THE EFFECT OF KINESIO TAPE ON SINGLE LEG BALANCE

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Jessica Achatz

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A thesis prepared by Jessica Achatz

In partial fulfillment of the requirements for the degree,
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Frank Novotny 5/6/2015

Dr. Frank Novotny Date
Director of the Graduate School

Tracey L Robinson 5-6-2015

Dr. Tracey Robinson Date
Chairperson of Thesis Committee

Thesis Committee Members:

Tracey L Robinson
Dr. Tracey Robinson

Brian Zuleger
Dr. Brian Zuleger

Josh Dreher
Josh Dreher

Abstract

Tape is commonly used as a performance aide in the athletic population. Kinesio tape has gained significant popularity in recent years, but there is a lack of scientific evidence on its efficacy. The current study aimed to determine if an application of kinesio tape, placebo tape, or no tape were effective measures in aiding single leg balance. Thirty (15 males and 15 females) division II athletes (age: 21±2 years; height: 69±7 inches; weight 191.5±71.5 pounds) were recruited to participate in this study. The volunteers participated in men's soccer, women's soccer, men's lacrosse, women's lacrosse, football, women's track and field, men's track and field, women's basketball, men's basketball, softball, baseball, and women's volleyball. Participants were randomly assigned to a starting group (control, kinesio tape, or placebo tape) and all participants completed all three conditions. Kinesio tape, placebo tape, or no tape was applied to the participants. Single leg Balance Error Scoring System (BESS) testing was performed by the participants on their dominant leg in each testing condition. Total BESS scores were collected by combining the total amount of errors from the firm and foam single leg conditions. A repeated measures analysis of variance (ANOVA) was run on the data. There were significant differences ($p<0.05$) between the control group ($M = 3.4$, $SD = 1.92$) and both the kinesio tape ($M = 6.43$, $SD = 2.05$) and placebo groups ($M = 6.47$, $SD = 2.18$), but no significant differences between the kinesio tape and placebo tape groups. The results of the current study suggest that kinesio tape and placebo tape, on division II athletes, are not effective measures in aiding single leg balance. In fact, they appear to worsen balance compared to the no tape condition.

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Chapter 1: Introduction

Kinesio taping is one of the latest trends to strike the athletic population. Kinesio tape was developed by Dr. Kenzo Kase, an American trained Japanese chiropractor and acupuncturist, in the mid-1970s (Williams, Whatman, Hume, & Sheerin, 2012). Kase developed the tape due to limitations he came across while working with prophylactic athletic taping and McConnell® Taping on his own patients (Kase, 2003). Prophylactic athletic taping is traditionally used to either assist or limit a movement by applying high tensile strength non-elastic white and elastic tape (Kase, 2003). The tape is used to protect acute injuries, prevent excess movement at a joint, and protect a joint from further injury (Kase, 2003). McConnell® Taping has primarily a bracing or strapping purpose and has limited therapeutic function (Kase, 2003). There are two types of tape applied: a brown rigid tape is placed over a white cotton mesh tape (Kase, 2003). McConnell® tape has a limited wear time of approximately 18 hours due to adverse skin reactions (Kase, 2003).

The hypothesized functions of kinesio tape are to re-educate the neuromuscular system after injury, reduce pain, optimize performance, prevent injury, and promote improved circulation and healing (Williams et al., 2012). The flexible, adhesive tape was designed to mimic the qualities of skin (Williams et al., 2012). The adhesive on the tape is applied in a wave-like pattern to mimic the qualities of the fingerprint on the fingertip (Kase, 2003). This not only assists in the lifting of the skin, but also allows for zones in which moisture can escape (Kase, 2003). Kinesio tape is 100% cotton and can be worn for three to five days while still upholding its therapeutic benefits (Williams et al., 2012).

Although kinesio tape has been used for many years, the brightly colored tape became popular after the 2008 Olympic Games in Beijing, China (Williams et al., 2012). The tape was donated to 58 countries for use on many of the countries' high-profile athletes (Williams et al., 2012). The national television exposure proved to be extremely beneficial for the popularity and use of kinesio taping (Ujino, Eberman, Kahanov, Renner, & Demchak, 2013).

Kinesio taping is a popular topic of debate within many groups of orthopedic clinicians (Williams et al., 2012). Many health professionals question whether kinesio tape actually provides therapeutic benefits to an athlete, or if it simply acts as a placebo (Williams et al., 2012). The theory behind kinesio tape is that it lifts the upper layers of skin to create more space between the dermis and the muscle (Williams et al., 2012). This allows for better lymph flow and drainage of the affected area (Williams et al., 2012). With respect to these potential claims, kinesio tape should ideally help reduce edema, improve proprioception, range of motion, strength, and decrease pain (Williams et al., 2012).

Since kinesio tape is a fairly new product to a majority of the population, minimal research exists for kinesio tape. The current research supports some of the claims the manufacturers make for their products, but does not support all of them (Aktas & Baltaci, 2011; Huang, Hsieh, Lu, & Su, 2011; O'Sullivan & Bird, 2011; Ujino et al., 2013; Yoshida & Kahanov, 2007). A few researchers demonstrated that kinesio tape may have a small beneficial effect on strength and active range of motion of an injured area (Aktas & Baltaci, 2011; Huang et al., 2011; O'Sullivan & Bird, 2011; Ujino et al., 2013; Yoshida & Kahanov, 2007). Kinesio tape is hypothesized to concentrically pull on the fascia, which in turn, may stimulate increased muscle contractions (Yoshida & Kahanov, 2007). Also, kinesio tape may better align muscles to help increase strength (Williams et al., 2012). Another theory is that the application of kinesio tape increases range of motion due to the increased sensory feedback that reduces fear of movement (Williams et al., 2012). An additional concept is that kinesio tape relieves pain (Garcia-Muro, Rodriguez-Fernandez, & Herrero-de-Lucas, 2010; Gonzalez Enciso, 2009; Merino Marban, Fernandez-Rodriguez, Iglesias Navarrete, & Mayorga Vega, 2011; Ujino et al., 2013). Another notion is that the tape lifts the skin to directly reduce the pressure of subcutaneous nociceptors (Garcia-Muro et al., 2010; Gonzalez Enciso, 2009; O'Sullivan & Bird, 2011; Ujino et al., 2013; Williams et al., 2012). Kinesio tape is theorized to stimulate sensory pathways in the nervous system to increase afferent feedback (Garcia-Muro et al., 2010; Gonzalez Enciso, 2009; Merino Marban et al., 2011 Ujino et al., 2013).

Proprioception is a specialized variation of the sensory modality of touch that encompasses the sensation of joint movement (kinesthesia) and joint position sense (Baltaci & Kohl, 2003). Hypothetically, kinesio tape can increase proprioception. Proprioceptive information can be used to correct velocity and timing errors induced by sudden perturbations of resistance during multi-joint movement (Baltaci & Kohl, 2003). Without proprioception and knowledge of results, the proprioceptive contribution to the time-keeping mechanism depends on the effectiveness of the efferent signal (Baltaci & Kohl, 2003). The maintenance of balance depends on the visual, vestibular, and proprioceptive stimulus (Subasi, Gelecek, & Aksakoglu, 2008). Capsule-ligamentous and muscular proprioceptive afferents are both important in providing joint stability (Subasi et al., 2008). According to Williams et al. (2012), kinesio tape will stimulate the cutaneous mechanoreceptors to increase proprioception.

Purpose

The purpose of this study was to determine if an application of kinesio tape is an effective measure in aiding balance.

Hypothesis

It was hypothesized that kinesio tape would be effective in aiding balance due to its increased proprioceptive abilities.

Delimitations

Only Division II collegiate athletes from Adams State University that have not used kinesio tape before were included. The results of this study will apply only to athletes with no current injuries. Athletes were used due to their familiarity with the Balance Error Scoring System (BESS) test which tests for single leg balance. Athletes at Adams State University are baseline tested. Participants were asked to divulge previous lower extremity injuries prior to the study, and were excluded if they had been previously injured in the past month. Two-inch Elastikon Elastic Tape was used as the placebo condition in the study due to its similar size and feel to Mueller kinesiology tape.

Limitations

Possible learning effects of the balance error scoring system (BESS) may exist. Participants may not have been honest when reporting dominant leg. Balancing on a single leg for 20 seconds is not a normal occurrence.

Assumptions

All tape was applied by a Certified Athletic Trainer in the appropriate manner. Athletes were used since they are familiar with tape applications. All testing was done in a standardized fashion by a Certified Athletic Trainer. It was assumed that the tape is what is improving balance and not a placebo, and that participants were truthful when reporting their dominant leg. It was assumed that the Balance Error Scoring System (BESS) is a reliable and valid clinical measure of balance (Bell, Guskiewicz, Clark, & Padua, 2011; Murray, Salvatore, Powell, & Reed-Jones, 2014). It was assumed that the participants performed to the best of their abilities.

Definition of terms

Balance: the ability to stay upright or stay in control of body movement (Bressel, Yonker, Kras, & Heath, 2007).

Dynamic balance: maintaining equilibrium when moving (Bressel et al., 2007).

Elastikon: a high twist, cotton elastic cloth tape with a rubber-based adhesive (Williams et al., 2012).

Joint stability: derived from a number of structures and mechanisms, both mechanical and neural, that serves to restrict joint motion to normal anatomical limits (Blackburn, Guskiewicz, Petschauer, & Prentice, 2000).

Kinesio tape: a flexible, cotton, adhesive tape that was designed to mimic the qualities of skin (Williams et al., 2012).

Proprioception: the inborn kinesthetic awareness of body posture including movement, tension, and changes in equilibrium (Baltaci & Kohl, 2003).

Proprioceptive sense: is derived from a culmination of sensory input from specialized receptors in muscles (muscle spindle receptors and Golgi tendon organs), joint capsules, ligaments, and cutaneous receptors, that is conveyed to the central nervous system through afferent neural pathways (Blackburn et al., 2000). Information from these mechanoreceptors is processed to provide a neural signal designed to facilitate neuromuscular control in an effort to compensate for deviations in stance or gait (Blackburn et al., 2000).

Range of motion (ROM): the amount of movement within a joint (Prentice, 2006).

Single leg balance: the ability to stay upright or stay in control of body movement on one leg (Bressel et al., 2007). This is measured using the Balance Error Scoring System (BESS) test.

Static balance: maintaining equilibrium when stationary (Bressel et al., 2007).

Trigger points: small, hyperirritable areas within a muscle (Prentice, 2006).

