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Influence of different directions of the Kinesio tape application on the rectus femoris muscle on the quality of the knee flexion pattern in a prone position

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Original article

Abstract

Introduction: Movement patterns are sequences of movements performed automatically. Due to sedentary lifestyles, lack of physical activity, and poor posture habits, these patterns are often inappropriate. Analysis and re-education of the performance of movement patterns are the methods of preventing pain and musculoskeletal dysfunction. The research aimed to compare the effectiveness of different directions of the Kinesio tape application on knee flexion range of motion in young women.

Material and methods: The study involved 40 women aged 21–25; 10 women with a normal range of active knee flexion measured in the prone position and 30 women with limited active flexion of both knee joints, who were randomly assigned to one of two groups: with the Kinesio tape application from the origin to the insertion of the rectus femoris muscle (14 women) and with the Kinesio tape application from the insertion to the origin of the rectus femoris (16 women). The active and passive knee flexion test was used to evaluate the effectiveness of the Kinesio tape application. The test was performed before applying the tape, immediately after application, three days after wearing the application, and four days after removing the application. Statistical analysis was performed using the Statistica v.13 program and the differences and correlations were considered significant for $p < 0.05$.

Results: The Kinesio tape application increased the range of controlled active knee flexion The research showed a statistically significant increase in the range of active flexion of the knee joint after using both directions of the tape application however, in the E1 group, a difference in the range of motion was observed immediately after application, while in the E2 group after three days of wearing it. In both groups, the effect was maintained on the fourth day after removing the application.

Conclusions: The Kinesio tape application may be useful in increasing the range of controlled knee flexion however, it does not improve the range of knee flexion to normal values.

Keywords

- Kinesiology taping
- movement pattern
- knee joint
- rectus femoris
- lumbar-pelvic-femoral complex

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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Introduction

Physical fitness requires many conditions, and the basics are a properly formed musculoskeletal system and a well-functioning nervous system. Thanks to them, it is possible to maintain a healthy body shape in a static position or during walking and other activities. For movement to be aesthetic, and economical and minimize the risk of pain, injury, and degenerative disease, movement patterns associated with the automatic performance of everyday activities should be correct. This means that the muscle groups, those directly responsible for the execution of movement and those that determine stabilization should be activated to work in a set order. Sometimes, however, dysfunctions occur, i.e., incorrect muscle length, imbalance between synergistic or antagonist muscles, movement restrictions, or excessive, uncontrolled movement.[1]

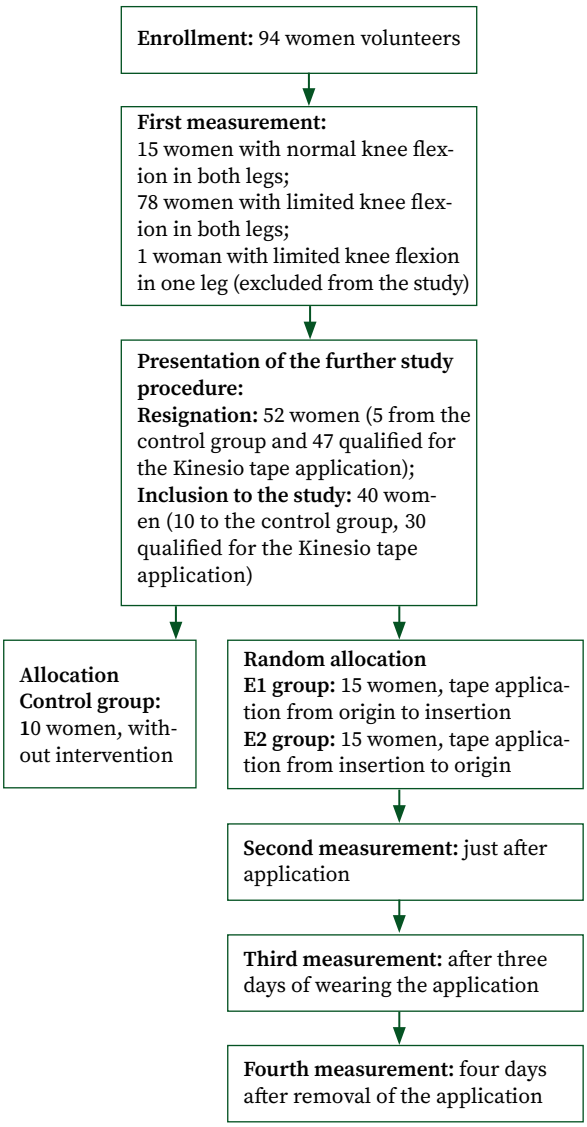
As a consequence of hipertension in one muscle group, compensation occurs as an excessive and uncontrolled movement in the adjacent body segment. If such a situation lasts, it can result in pathological tissue changes and pain.[2] An example of an often disturbed movement pattern is knee flexion in the prone lying. The rectus femoris is stronger than the abdominal muscles in many people, especially with a sedentary lifestyle, and then knee flexion initiates hip flexion, pelvic tilt, and lumbar spine extension. This mechanism can lead to back pain so the pattern should be improved.[3]

