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The Effects of Hip Elastic Taping on Knee Kinematics, Kinetics, and Pain

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BY

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Abstract

The aim of this study was to assess the acute effects of hip elastic taping on knee kinetic and kinematic variables in participants with anterior knee pain (AKP). Fourteen women with AKP participated in the study. All participants performed both elastic taping and no taping conditions. They were screened with a questionnaire for prior injuries, surgeries, pain level, and experience with elastic taping. Participants were then screened during the single-leg squat (SLS) task. Inclusion criteria for further testing included a 10% increase in knee valgus and 10% increase in hip adduction when compared to the non-affected leg. Knee frontal plane motion, knee frontal plane moments, mean vertical ground reaction force (vGRF), and AKP were used as the main outcome measures. Among all outcome parameters significant differences were found in knee frontal plane motion and knee frontal plane moment. No significant differences were found in vGRF and pain. Therefore, elastic taping on the hip shows to be an effective treatment in reducing frontal plane kinematics and kinetics in patients with AKP.

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Chapter 1

Introduction

Weakness in proximal hip stabilizers has been shown to increase femoral internal rotation and adduction in females (Heinert, Kernozek, Greany, & Fater, 2008; Witvrouw, Callaghan, Stefanik, Nnoehren, Bazette-Jones, & Crossley, 2014). Recent evidence suggests that decreased neuromuscular control at the hip is one of the major contributing factors of anterior knee pain (AKP) causing valgus collapse during dynamic movement (Crossley, Zang, Schache, Bryant, & Cowans, 2011; Hollman, Galardi, Lin, Voth, & Whitmarsh, 2014; Prins & van der Wurff, 2009). AKP is the most common pathology affecting 9-15% of the active adult and adolescent populations (Crossley et al, 2011; Hollman et al, 2014; Reiman, Bolgla, & Lorenz, 2009; Sanchis-Alfonso, 2014). Globally, AKP accounts for 15-40% of all knee pathologies seen in the sports injury clinic although exact prevalence is unknown (Witvrouw et al, 2014). Across the population, AKP is observed more frequently in women than in men and among adolescent girls compared to women (Roush & Bay, 2012; Witvrouw et al, 2013). DeHaven and Lintner (1986) reported that 33% of females reported AKP. Fairbank, Pynsent, van Poortvliet, and Phillips (1984) reported that 32% (69 out of 219) of teenage females presented with AKP. Taunton, Ryan, Clement, McKenzie, Lloyd Smith, and Zumbo (2002) also found the prevalence of female runners with AKP to be approximately 30%. AKP usually occurs insidiously and is characterized by peripatellar pain associated with activities such as stair climbing, prolonged periods of sitting, squatting, kneeling, and running (Crossley et al, 2011; Hollman et al, 2014; Witvrouw et al, 2014). To combat hip weakness, and thus AKP, therapists and athletic trainers rely on rehabilitation and elastic taping.

A review of the literature on muscular weakness and AKP reports that elastic taping shows promise (Freedman, Brody, Rosenthal, & Wise, 2014; Hyeyoung & Byoung-Hee, 2013; Kuo & Huang, 2013; Lee, Yoo, & Lee, 2010; Lee & Yoo, 2012). A 2014 study investigating anterior knee elastic taping and its effect on pain and function showed that the anterior knee application improved both pain and function (Freedman et al., 2014). Elastic taping, when applied to the knee, decreased pain during the stair ascent, the stair descent, and the single leg triple jump. A study conducted by Lee et al. (2010) found that applying elastic tape to the wrist flexors of the dominant hand allowed the flexors to produce greater force than the untaped condition. Another study conducted by Hyeyoung and Byoung-Hee (2013) concluded that applying elastic tape to both the quadriceps and the hamstrings increased strength and power in the sagittal plane when compared to an untaped condition. When testing the effects of elastic tape on isometric wrist and finger extension strength, Kuo and Huang (2013) found that there were significant increases in both directly after the elastic tape was applied. Decreased muscular strength at the hip can have an effect on the joints proximal and distal.