Chapter 2: Review of Literature

Introduction

Several manufacturers make claims about kinesio tape. Dr. Kase created Kinesio® Tex Tape (Kinesio USA, LCC, 2013). Kase claims the tape has the ability to re-educate the neuromuscular system, reduce pain and inflammation, enhance performance, prevent injury, promote improved circulation and healing, and assist in returning the body to homeostasis (Kinesio USA, LCC, 2013). Mueller Kinesiology Tape representatives claim that their product lifts the skin to help maintain flexibility, improve circulation, relieve pain, and enhance recovery (Mueller Sports Medicine, Inc., 2014). For the purpose of this study, Mueller Kinesiology Tape was used. Another kinesiology tape, KT TAPE™, claims to create neuromuscular feedback (proprioception) that inhibits or facilitates stronger firing of muscles and tendons. This feedback creates support elements without the bulk and restriction commonly associated with wraps and heavy bracing (KT Health, 2011). Only KT TAPE™ claims to improve proprioception.

Since kinesio tape is a relatively new topic for the athletic population, it warrants more research. The current research does not provide much evidence for kinesio tape and balance. The purpose of this literature review was to compile research on the anatomy of the knee, especially as it relates to stability, proprioception, single leg balance, and kinesio tape, to determine if an application of kinesio tape was an effective measure in aiding balance.

Anatomy of the Knee

The knee is one of the most traumatized joints in the physically active population (Prentice, 2006). The knee provides stability in weight bearing and mobility in locomotion. The bones that make up the knee are the femur, tibia, fibula, and the patella (Prentice, 2006). The knee joint complex consists of several articulations between the femur and the tibia, the femur and the patella, the femur and the fibula, and the tibia and fibula (Prentice, 2006). The articular surfaces of the knee joint are completely enveloped by the largest joint capsule in the body (Prentice, 2006). Two oval fibrocartilages, the menisci, deepen the articular facets of the tibia, cushion any stress placed on the knee joint, and maintain spacing between the femoral condyles and tibial plateau (Prentice, 2006). The major stabilizing ligaments of the knee include the cruciate ligaments, the collateral ligaments, and the capsular ligaments (Prentice, 2006). The anterior and posterior cruciate ligaments account for a considerable amount of knee stability (Prentice, 2006). The medial and lateral collateral ligaments also provide stability and direct movement in the correct path (Prentice, 2006).

For the knee to function properly, a number of muscles must work together in a highly complex fashion (Prentice, 2006). Knee flexion is executed by the biceps femoris, semitendinosus, semimembranosus, gracilis, sartorius, gastrocnemius, popliteus, and plantaris muscles (Prentice, 2006). Knee extension is achieved by the vastus medialis, vastus lateralis, and vastus intermedius, and rectus femoris. External rotation of the tibia is controlled by the biceps femoris (Prentice, 2006). Internal rotation is accomplished by the popliteal, semitendinosus, semimembranosus, sartorius, and gracilis muscles. Rotation of the tibia is limited and can only occur when the knee is in a flexed position (Prentice, 2006). The iliotibial band on the lateral side primarily functions as a dynamic lateral stabilizer (Prentice, 2006).

The knee is the center of the lower extremity kinetic chain, and is directly affected by motions and forces above and below the joint (Prentice, 2006). The knee is affected by forces from the thigh, hip, pelvis, and spine which are above the knee, and the foot, ankle, and lower leg which are below the knee (Prentice, 2006). Abnormal forces that cannot be distributed must be absorbed by the tissues (Prentice, 2006). When the foot is in contact with the ground, a closed kinetic chain exists. In a closed kinetic chain, forces must either be transmitted to proximal segments or be absorbed in a more distal joint (Prentice, 2006). The inability of this closed system to dissipate these forces typically leads to a breakdown in some part of the system (Prentice, 2006). As part of the kinetic chain, the knee joint is susceptible to injury resulting from the absorption of the forces from above and below the joint (Prentice, 2006). The knee was chosen for this particular study since it is directly affected by the proximal and distal components of the kinetic chain.

Proprioception

The sensory receptors that are found in the skin, muscles, joints, ligaments, and tendons provide input to the central nervous system (CNS) regarding tissue deformation (Baltaci & Kohl, 2003). Mechanoreceptors are sensitive to joint pressure and tension caused by both dynamic movement and static position (Baltaci & Kohl, 2003). These afferent nerve fibers provide a sense of movement and position as well as contributing to a complex reflex system that acts to control posture and coordination (Baltaci & Kohl, 2003).

Visual and vestibular centers also contribute afferent information to the CNS regarding body position and balance (Yeh, Cluff, & Balasubramaniam, 2014). While standing, vision, proprioception, and vestibular inputs provide information about the body's orientation in the environment (Yeh et al., 2014). The contribution of these sensory modalities to the internal representation of the body's orientation and equilibrium depends on how the CNS assigns weight to each sensory modality (Yeh et al., 2014). As a person ages, the CNS assigns a lower weight to these modalities (Yeh et al., 2014). Visual feedback delays reduce balance performance in goal-directed posture control tasks (Yeh et al., 2014). The extent of postural variability caused by these feedback delays depend on age, with older adults exhibiting greater sway variability in delayed visual feedback conditions (Yeh et al., 2014).

Anterior cruciate ligament ruptures are some of the most common knee injuries in sports (Vathrakokilis, Malliou, Gioftsidou, Beneka, & Godolias, 2008). These injuries lead to impaired function and loss of proprioception. Rehabilitation should be based on proprioception. The ACL not only serves a mechanical role by limiting passive knee mobility, but also serves a sensory role through the mechanoreceptors deep in its tissue, which communicate with the neuromuscular system to provide proprioceptive feedback (Vathrakokilis et al., 2008). Vathrakokilis et al. (2008) assessed the influence of a balance-training program on knee joint proprioception, by comparing ACL reconstructed patients who had a lack of proprioceptive ability, and a control group (Vathrakokilis et al., 2008). A total of 24 participants had ACL surgery between eight to thirty months before the study (Vathrakokilis et al., 2008). Their mean age was 28.6 years old (Vathrakokilis et al., 2008). They were randomly assigned to an experimental group or a control group (Vathrakokilis et al., 2008). The experimental group performed a specific balance program for 8 weeks, 3 times per week, and 20 minutes per session (Vathrakokilis et al., 2008). The balance program consisted of five postural stability exercises: 1) a 2-min attempt to maintain single-limb stance on a hemi cylindrical balance board restricting movement in the anterior-posterior direction only, 2) a 2-min attempt to maintain single-limb stance while moving on a hemi cylindrical balance board restricting movement in the anterior-posterior direction only, 3) a 2-min attempt to maintain single-limb stance on a hemi cylindrical balance board restricting movement in the medial-lateral direction only, 4) a 2-min attempt to maintain single-limb stance while moving on a hemi cylindrical balance board restricting movement in the medial-lateral direction only, and 5) a 2-min attempt to maintain single-limb stance on a hemispherical balance board allowing movement in both anterior-posterior and medial-lateral directions (Vathrakokilis et al., 2008). The control group did not perform any balance training (Vathrakokilis et al., 2008). Proprioception of both groups was assessed using a Biodex stability system and two different kinds of balance boards (Vathrakokilis et al., 2008). The results showed that stability indices of balance appeared to improve for the reconstructed leg in the balance training group (Vathrakokilis et al., 2008). There were significant differences between the experimental group and the control group (Vathrakokilis et al., 2008).

Blindfolding a subject takes away the visual input causing the participant to rely more on other senses. To maintain postural control, sensory input from accurate external spatial orientation references is provided by the vestibular, visual, and somatosensory systems (Steindl, Kunz, Schrott-Fischer, Scholtz, 2006). This information is processed by the central nervous system to generate adequate muscle response, especially of the trunk and lower extremities. Kinesio tape will hypothetically stimulate the cutaneous mechanoreceptors to increase input caused by the lack of visual input.

Single Leg Balance

The act of balancing on a single leg may seem rather simple, but the complexity of this task demands a high degree of coordination among the various components of the neuromuscular system (Palmer, 2007). The proprioceptive afferent input to the central nervous system is believed to alter the efferent neural response in a manner that improves neuromuscular control of joints throughout the kinetic chain (Palmer, 2007). Training on a small base of support (single-limb) is believed to produce an adaptation that increases the sensitivity of muscle and joint mechanoreceptors, which decreases postural sway through improved muscle activation patterns for control over the body center of mass (Palmer, 2007).

Single leg balance training exercises can be categorized as either static postural balancing (stork standing) or dynamic maneuvers (jumps/plyometric training) on either a stable or unstable surface (Palmer, 2007). Poor postural balance, which may be attributable to previous injury or lack of proper training, has been associated with an increased risk of joint injury (Palmer, 2007). Interrelated muscle imbalances and biomechanical misalignments have been shown to increase ligament stress at the knee and ankle, which also increase injury risk. Single leg balance training exercises are effective for prevention of lower extremity injuries (Palmer, 2007).

Bressel et al. (2007) compared static and dynamic balance among 34 Division I collegiate female athletes competing or training in soccer, basketball, and gymnastics. Participants were assessed in static balance, dynamic balance, and leg length (Bressel et al., 2007). To assess static balance, participants performed a BESS test (Bressel et al., 2007). Three stance variations (double leg, single leg, and tandem) on two surfaces (stiff and compliant) were used (Bressel et al., 2007). An Airex Balance Pad was used for the compliant surface (Bressel et al., 2007). Dynamic balance was assessed using the Star Excursion Balance Test (SEBT) (Bressel et al., 2007). Participants were asked to maintain a stable single leg stance with the test leg and to reach for maximal distance with the other leg in each of the 8 directions (Bressel et al., 2007) Participants were then asked to execute a touchdown without using the reach leg for support (Bressel et al., 2007). The testing grid consisted of 8 lines, extending from a common point at 45 degree angle increments (Bressel et al., 2007). The grid was created using standard white athletic tape placed on a firm, textured tile surface (Bressel et al., 2007). The middle of the grid was marked with a small dot that athletes were asked to center the stance foot over during testing (Bressel et al., 2007). The grid was marked at 1-cm increments from the center outward to facilitate scoring during testing (Bressel et al., 2007). Participants performed three trials for each leg (Bressel et al., 2007). Leg lengths of both legs were measured using a tape measure to determine the distance between the anterior superior iliac spine and the medial malleolus of the same leg (Bressel et al., 2007).

Balance error scoring system (BESS) scores for the gymnastics group were 55% higher than for the basketball group. The star excursion balance test scores were 7% higher in the soccer group than the basketball group (Bressel et al., 2007). Basketball players displayed inferior static balance compared with gymnasts and inferior dynamic balance compared with soccer players (Bressel et al., 2007). Researchers suggested that by challenging sensorimotor systems, balance may be enhanced in trained athletes (Bressel et al., 2007).

