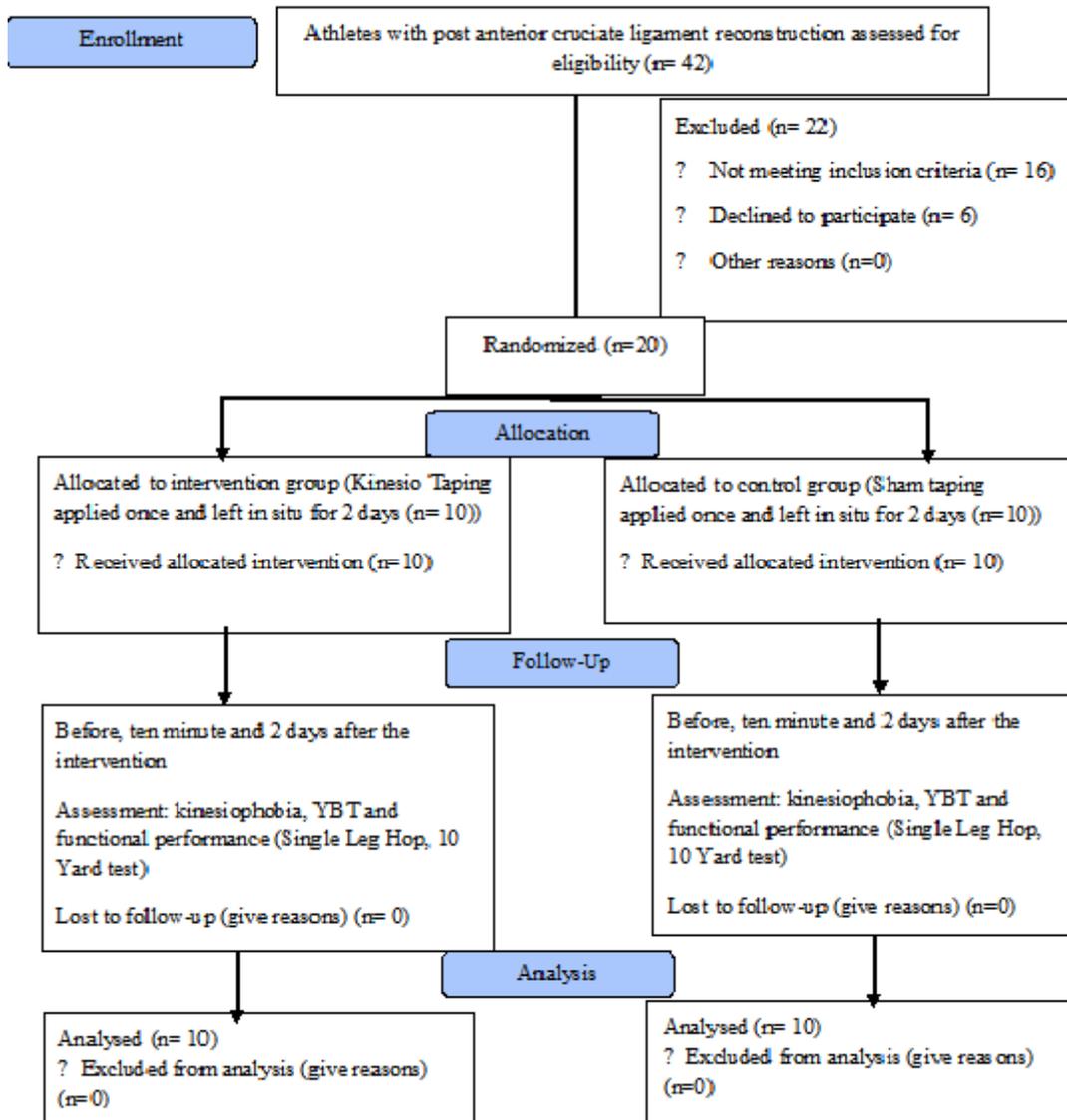


Figure 1

Flow diagram of study selection and data collection process



Figure 2

Kinesio tape applications used in the study



Figure 3

Placebo kinesio tape applications used in the study

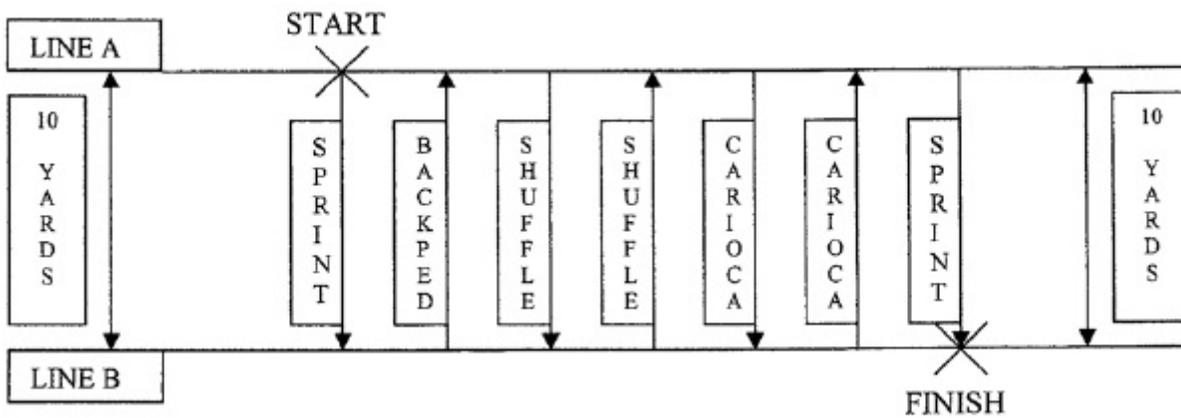


Figure 4

10 Yard Lower Extremity Functional Test

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Formula1.jpg](#)
- [CONSORT2010Checklist.doc](#)