The human body, being a kinetic chain, does not act in singularity. This means that when overuse pain occurs at a joint it does not necessarily mean that it is the source of the pathology. For example, disruption of the normal alignment of the lower extremity due to underactive hip abductors and external rotators or overactive hip adductors and internal rotators will cause change in the kinematics of normal, everyday weight bearing activities. In a 2012 investigation conducted by Dabholkar, Joshi, and Yardi on hip muscle strength between participants with and without AKP, it was found that those with AKP had significantly weaker hip muscles in the abductors, adductors, extensors, flexors, external rotators, and internal rotators. Pathologies associated with dynamic malalignment of the tibiofemoral joint include iliotibial band friction syndrome, patellofemoral pain syndrome (Moradi, Akbari, Ansari, Emrani, & Mohammadi, 2014), chondromalacia patella, ankle instability, and injuries to the anterior cruciate ligament (Boudreau, Dwyer, Mattacol, Lattermann, & Uhl Medina, 2009).

It is important for the clinician to analyze dynamic movement through various functional tests during observation of individuals with hip, knee, and ankle pathologies. Currently, there are a few functional tests that correlate directly with lumbopelvic musculature and strength including the deep squat (Lamontagne, Kennedy, & Beaule, 2009), single leg stance (Lequesne et al, 2008), single leg squat (Crossley et al, 2011), and the star excursion balance test (Norris & Trudelle-Jackson, 2011). The deep squat test is used to assess lumbopelvic kinematics. The single-leg stance test is a 30 second balance test utilized to assess any hip abductor tendinopathy or weakness, whereas the single-leg squat test is performed to analyze any weakness or slow neuromuscular activation of the hip abductors and external rotators. The star excursion balance test consists of 3 motions involving anterior, posteromedial, and posterolateral reaches. Any weakness in hip abductor and external rotators can be detected during the posteromedial and posterolateral directions.

To review, it can be said that elastic taping may be a good augment to rehabilitation when the goal is to increase hip strength. Reviewing past literature, it shows that the taping has been applied directly on the site of pain. The research is lacking on a proximal, or even a distal, approach to taping especially at the tibiofemoral joint. Therefore, the aim of this study is to investigate whether elastic taping, if applied to the hip, can decrease pain at the knee, increase force produced at the hip, and whether the increased force at the hip can decrease the force produced at the knee.

STATEMENT OF THE PROBLEM

Currently, the research shows that the elastic taping has been placed directly on the site of pain. In a study on the effects of elastic taping on AKP, Aytar et al. (2011) placed the elastic tape on the patella and quadriceps while Chen et al (2008) placed the elastic tape on the vastus medialis. There lacks evidence of the investigators applying tape on a joint proximal or distal to the pain.

The aim of this study, therefore, is to determine if elastic taping can decrease vertical ground reaction forces, increase valgus moment at the tibiofemoral joint, decrease AKP, and decrease mean ground reaction forces by applying elastic tape on the hip. If such a relationship exists we, as clinicians, will be able to incorporate elastic taping as a prophylaxis to supplement rehabilitation of either the knee or the hip and treat the root cause appropriately.

HYPOTHESES

1. Elastic Tape will decrease valgus angles at the tibiofemoral joint
2. Elastic tape will increase valgus moment at the tibiofemoral joint
3. Elastic tape will decrease mean ground reaction force GRF.
4. Elastic tape will decrease AKP

VARIABLES

Dependent Variables:

1. AKP
2. Total ground reaction force produced by the participant.
3. Frontal plane kinematics at the tibiofemoral joint.
4. The joint moment of the tibiofemoral joint in the frontal plane

Independent Variable:

1. Taping versus No Taping

OPERATIONAL DEFINITIONS

1. Dynamic Malalignment: Alterations to a joint's motion or position during movement which can lead to injury.
2. Elastic Taping Method: An elastic taping method introduced in 2012 by Dr. Steve Agocs which uses length tension of the tape and movement pattern of the muscle to obtain a specific outcome.
3. Kinetic Chain Approach: Pain in an area caused by a dysfunction in a joint distal or proximal to the affected area.
4. Functional Movement: Any movement that mimics activities of daily living.
5. Kinematics: 2-dimensional analysis used to show changes in force, torque, joint angles, and velocities during dynamic movement.
6. Dynamic Movement: Any movement that requires a change in bodily position such as locomotion.

