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The effects of kinesiотaping on medial-lateral postural sway in one leg stance

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Aim of this study was to assess does kinesiotape have effect on medial-lateral postural sway in one leg stance. Subjects of this study were 6 students of Satakunta University of Applied Sciences, 5 females and 1 male. The exclusion criteria were: Acute ankle sprain, skin irritation, disease on taping site, inability to do a 20 second one leg stance and whilst under the influence of alcohol.

To assess the effect of kinesiotape all the subjects performed a one leg stance for 20 seconds eyes open and eyes closed on Metitur Good balance –system to assess the baseline score. After recording initial results the kinesiotape was applied and after 10-15min of the application the second measurements were done.

Based on results kinesiotape has a reducing effect on medial-lateral postural sway in one leg stance. Mean changes were 99,5mm when eyes were open and 157,8mm when eyes were closed. Changes were statistically almost significant in eyes open testing and when comparing the changes between the eyes open testing to eyes closed and changes were statistically significant when eyes were closed.

The further studies are needed to perform the tests again with a larger subject group to receive more accurate results. Only 2 out of the 6 subjects were able to perform a one leg stance eyes closed for 20 seconds. This increases the criticism level of the formula used to calculate the p-value, which is used to prove the statistical significance level.

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1 INTRODUCTION

Kinesiotape (KT) is increasing interest nowadays with health care professionals as well as among other people. (Kåla & Kataja 2011, 5) KT is an innovating and functional form of therapy and treatment. It is simply an effective method to reduce pain and therefor enabling active function and movement. (Walker, Grönholm, Salminen, Wegelius & Larsson 2014, 258.)

Instead of fixating KT is meant for stimulating, guiding, and supporting the normal movement patterns. There are more target areas than just muscles such as fascia, circulatory system and other supportive tissues. (Kåla & Kataja 2011, 10.) There are various different methods of applying KT and based on a thorough client examination, the most suitable application can be decided. (Kåla & Kataja 2011, 12.)

One leg stance is part of everyday living. Testing and analyzing one leg stance is a good way to measure equilibrium. One leg stance is a static performance but is still used frequently in activities such as climbing stairs and walking. (Parreira, Boer, Rabello, Costa, Oliveira Jr. & Silva, 2013, 313.)

Musculoskeletal, sensory and central nervous systems create postural control. Using a force platform it is possible to receive numeric values of the balance control systems. (Pajala, Era, Koskenvuo, Kaprio, Törmäkangas & Rantanen, 2008, 171.) A force platform measures the center of pressure (COP) changes and the parameters received are a good indicator of postural control. (Parreira, Boer, Rabello, Costa, Oliveira Jr. & Silva, 2013, 312.)

In this thesis there are presented the results of the study that was carried out in winter 2015 and spring 2016 to determine whether there is decreasing effect to medial-lateral postural sway in one leg stance. Testing is done eyes open and closed and then compared to results when the testing is done with KT. Postural sway is measured by using Metitur Good balance –system.

2 KINESIOTAPE

KT is an elastic tape made of cotton which has glue that is acryl based, hypo allergic and activates by heat. The KT can last and held on the skin for even up to 8 days without any significant skin reaction due to water resistance and breathability. KT has covering to protect the glue and has a pre stretch of 10%. The KT can only be stretched in the longitudinal direction. The KT methods are based on the shrinking phenomenon which always happens towards the starting anchor. There are two or more anchors depending on which form of technique is in usage. Every method starts and ends with an anchor which is placed with absolutely no stretch to help keep the KT in place. (Kåla & Kataja 2011, 10-13.)

2.1 History of kinesiotaping

KT has spread more widely in the past 10 years but the roots of the techniques originate in the 1970-1980th Japan. A chiropractitioner named Dr. Kenzo Kase and he's colleagues are consider as the inventors of KT. They tested moving and guiding of the skin to different directions during muscle and functional performance tests. Results were that the assistance can relief pain and assist with quality and quantity of movements. (Walker, Grönholm, Salminen, Wegelius & Larsson 2014, 258.)