Effective methods of re-education of movement patterns are needed to improve body posture and movement quality and thus prevent musculoskeletal dysfunctions. In this study, we observed whether the Kinesio tape application can help restore the correct movement pattern of knee flexion in the prone position. We chose this method because it is widely available, cheap, non-invasive, and easy to use, and its effectiveness in correcting muscle and fascia dysfunctions and reducing pain has been proven.[4-11] So far, studies on the effect of Kinesio taping on the range of motion have focused on passive movement,[5,7,11,12] and active movement has been less frequently studied.[9] Compensations accompanying movement have not been studied so far. Therefore, we assessed the effect of the Kinesio tape application on the range of passive and active movement performed only in the range free from uncontrolled pelvic tilt. Some researchers recommend applying the Kinesio tape from the origin to the insertion to reduce excessive muscle tension, while others recommend the opposite direction.[4,13] In our study we compared the effects of both methods.

Material and methods

In the study, the volunteers were women between the ages of 20 and 25, who had no lower limbs, pelvic, or spine injury in the last year, had no pain in the previous month, had no skin lesions that prevented the application of the Kinesio tape (wounds, protruding moles, psoriasis, skin eczema, allergic reactions), were not allergic to tape or acrylic, or components of the adhesive spray and felt well on the day of the study. 94 women volunteered, all of whom, after getting acquainted with the purpose and plan of the research, signed their consent to participate in the project. The research process is illustrated in Diagram 1.

Diagram 1. The research process



The research was carried out in the following steps:

STEP 1. Preparation for the study

A preliminary measurement of the active range of knee flexion was performed (details on how to perform the test are provided in Step 3). The results of this test were used to qualify for the control or experimental group. Women with a negative test result (normal range of motion) – 15 people – were qualified to the control group. One woman was excluded from the study because she tested positive in one leg and negative in the other. 78 women with positive test results in both legs (active knee flexion free from compensation in the lumbar spine less than 120°) were qualified for the groups with the Kinesio tape application. One person with an interference screw in the left knee joint (Biosure PK S & N) was excluded from this group.

The women qualified for the project were presented with a detailed schedule of the next measurements. At this stage, 52 women resigned: 5 from the control group and 47 qualified for the Kinesio tape application. Finally, 10 women were qualified for the control group and 30 for the Kinesio tape application.

STEP 2. The first measurement, the division into two experimental groups, application of the Kinesio tape, and the second measurement

The following measurements were carried out:

- Active knee flexion test (performed in the same way as the preliminary test; the results of this measurement were analyzed).
  Starting position: back lying position on the couch.
  Performance: The examined woman slowly bent her leg at the knee joint until she felt the end of the range of motion or heard the command: "Stop!". At that moment, the participant stopped her movement. The therapist observed the lumbosacral region and commanded "Stop" when there was compensatory movement in the pelvic region and/or the lumbar spine (deepening of the lumbar lordosis, lifting of the buttocks). In the obtained position of the knee joint, the therapist measured the extent of flexion using a goniometer. The axis of rotation of the goniometer was at the axis of rotation of the knee joint. The stationary arm of the goniometer pointed toward the greater trochanter of the femur and the movable arm towards the lateral ankle. The result was read with an accuracy of 1°. The active knee flexion test was performed on both lower limbs.[14]
- Passive knee flexion test
  Starting position: prone lying position, pelvic stabilization with a belt.
  Execution: The therapist stood on the tested leg side of the couch. With one hand, he grasped the examined leg in the ankle area and bent the knee joint until the final muscle resistance was felt. The resulting flexion range was then measured with the goniometer as described above.[14]
  In the first examination, active and passive range of motion was assessed to eliminate participants with a structural deformity that would be indicated by similar limitations in both active and passive motion. The presence of a control group in the first examination was intended to show how active and passive range of motion differ between participants with and without limitations in free from compensation knee flexion.
- Spontaneous ball kick test
  The examined woman was asked to kick a ball in front of her. The test was conducted to determine which leg was dominant. The dominant leg was considered to be the one with which the woman spontaneously kicked the ball.[15,16]
  Forty women were divided into three groups. The qualification for the control group of women who obtained negative results of the active knee flexion test for both legs was confirmed. Women who had positive tests for both legs were randomly divided (coin toss in the program: calculator percentages.com/rzutmoneta.html) into two experimental groups. Fourteen women were included in the first experimental group (E1), where The Kinesio tape was applied to one of the legs from the origin rectus femoris muscle to its insertion. Sixteen women were included in the second experimental group (E2), in which The Kinesio tape was applied to one of the legs from the rectus femoris insertion to its origin. Both applications were made using a muscle technique, without tension. Women who were assigned odd numbers in the database had an application on the non-dominant leg, while those who were assigned even numbers had an application on the dominant leg. Legs on which there was no the Kinesio tape application constituted the control measurement.

- The Kinesio tape application method
  Materials used: Skinsept pur solution by Ecolab for skin decontamination and degreasing, Mueller Quick Drying Adherente for kinesiotaping, K-active elastic tape.
  The tape was applied to all participants by the same physiotherapist who had completed a course qualifying them to use medical taping.
  Starting position: back lying on the couch.
  Group E1: Application from origin to insertion of the rectus femoris muscle.
  The therapist applied The Kinesio tape to the area of the lower anterior iliac spine, next the woman being examined abducted her leg off the couch, bent her knee, and then the therapist continued applying the tape along the rectus femoris muscle to an area approximately 2 cm above the patella. Then the examined woman put her leg on the couch and the therapist applied the end of the tape.[4,17]
  Group E2: Application from the insertion of the rectus femoris muscle to its origin.
  The therapist applied the base The Kinesio tape in the area of the tibial tuberosity, the examined woman flexed the knee for the therapist to continue applying the tape along the rectus femoris muscle to the area of its origin. Then the woman placed her leg on the couch and the end of the tape was applied. [4,17]
  The examined women were instructed on how to take care of the Kinesio tape application daily, and how to remove the application in case of skin irritation. The therapist also answered questions that arose during the research.

STEP 3 The third measurement after 3 days of wearing the application

Active and passive knee flexion measurements in both legs (with and without application) were performed in women from the experimental groups. The Kinesio tape was removed after the measurements.

STEP 4 The fourth measurement 4 days after removal of the application

The women from the experimental groups were tested for the last time for active and passive knee flexion in both legs.

Statistical analysis was performed using Statistica v.13. The basic descriptive statistics were used. The Shapiro-Wilk test (to test the normality of distribution), the Brown-Forsythe F test (to test homogeneity of variance), the t-test for dependent samples, the Wilcoxon test or ANOVA test for repeated measures, and the Tukey post hoc test for differences between measurements, the t-test for independent samples, the Mann-Whitney U test or the Kruskal-Wallis test for differences between groups were also used. Differences were considered significant at $p < 0.05$.

Results

In the first measurement, both experimental groups differed statistically significantly from the control group in the active and passive knee flexion range of motion. These differences were diagnosed in both legs. No significant differences between the first and second experimental groups were observed (Table 1).

In group E1, where the Kinesio tape was applied from the origin to the insertion of rectus femoris, there was a statistically significant increase in the range of active knee flexion immediately after applying the tape (comparison of measurements 1 and 2). A significantly greater range of motion was also seen after 3 days of wearing the application (comparison of measurements 1 and 3) and 4 days after removal of the application (comparison of measurements 1 and 4). Between measurements 2, 3, and 4, the range of active knee flexion did not change (Table 2).

In group E2, where the Kinesio tape was applied from the insertion to the origin of the rectus femoris, there was a non-significant increase in the range of knee flexion immediately after application of The Kinesio tape. However, the range of active knee flexion was significantly greater after 3 days of wearing the application compared to the first measurement. 4 days after removal of the Kinesio tape, the range of active knee flexion changed slightly and was still statistically significantly greater than in measurement one.