ASSUMPTIONS

1. It is assumed that all participants have not had surgery within the last 6 months and are not currently following a rehabilitation program for any pathology at the knee or hip.
2. It is assumed the Vicon software is running properly and reporting the data correctly.
3. It is assumed that participants will give their maximal effort for every trial.
4. It is assumed that all participants will rate their pain as accurately as possible.
5. It is assumed that the participant is able to perform a single leg squat to a depth of 45°.

LIMITATIONS

1. Participants are not able to perform the single-leg squat to the correct depth.
2. Participants will not have knee valgus angles greater than 10° when compared bilaterally.
3. Participants will not have a decrease in hip abduction strength greater than 10% when compared bilaterally.
4. The testing with the elastic tape will be performed directly after application. This may affect outcomes as it is stated that elastic taping works better the longer it is applied.

DELIMITATIONS

1. Female students at Barry University

2. A decrease of hip abduction force production of 10% compared to the contralateral leg
3. Anterior knee pain greater than or equal to 1 on a 1-10 pain scale.
4. Never have used any form of elastic taping (Rock Tape or Kinesio Tape) as this may increase bias.

SIGNIFICANCE OF THE STUDY

Elastic taping has been researched extensively by clinicians to determine the efficacy of its claims. Primarily, the studies' methodologies show that the tape is applied directly on the site of aggravation and does not utilize an approach where the tape is applied to the source.

As studies have shown, the evidence is promising on the efficacy of elastic taping on strength. It is important to observe global movement when trying to evaluate, diagnose, and treat injuries to the lower extremity. Current research has shown that pathologies of the lower extremity involving dynamic malalignment of the knee can be attributed to the joints distal to the pain at the ankle and proximal at the hip. This study will investigate whether elastic taping, if applied at the hip, has an effect on hip strength and tibiofemoral joint dynamics including kinetic and kinematic patterns.

Chapter 2

Literature Review

Background Information

Patellofemoral pain (PFP) is one of the main reasons for consultation about the knee (Crossley et al, 2011; Hollman et al, 2014; Reiman, Bolgla, & Lorenz, 2009; Sanchis-Alfonso, 2014). Clinically, the presentation of PFP occurs more frequently in men than in women and in the adolescent population from the ages of 12-17 (Crossley et al, 2011; Hollman et al, 2014; Reiman, Bolgla, & Lorenz, 2009; Sanchis-Alfonso, 2014; Witvrouw et al, 2014). Although true prevalence is unknown, Witvrouw et al (2014) has stated that the much-cited figure of 25% is based on sports medicine clinics that ascertain bias.

PFP usually occurs insidiously and is characterized by peripatellar and diffused pain. It is associated with activities that increase compressive forces on the patella such as stair climbing, prolonged periods of sitting, squatting, kneeling, and running (Crossley et al, 2011; Hollman et al, 2014; Witvrouw et al, 2014). Other factors contributing to PFP and anterior knee pain include patellar tilting and altered patellar tracking (Crossley et al, 2011). Researchers now agree that patellar tilting and maltracking are considered to be secondary to abnormal femoral kinematics in the transverse plane (Crossley et al, 2011; Hollman et al, 2014; Prins & van der Wurff, 2009; Sanchis-Alfonso, 2014).

Anatomy of the Hip

The hip is comprised of the pelvis and femur (Starkey, Brown, & Ryan, 2010). The pelvis is formed by two innominate bones consisting of the pubis, ilium, and ischium (Starkey et al., 2010). The thigh is comprised of the femur. The hip is comprised of the articulation of the head of the femur to the acetabulum of the pelvis. This structure is stabilized by dynamic and static stabilizers. The static stabilizers consist of the iliofemoral ligament, which reinforces the anterior joint capsule, the pubofemoral ligament, and the ischiofemoral ligament. The iliofemoral ligament consists of 3 ligamentous fibers: anterior, superior, and inferior. The anterior fibers restrict hip extension, the superior fibers restrict hip adduction, and the inferior fibers restrict hip abduction. The pubofemoral ligament restricts hip abduction and hyperextension. The ischiofemoral ligament restricts hip extension (Starkey et al., 2010).

