

The Immediate Effect of Kinesio Tape on Hamstring Muscle Length and Strength in Female University Students: A Pre-post Experimental Study

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Abstract

Background: Kinesio tape has been proposed to improve the muscle extensibility. However, there are contradictory results in the literature.

Objective: To investigate the effect of Kinesio tape on hamstring muscle lengthening and on hamstring and quadriceps muscle strengthening in university students with hamstring muscle tightness.

Methods: In this pre-post experimental study, 96 female students with hamstring muscle tightness were recruited from Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia, and randomly assigned to Kinesio tape, sham tape, or control groups (32 in each group). The inhibition technique was used for the Kinesio tape application, with the tape being applied from the muscle insertion to the origin. Measurements were taken before and 15 min after the intervention. Outcome measurements included active knee extension test to measure the hamstring muscle length, and isometric strength measurements of hamstring and quadriceps muscles using a handheld dynamometer.

Results: A significant increase in the immediate hamstring muscle length was found in both the Kinesio ($P = 0.001$) and sham ($P = 0.004$) tape groups, while no difference was noted in the control group ($P = 0.066$). The muscle lengthening was significantly greater in the Kinesio tape group than the sham tape ($P = 0.001$) and control ($P = 0.001$) groups. There was no difference in the pre- and post-measurements in the quadriceps and hamstring muscle strengths in all three groups.

Conclusions: These results demonstrate that applying Kinesio tape has an immediate effect on hamstring muscle extensibility, but has no effect on the quadriceps and hamstring muscle strengths.

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Keywords: Hamstring extensibility, hamstring muscles, hamstring strength, Kinesio tape, muscle strength, muscle tightness, physiotherapy techniques, range of motion, sham tape

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INTRODUCTION

The hamstring muscle is considered as an essential muscle in the movement of the lower limb and stabilization of body posture. The hamstring muscle play an important role in the performance of many activities of daily livings, e.g., running, walking, and jumping.^[1] The function of the hamstring muscle during the gait cycle is mainly to assist in stabilizing and producing movement in the knee joint.^[1] The multi-joint connections of the hamstring muscle, along with its variety of functions, tend to shorten this muscle, as this expose the muscle to a high number of tensional forces.^[2] Individuals who spend a long time in sitting position such as students with a bad posture during study, desk workers, and people with poor physical activity are predisposed to developing such tightness in the hamstring muscle and postural spine curvature disorder.^[3,4]

There are two causes of reduced muscle extensibility: anatomical and physiological. The anatomical causes refer to muscle shortness and muscle stiffness. Muscle shortness is defined as a reduced ability of the muscle to lengthen due to a reduction of the sarcomeres units or a decrease in connective tissue elasticity.^[5] Muscle stiffness is a biomechanical term defined as the amount of force needed to elongate the muscle and does not relate to muscle length. The physiological cause of decreased muscle extensibility is the activity of the alpha motor neurons, which increases the force needed for muscle elongation, as seen in the muscle spasticity of patients with upper motor neuron lesion.^[6] Reduced hamstring muscle extensibility is usually referred to hamstring tightness. Nevertheless, this term is nonspecific and its use is limited in research settings and clinical practice.^[5]

Limited hamstring flexibility affects the individual's level of function and predispose them to multiple muscular overuse injuries such as muscle strains.^[7] This is due to hamstring tightness reducing the ability of the muscle to elongate rapidly without injury.^[8] A recent study revealed that limited hamstring flexibility not only predisposes the muscle to injury but also impairs sports activities such as the vertical jump, kicking speed, and sprint in football players.^[9] Limited hamstring flexibility is also believed to increase the risk of low back pain, knee pain, Osgood-Schlatter disease, and lower extremity injury.^[10-12] Radwan *et al.*^[13] revealed that the greater the hamstring tightness, the higher the low back pain severity.

