



The Effect of Tension and the Extent of Coverage of Kinesio Tape on the Knee Extensor Torque in Healthy Young People

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Abstract

Introduction: Increase in muscle strength is one of the effects attributed to Kinesio tape. Several studies that have been conducted in this area provided conflicting results. Perhaps one of the reasons for various results is the difference methods of applying Kinesio tape. Due to the fact that Kinesio tape effect depends on the factors such as the amount of its tension and coverage, we aims to investigate the immediate effect of these factors on muscle strength.

Materials and Methods: Thirty healthy non-athlete female were recruited and their maximum knee extension torque were measured before and after applying 9 different modes of Kinesio taping. Kinesio tape was applied with three levels of tension (0%, 30% and 60%) and also three different levels of contact area on the front of thigh of subdominant leg in random order.

Results: Kinesio taping was able to increase the knee extensor torque significantly ($P < 0.05$). The net effect of the two factors of tension and coverage of Kinesio tape on the increase of muscle strength was not statistically significant, but the interaction of tension and area of coverage does create a significant effect ($P < 0.05$).

Conclusion: Although the KT can increase the quadriceps muscle's strength, changing the tension or extension of kinesio taping alone, cannot alter its immediate effect on the knee extensor torque. However higher tension and extensive application of kinesio tape could result in the highest increase in force production.

Keywords: Kinesio tape; Torque; Tension

Introduction

Sticky tapes that are used widely in sport rehabilitation divided into two categories: elastic and non-elastic. Non-elastic tapes, known as athletic tape or leuko tape, can create a strong adhesive force and is usually used to restrict movement. Of course, skin damage is possible due to the excessive force that is applied on it. On the other hand, due to the skin perspiration, it cannot be used for a long time. Elastic tapes such as KT were first introduced in 1970 in Japan and Korea. Due to its texture and adhesiveness, this tape has less contact with tissue, helps respiration, and causes less damage to skin [1]. The effects attributed to KT are: improvement of blood circulation, lymph mobilization and thereby reducing edema, pain, improving muscle force production as well as stimulating its deep sensation that is necessary for balance and posture.

There are many theories proposed about the mechanism underlie the effect of KT, such as:

- Lifting Effect-the increase of interstitial space because of elasticity and adhesiveness of KT that effects on blood circulation and lymph circulation.
- Pain Gate-that decreases the pain through mechanical stimulation of the skin and mechanism of pain gate control [2].
- Neuro-facilitation in which the stimulation of mechanoreceptors of the skin through reflex mechanisms can increase the excitability of muscle [3].

Three factors are among the most important ones when using KT: Surface tension, contact

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Figure 1: The designed chair to measure the knee extensor torque.

area, and the length of time that KT is applied. Some studies have investigated the effect of time but they are rare and all have examined the muscle force changes [4-7]. These studies showed that the KT effect increases gradually, but the reported time of reaching the peak muscle strength is different in various studies. Since KT has its primary effect on the skin receptors, it is plausible that the more stretch and coverage of the tape on the skin could result in more receptors recruitment and therefore stronger effects. The methods of applying tapes including the percentage of tension, and its amount of coverage on the skin, as well as the method of reporting the amount of tension are different in various studies, and therefore, the comparison is almost impossible and therefore, it is impossible to make any conclusion about the most effective level of tension and skin coverage of KT for maximum muscle force generation [8-11].

Material and Methods

This is a comparative observational study using a simple convenience sampling method. Totally, 30 non-athlete healthy women with an average age of 24 ± 5.2 and BMI equal to 22 ± 2.1 were recruited in this study. Inclusion criteria were: having BMI between 20 and 25, age between 18 and 30, weekly and regular exercise less than 6 hrs. Exclusion criteria includes: having systemic disorders, neuromuscular injuries to lower limb, fractures in lower limbs, using drug and alcohol in the last 48 hrs, pregnancy, hip and lower extremities surgery during the last 6 months, skin disease or scar tissue in the thigh area, cardiovascular problems, knee pain or joint symptoms in the past year and allergy to tape [11-15].

The study was approved by local ethical committee and all the volunteers signed an informed consent form before being enrolled in the study. To warm-up, all volunteers were asked to cycle for 5 min at their comfortable pace. In order to identify the preferred leg, the subjects were examined by hit-the-ball test [16-18].

In this study, a dynamometer (with maximum measurable force of 100 kg) was used to study the quadriceps muscle's strength [19]. The maximum knee extension torque was measured 3 times at 60

knee flexion [20] and the average of three trials was calculated. The device was calibrated before conducting the study.