The hip is supported by dynamic stabilizers on the anterior, posterior, medial, and lateral sides. Anteriorly, the hip is stabilized by the rectus femoris originating from the anterior inferior iliac spine and inserting on the tibial tuberosity via the patellar tendon, sartorius originating on the anterior superior iliac spine and inserting on the proximal anteromedial tibial flare, and iliopsoas group. Posteriorly, the hip is stabilized by the hamstring group comprising of the biceps femoris, semimembranosis, and semitendinosis, all originating on the ischial tuberosity. Medially, the hip is stabilized by the adductor muscle group including the adductor magnus originating on the inferior pubic ramus, ramus of the ischium, and ischial tuberosity, adductor brevis originating on the pubic ramus, and adductor longus originating on the pubic symphysis. Lateral hip stabilizers include the gluteus medius originating on the external surface of superior ilium and the tensor fascia latae originating anterior superior iliac spine, as well as, the external lip of the iliac crest. Also on the lateral side, the hip consists of 6 intrinsic muscles which help restrict femoral internal rotation during gait. The muscles include the piriformis, quadratus femoris, obturator internus, obturator externus, gamellus superior, and gamellus inferior (Starkey et al., 2010). Many of the muscles acting on the hip are biarticulate also acting on the knee. This means that if weakness in dynamic stabilization exists at the hip joint it will affect alignment of the knee. For example, if weakness exists at the Gluteus medius muscle, the femur will be in internal rotation and valgus collapse thus putting structures in the knee such as the anterior cruciate ligament and medial collateral ligaments under stress.

Assessing Hip Weakness

Weakness of the hip muscles may be a contributing factor to valgus collapse that can lead to PFP (Crossley et al, 2011; Hollman et al, 2014). Functional tests, although indirect, allow clinicians to measure muscle strength and power and are often used to assess components of functional tasks (DiMattia et al, 2005). The two most commonly used assessment tools for testing weakness of the hip muscles are the Trendelenburg and single-leg-squat test (SLS) (Crossley et al, 2011; DiMattia et al, 2005; Hollman et al, 2014).

The SLS is a functional test used to assess general muscle endurance and general lower extremity strength. Many daily and athletic activities involve components of the SLS (DiMattia, 2005). In 2005 a study by DiMattia and colleagues set to validify the method used to assess the SLS performance, as well as, determine the relationship between isometric hip-abduction strength and maximal hip adduction angle during a standardized SLS. The authors used fifty participants (age 24.32 ± 4.78 years; height 171.64 ± 11.16 cm; mass 74.48 ± 21.82 kg; 26 men, 24 females) and instructed them to perform the SLS. They used a 3 criteria grading system that looked for performance of hip flexion that should not exceed 65°, hip adduction, which should not exceed 10°, and knee valgus that should not exceed 10°. A score of “3” was given if the participants met all 3 criterion, a “2” if 2 out of 3 were met, a “1” if 1 out of three were met, and “0” if they were not able to perform the task. The participants were asked to squat on a single leg until the knee angle reached 60°. The results showed that the clinical-observation method in assessing the SLS resulted in a high specificity (0.84-0.87) and low sensitivity (0.25-0.22) when also assessing for hip adduction. When assessing for knee-valgus, the investigation showed moderate to high specificity (0.78-0.58) and low to moderate sensitivity (0.46 and 0.58) (DiMattia, 2005). Although they found a low negative correlation this study did have limitations. They only used an active population that was asymptomatic. Secondly, knowing who was in each group is an important factor. Although the test may not be reliable or valid for a participant who was rated a “3,” we could get a wealth of information knowing who was in group “1” or even group “0.”