Several studies have previously investigated and analyzed the effectiveness of different treatment technique to improve the hamstring extensibility.^[14,15] There is lack

of agreement found about the most effective treatment protocol to improve the hamstring extensibility.^[16] The most recommended treatment for hamstring muscle tightness is the stretching exercises. However, many individuals have a poor compliance with the stretching exercises, especially those who cannot tolerate the pain that comes up from the stretching exercises.^[17]

Kinesio taping is another option for the treatment of poor hamstring extensibility. It was developed by Kenzo Kase in 1970 and gained wide popularity by the elite athletes.^[1] The Kinesio tape differs from other elastic tapes, as it contains certain viscosity and special weaves that allow skin ventilation and minimizes skin discomfort. The smooth feeling and the ability to move freely are the main property within the Kinesio tape that was preferable and desirable for the athlete's treatment and prevention.^[18] The major advantages of Kinesio tape are the similarity of its thickness to human skin, thus permitting the normal range of motion, its ability to be stretched up to 55-60% of its length and to be worn for 3-4 days continuously.^[19,20]

The main two physiological targets of Kinesio tape application are either facilitation or inhibition of motor activity; consequently, the methods of tape application differ according to the specific objectives.^[19] The literature has revealed that most of the studies of Kinesio tape were done as a facilitator of muscle motor activity. However, the results of these studies have been contradictory.^[1,21,22] Several studies have investigated the effect of Kinesio taping on different functional activities, using different taping techniques for different muscles, and the results of these studies have also been contradictory.^[23,24] Most of the literature does not only investigate the effect of Kinesio tape on pain relief, but also includes many measurable outcomes such as the range of motion and different Activities of Daily Living questionnaires.^[19,20,25] Castrogiovanni *et al.* examined the effect of Kinesio tape and exercise on physical limitation in patient with knee osteoarthritis, and revealed a reduction in knee pain and improvement in knee function following the use of Kinesio tape combined with exercise.^[26] A narrative review study reported the effect of Kinesio tape in spine curvature disorders, and stated that Kinesio tape could have a positive impact on body posture and can be a conceivable solution to avoid the bracing side effects.^[27]

Limited studies in the literature have studied the effect of Kinesio tape as an inhibitor of muscle motor activity. These studies applied the Kinesio tape differently from each other in normal subjects and revealed different findings.^[28-30]

There is also a lack of studies on the effect of Kinesio tape on hamstring muscle, and the studies available have contradictory results due to differences in tape application and differences in the methodology and outcome measures among these studies.^[14,31,32] Merino-Marban *et al.* investigated the effect of Kinesio tape on hamstring muscle extensibility in university students. They revealed that no acute effect was found in improving hamstring extensibility as a result of the Kinesio tape application.^[32] On the other hand, in a study that compared the effect of Kinesio taping with proprioceptive neuromuscular facilitation (PNF) with static stretching of the hamstring muscle in 30 active male participants, it was found that PNF was the best immediate treatment for hamstring extensibility, whereas Kinesio tape appeared to be more effective for a longer duration. However, this study also used a different application of the Kinesio tape from the inventor guidelines.^[31] Therefore, there is need for further studies to validate the effect of Kinesio tape on hamstring muscle. Accordingly, the present study was conducted to examine the immediate effect of Kinesio tape on the hamstring muscle extensibility and on hamstring and quadriceps muscle strengthening using the inhibition technique.

METHODS

Study design, setting, and participants

This is a pre–post experimental study conducted at the physical therapy department laboratory of Imam Abdulrahman Bin Faisal University (IAU) from March 2016 to May 2017, with one session (half an hour) for each participant. All the assessments and treatment procedures were performed by the primary researcher.

The study was approved by Institutional Review Board of IAU, and all participants provided written consent.