Balance Error Scoring System

Humans rely on signals from sensors in the legs and torso (proprioceptors) to maintain good balance (Wilkins, McLeod, Perrin, & Gansneder, 2004). Clinicians often use balance assessments in the evaluation and rehabilitation of a variety of postural-stability problems related to orthopedic and mild head injuries. The Balance Error Scoring System (BESS) is a clinical field test that can be used for sideline evaluations of an athlete's postural stability (Wilkins et al., 2004). The BESS was developed to provide health care professionals with an inexpensive and objective way to assess postural stability outside the laboratory (Wilkins et al., 2004). The BESS measures an athlete's postural stability through a clinical-assessment battery and is scored by counting the errors the athlete commits during the tests (Wilkins et al., 2004).

For the BESS test, three different stances (double, single, and tandem) are completed twice: once while on a firm surface and once while on a foam surface, for a total of six trials (Prentice, 2006). Refer to Appendix A for testing instructions and testing positions. All testing is done without shoes. Participants are asked to assume the required stance by placing their hands on the iliac crests and close their eyes for twenty seconds (Prentice, 2006). During the single leg stances, participants are asked to maintain the contralateral limb in 20 to 30 degrees of hip flexion and 40 to 50 degrees of knee flexion (Prentice, 2006). The participant is also asked to stand quietly and as motionless as possible in the stance position, keeping the hands on the iliac crest, and eyes closed (Prentice, 2006). The single-limb stance tests are performed on the non-dominant foot (Prentice, 2006). This same foot is placed toward the rear in the tandem stances. Subjects are told that upon losing their balance, they are to make any necessary adjustments and return to the testing position as quickly as possible (Prentice, 2006). Performance is scored by adding one error point for each error committed (Prentice, 2006). The errors include hands lifted off iliac crest, opening the eyes, step, stumble or fall, moving hip into greater than 30 degrees of abduction, lifting forefoot or heel, or remaining out of the test position for greater than five seconds (Prentice, 2006) Trials are considered to be incomplete if the athlete cannot sustain the stance position for longer than five seconds during the entire twenty-second testing period (Prentice, 2006). These trials are assigned a standard maximum error score of 10 (Prentice, 2006). During the trials, a spotter will be placed behind the participants to ensure safety (Prentice, 2006). Total scores from each stance and condition will be added to give the total

BESS score (Prentice, 2006). Balance test results during injury recovery are best compared to baseline measurements (Prentice, 2006).

In 2004, Wilkins et al. found that fatigue altered balance. 27 male Division I athletes were tested. Participants were randomly assigned to either a control or fatigue group. Each group performed a pre and post-test of the BESS test on firm, foam, and tremor box surfaces (Wilkins et al., 2004). After the pre-test, the control group rested for 20 minutes. The fatigue group followed a circuit design fatigue protocol. The protocol consisted of 7 stations that included: moderate jogging, straight-line sprint work, push-ups, sit-ups, and step-ups (Wilkins et al., 2004). Once the control group rested for 20 minutes, they were given the BESS test again. When the fatigue group was finished with the fatigue protocol, they were immediately tested again. Wilkins et al. (2004) found a significant increase in total errors from pre-test to post-test in the fatigue group, and a significant decrease in errors in the control group. A significant difference was also found between groups on the post-test (Wilkins et al., 2004). Wilkins et al. concluded that the BESS error scores increased immediately after the fatigue protocol, demonstrating that balance ability diminished.

Wilkins et al. (2004) also found that balance performance decreased when subjects needed to rely on vestibular input as their only accurate sensory input. Balance depends upon the CNS and on the three sensory systems (visual, vestibular, and somatosensory) (Wilkins et al., 2004). Alterations in CNS ability due to fatigue will likely affect one's ability to maintain balance (Wilkins et al., 2004). To stimulate reflex joint stabilization, some believe that activities should focus on sudden alterations in joint positioning (Eisen, Danoff, Leone, & Miller, 2010). Unstable surfaces provide these sudden alterations and make training more dynamic, and possibly more applicable to a sporting context (Eisen et al., 2010). There does appear to be a slight practice effect with repeated administration of the BESS (Valovich, Perrin, & Gansneder, 2003). The current study attempted to account for any practice effect by using a different starting order for each group.

For this study, some modifications were made to the BESS test. First, only one stance (single leg) was used. This stance was done on the dominant leg as opposed to the non-dominant leg since most people are right-side dominant (Kiyota & Fujiwara, 2014). In static conditions there is no lateral dominance of stability during single leg stance (Kiyota & Fujiwara, 2014). In dynamic conditions, right-side dominance of postural stability is recognized (Kiyota & Fujiwara, 2014). The conditions, firm and foam, remained the same. The second modification was that the participants were blindfolded. Eye-opening was an error for the original BESS test. For this study, eye-opening was not an error due to the use of the blindfold. The participants were blindfolded so that they were not aware of which taping condition was applied to their knee during testing. The use of a blindfold will not affect the total BESS score or the results of the study. The results will not be affected since the participants can still accumulate any of the other five types of errors (hands lifted off iliac crest; step, stumble, or fall; moving hip into >30° of abduction; lifting forefoot or heel; and remaining out of the testing position > 5 seconds).

Kinesio Tape and Soft Tissue

Kinesio taping and patellar taping are two different taping methods that can be used for protection against acute injuries, prevention of excess movement at a joint, protection of a joint from further injury, and potentially help with balance. Kinesio tape is a flexible, cotton, adhesive tape that was designed to mimic the qualities of skin (Williams et al., 2012). Patellar taping uses a rigid, adhesive tape (Williams et al., 2012). Kinesio tape can stretch up to 50% of its original length, while patellar taping does not stretch and is mainly used for realignment issues (Williams et al., 2012).

Kinesio tape has been popularized for its soft tissue benefits (O'Sullivan & Bird, 2011). Fascia is one soft tissue that can be affected by kinesio tape (Kase, 2003). Fascia is a connective tissue that surrounds and separates muscle tissue, and is thought to be part of the exoskeleton (O'Sullivan & Bird, 2011). Fascia unloading is the reduction in tension of the inter-connected fascia layers in response to the mechanical load applied to the tissue during movement (O'Sullivan & Bird, 2011). Kinesio tape facilitates this fascia unloading technique in an attempt to alter the connective tissue response to mechanical strain (O'Sullivan & Bird, 2011). By lifting the skin, subcutaneous blood flow and lymphatic drainage are increased (O'Sullivan & Bird, 2011). This unloads the underlying fascia, thereby reducing pain (O'Sullivan & Bird, 2011). Kinesio tape may facilitate improved performance in sports that require repetitive high-intensity muscular efforts and eccentric loading (O'Sullivan & Bird, 2011). These sports allow for repetitive unloading of the fascia and increased blood flow to the working muscles (O'Sullivan & Bird, 2011).

One of the most interesting uses of kinesio tape is for the management of scars and keloids. Karwacińska et al. (2012) studied 54 children aged 2-18 years old with hypertrophic scars, keloids, and contracture scars. After just three weeks of the kinesio tape application, 37 participants declared that the application of kinesio tape improved the cosmetic outcome and perception of the scar (Karwacińska et al., 2012). When the entire 12 week process was completed, all 54 participants noted improvement in the prominence and perception of their scars

(Karwacińska et al., 2012). Karwacińska et al.'s (2012) study shows that kinesio tape contributes to a positive cosmetic outcome and reduces limitations with respect to scar mobility, which confirms the validity of introducing this form of treatment as one of the methods for scar management.

Kinesio Tape and Pain

Pain has a considerable impact on both the individual sufferer and society at large (González Enciso, 2009). Pain is a worldwide costly illness for developed countries (González Enciso, 2009). Pain is the first cause of disability and loss of quality of life among individuals who are less than 45 years old (González Enciso, 2009). In a 2009 study, González Enciso wanted to find out if kinesio tape was a cheaper, more effective, and faster option for physiotherapists in treating non-specific low back pain. Participants ranging from 20-50 years old were treated with either kinesio tape in the lumbar area, or with exercise therapy and postural re-education (González Enciso, 2009). To begin, participants were given three assessment tools: the Quebec Back Pain Disability Scale, the Oswestry Low Back Pain Disability Questionnaire, and the Roland Disability Questionnaire (González Enciso, 2009). The kinesio taping group received an application of kinesio tape three different times separated by 5-7 days (González Enciso, 2009). The exercise therapy group was instructed in the exercises (supine pelvic tilt, curl up, oblique curl up, bridge, prone back extension, prayer stretch, side-lying hip abduction, and alternate arm-leg raise) on two separate occasions (González Enciso, 2009). All exercises were done in one set with ten repetitions (González Enciso, 2009). The researchers contacted the participants in this group once a week to ensure that they were following the therapy (González Enciso, 2009). After three weeks, participants were again assessed using the three methods mentioned previously (González Enciso, 2009). The results showed that no significant differences existed before and after the interventions (González Enciso, 2009). Kinesio taping does not seem to be effective for treating the lumbar area (González Enciso, 2009). Exercise therapy moderately improved the disability and pain of the participants, but the outcome was not statistically significant for any of the groups (González Enciso, 2009).

Shoulder pain is another area of concern for many over-head athletes (García-Muro et al., 2010). In a 2010 case study done by García-Muro et al., the researchers followed a 20-year old swimmer having an intense bout of shoulder pain. Trigger points in the deltoid were found to be the cause after a thorough clinical evaluation (García-Muro et al., 2010). Kinesio tape was applied to reduce pain and increase shoulder range of motion (García-Muro et al., 2010). Pain level, joint motion, and shoulder function obtained from this study may lead researchers to suggest that treatment with kinesio tape contributed to the resolution of the patient's pathology, producing an immediate improvement and resolving the problem in the following days (García-Muro et al., 2010). García-Muro (2010) also questioned however, whether the actual pain relief was from the effects of the kinesio tape, or if it was from the passing of time. The overall enhancement might be the result of the normalization of muscular function and not merely an analgesic effect (García-Muro et al., 2010).

Triathletes have found use in kinesio tape for pain and soreness (Merino Marban et al., 2011). One study used kinesio tape on the calves of six male triathletes 1 to 2 hours before competition (Merino Marban et al., 2011). No warm-up was performed by the participants prior to the application of the kinesio tape to both legs (Merino Marban et al., 2011). Between 5 to 10 minutes after the race, the triathletes were evaluated about perceived pain and soreness in the gastrocnemius and soleus muscles by Borg's scare CR10 (Merino Marban et al., 2011). The triathletes were also interviewed about contractures or cramps in any other muscle (Merino Marban et al., 2011). During the competitions, none of the competitors suffered contractures or cramps in the musculature of the calves and pain was never more than 2 on a 10 point scale (Merino Marban et al., 2011). Merino Marban et al. (2011) hypothesized that the kinesio tape presented undulations on the back of the calf that provoked an elevation of the epidermis and in consequence an improvement of local blood circulation and a decrease of the perceived pain. This improvement of blood circulation may be one of the reasons of kinesio tape's efficiency during the competition (Merino Marban et al., 2011).