In none of the subsequent measurements did the experimental groups E1 and E2 differ statistically significantly.

A comparison of the range of active knee flexion in the leg without The Kinesio tape application showed no significant differences between groups E1 and E2 or between consecutive measurements in either experimental group (Table. 3).

Table 1. Comparison of the active and passive range of right and left knee flexion in both experimental groups and in the control group in the first measurement (the Kruskal-Wallis)

Variable	Group	Mean	Median	Min	Max	SD	*p*
AROM right leg [°]	E1	38.64	40.00	24.00	57.00	9.55	E1 & E2 $p = 0.264$ E1 & C $p < 0.001^*$ E2 & C $p < 0.001^*$
	E2	43.81	42.00	27.00	64.00	9.91	
	C	124.30	122.00	120.00	137.00	5.52	
AROM left leg [°]	E1	45.21	45.00	30.00	63.00	10.31	E1 & E2 $p = 0.934$ E1 & C $p < 0.001^*$ E2 & C $p < 0.001^*$
	E2	44.06	43.00	27.00	60.00	8.52	
	C	124.70	121.50	119.00	143.00	7.319	
PROM right leg [°]	E1	121.29	125.00	97.000	145.00	13.78	E1 & E2 $p = 0.999$ E1 & C $p = 0.032^*$ E2 & C $p = 0.027^*$
	E2	121.31	120.50	109.00	141.00	8.88	
	C	132.70	132.50	123.00	142.00	6.50	
PROM left leg [°]	E1	122.00	125.50	92.000	143.00	14.04	E1 & E2 $p = 0.974$ E1 & C $p = 0.023^*$ E2 & C $p = 0.012^*$
	E2	121.13	120.50	105.00	140.00	9.10	
	C	134.50	134.00	124.00	147.00	7.99	

AROM – active range of motion, PROM – passive range of motion, E1 – application from the origin of the muscle, E2 – application from the insertion of the muscle, C – control group, * – statistically significant difference

Table 2. Comparison of the active range of motion of the knee flexion of the lower limb with the Kiesio tape application in both experimental groups in subsequent measurements (intragroup comparison – Wilcoxon test, ANOVA for repeated measures and Tukey's post hoc, intergroup comparison - t-test for independent samples and Mann-Whitney U test)

E1 group					Measurement	E2 group					*p*
Mean	Median	Min	Max	SD		Mean	Median	Min	Max	SD	
40.14	40.00	24.00	62.00	9.87	1	41.69	42.00	27.00	51.00	7.13	E1 & E2 $p = 0.624$
45.50	47.50	26.00	61.00	8.97	2	45.25	44.50	32.00	57.00	7.63	E1 & E2 $p = 0.935$
46.64	49.00	32.00	62.00	8.65	3	49.31	47.50	37.00	59.00	7.68	E1 & E2 $p = 0.378$
45.00	45.50	33.00	63.00	8.83	4	47.69	46.00	35.00	66.00	7.67	E1 & E2 $p = 0.380$
1 & 2 $p = 0.012^*$ 1 & 3 $p = 0.002^*$ 1 & 4 $p = 0.025^*$ 2 & 3 $p = 0.897$ 2 & 4 $p = 0.990$ 3 & 4 $p = 0.749$						1 & 2 $p = 0.073$ 1 & 3 $p < 0.001^*$ 1 & 4 $p < 0.001^*$ 2 & 3 $p = 0.032^*$ 2 & 4 $p = 0.330$ 3 & 4 $p = 0.667$					

E1 – application from the origin of the muscle, E2 – application from the insertion of the muscle, * – statistically significant difference

Table 3. Comparison of the active range of motion of the knee flexion of the lower limb without the Kinesio tape application in both experimental groups in subsequent measurements (intragroup comparison – Wilcoxon test, ANOVA for repeated measures and Tukey's post hoc, intergroup comparison – t-test for independent samples and Mann-Whitney U test)