Dr. Kenzo Kase's leading idea was that KT should support the body's own healing process. The KT should not be used to force the body to act in a certain way but to guide, assist and teach to find the optimal position or movement. (Walker, Grönholm, Salminen, Wegelius & Larsson 2014, 258.) KT effects are based on body's own healing process through proprioception. (Kåla & Kataja 2011, 10)

2.2 Different application methods

The application of Kinesiotape can be divided into different techniques that differ from one another depending on the placing and the applied stretch on the tape. These methods can be combined together to receive the desired benefit. (Kåla & Kataja

2011, 16.) There are various techniques of applying Kinesiotape for different locations and desired effect on the body such as muscle activation and relaxation, fascial stimulation, position corrective, lymphatic and combination of techniques. (Kåla & Kataja 2011, 7.)

Using Kinesiotape on muscles we can effect on the function and the tone of that specific muscle. When applying a muscle activation or relaxation technique, the only difference is the location where the taping is started from. Muscle activation is done by placing the first anchor 1-2cm outside of the muscle's origin and then applying a stretch to the muscle, after the tape is applied with 10-15% stretch along the muscle towards the insertion the second anchor is placed on top of the muscle insertion. In this technique the stretch on the tape pulls the mechanoreceptors towards the origin of the muscle causing an activation effect on that muscle. Muscle relaxation application is performed with the same technique expect the starting point of the tape is the insertion of the muscle and taping is finished at the origin. (Kåla & Kataja 2011, 18.)

Fascial, lymphatic and position corrective kinesiotaping techniques are used to reduce pain, guide the joint into a position, inhibit a movement in the joint and draining the tissue of extra fluids. (Kåla & Kataja 2011, 66, 74 and 94.) The fascial technique is done by guiding or inhibiting the direction of movement of the fascia. This proprioceptive and mechanical stimulation normalizes the function of the ligament, tendon or fascia and there for reducing pain. (Kåla & Kataja 2011, 66.) Lymphatic taping technique is based on the concept that after the kinesiotape has been applied with 10-15% stretch on to the skin the tape starts to return to normal length and therefor giving a lifting effect on the skin. This phenomenon reduces pressure on the subcutaneous tissue. The pressure is lower under the tape, and the extra fluids in the tissue advances toward a location with less pressure. Using this method and correctly placing the strips of kinesiotape it is possible to drain the extra fluids all the way back to the blood circulation. (Kåla & Kataja 2011, 94.) The goal for position corrective kinesiotaping is to guide the joint into a desired position or to inhibit a certain direction of movement. The joint is assisted to the position by active movement and manual guiding. The use of kinesiotape is intended to maintain the achieved position. (Kåla & Kataja 2011, 74.)

3 BALANCE

The ability to maintain our body's center of mass over its base of support is called balance. When the balance ability is working properly, for e.g. we are capable of maintaining balance and posture through different conditions, positions and activities. The balance consists of a complex set of sensorimotor control systems. The sensorimotor control system includes the vestibular system, sensory input, integration of the sensory input and motor output. (VEDA, 1.) The response these systems create is what helps a person to maintain the balance. These responses combined with the information received from the sensorimotor control system are called postural control. (Kauranen 2011, 180) Postural control consists of two main functions, postural equilibrium and postural orientation. (Horak 2006, ii8) These functions mean maintaining balance and fixing position and orientation to receive accurate information from the external world. (Massion 1994, 877) Different strategies are applied in postural control depending on the type of stance and magnitude of disturbances from the external world such as ankle, hip and foot tilt strategy. (Hoogvliet 1997, 14; Hur 2010, 2)

3.1 Sensory systems

The balance sensory input includes the visual, proprioceptive and vestibular systems. (VEDA, 1) The visual system's relation to balance is based on the individual's ability to anticipate and time movements correctly which assists in maintaining balance. The horizontal line is essential to control of balance. (Kauranen 2011, 157.)