Crossley et al (2011) performed a study to determine a clinical rating of performance on the SLS task based on physical therapists, as well as, to determine if those who received a “poor” rating on the SLS performed differently than those rated as “good.” In the study, the investigators recruited 34 healthy adults (mean ± *SD*: age, 24 ± 5 y; height, 1.69 ± 0.10 m; mass, 65.0 ± 10.7 kg). For the SLS, the participants were asked to stand on a 20-cm high box and perform 5 consecutive SLS at a rate of 1 per 2 seconds. During the SLS, the participants were recorded through digital video placed 3 m in front of them for the investigators to review. In order to determine criteria for the clinical rating of the performance of the SLS task a panel of 5 physical therapists formed a consensus panel. Each member of the consensus panel reviewed the DVD of the participant performing the SLS. The panel then met to discuss their decision. To be rated as “good” participants needed to meet the requirements in 4 out of 5 criteria as described by Crossley et al (2011) and to be rated as “poor” the participant must not have met all of the requirements for at least 1 criterion. For EMG analysis, all participants were fixed with silver-silver chloride surface electrodes for the anterior gluteus medius and intramuscular electrodes for the posterior gluteus medius. A handheld dynamometer was used to measure isometric hip strength in external rotation, abduction, and truck side flexion. The results showed excellent interrater reliability between the two experienced physical therapists (agreement 80%-87%; $\kappa = 0.700\text{-}0.800$) and substantial for the least experienced rater (agreement 73%; $\kappa = 0.600$). The results also showed that participants rated as “good” performers had an earlier onset timing of anterior gluteus medius (mean difference, -152; 95% CI, -258 to -48 ms) and posterior gluteus medius (mean difference, -115; 95% CI, -227 to -3 ms) than those rated “poor.” Hip abduction torque was shown to be greater in the “good” group (mean difference, 0.47; 95% CI, 0.10-0.83 $N{\cdot}m{\cdot}Bw^{-1}$) than in the “poor” group. There were no differences between groups in hip external rotation (mean difference, 0.14; 95% CI, -0.20-0.48 $N{\cdot}m{\cdot}Bw^{-1}$). The results indicate that the SLS test is a valid and reliable tool to test for hip weakness in the clinical setting.

Hollman et al (2014) compared hip and knee kinematics, as well as, hip muscle function and magnitudes of gluteus maximus and medius between the groups rated as “poor” and “good” during the SLS test. To rate the participants they followed the same criterion as Crossley et al (2011). Kinematic data was collected using Vicon’s Plug-in Gait model. For EMG data, surface electrodes were placed on the gluteus maximus, at one-half the distance from the sacrum and greater trochanter, and the gluteus medius at one-third the distance of the greater trochanter and the iliac crest. The results showed that “poor” performers completed the SLS test with more hip flexion (mean difference = 7.6°, 95% CI = 0.8° to 14.4°, $p = 0.03$) and adduction (mean difference = 6.3°, 95% CI = 3.2° to 9.4°, $p < 0.01$) than the "good" group. The SLS was also performed with more medial hip rotation, although not statistically significant (mean difference = 7.0°, 95% CI = -0.6° to 14.6°, $p = 0.07$). Knee kinematics, hip abduction, hip flexion, and gluteus maximus and medius did not differ between groups. Interestingly, increased medial hip rotation (partial r = 0.35, 95% CI = 0.05 to 0.59, $p = 0.04$) and adduction (partial r = -0.42, 95% CI = -0.13 to -0.64, $p = 0.03$) along with decreased recruitment in gluteus maximus (partial r = 0.35, 95% CI = 0.05 to 0.59, $p = 0.04$), contributed to an increase in knee valgus.

Kinesio Tape®

Kinesio Tape® is widely gaining acceptance as an augment to the treatment of various pathologies (Yasukawa, Patel, & Sisung, 2006). Theoretically, Kinesio Tape® exhibits its efficacy through the stimulation of neurological and circulatory systems over the muscles it is placed (Kase, 2005). There are four major functions of Kinesio Tape®: 1) strengthen weakened muscle, 2) control joint instability, 3) activate endogenous analgesic system, and 4) assist in postural alignment (Kase, 2005; Yasukawa, Patel, & Sisung, 2006).