E1 group					Measurement	E2 group					p
Mean	Median	Min	Max	SD		Mean	Median	Min	Max	SD	
43.71	43.00	28.00	63.00	10.79	1	46.19	46.00	27.00	64.00	10.45	E1 & E2 $p = 0.529$
43.07	44.00	28.00	58.00	9.63	2	46.25	45.00	28.00	64.00	9.30	E1 & E2 $p = 0.366$
42.00	41.50	30.00	56.00	9.76	3	46.13	46.00	32.00	62.00	7.87	E1 & E2 $p = 0.211$
43.93	43.50	30.00	57.00	8.57	4	46.50	44.00	36.00	63.00	7.47	E1 & E2 $p = 0.387$
1 & 2 $p = 0.980$ 1 & 3 $p = 0.733$ 1 & 4 $p = 0.999$ 2 & 3 $p = 0.917$ 2 & 4 $p = 0.955$ 3 & 4 $p = 0.655$						1 & 2 $p = 0.999$ 1 & 3 $p = 0.999$ 1 & 4 $p = 0.995$ 2 & 3 $p = 0.999$ 2 & 4 $p = 0.997$ 3 & 4 $p = 0.992$					

E1 – application from the origin of the muscle, E2 – application from the insertion of the muscle, * – statistically significant difference

Discussion

The Kinesio tape awpplication statistically significantly increased the free-of-compensation knee flexion in both study groups. However, if the tape was applied from the origin to the insertion of the rectus femoris, the improvement was seen directly after application, while in the case of the tape was from the insertion to the origin, the improvement was noted after three days (possibly already present a few hours after application, but this was not tested). The beneficial effect was similar in both groups and persisted for four days after application removal. Although a statistically significant increase in the free of compensation range of motion was obtained, it was still significantly less than the norm defined at 120°. The range of passive motion increased significantly only in the group taped from origin to insertion, which supports the methodology recommended by Langendoen.[18]

The results of studies on the effect of the Kinesio tape on muscle elasticity are ambiguous. As indicated by the meta-analysis conducted by Lu et al.,[13] this method can significantly improve the range of active painless knee flexion in people with osteoarthritis. In their studies, Cho et al.[12] also observed a reduction in pain and an improvement in the range of motion in patients with knee osteoarthritis, but if the tape was applied to stretched tissue (stretching was achieved by 60° knee joint flexion). In turn, Lemos et al.[17] applied taping to the rectus femoris every 24 hours for 3 days, changing the application direction and the tape tension (0%, 10%, 75%–100%) and did not observe significant changes in muscle elasticity or strength. However, they studied healthy people without any dysfunctions or restrictions. Halski et al.[12] also did not note any changes in the elasticity of the rectus femoris muscle 24 hours after applying the Kinesio tape to the rectus femoris muscle. However, it should be clear that they also studied young, healthy individuals, who were volleyball players.

Akbaş et al.[7] and Coskunsu et al.[19] demonstrated biceps femoris increased flexibility after the Kinesio tape application however, both researcher teams combined taping with exercises or the PNF method. An increased range of motion as the Kinesio tape application result was noted by Gusella et al.[5] on the rotators of the shoulder, and Kim and Lee[8] on the forearm muscles. On the other hand, Gomez-Soriano[20] did not observe a change in calf muscle flexibility after the Kinesio tape application, either immediately after application or 24 hours after. They performed the application from insertion to origin, but it should be noticed that they studied healthy individuals with normotonic muscle tone.

Lumbroso et al.[11] also applied tape from insertion to origin to the gastrocnemius and observed an increased range of motion.

As it has been proven, there are no clear guidelines regarding the Kinesio tape application to reduce the tension of hypertonic muscles and increase the limited range of motion. However, it seems that this method can be useful. The innovation of the presented research is the inclusion of compensation in the adjacent body segment when assessing the range of motion changes after the Kinesio tape application. The obtained results allow us to assume that this method can successfully support the re-education of movement patterns in patients with musculoskeletal pain and faulty body posture. However, before such a procedure can be recommended for wide use, further studies should be conducted on a larger group of patients and be supplemented with a placebo group. The study group included only young women without pain or musculoskeletal dysfunction, so the findings cannot be transferred to the general population.

Conclusions

1. The Kinesio tape application to the rectus femoris muscle improves the active range of free from compensation in the lumbar-pelvic region knee flexion.
2. The effect of increased knee flexion is visible immediately after application, after 3 days of wearing the tape, and after 4 days of removing the application.
3. Application from origin to insertion and from insertion to origin gives similar results. However, application from origin to insertion gives the effect faster and has a more pronounced effect on the range of passive movement.

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