Proprioceptors are body's internal sensors that provide the Central nervous system with current information concerning positions, movements, directions and velocity for different body parts. (Kauranen 2011, 169) The proprioceptive feedback is carried out by muscles', joints' and skin's sensory receptors that are sensitive for changes in pressure and length. (VEDA, 2) The proprioception in the joint conveys the information of the joint's position into to the brain using the knowledge received from the joint receptor's changes in pressure. The Golgi tendon organ works in the

muscle tendon as a protective mechanism. If the force towards the tendon is great enough to cause muscle damage, The Golgi tendon organ tries to prevent muscle contraction and at the same time the antagonist muscle contracts. This reflex is also known as the phenomena of a leg giving away from under you. Muscle spindles are inside the muscles and inside these spindles there are muscle cells that are surrounded with nerve endings. When a stretch is applied to the muscle it irritates the nerves which then transport the information to the spinal cord. (Karhumäki, Kärkkänen, Nieminen & Syrjäkallio-Ylitalo 2014, 181.)

The vestibular system is sensing the movement and position of the head. (Karhumäki, Kärkkänen, Nieminen & Syrjäkallio-Ylitalo 2014, 182) When considering physiology and function the vestibular system is part of the proprioceptive system. (Kauranen 2011, 175) The vestibular system has five parts in both ears: utricle, saccule and three semicircular canals. The utricle and saccule senses the linear movements and gravity, whereas the semicircular canals detect rotational movements. (VEDA, 2.)

3.2 Postural control

Postural stability relates to parts of the body or phenomena that affect the balance such as local proprioception, trunk and neck area or losses in the motor control of the lower limbs. A good way to measure postural stability is to calculate the magnitude of sway or steadiness to normal changes when standing. (Lederman 2010, 26.) Postural control is often examined by using a force plate combined with timing the performance of some sort of upright stance such as a one-leg stance. (Strang & DiDomenico 2010, 27)

3.2.1 Ankle strategy

The ankle strategy is a form of postural control. This strategy is applied when the foot is fully supported on a contact surface. In this position then ankle muscles can operate by using reverse action. In example if a person sways forward in an upright

stance, moving the center of gravity over the base of support, the gastrocnemius muscles activate and bring the person back to midline. The ankle strategy also known as the inverted pendulum is most effective when standing on firm surface and correcting small perturbations in the balance. The use of inverted pendulum requires muscle strength and an intact joint range about the ankle. (Everett & Kell 2010, 77.)

3.2.2 Foot tilt strategy

The Foot tilt strategy is a modification to ankle strategy when performing a one-leg stance. The adaptation happens due to narrowing of the base of support in the frontal plane. The difference to ankle strategy comes on preferring information of the foot tilt rather than changes in the center of gravity. (Hoogvliet 1997, 15.)

3.2.3 Hip strategy

The hip strategy is a secondary option for the ankle strategy and is active when the perturbations are greater than a small sway, the surface is smaller or there are quickly applied interferences. The hip strategy uses the bigger muscles around the hip and knee to provide better control of the center of gravity. In a difference to the usage of hip strategy to ankle strategy, forces that are applied in the mediolateral direction are studied that the size of the perturbations are irrelevant. The mediolateral forces active muscles in a proximal to distal order. The mediolateral movements are limited in the ankle and knee joint when standing on both legs, which causes them to play a very insignificant role in the mediolateral stability in normal standing. (Everett & Kell 2010, 77-78.)

4 METITUR

Metitur Good balance –system is based on measuring and analyzing the forces coming in a vertical direction on to the force platform. The Metitur Good balance -system

is a tool consisting of a triangular power plate, a frame to go around it and safety rails. There is also a computer connected to a printer which will print out the results and sensors at each corner of the triangle and all three force signals are measured and transformed into a numeric value. (Metitur Oy 2003,4.)

The safety railing around the force platform is meant to provide the client with a sensation of security that fear of falling would not affect on to the measurement. (Metitur Oy 2003, 4) There are also other factors that have to be taken into consideration in the environment to receive the best possible results such as lighting, temperature, sounds. (Metitur Oy 2003, 7.)