Inclusion and exclusion criteria

Female college students enrolled in the 2016–17 academic year at IAU who were aged 18–25 years, had a body mass index ranged between 18–30, and a reduced hamstring muscle length (hamstring tightness), as defined by the literature (popliteal angle $<160^\circ$) were eligible for inclusion.^[33]

Students with lower limb musculoskeletal disease, abdominal, lower limb and spinal surgery, pregnancy, previous injury or trauma to hamstring muscle, hip, knee or ankle joints, skin allergy, low back pain, or any neurological impairment in the lower extremity were excluded.^[1,14,31]

Sample size calculation

The sample size was calculated by using Inference for Means: Comparing Two Independent Samples software (<http://www.stat.ubc.ca/~rollin/stats/ssize/n2>), where the alpha = 0.05, value for desired power = 0.80, pre-treatment mean value = 133.73 degree, post-treatment mean value = 141.13 degree, SD = 10.43.^[14] The required sample size was found to be 32; the study required participants in three groups, and thus a total of 96 participants was estimated as the total required participants. A poster announcement was published at IAU at the following colleges: medical, applied medicine sciences, administration, and community service. Accordingly, 96 female students with hamstring tightness were recruited through convenience sampling.

Procedures

Assessment procedure

Eligible students underwent a tape allergy test by applying a small piece of Kinesio tape to their skin for 10 minutes. If the students did not have any allergic reaction, they were enrolled in the study. Participants selected a sealed envelope that randomly assigned them to the Kinesio tape, sham tape, or control groups; the participant handed the unopened envelope back to the investigator and were blinded to the group they were assigned.

The participants were informed about the duration of the participation and any possible risk or discomfort that may be involved before signing the informed consent form. All participants walked on a treadmill (Johnson fitness – T7000) for 5 min as a warm-up to pre-condition the muscles before the initial examination. All participants were examined for the initial outcome measures (pre-test measures), which were the hamstring length measurement and strength measurement of the hamstring and quadriceps muscles. Then, each group followed the treatment program specified for their particular group. Afterward, all participants were given a standardized 10-min rest followed by 5 min walking on the treadmill with the same speed as in the warm-up to pre-condition the muscles before performing the final outcome measurements. The same outcome measurements were repeated at the conclusion of the treatment period (post-test) [Figure 1].

Hamstring length measurement

Hamstring muscle length was measured using the active knee extension test (AKE).^[14,31] AKE is associated with minimal pelvic and lumbar motion, and thus is considered a suitable and preferable test for evaluating the length of the hamstring muscle.^[34,35] Hamid *et al.* revealed that the

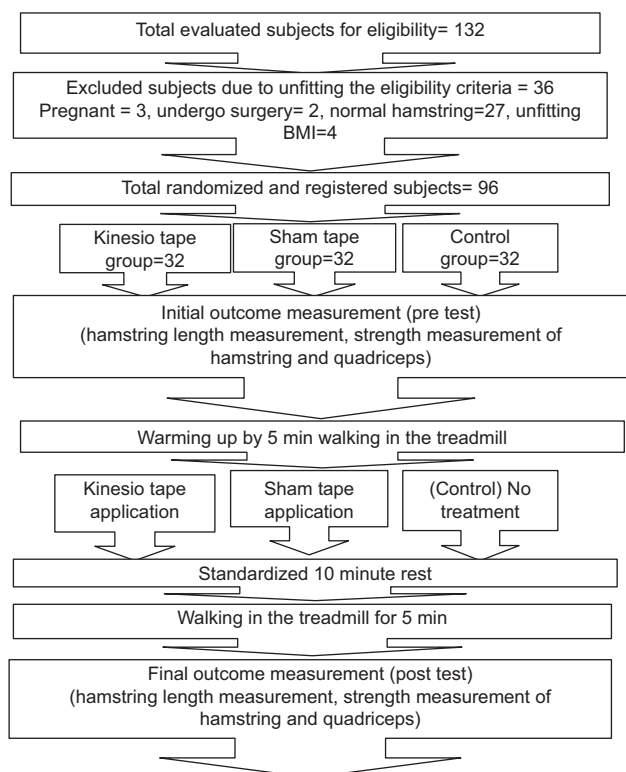


Figure 1: The flow diagram of subject's recruitment and procedure

AKE test can be performed with a single assessor and have an excellent intra-rater reliability.^[34] The hamstring length measurement was performed in a supine position with 90° hip flexion touching the horizontal bar apparatus posteriorly. The non-tested lower limb was secured with a strap attached to the table. While the participants maintained the contact between their thigh and the horizontal bar apparatus by another strap with the pelvic stabilized, they were asked to extend the leg as much as possible. The angle of the knee joint was measured with a Universal goniometer (Sammons Preston, Bolingbrook, IL, USA). The measurements were done three times, and the mean value was recorded.^[14]