Kinesio Tape and Range of Motion

Kinesio tape can be used as a treatment method to improve joint range of motion (ROM) (Ujino et al., 2013). Kinesio tape is currently used in clinical practices in conjunction with joint mobilizations, ROM exercises, and active/passive stretches (Ujino et al., 2013). Due to its elasticity, kinesio tape is theorized to increase interstitial space by lifting the skin over the targeted treatment area, which is the mechanism believed to decrease pain, increase blood and lymphatic circulation, and increase joint mobility (Ujino et al., 2013). Multiple therapeutic interventions are often administered in tandem (Ujino et al., 2013). This can explain how kinesio tape with associated stretching can improve ROM (Ujino et al., 2013).

A recent study found that kinesio tape, when applied to the dominant shoulder's scapulothoracic joint, can increase shoulder ROM (Ujino et al., 2013). Also, the results surprisingly found that the combination of kinesio tape and stretching did not change ROM in healthy populations, but impacted motion restricted people (Ujino et al., 2013). The participants included 71 healthy volunteers ranging in age from 18-40 years old, with no history of shoulder injury (Ujino et al., 2013). Participants were randomly assigned to 3 treatment groups: kinesio tape, stretch, and kinesio tape and stretch (Ujino et al., 2013). Internal and external rotation of the shoulder was measured using a digital inclinometer (Ujino et al., 2013). The kinesio tape group and the kinesio tape/stretch group had kinesio tape applied to the dominant shoulder for stabilization of the scapulothoracic joint prior to the stretching program (Ujino et al., 2013). One "I" strip of tape covered the skin surface from the anterior portion of the glenoid rim to the inferior border of the lower trapezius (Ujino et al., 2013). A second "Y" strip of tape covered the skin surface from the medial portion of the spine of the scapula to the anterior portion of the glenoid rim (Ujino et al., 2013). The stretch and kinesio tape/stretch groups followed a self-stretching program targeting the shoulder once per day for 4 days (Ujino et al., 2013). The stretches included the sleeper stretch, doorway stretch, and cross-body stretch (Ujino et al., 2013). Each stretch was performed three times with a 30-second hold and a 15-second relaxation period between stretches (Ujino et al., 2013). The purpose of the kinesio tape technique was to alter scapular position in a manner that would increase glenohumeral ROM, which was expected for both the kinesio tape and kinesio tape/stretch groups (Ujino et al., 2013). Stabilization of the scapula could decrease the ROM, but such an effect was only observed in the kinesio tape/stretch group (Ujino et al., 2013). Kinesio tape application may contribute to muscle activation, which could have generated tension in the lower trapezius, supraspinatus, and infraspinatus muscles to improve ROM (Ujino et al., 2013).

A study by Yoshida & Kahanov (2007) found some support for kinesio tape. Prior to the study, 30 healthy participants had their trunk range of motion measured using a tape measure

(Yoshida & Kahanov, 2007). Lower trunk flexion, extension, and right lateral flexion were measured (Yoshida & Kahanov, 2007). A crossover design was used to eliminate the ROM taping routine as a variable (Yoshida & Kahanov, 2007). Kinesio tape was applied to 15 of the participants after the end of the ROM measurements in the untaped status (Yoshida & Kahanov, 2007). The remaining subjects had their ROM measured in a taped status first, followed by the untaped status (Yoshida & Kahanov, 2007).

When kinesio tape was applied to the sacrum in a Y-shaped pattern, a significant difference in trunk flexion ROM was shown (Yoshida & Kahanov, 2007). This led researchers to believe that while bending forward, the participant was able to feel the stretch of the tape (Yoshida & Kahanov, 2007). The tape may help the participant to have an increased range of flexion since they can feel the stretch and have some sort of stopping point for their flexion (Yoshida & Kahanov, 2007). Participants did not show differences in extension or lateral flexion (Yoshida & Kahanov, 2007). These movements did not put much of a stretch on the tape, therefore reducing its ability to stimulate cutaneous mechanoreceptors (Yoshida & Kahanov, 2007).

The theory is that kinesio tape and a circulatory or neurological activation is based on the tape's elastic properties, which is purported to support/enhance joint functions (Yoshida & Kahanov, 2007). Proponents of kinesio tape state that tape convolution areas may increase the flow of blood and lymphatic fluids due to a lifting effect, which creates a wider space between the skin, muscle, and interstitial space (Yoshida & Kahanov, 2007). Kinesio taping on injured areas where major blood vessels existed is theorized to increase blood volume (Yoshida & Kahanov, 2007). The increase in blood circulation is theorized to affect muscle functions, and as a result may impact lower trunk flexion ROM (Yoshida & Kahanov, 2007). According to Yoshida & Kahanov (2007) kinesio tape helped stimulate cutaneous mechanoreceptors; it is theorized to help control posture.

A 2011 study done by Cortesi, Cattaneo, & Jonsdottir focused on the effects of kinesio tape on standing balance in 15 male participants with multiple sclerosis. They found the effects of taping were specific and axis dependent: reduction of sway was seen only in the antero-posterior axis (Cortesi et al., 2011). This was expected since the application of the tape acted primarily on the flexor-extensor movement of the ankle joints (Cortesi et al., 2011). The application of taping may improve perceived joint stability, joint position sense, and confidence (Cortesi et al., 2011). Subjects with MS have relevant balance disorders and taping may improve quiet standing posture with eyes closed (Cortesi et al., 2011). Traditionally, the amount of motion and velocity of the center of pressure have been assumed to be a reflection of the degree of instability and are considered controllable variables in the regulation of upright posture (Cortesi et al., 2011). The reduction of amplitude can be considered indicative of a better control of balance in the antero-posterior axis in that particular group of subjects (Cortesi et al., 2011).

Kinesio Tape and Strength

Taping techniques are widely used to reduce and/or prevent the severity and incidence of knee injuries in sports (Aktas & Baltaci, 2011). In 2011, Aktas & Baltaci did a study to determine which application is more effective regarding muscular strength and functional performance. The groups were kinesio tape, knee brace, or both (Aktas & Baltaci, 2011). Twenty physically active subjects, males and females, with no previous history of lower extremity injuries were used in the study (Aktas & Baltaci, 2011). Each participant was required to visit a clinic on three separate occasions within one week (Aktas & Baltaci, 2011). Muscular strength and jump performance were tested in each of the three groups (Aktas & Baltaci, 2011). Muscular strength was measured using the Isomed 2000 isokinetic dynamometer (Aktas & Baltaci, 2011). Isokinetic testing was carried out with 10 repetitions at 180 degrees/second, a break of 1-minute rest for each leg, and 5 repetitions at 60 degrees/second (Aktas & Baltaci, 2011). Each repetition consisted of reciprocal concentric quadriceps hamstring contractions (Aktas & Baltaci, 2011). For both vertical jump and one leg hop tests, a standard metric tape measure was used. Tests were repeated three times with 1-minute rest intervals between each attempt (Aktas & Baltaci, 2011). The average of the three repetitions was considered the outcome measure (Aktas & Baltaci, 2011). Aktas and Baltaci found that kinesio tape brought about a significant increase in hop distance in both the dominant and non-dominant extremity, and in isokinetic knee extension peak torque (Aktas & Baltaci, 2011). The kinesio tape application was more effective in terms of muscular strength and jump performance than knee brace and kinesio tape plus knee brace (Aktas & Baltaci, 2011). Physical therapists and athletic trainers may apply kinesio tape to a patient to support knee musculature, to encourage the tissue healing process, and to avoid limiting the improvement of knee muscle performance (Aktas & Baltaci, 2011).

Another study has been done with kinesio tape and knee function (Wong, Cheung, & Li, 2012). This study focused on isokinetic knee function in 30 healthy subjects with and without kinesio taping (Wong et al., 2012). Maximal concentric knee extension and flexion at three angular velocities (60, 120, and 180 degrees/second) were measured with an isokinetic dynamometer (Wong et al., 2012). There was no significant main effect in normalized peak torque and normalized total work done between taping conditions and angular velocities (Wong et al., 2012). Conversely, participants demonstrated significant shorter time to peak exhaustion torque with the tape condition (Wong et al., 2012). Pair-wise comparisons indicated that such time reduction occurred at all three angular velocities (Wong et al., 2012). The investigation demonstrated the application of kinesio tape did not alter the muscle peak torque generated and total work done, but shortened the time to generate peak torque (Wong et al., 2012).

Chronic inversion ankle sprains are common in basketball players (Bicici, Karatas, & Baltaci, 2012). In 2012, Bicici et al. conducted a study of 15 male basketball players between the ages of 18 and 22 who experienced chronic inversion ankle sprains. They were taped with either kinesio tape or standard athletic tape (Bicici et al., 2012). They then performed a battery of functional performance tests such as a hopping test, single limb hurdle, dynamic balance, vertical jump, and standing heel rise test. The performance tests were performed by all participants at one-week intervals (Bicici et al., 2012).

The results identified that the group taped with kinesio tape did not significantly improve the performance on any of these tests, but it also did not negatively impact them either (Bicici et al., 2012). The results from the participants of the athletic taped group showed that the athletic tape caused a significant decrease in performance in vertical jump and standing heel rise tests (Bicici et al., 2012).

A 2011 study by Briem, Eythorsdottir, Magnusdottir, Palarsson, Runarsdottir, & Sveinsson investigated the effect of two adhesive tape conditions compared to a no-tape condition on muscle activity during a sudden inversion perturbation. The participants were 51 male premier-league soccer athletes (Briem et al., 2011). Participants were tested for functional stability of both ankles with the Star Excursion Balance Test (SEBT) (Briem et al., 2011). Based on the results, those with the 15 highest and those with the 15 lowest stability scores were selected for further testing (Briem et al., 2011). Muscle activity of the fibularis longus was recorded with surface electromyography during a sudden inversion perturbation (Briem et al., 2011). Each participant was tested under 3 conditions: ankle taped with non-elastic white sports tape, ankle taped with kinesio tape, and no ankle taping (Briem et al., 2011).

Briem et al. (2011) found a significantly greater mean muscle activity when ankles were taped with nonelastic tape compared to no tape, while kinesio tape had no significant effect on mean or maximum muscle activity compared to the no-tape condition (Briem et al., 2011). Neither stability level nor taping condition had a significant effect on the amount of time from perturbation to maximum activity of the fibularis longus muscle (Briem et al., 2011) According to these researchers, the efficacy of kinesio tape in preventing ankle sprains by enhancing dynamic muscle support of the ankle is unlikely, as it had no effect on muscle activation (Briem et al., 2011).