Testing environment and conditions should be neutral with sound, lighting, temperature and clothing. Sudden rises in noise may affect the balance. There needs to be sufficient lighting, but not so bright that it causes dazzling. Temperature should be at a neutral level sense heat or cold may cause additional motor activity. Clothing should be so that it does not give advantages or disadvantages during the test. Main focus is to have the same environment and conditions for all participants. (Metitur Oy, 2003. 7.)

5 PURPOSE AND OBJECTIVE OF THESIS

Aim of this study is to research how does lateral stabilization kinesiotaping of ankle effect on lateral postural sway in one leg stance with eyes open and eyes closed. There are three results to be analyzed. A. Comparison of with and without the tape eyes open. B. With and without the tape eyes closed. C. How do the results of A differ to results of B.? The tests subjects of this study are 6 randomly selected physiotherapy students from Satakunta University of applied sciences. The exclusion criteria are: Acute ankle sprain, skin irritation, disease on taping site, inability to do a 20 second one leg stance and whilst under the influence of alcohol.

The Research questions are:

1. How does kinesiotaping effect on Medial-lateral postural sway when eyes are open and when eyes are closed?
2. How significant is the difference when comparing the changes between eyes open testing results to the changes in eyes closed testing results?

6 METHODOLOGY

When conducting quantitative study firstly the group of subjects (population) needs to be defined. In a research information is gathered by measuring the population. There are different types of measurement scales used depending on the variable that is being examined. Nominal, ordinal, ratio and interval scale are the four different types of measurement scales. In this study the scaling that is being used is interval scale which is meant for measuring difference between individual values. With numeric values we can differentiate is something larger, smaller or the same size. (Holopainen & Pulkkinen 2002, 12-13.)

Before testing the population a decision concerning the study type has to be made. Is the research done as a census study where every subject is measured or as a sample study where a smaller group of the population is measured. A census study is usually best to perform if the population is small. (Holopainen & Pulkkinen 2002, 27-28.)

Analyzing of how truthful specific assumptions or claims are is connected to nearly all research activity. Statistical testing is used to examine the accuracy of the hypothesis made of the population. (Holopainen & Pulkkinen 2002, 156.) The most common parametric tests are mean tests such as student t-test and paired sample t-test. (Holopainen & Pulkkinen 2002, 158-170.)

6.1 Client inclusion, exclusion and contraindications

Sample of this study was drawn from Satakunta University of applied sciences. The population was 6 persons. The clients were randomly selected of a Physiotherapy class which had 23 students. Before randomly selecting the clients, students were excluded if they did not volunteer, possess one or more of the contraindications for KT application or knew of incapability to do a 20 second one leg stance. Out of 23 students there were 16 volunteers and 6 subjects were randomly selected out of those volunteers. All of the 6 subjects that were randomly selected participated in the testing.

There were 6 subjects, 1 male and 5 females between ages of 21-25 with high athleticism level. The following table will give a closer description of the ages and athleticism levels of the subjects.

Description of subject	Age	Athleticism level (0-7)
Min	21	4
Max	25	7
Mean	23,3	5,3
Standard deviation	± 1,4	±1,2

Table 2. Description of subject ages and athleticism level.

Contraindications for application of KT were skin irritation, damage or disease on taping site (Kåla & Kataja 2011, 14). Contraindications for the test were acute ankle injury on tested leg and/or whilst under the influence of alcohol. Clients filled a pre-questionnaire concerning athletic level and current health status (Appendix 1). From the questionnaire question number 4 and the instructions below is referenced from the article: Prediction of functional aerobic capacity without exercise testing. Medicine and science in sports and exercise by Jackson, Blair, Mahar, Weir, Ross & Stuteville in 1990.

6.2 Execution of the testing process

Subject goal was to try to maintain a one leg stance for 20 seconds with minimum sway. The subjects were instructed with placing of different body parts to minimize additional sway and to receive better results. Head was to be maintained still, hands crossed over the chest, and standing was done in the middle of the platform without footwear to receive the most accurate measured values. (Metitur Oy 2003, 8)

After the subject was guided in the testing process, subject's weight and height was measured. Then the results were measured for eyes open and eyes closed without KT tests. After the two tests the subject received the application of the KT and waited for 10-15min. During this time the subject filled the questionnaire and after the testing was performed again.