The subjects sat on the seat on a chair with an adjustable arm that was designed for this study. Their thigh and knee angle was set at 90-degree and 60 degrees flexion, respectively. Dynamometer, embedded in an adjustable lever was fixed to be in contact with the lower leg above the ankle joint. The axis of rotation of the adjustable lever was set at the level of external condyle of Femur. The distal end of the femur, as well as the trunk and pelvis were fixed before each measurement to avoid compensatory contribution from other segments (Figure 1).

The participants were asked to increase the force of contraction gradually to reach full contraction, avoiding explosive contraction, and also maintain the maximum force for at least 5 seconds. The participants could primarily apply two contractions to get familiar with the study trend.

Taping method

Before starting the study, the test area was shaved and cleaned. The KT with a width of 5 cm was used and the tape was attached 10 cm below the anterior superior iliac spine to the upper part of the patella. To control the initial situation of the participant and the amount of tissue elasticity, tape was applied in a sitting position, with the knee and hip put at 90° of flexion. Three tensions of 0, 30 and 60 percent were used and three different level of coverage were applied by changing the number of parallel strip of tape from one to two and three strips. Each tape was overlapped with pervious one by one-third the width (Figure 2).

Quadriceps muscle covers the anterior and external surface of thigh. While increasing the number of tapes, we were careful not to reach out of the frontal and lateral surfaces of thigh and tape other muscles. No stretch was applied three centimeters at the origin and insertion of the tape. To achieve the exact tension of the tape with similar length (and coverage area) the following formula was used [18].

$$\left[\left(\frac{FL - 6}{\text{tension}} \right) + 6 \right] \cdot \text{pretention} = \text{length of tape to be cut}$$

Where,

FL: the total length of tape (from 10 cm below the anterior superior iliac spine to the upper pole of patellar)

6: the length of tape without stretching

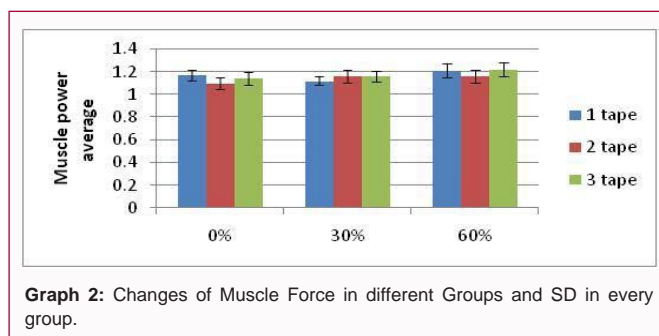
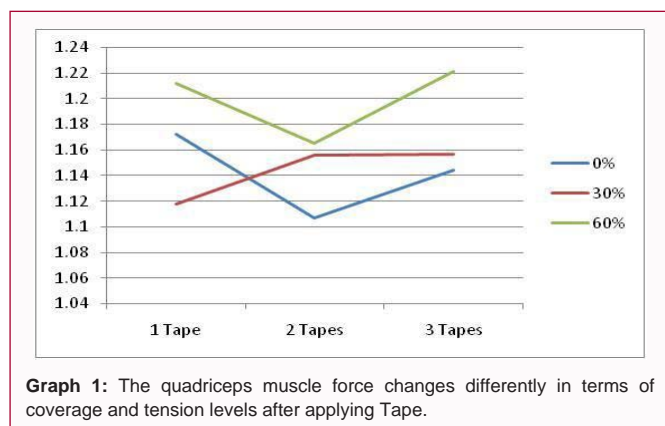
Tension: ratio of tape traction, for example, it equals 1.5, in the stretch of 50 percent.

Pretention: the tension of tape when it is attached to its cover paper.

The order of applying different modes of tapes was set based on table of random numbers in order to control the effect of fatigue and training. Each maximum contraction was repeated three times



Figure 2: How to apply Kinesio tape with different coverage area.



and the average of three repetitions was set as the maximum knee extension torque. For each mode of tape, 30 seconds rest was given between repetitions and a 3 min rest was also given to the participants before the next mode of tape was applied [20]. The percentage of changes in maximum knee extension torque after applying the tape was calculated compared to the no tape trial. The data was analyzed by repeated measure ANOVA test with two within subjects' factors of level of tension and level of coverage.