Kinesio Tape® is an elastic, latex-free tape that stretches longitudinally and conforms to the body to allow full range of motion (ROM). The taped area can be used to facilitate a weakened or overused muscle if the application procedure is followed correctly. In order to support muscle, it is theorized that the tape relieves pain, improves ROM, reduces muscular fatigue, and helps improve contraction of weakened muscles. To support and correct joint problems it is said to adjust malalignments caused by shortened muscles, relieve pain, improve ROM, and lastly, to normalize muscle tone. Kinesio Tape® is applied based on the treatment outcome. To support chronically fatigued muscles and assist with muscular contraction the tape should be placed from the origin to the insertion of the muscle with the tape stretched to a tension of approximately 15%. Ligamentous and joint damage requires a tape tension of approximately 75-100+%. For the prevention of over-contraction, the tape should be placed from insertion to origin with the tape stretched to a tension of 0% (Kase, 2005, Yasukawa, Patel, & Sisung, 2006). Although there are many uses of Kinesio Tape® the research is inconclusive on what it is purported to do.

One of the effects Kinesio Tape® is stimulation of cutaneous mechanoreceptors in order to reduce pain (Kase, 2005; Lee & Yoo, 2012; Yasukawa, Patel, & Sisung, 2006). In a 2012 case study by Lee and Yoo on the effects of Kinesio Tape® on sacroiliac joint dysfunction and pain they attained positive results associated with the application of Kinesio Tape®. The patient presented with chronic low back pain for 2 years with referred pain leading to the buttock area. The clinicians initial assessment revealed an anterior pelvic inclination of 17.5° and 19° on the right and left sides, respectively. During pain provocation tests the patient tested positive for the Gaenslen's Test, Patrick Test, and resistive abduction test. The patient rated their pain an 8/10 on a visual analog scale. The clinician then applied a posterior pelvic tilting tape for 2 weeks at a rate of 6 times per week in 9 hour intervals in order to maintain constant mechanical correction. Their results showed a decrease in anterior pelvic inclination to 11° and 12° on the right and left sides. For pain, the rating was decreased from an 8/10 to a 7/10 and negative results on the Patrick Test and resistive abduction test (Lee & Yoo, 2012). Similarly

Freedman et al (2014) found significant decreases in pain in patients with PFP when Kinesio Tape was applied around the patella. Forty-nine patients with PFP were randomly assigned to either a sham taping or Kinesio Taping group. Patients were then asked to rate their pain using a Visual Analogue Scale before and after 4 functional tasks: step up, step down, single-leg triple jump, and deep squat. Results showed that there were significant decreases in pain during the step up [$t(49) = -2.31$, $p = 0.025$, $d = 0.33$], step down [$t(49) = -2.29$, $p = 0.026$, $d = 0.32$], and single-leg triple jump [$t(49)$, -4.29, $p < 0.001$, $d = 0.61$].

Conversely, Firth et al (2010) wanted to investigate the effects of Kinesio Tape on hop distance and pain. Both the single leg hop test and a 10 cm visual analog scale were measured with and without taping. In the Achilles tendinopathy group there was no change in pain level (range, 0-5.6 cm; mean, 1.4 ± 1.4 cm respectively; $p = 0.74$). It was also shown that hop distance remained unaffected, as well, when comparing hopping with the tape on and off (89 ± 30 cm and 88 ± 31 cm, respectively; $p = 0.56$). Similarly, Aytar et al (2014) wanted to assess the initial effects of Kinesio Tape on patients with PFP. Twenty-two subjects with PFP were randomly assigned to either a placebo Kinesio Tape or Kinesio Tape group. The patients were asked to walk 50m, ascend, and descend stairs 12 steps in which they rated their pain with a Visual Analogue Scale. Results showed that there was no significant difference in pain between those with the placebo tape or Kinesio Tape.

A second effect of Kinesio Tape is the ability to correct joint positioning (Kase, 2005; Yasukawa et al., 2006). A study conducted by Shields et al (2013) investigated static postural control differences, specifically in time-to-boundary and center of pressure, between individuals who had healthy ankles, copers, and those who had chronic ankle instability. To do so 60 college-aged students were recruited and grouped based on the score they achieved on the Cumberland Ankle Instability Tool. They performed a single-leg-balance task on a force plate while location and center of pressure were tracked. After baseline assessment was collected, the lateral ankle sprain technique was applied to each individual and they were asked to perform the single-leg-balance task again. Their results showed no group by condition interaction effect ($P > 0.05$). However, they did find significant differences in time-to-boundary between pretest and 24 hours after Kinesio Tape was applied ($p = 0.025$) and time-to-boundary standard deviation in the medial/lateral directions between pretest and 24 hours after Kinesio Tape was applied ($p = 0.009$). What they did not discuss was if the Kinesio Tape had an effect on center of pressure (Shields et al, 2013).