The KT method was chosen using the principles of the position corrective taping. The testing idea was to analyze the effectiveness of the taping method when using only one strip of KT around the ankle.



Fig. 1 Lateral aspect of the ankle



Fig. 2 Medial aspect of the ankle

The prior to application of KT there were two phases. First the subject sat down on a plinth with leg straight and fully supported having only the ankle over the edge of the plinth. Phase two was to passively guide the ankle into a neutral position and having an active hold.

Application of the tape started with measuring the correct length of the tape which was from lateral malleolus to medial malleolus going from the sole of the foot. The KT was applied with 100% stretch starting from under the sole of the foot and placing the sides over the medial and lateral malleolus. The idea is to create a pull towards both malleolus which would therefor reduce the ankle inversion and eversion.

6.3 Analyzing results

In this thesis we create a null hypothesis (H_0) and alternative hypothesis (H_1). H_0 means that there is no difference between the means received from the tests with and without KT. The H_1 means that KT has an effect on the means. The goal is to try to dismiss the H_0 . This would mean that the H_1 is valid. After testing the hypothesis it is impossible to be absolutely sure is the conclusion correct. The significance value (p-value) describes how statistically significant the result or difference is. (Holopainen & Pulkkinen 2002, 156-157.) Excel computer program was used to help analyze.

The paired sample t-test is used when one subject is measured twice. Then we create the H_0 which means the mean of both measurements would be the same. (Holopainen & Pulkkinen 2002, 170.) In this setting it would be so that the mean received from the test without KT would be the same as the mean received of the test with KT.

The value that is measured is the distance gone in the Medial-Lateral direction by center of pressure (COP). With these values the first thesis question can be answered. To answer the second question of the thesis we calculate the p-value and by comparing the changes in the means between eyes open and eyes closed. This way we can consider the increased or decreased effect of the KT when eliminating visual aspect of the balance ability.

7 RESULTS

Test results were received for both questions. The outcomes were presented in graphs and by numeric values. Firstly we look at the results for the effects of kinesiotape and secondly comparing the difference that KT provided.

7.1 The effects of Kinesiotape

For the eyes open testing the paired sampled t-test results gave test statistics value of 2,89 and the p-value of this test statistics and compared to the amount of subject was 0,01-0,025 (Holopainen & Pulkkinen 2002, 332) This means that the H_0 can be dismissed with a 1-2,5% error margin. For the eyes closed testing the paired sampled t-test results gave test statistics value of 10,8 and the p-value compared to the amount of subject was less than 0,005.

The testing Eyes open test result means were 469,1mm ($\pm 82,2$ mm) without KT and 369,6mm ($\pm 112,1$ mm) with KT. These means has a difference of 99,5mm. Eyes closed test result means were 914mm ($\pm 90,7$ mm) without KT and 756,2mm ($\pm 111,3$ mm) with KT.