Results

The repeatability of the data was verified in a methodological study performed two times in a single day (with 30 minutes interruption) in 10 subjects (ICC=90%). Data obtained from 30 patients is shown in Table 1. In this table, the relative changes of participants were listed compared to no-tape mode. All modes of tapes resulted in a meaningful increase in torque ranged from 10% to 22% and an average of 16%.

The results show that the amount of tension and coverage of tape had no effect on maximum torque amount ($P < 0.05$), but the interaction of coverage and tension levels showed statistically significant effect on the maximum knee extension torque ($P < 0.05$). Figure 1 shows that at different level of tensions, with changes in the number of kinesio tape strips, the pattern for muscle force production varies. Because of differences in the interaction of tension and level of coverage, a more detailed analysis was performed in different groups to evaluate the significance of these differences. Nine different types were compared pair wisely, but no differences were observed in the various modes of tapes.

Discussion and Conclusion

In this study we use nine different modes of tape to study the effect of level of tape tension and coverage on the muscle strength. Three tension modes of 0%, 30% and 60% were used and each was evaluated with different levels of skin coverage. Generally, adopting KT disregarding the tension and coverage level led to immediate increase in the maximum quadriceps force production about 16% ($p < 0.05$). Changing the tension and coverage level was not able to change the muscle force production. Among 30 samples, all except 2 participants show immediate increase of muscle's strength after applying tape; 2 of them showed a very high increase of strength, more than 1.5 times compare to no-tape muscle strength. This reinforces the hypothesis that the level of response to KT could probably differ among people due to the skin texture variations. Since the texture of skin is different between men and women, and the responses to KT may also be different, we only studied women to control the possible

Table 1: The mean and standard deviation (StD) of the maximum knee extensor torque as percentage, compared to no-tape mode in all levels of tape coverage (1,2,3) and tension (t0,t30,t60).

Tape Mode	Mean	StD
t0-1	117%	26%
t0-2	111%	27%
t0-3	114%	33%
t30-1	112%	21%
t30-2	116%	30%
t30-3	116%	26%
t60-1	121%	33%
t60-2	117%	30%
t60-3	122%	35%

sex effect.

The results of this study showed that at least, in the case of immediate effect of tape on muscle strength, the amount of tension and coverage are ineffective. Of course, this study doesn't consider the effect of longer application of KT on muscle strength.

Literature reveals contradictory findings for the effect of taping on the muscle force production. Studying Quadriceps muscle and comparing the muscle force-before and after applying tape [21-23], showed no difference in the strength of muscle except for one case that has a different taping method, covering more area and also taped internal vastus, external vastus, and Rectus femoris, separately [21]. In other studies, only one part of Quadriceps muscle, usually rectus femoris or external vastus has been taped [22]. These studies showed some increase in eccentric contraction of muscle and no difference was observed in concentric muscle contraction after applying tape.

Gastrocnemius and hamstring muscles have been evaluated in two separate works and both showed some increase in force following application of KT [4]. In another investigation however, dorsiflexion and plantar flexion force has been evaluated and no changes was observed after KT application [3].

What distinguishes this study and the previous study on gastrocnemius is the fact that force has been evaluated in two different angles of 45° and 90°. This might give us a clue that the joint angle, at which the muscle contraction force is measured, can affect the result. Probably, muscular kinesio-taping could bring about different outcomes when we compare the muscle force at different joint angles. Another point in these studies is the different behavior of muscles such as gastrocnemius and hamstring muscles to KT that could reflect the difference of various muscles reaction to KT. In the gastrocnemius KT group, gastrocnemius strength in addition to hamstring and in

the hamstring KT group, the hamstring strength has been measured in addition to quadriceps force [4]. It was observed that after two days taping, in the gastrocnemius group, the hamstring strength increase along with gastrocnemius but there was no relationship between hamstring and quadriceps strength in the hamstring group. Perhaps the myofacial relationship between muscles may be effective in this remote effect after taping. The increase of force in upper quarter muscles such as biceps and forearm muscle's has also been reported in several investigations after using KT [6,13,14].

Briefly, due to the ineffectiveness of changing tension and coverage level on the quadriceps extensor torque in the present study, we can say that applying any modes of tape may change the muscle force. There are many other factors such as duration of taping, gender, joint angle, muscle type and even psychological differences that are not considered yet and may affect the results of kinesio taping. Based on the result of this study and the information gathered from the literature it would be very hard to predicate the impact of KT on the muscle strength unless the effect of all these possible factors is investigated.

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