Kinesio Tape and Single Leg Balance

A 2012 study by Lins, Neto, Amorim, Macedo, and Brasileiro, analyzed the immediate effects of applying kinesio tape on the neuromuscular performance of femoral quadriceps muscles, postural balance, and lower limb function in healthy subjects. Sixty female participants were randomly assigned to three groups of 20 subjects each: a control group, nonelastic adhesive tape, and kinesio tape (Lins et al., 2012). Participants were assessed for single (hop as far as possible on dominant limb) and triple hops (three consecutive hops on dominant limb, as far as possible), postural balance, peak concentric and eccentric torque, and electromyographic activity of the vastus lateralis (VL), before and after interventions (Lins et al., 2012). No significant differences in electromyographic activity of the VL or concentric and eccentric knee peak torque were recorded, between groups, and initial and final assessment in any of the three groups (Lins et al., 2012). There were also no significant differences in single and triple hop distances and one-footed static balance between the three groups (Lins et al., 2012). Application of kinesio tape to femoral quadriceps muscles did not significantly change lower limb function, postural balance, knee extensor peak torque, or electromyographic activity of the VL muscle given that other muscles and joints such as the hip and ankle are also involved in single leg balance (Lins et al., 2012).

Patellar Taping

Patellar taping is a simple technique introduced in the mid 1980's to alleviate the symptoms of patellofemoral pain syndrome (PFPS) or anterior knee pain (Barton, Balachandar, Lack, & Morrissey, 2014). Adhesive, rigid taping is applied to the knee to reduce lateral glide, tilt, and rotation of the patella according to assessment findings (Barton et al., 2014). The primary goal is to reduce pain by at least 50% during relevant functional activity (Barton et al., 2014). Realignment of the patella was one of the proposed mechanisms for the success of this technique (Barton et al., 2014). However, it has been shown from radiographic, computerized axial tomography, structural magnetic resonance imaging (MRI), and kinematic studies that the tape does not significantly alter patellar mediolateral alignment (Callaghan, McKie, Richardson, & Oldham, 2012).

Patellar taping can improve proprioception of the knee in people who are healthy and in people with PFPS (Callaghan et al., 2012). A 2012 study by Callaghan et al. investigated the sensory input hypothesis using functional magnetic resonance imaging (MRI) when taping was applied to the knee joint during a proprioception task. The sensory input hypothesis states that other more subtle sensory mechanisms at work through skin, tendon, and muscle stimulation may account for the improvement of a joint position task (Callaghan et al., 2012). The participants included 8 right-leg dominant males with a mean age of 29 years (Callaghan et al., 2012). Each participant performed 2 right knee extension repetitive movement tasks: one simple (full knee extension: from 40 degrees of flexion to 0 degrees of flexion) and one proprioceptive (from 40 degrees of flexion to 20 degrees of flexion) (Callaghan et al., 2012). These tasks were performed with and without patellar taping and were auditorally paced for 400 seconds at 72 beats/min (1.2 Hz) (Callaghan et al., 2012). Full brain fMRI images were obtained using an echo planar imaging sequence (Callaghan et al., 2012). Each task lasted for 400 seconds so that 80 images were acquired per scan (Callaghan et al., 2012).

Callaghan et al. (2012) found that an application of a simple patellar taping technique (covering at least 50% of the circumference of the knee) stimulated areas of the brain associated with sensation, coordination, decision making, planning of complex coordination tasks, and the coordination of the unconscious aspects of proprioception. Applying an external appliance such as tape may reduce the risk of injury by enhancing proprioception. Callaghan et al. (2012) concluded further research needs to be done to demonstrate which taping technique has a greater or lesser effect on activity in the proprioception areas of the brain (Callaghan et al., 2012).

Conclusion

Injuries can alter an individual's proprioception. Proprioceptive deficits can be rectified by stimulating skin during motion and by pressure on underlying muscles and the joint capsule. This was the basis for the proposed investigation. Kinesio tape was hypothesized to stimulate the mechanoreceptors in the skin, muscles, joint, ligaments, and tendons to provide input to the CNS to theoretically improve balance.

Since kinesio tape is a new trend, it unquestionably requires more research. Further research should focus on the efficacy of the tape in the treatment of athletic injuries and in clinical settings. The research is extremely conflicting. In some studies, kinesio tape has shown promise for proprioception uses and should be investigated further with regard to proper technique and efficacy for specific pathological conditions (Callaghan et al., 2012; Cortesi et al., 2011; O'Sullivan & Bird, 2011; Ujino et al., 2013; Yoshida & Kahanov, 2007). Several current studies do not support claims made by proponents of kinesio tape (Bicici et al., 2012; Briem et al., 2011; García-Muro et al., 2010; González Enciso, 2009; Lins et al., 2012; Wong et al., 2012). Athletic Trainers and Physical Therapists regularly use kinesio tape in their practice. For smaller schools and clinics, kinesio tape is an expensive budget item. If the purported claims are not supported, these schools and clinics can spend their kinesio tape budget elsewhere.

Chapter 3: Methods

The purpose of this study was to determine if an application of kinesio tape or placebo tape are effective measures in aiding balance. The dependent variables are the balance error scoring system (BESS) total test scores (Appendix A) for the control, kinesio tape, and placebo tape conditions. The independent variables in this study are the applications of kinesio tape or placebo tape to the anterior knee. The control variable is no tape.

Setting

The study took place in the exam room of the Athletic Training Room in Plachy Hall at Adams State University to ensure privacy. The study was completed when the Athletic Training Room was closed to safeguard the anonymity of the participants and to limit distractions. The participants were constantly under the supervision of a Certified Athletic Trainer.

Population

Thirty college-aged male and female athletes of all sports voluntarily participated in this study. Participants were chosen based on their participation in collegiate athletics. Athletes were on a current roster for their sport. The participants were recruited by word of mouth, through Adams State University Athletics, and by e-mails sent to Adams State University coaches and athletes. All participants provided written informed consent to take part in the study (Appendix B) which was approved by the Adams State University Institutional Review Board. Participants were asked to divulge any existing injuries that may affect their participation in the study. If currently injured, or injured within the last month, they were excluded from the study. Participants were also excluded if they previously used kinesio tape or if they had a bias against kinesio tape.

Upon consent, participants were randomly assigned to a group (5 males and 5 females made up each group) to determine the order in which the kinesio tape, placebo tape, or control condition was applied. The participants were assigned a random number to be identified by throughout the study. Ten participants started with kinesio tape, ten participants started with the placebo tape, and ten started with no tape. One group started with the control and then moved on to the kinesio tape condition, followed by the placebo tape. The kinesio tape group was followed by the placebo tape, and then the control group. Lastly, one group started with the placebo tape followed by the control and kinesio tape conditions.

Exclusion criteria included subjects that currently had any lower body injuries, as well as any athletes that suffered or were recovering from concussions or balance problems within the last month. This was determined by an interview by the principal investigator, who is a Certified Athletic Trainer, before testing began. Other exclusion criterion included participants who did not want to use or had a bias towards kinesio tape/placebo tape. Participants were asked prior to testing if they had any feelings towards kinesio tape. If the principal investigator felt they were biased in any way, the participants were excluded. Any severe health-related issues were considered on a case to case basis.

Instrumentation

Basic subject characteristics such as height, weight, age, gender, and sport were taken prior to the first trial. Height and weight were measured using a scale with a height rod (Detecto Scale, Model 339). The subjects were asked their age, gender, and sport. This was recorded on the BESS score card.

Two-inch wide Mueller kinesiology tape and 2-inch wide Johnson & Johnson Elastikon elastic tape were used for this study. If hair was present on the participant, the area of tape placement was shaved with a razor prior to tape application. A twin blade disposable razor was used; 99% isopropyl alcohol was used to clean the skin prior to tape application. Tape was applied to the anterior knee starting at the distal musculotendinous junction of the quadriceps and ending at the tibial tuberosity (Appendix C) (Kase, 2003). For the kinesio tape application, the tape was fully stretched to its capacity of 50% and then tension was released to approximately a 30% stretch prior to skin contact. Cramer tape remover was used on the skin after the tape was removed to get rid of the remaining tape residue. A BESS test (Appendix A) was conducted and scored (Prentice, 2006). The foam pad used was a standard Airex Balance Pad (19.7"x16.1"x2.4"). A Sportline 240 Econosport Stopwatch was used to measure time.

Research Design

A randomized controlled, crossover trial design was used to compare the total BESS scores for the 3 conditions: the kinesio tape, placebo tape, and the control (no tape).

Each participant was asked to state their dominant leg. This was done by asking the participant to determine which foot they would use to kick a ball (Prentice, 2006). The kicking foot was considered the dominant foot (Prentice, 2006). This was the leg in which the tape was applied and the single leg balance was performed. The skin was cleaned by a Certified Athletic Trainer with rubbing alcohol prior to the tape applications. The Certified Athletic Trainer also applied the tape (Appendix C). Throughout the application and balance process, the participant was blindfolded. The participant was then asked to perform the BESS test. The kinesio tape, placebo tape, and control group each balanced on a firm and a foam surface in a randomized order. The participant balanced on their dominant leg with their hands on their hips and blindfolded (refer to figure in Appendix A). A spotter was present to ensure the safety of the participant. Participants rested for one minute between the firm and foam conditions (Aktas & Baltaci, 2011). After each trial, the participant was helped back to the table and the tape was removed with tape remover, and the skin was cleaned with rubbing alcohol. The next tape was applied and the balance process was repeated. Time between trials was 3 minutes to remove and reapply tape. Participants were tested one at a time to ensure that they were not influenced by other subjects. Total testing time was approximately 15 minutes.

All data was kept in a locked filing cabinet in the Adams State Athletic Training Room. Anonymous identifiers were used to keep track of the participants. Names/identities were not used in any capacity outside of the study. Any written or oral publication and/or presentation of this research will only show group data. Individual subjects were never identified.

Reliability/Validity

The BESS is a low-technology assessment of balance that is subjective and relies upon rater interpretations of balance deficits (Prentice, 2006). The BESS has high reliability (Murray et al., 2014). Intra-tester reliability ranged from intraclass correlations (ICC) of 0.78 to 0.96 for the total BESS score (Bell et al., 2011). The BESS has been thoroughly examined and systematically reviewed in many populations, including young adults, old adults, athletes of different sports, and persons with concussions; furthermore, it is emerging as the current gold standard in non-laboratory settings to evaluate balance deficits (Murray et al., 2014). The same individual should administer the BESS for serial testing (Bell, et al., 2011). The BESS has moderate to high criterion-related validity, but the level of agreement depends on the testing condition. Difficult stances had better agreement (single leg foam: $r = 0.79$, tandem-foam: $r = 0.64$) compared with easier stances (single leg firm: $r = 0.42$, double-leg foam, $r = 0.31$) (Bell et al., 2011).

To ensure reliability for tape placement, the principal investigator was the only one to apply tape to the participants. The tape started from the distal quadriceps muscles and ended at the proximal tibia (Appendix C).