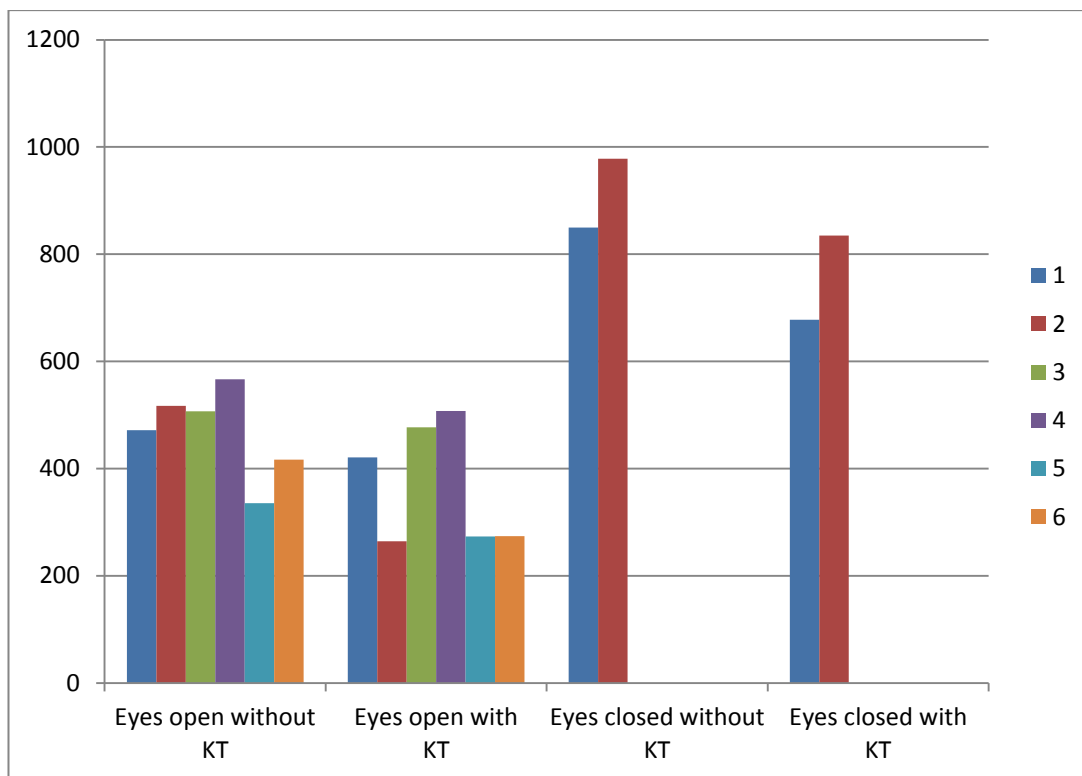


Chart 1. Results of the 6 subjects in the balance test

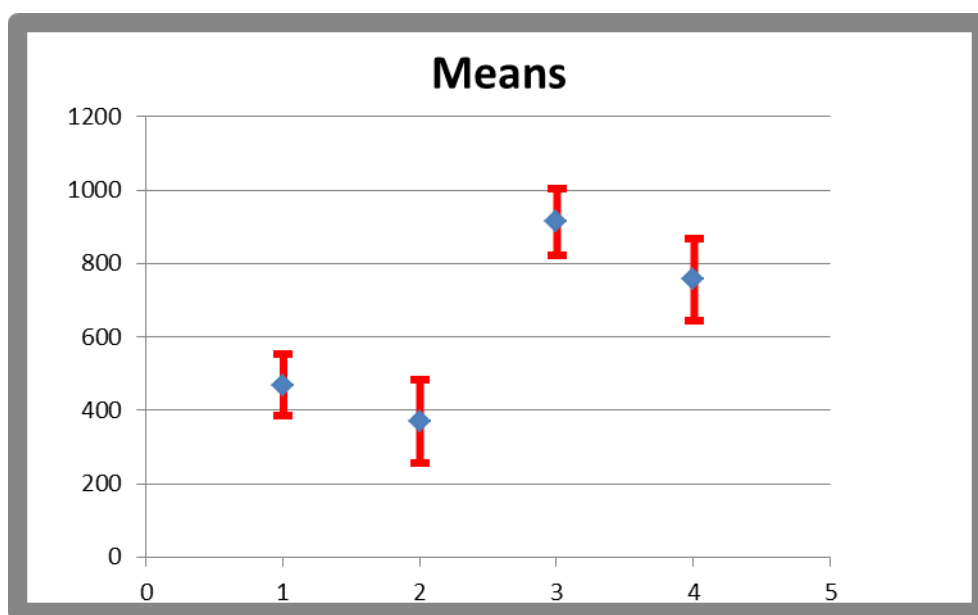


Chart 2. Mean and Standard deviation of test subjects' results 1.Eyes open without KT 2. Eyes open with KT 3. Eyes closed without K 4. Eyes closed with KT

7.2 Comparison of the differences

The paired sampled t-test can also be calculated the statistical significance on the difference how much assistance KT gave comparing eyes open and eyes closed statistics. The calculated value is 4,4 which means the p-value is less than 0,025

The difference in means that were received with and without KT were 99,5mm ($\pm 84,3$ mm) with eyes open and 157,8mm ($\pm 20,6$ mm) with eyes closed. The chart below presents these outcomes.