Hamstring and quadriceps muscle strength measurement

A handheld dynamometer was used to measure hamstring and quadriceps muscle strength and the data was recorded from the screen of the device (micro-FET; Hoggan Health Industries, Draper, UT, USA). The hamstring strength measurement was done with the participants in the prone position with the knee in a 90° flexion position, following which they were asked to flex the knee as hard as possible while the researcher held the movement with the handheld dynamometer placed proximal to the medial malleolus on the posterior aspect of the leg. The quadriceps strength measurement was done with the same procedure, but from a sitting position on the edge of the bed with the knee and hip in a 90° flexion position, and the participants were

asked to support their back and to extend their knee as hard as possible while the researcher held the movement with the dynamometer placed on the anterior aspect of the leg. The hamstring and quadriceps measure was done by holding the handheld dynamometer for 5 seconds; the test was performed three times, and the mean value was recorded.^[1] All strength values were normalized using the following equation: $[(\text{kg force}/\text{kg body mass}) \times 100]$.^[36]

Treatment procedure

Kinesio tape group

The tape was applied to the hamstring muscle using one Y-shaped original Kinesio tape (Kinesio Tex Gold® FingerPrint tape 5 cm, the Netherlands) with the insertion to origin technique to relieve hamstring tightness. The muscle was in a stretched position for 15 seconds (hip flexion and knee extension, and then the tape was applied) with a 25% stretch of the tape.^[1,32]

Sham tape group

The tape was applied to the hamstring muscle using a one I-shaped strip (Kinesio Tex® Tape 5 cm) with no stretch in the tape. The tape was applied perpendicularly over the upper third of the hamstring muscle while the muscle was in a stretched position.^[32]

Control group

The participants had no treatment but were in the same position as the previous groups (the hamstring muscle maintained in a stretching position for 15 seconds).^[14]

Statistical analysis

All the statistical analyses were done using SPSS version 23. Means and standard deviations of the quantitative variables were computed for every group. A paired sample *t*-test was used to determine differences in the mean scores between the pre and post measurement for every group (according to the central limit theorem, as the sample size in every group was >30).^[37] The ANOVA test was used to determine whether there was a significant difference in the mean scores between the three groups. If differences existed, pairwise post hoc multiple comparisons were used to determine which means differed. In all statistical tests, *P* value <0.05 was considered statistically significant.

RESULTS

A total of 96 female students (32 in each of the three groups) participated in this study. The demographic characteristics of the participants in each group is shown in Table 1. There were no significant differences between the three groups in terms of age, weight, height, and BMI measurements.

Effect on hamstring muscle length

A significant difference was noted in the pre-and post-hamstring muscle length in both the Kinesio ($P = 0.001$) and sham ($P = 0.004$) group; no such significant difference was found in the control group ($P = 0.066$) [Figure 2]. The ANOVA tests found a significant difference between the three groups in the post-length measurement of the hamstring muscle ($P = 0.001$). The pairwise post hoc multiple comparison test revealed that the post-hamstring muscle lengthening was significantly higher in the Kinesio tape group than the sham tape group ($P = 0.001$) and the control group ($P = 0.001$), while no significant difference was found between the sham tape group and the control group ($P = 0.404$).

Effect on quadriceps and hamstring muscle strength

In the quadriceps and hamstring muscle strength, there was no significant differences in the pre and post measurements in the Kinesio tape group ($P = 0.341$ and 0.943 , respectively), sham tape group ($P = 0.765$ and 0.785 , respectively) and the control group ($P = 0.060$ and 0.675 , respectively) [Figures 3-5].