Statistical Analysis

Data (total BESS scores for each condition) was compiled in an Excel spreadsheet. Total BESS scores were the total of the firm and foam surfaces added together. Analysis of the BESS total scores for each condition (control, kinesio tape, placebo tape) included a repeated measures analysis of variance (ANOVA). BESS total scores were compared for every condition (control, kinesio tape, and control). Statistical significance of $p < 0.05$ was set a priori for the repeated measures ANOVA analyses. If statistically significant results were found in the ANOVA, Bonferroni's post hoc test was run to determine which specific groups differed. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 22 (IBM Corp., 2013).

Chapter 4: Results

Prior to any data collection, three volunteers were excluded from the study. One potential participant was excluded due to a bias towards kinesio tape. The other two volunteers were excluded due to previous use of kinesio tape. The exclusion of these potential participants did not affect the total number of participants. Thirty participants (15 males and 15 females) were still used for this study. The average age of the participants was 21±2 years, the height was 69±7 inches, and the weight was 191.5±71.5 pounds. The volunteers participated in men's soccer (N=3), women's soccer (N=3), men's lacrosse (N=3), women's lacrosse (N=3), football (N=2), women's track and field (N=2), men's track and field (N=3), women's basketball (N=2), men's basketball (N=2), softball (N=4), baseball (N=2), and women's volleyball (N=1) at Adams State University.

Data Analysis

Table 4.1
Descriptive Statistics

	Mean	Std. Deviation	N
Control Group	3.400	1.923	30
Kinesio Group	6.433*	2.046	30
Placebo Group	6.467*	2.177	30

Note: Mean scores on a scale of 0-10 errors. Lower scores indicate fewer errors.
* Indicates significance ($p<0.05$) between kinesio and placebo groups vs. control group

Data was run through a repeated measures ANOVA (IBM Corp., 2013), with a significance set at $p<.05$. Sphericity was corrected using the Greenhouse-Geisser estimates of sphericity. The results (Appendix D), with the corrected Greenhouse-Geisser degrees of freedom show that balance was significantly affected by the taping condition used, $F(1.326, 38.468) = 62.792$, $p< .05$. Mauchly's test indicated that the assumption of sphericity had been violated,

$X^2(2) = 19.846$, $p < .05$, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε=.663). The results show that there were significant differences between groups on balance. V (Pillai's Trace) = 0.745, $F(2,28) = 40.923$, $p < .01$. The pairwise comparisons for the main effect of taping condition were corrected using a Bonferroni adjustment. There were significant differences ($p<0.05$) between the control group (M = 3.4, SD = 1.92) and both the kinesio tape (M = 6.43, SD = 2.05) and placebo groups (M = 6.47, SD = 2.18), but not between the kinesio tape and placebo tape groups. Lower mean scores correlate with lower total BESS scores. Mean scores are on a scale from 0-10 errors. The lower the score, the fewer the errors the participants committed.

Chapter 5: Discussion

Discussion of Results

The results of the study do not support the hypothesis that kinesio tape is an effective measure in aiding balance due to its increased proprioceptive abilities. Balance was significantly affected by the taping condition used. There were significant differences between the control group and both the kinesio and placebo tape groups. This suggests that kinesio tape and placebo tape were not effective measures in aiding single leg balance. In fact, kinesio tape and placebo tape appear to be a detriment compared to no tape. The mean number of errors for the kinesio tape (M = 6.43) and placebo group (M = 6.47) were very close and not significantly different in affecting balance. This may be attributed to the mechanoreceptors of the knee joint being stimulated, or lack thereof, by the tape (Baltaci & Kohl, 2003). Mechanoreceptors are sensitive to joint pressure and tension caused by both dynamic movement and static position (Baltaci & Kohl, 2003). These afferent nerve fibers provide a sense of movement and position as well as contributing to a complex reflex system that acts to control posture and coordination (Baltaci & Kohl, 2003). The control group (M = 3.4) had almost half the amount of errors that the kinesio and placebo tape groups had. The researcher speculates that this may be attributed to the participants trying harder without relying on the tape to potentially help their balance. Kinesio tape and placebo tape may have also negatively affected the mechanorecptors in the anterior knee. Both uses of tape negatively affected the participants' balance.

Tape on the anterior knee was a foreign sensation for most of the athletes. Participants were excluded from the study for previously using kinesio tape. Callaghan et al. (2012) found that an application of a simple patellar taping technique (covering at least 50% of the circumference of the knee) stimulated areas of the brain associated with sensation, coordination, decision making, planning of complex coordination tasks, and the coordination of the unconscious aspects of proprioception. The data from Callaghan et al. (2012) supports that taping may be an efficacious therapy due to subtle mechanisms affecting the brain. The current study did not find these improvements, but the researcher speculates that this could be attributed to the tape covering less than 50% of the circumference of the knee. In the current study, the applied tape covered about 10% of the circumference of the knee. It is possible that the small percentage of contact by the tape did not stimulate enough areas of the brain to positively affect proprioception or balance.

According to the current data, using kinesio tape or placebo tape to improve single leg balance is not practically significant. Both taping groups (kinesio and placebo) did worse on the BESS test. The randomized starting conditions rule out any practice effects of the BESS test. Taping is also an expensive technique to use for improving balance in most clinical settings. Applying an external bracing technique such as tape may reduce the risk of injury by enhancing proprioception (Callaghan et al., 2012). Callaghan et al. (2012) concluded further research needs to be done to demonstrate which taping technique has a greater or lesser effect on activity in the proprioception areas of the brain (Callaghan et al., 2012). The current study found that kinesio taping to the anterior knee did not improve balance.

Recommendations

Since this is one of the first studies performed on balance and kinesio tape, the current findings lead to great possibilities for future studies to expand upon. The current study does not support the use of kinesio for improving single leg balance. Future research should consider studying kinesio tape and single leg balance on the non-dominant leg. Most individuals tend to balance better on their dominant leg (Vathrakokilis et al., 2008). By using the non-dominant leg, researchers may find kinesio tape or placebo tape to be effective measures in aiding balance.

Future research could also be directed towards using non-athletes or non-balance trained individuals. The current study used thirty balanced trained athletes. Research has suggested that by challenging sensorimotor systems, balance may be enhanced in trained athletes (Bressel et al., 2007). Training on a small base of support (single-limb) is believed to produce an adaptation that increases the sensitivity of muscle and joint mechanoreceptors, which decreases postural sway through improved muscle activation patterns for control over the body center of mass (Palmer, 2007). Poor postural balance, which may be attributable to previous injury or lack of proper training, has been associated with an increased risk of joint injury (Palmer, 2007). The total BESS error scores and risk of injury may be lower for balanced trained individuals. Research done on non-athletes found that the application of taping may improve perceived joint stability, joint position sense, and confidence in participants with multiple sclerosis (Cortesi et al., 2011). Further research should be done using non-athletes and people with physical ailments to fully understand the effectiveness of kinesio tape.

As previously mentioned, research by Baltaci & Kohl (2003) suggests that mechanorecptors are sensitive to joint pressure and tension caused by both dynamic movement and static position. The researcher speculates that kinesio and placebo tapes may not enhance the mechanoreceptor's sensitivity of the anterior knee in a static stance. In turn, single leg balance was not improved with kinesio or placebo tapes. Future research could test participants in a more dynamic movement than the BESS. The foam pad of the BESS is the dynamic portion of this study. The dynamic movement may cause the mechanoreceptors to be affected differently than the BESS test used in this study, which combined scores for foam and firm surfaces. The combination of foam (somewhat dynamic) and firm (static) stances allow for a well-rounded balance score. Future studies can use dynamic machines such as a Biodex or Balance System™ SD. These machines are very costly and may be difficult to find outside of major universities. On the other hand, researchers could test single leg balance in a completely static position. This means maintaining equilibrium while completely stationary (Bressel et al., 2007). The current study used a mixture of static and dynamic testing as per normal BESS testing protocol. Testing in a completely static position may be affected differently by kinesio tape than a combination of static and dynamic positions.

Kinesio tape can stretch up to 50% of its original length (Williams et al., 2012). The current study did not put that much of a stretch (approximately 30% stretch) on the kinesio tape due to investigator choice. Other researchers have used between 30-50% stretch on the kinesio tape with varying results (García -Muro et al., 2010; Karwacińska et al., 2012; Merino Marban et al., 2011; Ujino et al., 2013; Yoshida & Kahanov, 2007). Future research should be directed towards using different pulls of tension (between 30-50% stretch) on the kinesio tape, as well as different application positions with potentially different angles of pull, to see if single leg balance is affected differently. Kinesio tape is normally aligned with the muscle fibers (García - Muro et al., 2010; Merino Marban et al., 2011; Ujino et al., 2013; Yoshida & Kahanov, 2007). Different angles of pull on the tape may affect more or less mechanorecptors of the knee. These positions may or may not improve single leg balance.

The current study measured balance using the BESS. Future research could use a different balance test that athletes are not as familiar with, such as the star excursion balance test (SEBT) to measure balance. The SEBT is a cheap and easily replicable test (Olmsted, Carcia, Hertel, & Shultz, 2002). The SEBT may provide significantly different results since it is a dynamic test that requires strength, flexibility, and proprioception (Olmsted et al., 2002). The SEBT is challenging even to athletes and physically active individuals (Olmsted et al., 2002). The current study did not require strength or flexibility. One problem that may arise is the learning curve that is experienced with the SEBT (Olmsted et al., 2002). The current study used randomized starting orders to account for the learning curve of the BESS. The more times the SEBT is performed, the easier the test becomes so this must be accounted for in future research.

Another problem that may arise is fatigue. The current study allowed the participants to have 3 minutes of rest between trials. Although it was not measured, the researcher observed and did not feel that the participants were fatigued during this study. Wilkins et al. (2004) found a significant increase in total errors of the BESS in participants who were in a fatigued state, demonstrating that balance ability diminished. Further research must make sure that participants are not in a fatigued state while testing. This can be controlled by using exercise logs, and by providing ample rest time between trials. Randomization of conditions, as was done in the current study, should also control for fatigue.

The current study used a blindfold to take away the visual sense from participants, as well as blinding the participants to the taping condition being used. The kinesio tape hypothetically stimulates the cutaneous mechanoreceptors to increase input caused by the lack of visual input (Steindl et al., 2006). Future studies should look at the difference vision makes in single leg balance and different ways to disguise treatments. Disguising treatments may be difficult and will require creative thinking of future researchers.

Fads come and go in the fitness industry. Further research needs to be done to determine the effectiveness of kinesio tape. Kinesio tape may provide a psychological (placebo) effect, not a physiological one. Also, future research should determine if a peer pressure effect may be present with kinesio tape (Kandel & Lazear, 1992). People see athletes and celebrities using the tape and think the tape will help them as well.