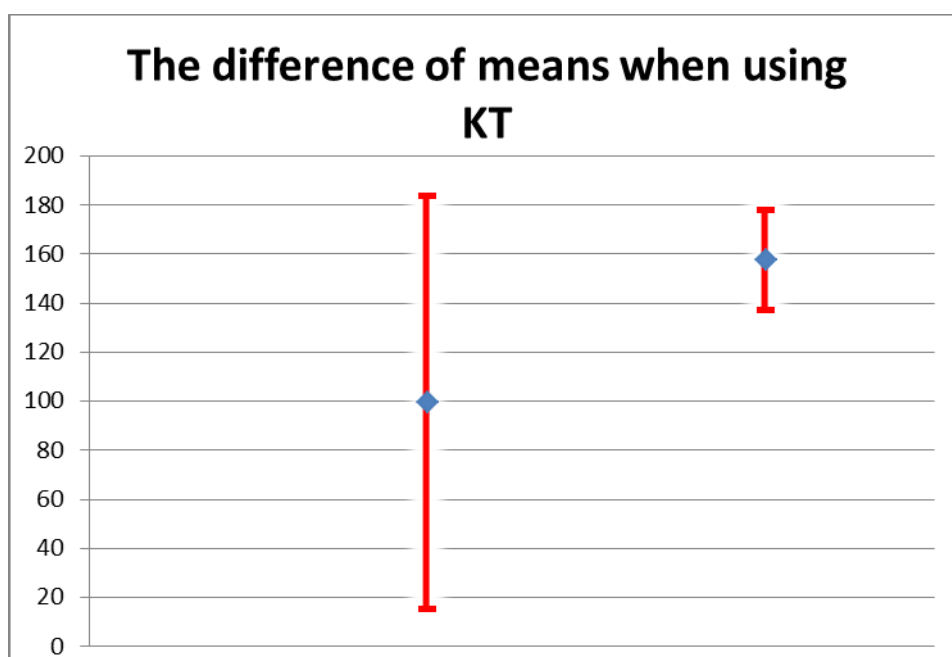


Chart 3. this figure shows how much was the mean and standard deviation of the difference KT created.

8 CONCLUSION

The H_0 was dismissed in all three conditions with a small margin of error. Based on this study we can assume that this specific KT method has statistically almost significance decreasing effect on medial-lateral postural sway when eyes are open and statistically significant when eyes are closed because the error margins were 1-2,5% and

less than 0,5%. To answer the second question of this thesis due to less than 2,5% margin of error which means there is statistically almost significant evidence for us to also assume that the effects of KT increase when the visual aspect of balance is inhibited.(Holopainen & Pulkkinen 2002, 157)

9 DISCUSSION

The thesis process started in December 2014 when the subject was decided. The thesis subject was chosen to measure the effects of KT on medial-lateral postural sway in one leg stance. The KT application method was chosen from a KT course which I participated in at Satakunta University of applied sciences in the fall of 2015. Method was selected because it was easy to apply which lead to a small risk of applying the KT differently to the subjects. The writing process started by first writing the research questions, then the table of content and theoretical framework. Theory part was written throughout January to April 2016. Subject testing was performed at Satakunta University of applied sciences in February 2016. Testing results were analyzed during March and April of 2016. Thesis was finished at the end of April 2016 and presented during May 2016.

December 2015	writing research questions and aims
February 2016	client selection and testing
January-April 2016	Writing theory and analyzing results.
May 2016	presentation of thesis

Table 1. Thesis process.

The thesis subject and questions were easy to figure out but the most difficult part of the thesis process was to start writing the questions and theory around the subject. Once the theory was written for most part the writing started going smoothly. Writing the theoretical framework was difficult to start because it is very time consuming to find references and finding ways to create good paragraphs and make the best possible theoretical background. Another difficult part was to find additional and suitable references.