DISCUSSION

This study revealed a significant immediate effect of Kinesio tape on the hamstring muscle length in both the Kinesio and sham tape groups in contrast to no significant effect observed in the control group. These results are in agreement with those of previous similar studies.^[14,31] Espejo-Antúnez *et al.*^[14] investigated the effect of Kinesio tape and electrical muscle elongation using the AKE test on 120 athletes with decreased hamstring extensibility and found that Kinesio tape and electrical muscle elongation significantly improved hamstring muscle extensibility. The AKE test showed a slightly higher increase in the electrical muscle elongation group, with no significant difference compared with the Kinesio tape group. In another investigation of the effect of Kinesiology tape on 30 male participants who engaged in recreational sports and who were randomly divided into the Kinesiology tape group, the static stretch group, and the PNF group, significant increase in active knee measurement was noted in both the

Kinesiology tape group and the PNF group. However, the PNF group had an immediate short-term improvement, while the Kinesiology tape group had an improvement over a greater time period.^[31]

The improvement of the hamstring muscle extensibility after the application of Kinesio tape can be explained by the elastic recoil property of the tape that causes micro-convolution or folds in the skin. This convolution produces a lifting effect on the skin, allowing for more space beneath the skin, and this improves the blood circulation in the taped area and affects the muscle and myofascial functions.^[38,39] In addition, Kinesio tape application causes an external load on the skin, which stimulates the cutaneous mechanoreceptors, resulting in activation of the modulatory mechanism within the central nervous system.

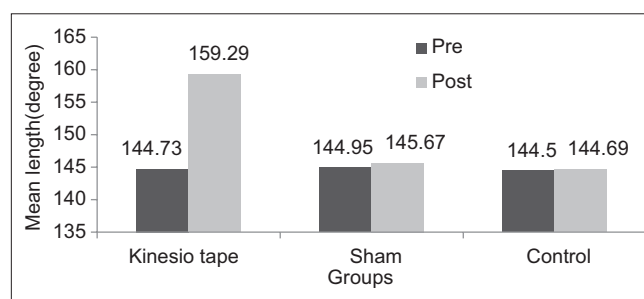


Figure 2: Comparison between pre and post hamstring muscle length among Kinesio tape group, sham tape group and control group

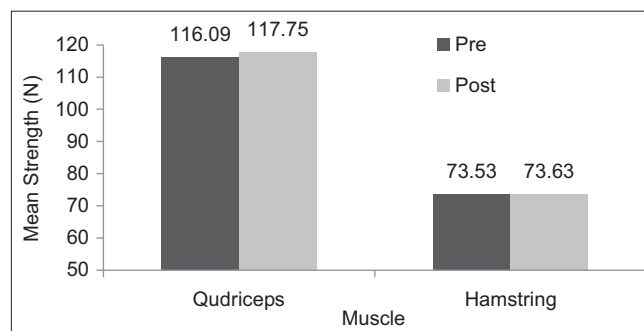


Figure 3: Comparison of pre/post quadriceps and hamstring muscle strength within Kinesio tape group

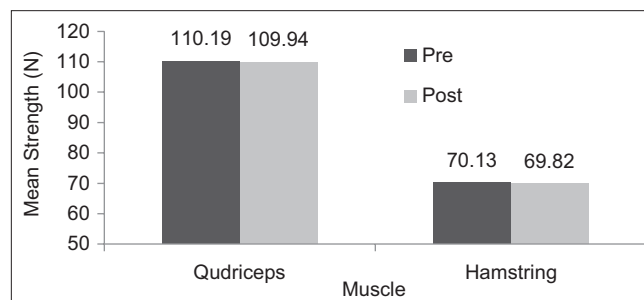


Figure 4: Comparison between pre/post quadriceps and hamstring muscle strength within the sham tape group

Table 1: Comparison of age, weight, height, and body mass index among the three groups

Variables	Mean (SD)			ANOVA P
	Kinesio	Sham	Control	
Age (years)	19.88 (1.43)	19.59 (0.98)	19.63 (1.04)	0.574 ^a
Weight (kg)	54.37 (9.42)	55.78 (8.68)	54.94 (7.31)	0.800 ^a
Height (cm)	159.47 (5.27)	159.78 (7.66)	159.28 (5.14)	0.947 ^a
BMI (kg/m ²)	21.79 (2.44)	21.76 (2.23)	21.59 (2.42)	0.935 ^a