The basis of the current study was that proprioceptive deficits can be rectified by stimulating skin during motion and by putting pressure on underlying muscles and the joint capsule. The hypothesized functions of kinesio tape were to stimulate the mechanoreceptors in the skin, muscles, joint, ligaments, and tendons to provide input to the CNS to theoretically improve balance. The current study does not provide evidence that kinesio tape is effective in aiding balance. Future research is needed to definitively rule out kinesio tape's proprioceptive abilities.

Chapter 6: Summary and Conclusion

The purpose of this study was to determine if an application of kinesio tape or placebo tape, to the anterior knee, compared to no tape, was an effective measure in aiding single leg balance. The data indicates that kinesio tape and placebo tape had no significant effect on single leg balance in thirty male and female collegiate athletes from a wide range of sports. In fact, single leg balance seemed worse using the kinesio tape and placebo tape compared to no tape. Based on the results of this study, kinesio tape does not appear to be a viable intervention for improving single leg balance.

Future studies should consider numerous aspects of the current study, and attempt to build upon them. Since kinesio tape is a fairly new product to the general population, future testing possibilities are endless. Single leg balance, kinesio tape tension, balance testing, dynamic movements, and visual impairments should be addressed in future research.

Practical Applications

Kinesio tape is frequently used in the athletic training and physical therapy fields. The hypothesized functions of kinesio tape are to re-educate the neuromuscular system after injury, reduce pain, optimize performance, prevent injury, improve balance, and promote improved circulation and healing (Williams et al., 2012). Athletic trainers and physical therapists frequently use the tape in their daily practices. The tape is a higher cost budget item. The current study found that kinesio tape does not improve balance. Athletic trainers and physical therapists should use their budget on other items or training to improve balance. Vathrakokilis et al. (2008) found that indices of balance improved with a balance training program. Balance training programs may be a more viable cost-friendly option for athletic trainers and physical therapists.

Until more research is done, kinesio tape may still be used for soft tissue problems, pain, range of motion, and strength. Further research needs to determine the efficacy of all kinesio tape's hypothesized functions.

The current study aimed to not only determine whether kinesio tape was effective in aiding single leg balance, but also set a foundation of research for future studies to build upon. Additional research is needed for future progress and understanding of kinesio tape and single leg balance.

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Appendix A

Balance Error Scoring System (BESS)

(Developed by the University of North Carolina's Sports Medicine Research Laboratory)

The Balance Error Scoring System provides a portable, cost-effective method of assessing static postural stability.

The BESS can be performed in nearly any environment.

Materials

1) Testing Surfaces
   -two testing surfaces are needed to complete the BESS test: floor/ground and foam pad
2) Stop watch
3) An assistant to act as a spotter
4) BESS Testing Protocol
   -these instructions should be read to the subject during administration of the BESS
5) BESS Score Card

If a subject commits multiple errors simultaneously, only one error is recorded. For example, if an individual steps or stumbles, opens their eyes, and removes their hands from their hips simultaneously, then they are credited with only one error.

Subjects who are unable to maintain the testing procedure for a minimum of five seconds are assigned the highest possible score, ten, for that testing condition.

Single leg stance: The hip is flexed to approximately 30° and knee flexed to approximately 45°. Hands are on the hips and eyes are closed.

The conditions (kinesio tape, placebo tape, no tape) will be randomized. The firm test for each condition will always be performed first, followed by the foam test. The foam condition is more difficult than the firm. Higher scores are more likely for this condition.

There will be one minute between firm and foam tests for each condition.

Direction to subject: If you were to kick a ball, which foot would you use? (This will be the dominant foot)

Now stand on your dominant foot.

You should try to maintain stability for 20 seconds with your eyes closed. I will be counting the number of times you move out of this position.

Place your hands on your hips. When you close your eyes the testing time will begin.

Directions to the spotter: You are to assist the subject if they fall during the test and help them get back into the position.

***Repeat each set of instructions for the foam pad

University of North Carolina Sports Medicine Research Laboratory. *Balance error scoring system (BESS)* [PDF document]. Retrieved from http://www.glata.org/documents/filelibrary/glata_2014_presentations/BESSProtocol_E5D9286115A3C.pdf

Testing Positions

Firm Surface

Foam Surface

BESS Score Card

Participant Number__________________________
Date of Test _____________________________
Starting Condition__________________________
Height_______Weight_______Age_______Gender________Sport___________________

Balance Error Scoring System (BESS)
(Prentice, 2006)

Balance Error Scoring System –

Types of Errors

1. Hands lifted off iliac crest
2. Step, stumble or fall
3. Moving hip into >30° abduction
4. Lifting forefoot or heel
5. Remaining out of test position > 5 sec

The BESS score is calculated by adding one error point for each error.

Score Card (# of errors)	**FIRM** surface	**FOAM** surface	**TOTAL SCORE**
Single Leg Stance Control			
Single Leg Stance Kinesio Tape			
Single Leg Stance Elastikon Tape			

Appendix B

IRB Approval

Adams State College

Request to obtain approval for the use of human participants – expedited review

Date: February 2nd, 2015

To: **Adams State College**

Request to obtain approval for the use of human participants – expedited review

Date: February 2nd, 2015

To: Rob Demski, ASU Institutional Review Board

Name: Jessica Achatz
Email: achatzjd@grizzlies.adams.edu
Mailing Address: 4 River Drive, Alamosa, CO 81101
Phone: 719-469-9608

Responsible Faculty Member

Chair of Thesis Committee: Tracey Robinson, Ph.D.
Email: tlrobins@adams.edu
Phone: 719-587-7663

Subject: The Effect of Kinesio Tape on Single Leg Balance.

Others in Contact with Human Participants:

Research Assistants: Megan Ulery, ATC

The title of the research: The Effect of Kinesio Tape on Single Leg Balance (Master's Thesis Research)

Objectives of the research:

Kinesio taping is one of the latest trends to strike the athletic population. Kinesio tape is a flexible, adhesive tape that was designed to mimic the qualities of skin. There are three main manufacturers of kinesio tape: Kinesio® Tex Tape, Mueller Kinesiology Tape, and KT Tape™. The theory behind kinesio tape is that it lifts the upper layers of skin to create more space between the dermis and the muscle. This allows for better lymph flow and drainage of the affected area. With respect to these potential claims, kinesio tape should ideally help reduce edema, improve proprioception, range of motion, strength, and decrease pain. Out of these three manufacturers, only KT TAPE™ claims to improve proprioception.

Humans rely on signals from sensors in the legs and torso (proprioceptors) to maintain good balance. The sensory receptors that are found in the skin, muscles, joints, ligaments, and tendons provide input to the central nervous system (CNS) regarding tissue deformation. Mechanoreceptors are sensitive to joint pressure and tension caused by both dynamic movement and static position. These afferent nerve fibers provide a sense of movement and position as well as contributing to a complex reflex system that acts to control posture and coordination.

The main objective of this research is to see if an application of kinesio tape is an effective measure in aiding balance. Many health professionals question whether kinesio tape actually provides therapeutic benefits to an athlete, or if it simply acts as a placebo.

Benefits

The main benefit of this study will be to further the research on kinesio tape and its effect on balance. Other benefits include the effects of a placebo tape on a balancing task. The results of this study will help clinicians, such as Athletic Trainers and Physical Therapists, determine if an application of kinesio tape or a placebo tape are effective measures in aiding balance during rehabilitation. If found to be not effective, clinicians may stop using kinesio tape on their patients. Since kinesio tape is fairly expensive, clinicians may use their budget elsewhere if found not effective.

Risks and Discomforts

Every effort will be taken to minimize discomfort and risks throughout the study. There may be minimal physical and psychological discomfort while answering questions or performing balancing tasks. A spotter will be present during testing to minimize the chance of falling. Minimal discomfort may be present while the participant is blindfolded for approximately 10 minutes. In rare cases, the kinesio tape and placebo tape may cause a local allergic reaction or rash.

Methods of procedure:

1) All participants will be asked to sign a form of consent to participate in the study.
2) Upon consent, participants will randomly be assigned to a group to determine the order in which the kinesio tape, placebo tape, or control condition is applied. The participants will be assigned a random number to be identified by throughout the study. Ten participants (5 males and 5 females will make up each group) will start with kinesio tape, ten participants will start with the placebo tape, and ten will start with no tape. One group will start with the control and then move on to the kinesio tape condition, followed by the placebo tape. The kinesio tape group will be followed by the placebo tape, and then the control group. Lastly, one group will start with the placebo tape followed by the control and kinesio tape conditions.
3) Basic subject characteristics such as height, weight, age, gender, and sport will be taken prior to the first trial. This will be recorded on the BESS score card. The BESS score card is attached for further detail.
4) Each participant will be asked to state their dominant leg. This will be done by asking the participant to determine which foot they would use to kick a ball. The kicking foot is considered the dominant foot. This is the leg in which the tape will be applied and the single leg balance will be performed.
5) If hair is present on the participant, the area of tape placement will be shaved with a razor prior to tape application.

6) The skin will be cleaned by a certified athletic trainer with rubbing alcohol prior to the tape applications.
7) Tape will be applied to the anterior knee starting at the distal musculotendinous junction of the quadriceps and ending at the tibial tuberosity. The certified athletic trainer will apply the tape. Two-inch wide Mueller kinesiology tape and 2-inch wide Johnson & Johnson Elastikon elastic tape will be used for this study.
8) Throughout the application and balance process, the participant will be blindfolded. Participants will be blindfolded so that they do not know which type of tape is applied to them. If participants were not blindfolded, they may be biased towards one of the tape applications.
9) The participant will then be asked to perform a BESS test. The BESS test directions and stances are attached for further detail. The kinesio tape, placebo tape, and control group will each balance on a firm and a foam surface in a randomized order. The participant will balance on their dominant leg with their hands on their hips and blindfolded. A spotter will be present to ensure the safety of the participant. Total error scores for each condition (no tape, placebo tape, and kinesio tape) will be compared.
10) Participants will rest for one minute between the firm and foam conditions.
11) After each trial, the participant will be helped back to the table and the tape will be removed with tape remover, and the skin will be cleaned with rubbing alcohol.
12) The next tape will be applied and the balance process will be repeated.
13) Time between trials will be approximately 3 minutes to remove and reapply tape.
14) Participants will be tested one at a time to ensure that they are not influenced by other subjects.
15) Actual testing time will be approximately 15 minutes. Total participation time for the entire study will be no longer than 30 minutes. This includes signing the consent form, tape application, all pretesting, and testing.

Research Design: Data will be analyzed using SPSS statistical analysis software. The study will use a randomized controlled, crossover trial design. The independent variables in this study are the applications of kinesio tape or placebo tape to the anterior knee. The dependent variables are the Balance Error Scoring System (BESS) total test scores for the control group, kinesio tape group, and the placebo tape group. A one-way analysis of variance (ANOVA) will be used to compare BESS total test scores for each condition. If the ANOVA is found to be statistically significant, a post hoc test will be run.