There were few things that could have been done differently. Firstly the subjects could have been measured more than once for each parameter of the testing to receive individual standard deviations. Also by using randomization half of the subject could have been selected to perform the balance testing first with KT and afterwards without.

There was one problem that occurred during the testing which affects the analysis of the result. Only 2 of the 6 subjects could perform the one leg stance with eyes closed with and without KT. This creates an issue to when calculating the level of significance. When the amount of the subjects is very small that raises the criticism level of the equation for level of significance. The less you have subjects the higher difference you have to have in the results to receive a statistically significant difference.

There is one important factor that needs to be understood when observing the results. If this testing pattern was to be performed again the level of significance will most likely change. This testing process should be performed with a bigger subject group to reduce the risk of coincidence. Another way to get close to accurate results is if this test would be performed several times with the same amount of subjects and then calculating the mean of the p-values received from the tests.

When comparing the pre-questionnaire answers to the results of the tests we can find some combining factors. With subjects who had 6-7 activity level (0-7) also had smaller medial-lateral postural sway without KT when eyes were open. When activity level was reduced below 6 there wasn't any connection with starting scores. There was no connection between age, injuries, or activity level to how much difference KT created. Most of the subjects mention that they do gym activities. There could

have been more questions concerning on the type of training the subjects perform at the gym to see if those activities would have any connections between the results.

There is need for further studies for the same subject. It should be performed with a larger population with a larger variety of subject groups. Testing was only done to healthy physiotherapy students who all had high activity levels. It would be interesting to see how the KT would effect on people with ankle injuries and different backgrounds in activity levels.

In this thesis only the x-line distance was evaluated but often when measuring postural sway there is also included x-line velocity so for further studies the x-line velocity could be included in the results. Testing also could be done to see how many strips of KT applied overlapping one another would be the optimal amount to receive the best medial lateral postural control. For further studies there could also be a different variation of time to be standing on one leg.

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QUESTIONNAIRE FOR THESIS ON

The effects of kinesiotaping on lateral postural sway in one leg stance.

Circle/ fill the right answer.

1. Name (notice: This information is only for the tester. This information will not be presented in the thesis).

-

2. GENDER

Male / Female

3. AGE

-

4. ATHLETISM LEVEL (instructions on the bottom of the page)

1 / 2 / 3 / 4 / 5 / 6 / 7

List of the sports:

-

5. Which leg are you going to use in the test?

Left / Right

6. Chronic or acute injuries on the tested lower limb?

-

7. Are you experiencing any of the following symptoms?

- drowsiness (uneliasuus)
- dizziness (pyörimisen tunnetta)
- lightheadedness (huimausta)

8. Do you suffer from any long term illness? If yes, from what?

-

9. Are you suffering from any musculoskeletal problems (diagnosed, self-noticed, and/or pain)? If yes, from what/where?

-

10. Are you currently under the influence of alcohol?

No / Yes

Question 4 instructions (mark the number that best describes you in the past month)

I don't take part in any free time exercise or perform any strenuous activity

0 = I avoid walking and additional physical activity e.g. I always use lifts and instead of walking I always use a car when it's possible

1= I walk for fun, mainly use stairs, occasionally perform physical activity so, that I sweat and get out of breath

I perform regular physical activity or work, which demand reasonable physical endeavor e.g. golf, horseback riding, gymnastics, table tennis, bowling, gym, or gardening

2= 10-60 minutes per week

3= Over an hour per week

I perform regular strenuous physical activity e.g. running, jogging, swimming, cycling, rowing, skipping rope, or other heavy aerobically loading sport, like tennis, basket- or handball.

4= I run less than 2 km in a week or perform comparable physical activity less than 30 minutes per week

5= I run 2-10 km per week or perform comparable physical activity 30-60 minutes per week

6= I run 10-15 km per week or perform comparable physical activity 1-3 hours per week

7= I run over 15 km per week or perform comparable physical activity over 3h per week.