^aNo significant difference at ($P > 0.05$). SD – Standard deviation; BMI – Body mass index

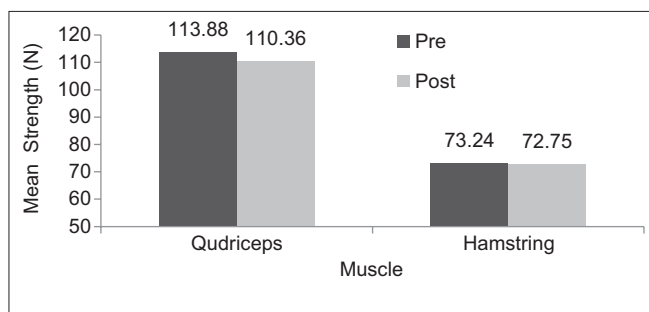


Figure 5: Comparison between pre/post quadriceps and hamstring muscle strength within the control group

These physiological changes in the muscle improve the tissue extensibility.^[30] The improvement in the sham tape group in our study indicated that even a small amount of Kinesio tape applied horizontally in the hamstring muscle creates a tactile sensation that stimulates the cutaneous mechanoreceptors and displays better improvement in the pre–post intervention than in subjects without Kinesio taping.^[40] However, this improvement of sham tape was not significant in comparison with the Kinesio tape group and a control group that did not use tape.

In contrast to our findings, in a study that assessed the immediate effect of Kinesio tape on hamstring extensibility in Spanish University students, Kinesio taping was found to not improve the hamstring muscle extensibility. However, in that study, they enrolled students with a normal hamstring extensibility range, whereas the present study enrolled students with hamstring tightness. A recent study investigated the effect of Kinesio tape on hamstring and gastrocnemius muscle flexibility in healthy young adults and found that the knee extension angle did not improve significantly after applying Kinesio tape in the hamstring muscle group. It should be noted that the knee extension angle was performed passively with no proper fixation or any apparatus to stabilize the hip joint at 90° flexion position. In addition, the study used a digital inclinometer, and the subject was responsible for grasping it. All these factors may indicate that poor controls influenced the results. In the current study, a universal goniometer was used with fixed firm stabilization during the assessment by adjusting a metal bar fixed to the assessment bed.

The current study found that Kinesio taping did not have a significant effect on the hamstring and quadriceps muscle strength (pre-and post-measurements) in all groups. These results were in agreement with some previous studies,^[22,41–43] but in contrast to those of other studies that found longer duration application of Kinesio taping (i.e., 1 to 2 days) improves muscle strength.^[1,44] In fact, Lumbroso *et al.*^[1]

had also found no immediate change of peak force in the hamstrings group, but the peak force significantly increased after 2 days. These results indicate that Kinesio tape may need a longer time to enhance the recruitment of motor units and achieve improvement, which was not done in the current study.

Limitations

A limitation of this study was that only female university students were recruited, which may limit the generalization of these findings to male students. In addition, only the immediate effect of Kinesio tape was examined in this study, and thus its short-and long-term effects were not investigated.

CONCLUSIONS

The application of Kinesio tape in university students with decreased hamstring flexibility resulted in a significant immediate increase in hamstring flexibility, which was shown by the AKE test. Kinesio tape showed a significant increase in hamstring muscle extensibility compared with the sham tape or no tape treatments. Therefore, we recommend the use of the Kinesio tape inhibition technique to immediately improve the muscle length of tight hamstring muscles. Kinesio tape had no significant immediate effect on the hamstring and quadriceps isometric muscle strength; however, short-and long-term usage studies are required for the same.

Ethical considerations

This study was approved by the institutional review board at IAU (Ref. no.: 2015-03-220). All subjects signed a consent form before participation, and they were informed that the data collected would be submitted for publication. This study followed the general principles of the Declaration of Helsinki, 2013.

Data availability statement

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Peer review

This article was peer-reviewed by three independent and anonymous reviewers.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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