The Setting: The study will take place in the Athletic Training Room Exam Room at Adams State University. The study will be completed when the Athletic Training Room is closed to safeguard the anonymity of the participants. The participants will be constantly under the supervision of a Certified Athletic Trainer.

Participants: Initial participants will include 30 athletes (15 male, 15 female) of any sport from Adams State University. Participants will be recruited by word of mouth and through ASU coaches. Athletes must be on a current Adams State University roster. Participants will not be compensated for volunteering in this study.

Protection Measures

Participation is voluntary and will be held confidential. You may choose not to answer any question you do not want to answer and/ or you may withdraw from participation at any time without penalty. Names will not be used in the study, participants will be assigned a number and group data will be reported. During the study, the data will be locked in a filing cabinet in the Adams State University Athletic Training Room. Only the researcher will have the key to the filing cabinet. Data will be locked under a password protected computer for five years in which the researcher only has the password. Adams State University reserves the right to use the results of this study for future research and/or presentation of results. Names/identities will never be revealed even at the conclusion of the study. Any written or oral publication and/or presentation of this research will only show group data; you as an individual subject will not be identified.

Consent: Participants will be asked to read over and sign the consent form before any testing begins. The informed consent is attached separately.

Changes: If any changes are made to the research I will contact the IRB immediately and fill out the needed paperwork.

Tracy L Robinson 2-10-2015

Name and Signature of Department Chair Date

2-6-15

Name and Signature of IRB Chair Date

RESEARCH PARTICIPANT CONSENT FORM

Consent Form

The Effect of Kinesio Tape on Single Leg Balance
Jessica Achatz
Adams State University
Department of Human Performance and Physical Education

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH

Kinesio tape was developed by Dr. Kenzo Kase, an American trained Japanese chiropractor and acupuncturist, in the mid-1970s. Kinesio tape is a flexible, adhesive tape that was designed to mimic the qualities of skin. The hypothesized functions of kinesio tape are to re-educate the neuromuscular system after injury, reduce pain, optimize performance, prevent injury, and promote improved circulation and healing.

The purpose of this study is to determine if an application of kinesio tape compared to a placebo tape or no tape is an effective measure in aiding balance. BESS total error scores will be compared to determine which condition, if any, aid balance.

PROCEDURES

1) Participants will be randomly assigned a starting group (kinesio tape, placebo tape, or no tape).
2) Height, weight, age, gender, and sport will be recorded.
3) Dominant leg will be determined.
4) Participant's skin will be shaved if hair is present, and cleaned using rubbing alcohol prior to taping.
5) Participants will be blindfolded.
6) Tape will be applied by a certified athletic trainer. The tapes used will be Mueller kinesiology tape and Johnson & Johnson Elastikon.
7) Participants will complete 3 randomized trials of the Balance Error Scoring System (BESS) wearing kinesio tape, placebo tape and no tape for twenty seconds or as long as possible.
8) Both foam and firm conditions will be tested. Participants will rest for 1 minute between foam and firm conditions.
9) The tape will be removed by a liquid tape remover.

DURATION OF PARTICIPATION

Total participation time for the entire study will be no longer than 30 minutes. Upon consent, testing will take approximately 15 minutes. Only 1 testing session is required for this study.

RISKS AND DISCOMFORTS

Every effort will be made to conduct testing procedures in such a way to minimize discomfort and risk. There may be physical and psychological discomfort with answering questions or performing balancing tasks. Because you will be asked to be blindfolded for approximately 15 minutes, you may experience a heightened awareness of your other senses. In rare cases, the kinesio tape and placebo tape may cause skin irritation, resulting in a local allergic reaction or rash.

BENEFITS

By participating in this study, participants may find an effective aid to improve their balance. Participation will also contribute towards the advancement of science.

CONFIDENTIALITY

Your privacy is always the number one concern. You may choose to withdraw from this study at any time, without penalty. All data files will be stored in a locked filing cabinet in the Adams State Athletic Training Room. Data will be locked under a password protected computer for five years in which only the researcher has the password. Names/identities will never be revealed even at the conclusion of the study. Any written or oral publication and/or presentation of this research will only show group data; you as an individual subject will not be identified.

INQUIRIES

Any questions or concerns regarding this study are welcomed. For questions please contact the researcher of the study, Master's student Jessica Achatz, Department of Human Performance and Physical Education, (719) 469-9608, achatzjd@grizzlies.adams.edu; or Dr. Tracey Robinson, Professor & Thesis Advisor, Department of Human Performance and Physical Education, (719) 587-7663, trobins@adams.edu; or Dr. Rob Demski, IRB Chair, (719) 587-7216, rmdemski@adams.edu.

PLEASE READ THE FOLLOWING STATEMENTS AND SIGN IN THE SPACES PROVIDED TO INDICATE YOUR CONSENT:

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a signed copy of this Consent Form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time. You voluntarily consent to participate in this study. By signing this form, you are not waiving any of your legal rights. You may withdraw from the study at any time.

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Printed Name of Subject Date

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Signature of Subject Date

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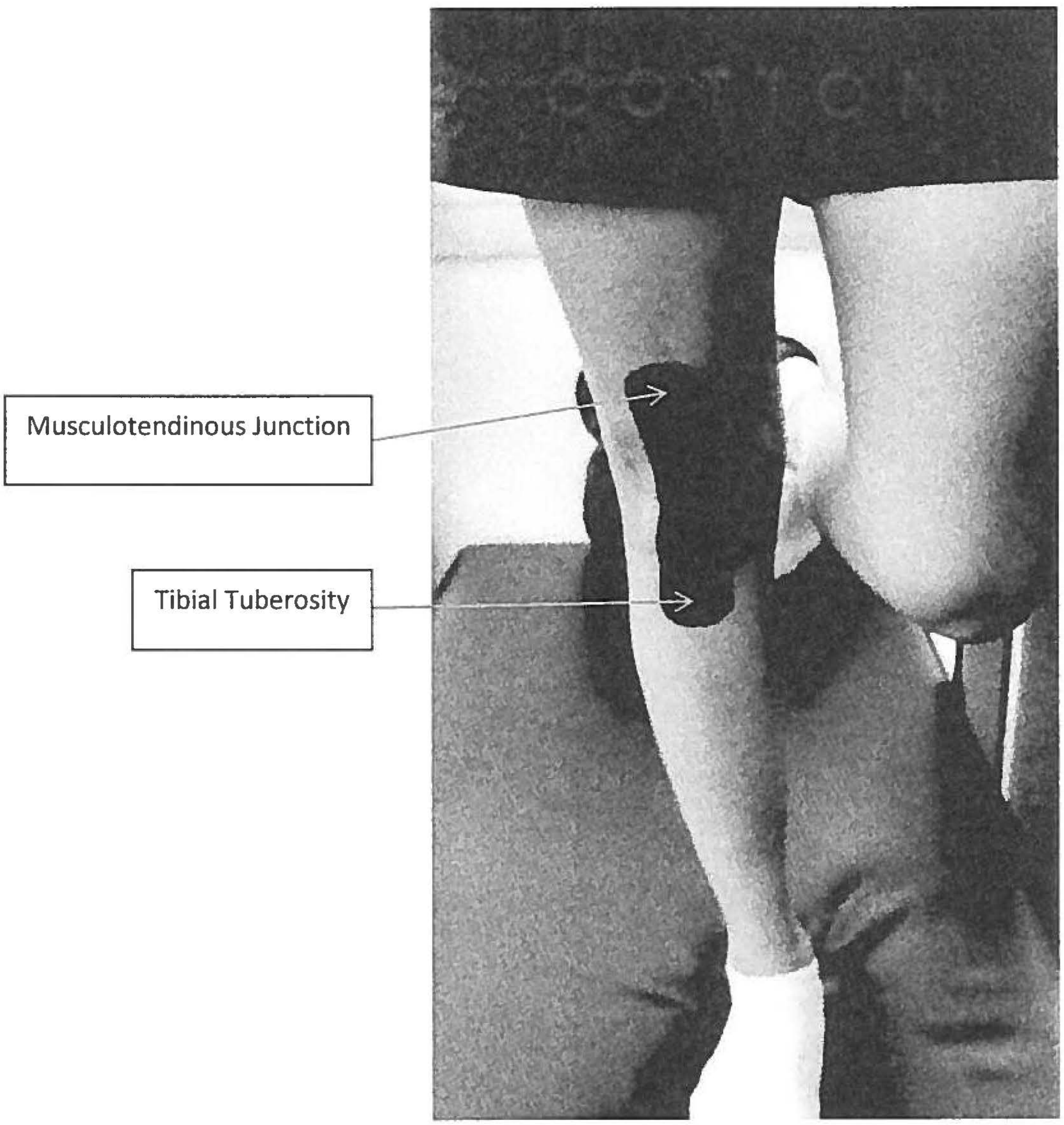
Signature of Principal Investigator Date

Appendix C

Tape application model

Tape placement for both the kinesio tape and placebo tape conditions.



Appendix D

Raw Data & Statistical Analyses

Participant Total BESS Scores

Participant Number	Total BESS Control	Total BESS Kinesio	Total BESS Placebo
1	5	8	7
2	5	7	8
3	6	8	8
4	3	5	4
5	7	9	8
6	4	4	4
7	6	8	7
8	1	4	3
9	3	6	6
10	1	3	2
11	4	7	6
12	0	1	2
13	8	8	8
14	5	9	7
15	4	5	5
16	4	6	6
17	3	7	8
18	2	8	8
19	2	6	7
20	1	8	8
21	4	5	5
22	2	7	7
23	1	6	8
24	2	4	4
25	2	8	7
26	3	7	9
27	5	10	10
28	2	5	5
29	4	6	8
30	3	7	7

Descriptive Statistics

	Mean	Std. Deviation	N
Control group	3.400	1.923	30
Kinesio group	6.433	2.046	30
Placebo group	6.467	2.177	30

Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
type_of_tape	.492	19.846	2	.000	.663	.683	.500

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Type_of_tape								
Greenhouse Geisser	186.067	1.326	140.27	62.79	.000	.684	83.292	1.00
Error (type_of_tape)								
Greenhouse-Geisser	85.933	38.468	2.234					

a. Computed using alpha = .05

Pairwise Comparisons

(I)type_of_tape	(J) type_of_tape	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	-3.033	.330	.000	-3.873	-2.194
	3	-3.067	.392	.000	-4.063	-2.070
2	1	3.033	.330	.000	2.194	3.873
	3	-.033	.182	1.000	-.497	.430
3	1	3.067	.392	.000	2.070	4.063
	2	.033	.182	1.000	-.430	.497

1=Control Group, 2=Kinesio Tape Group, 3=Placebo Tape Group

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed power[b]
Pillai's trace	.745	40.923	2.000	28.000	.000	.745	81.845	1.00

b. Computed using alpha = .05