Lee and Yoo (2012) found similar results in two separate case studies involving malalignments in both the pelvic inclination and scapular depression. In the first case study, the patient presented with chronic low back pain for 2 years with referred pain leading to the buttock area. The clinician's initial assessment revealed an anterior pelvic inclination of 17.5° and 19° on the right and left sides, respectively. The clinician then applied a posterior pelvic tilting tape for 2 weeks at a rate of 6 times per week in 9 hour intervals in order to maintain constant mechanical correction. Their results showed a decrease in anterior pelvic inclination to 11° and 12° on the right and left sides. In their second case study the patient presented with Scapular Depression Syndrome. The patient presented with tenderness over the right upper trapezius muscle with a pain rated as 6 out of 10 initially. Upon x-ray evaluation it was shown that the coracoid process of his right scapula was depressed compared to the left side. The authors applied a Scapular Elevation Technique for 8 weeks, 4 days per week, at 9 hour intervals; similar to the above case with the anterior pelvic tilt. After 2 months the patient presented with a pain level of 0 out of 10 and the right coracoid process showed signs of scapular elevation during the x-ray although specifics are not known due to scoliosis.

Thirdly, Kinesio Tape is also purported to support weakened muscles. This is achieved either by reducing muscular fatigue or helping improve contraction of weakened muscles (Kase, 2005; Yasukawa et al., 2006). Chang et al (2013) investigated the effects of Kinesio Tape on maximal grip strength on both healthy individuals and those with medial elbow epicondylar tendinopathy. Twenty-seven college athletes volunteered for the study and were separated into "healthy" and "MET" groups. The groups were then assigned to a control group, a sham tape group, and Kinesio Tape group. Maximum hand strength was measured in both groups. Their results indicated no significant interaction effect between the groups and the taping condition in the maximal grip strength ($F(2, 50) = 0.35$, $p = 0.50$).

Another study performed by Merion-Marban, Mayorga-Vega, and Fernandez-Rodriguez (2012) aimed to investigate the acute and 48-hour effects of Kinesio Tape on the strength of wrist flexors muscles, as well as, comfort level immediately and 48 hours after the application of KT tape. A sample of 31 healthy, university students volunteered for the study. Measures for grip strength were conducted using a digital hand dynamometer and comfort level was assessed using an 11-point rating scale with 0 = "very uncomfortable" to 10 = "very comfortable." Each arm was randomly assigned as a control and taped arm. Muscle strength was assessed under 4 conditions: 1) without tape;

2) 14 minutes after taping; 3) 48-hours after taping; and 4) 15 minutes after the removal of the tape. Their results showed the average obtained in the handgrip strength showed no interaction between group and time variables ($F(3, 156) = 1.140$; $p = 0.332$). Comfort rating after 15 minutes of wearing KT was 9.15 ± 1.03 and 48-hours after being 9.19 ± 0.92. Results of the Wilcox signed-rank test showed no statistical difference in the comfort level ($p = 0.809$).

Hyeyoung and Lee (2013) conducted a study to assess whether KT applied to the quadriceps and hamstring groups on 8 horse racing jockeys had an effect on strength and power during isokinetic dynamometer testing. Their study revealed that KT, in fact, increased force production. Eight jockeys volunteered for the study and were subjected to KT taping of the rectus femoris, vastus lateralis, vastus medialis, biceps femoris, semimembranosis, and semitendinosis. Isokinetic dynamometer testing using the Biodex System3 using a concentric-concentric protocol set at 60° and 180° per second was then used for both taped and untaped conditions. The results showed at 60° per second there was a significant difference (131.50 ± 18.18 before and 137.50 ± 17.40 after KT; $p = 0.004$) in peak torque for the right extensor, a significant difference in peak torque for the right flexor (67.38 ± 9.26 before, and 75.38 ± 11.88 after the application of KT; $p = 0.012$), a significant difference in the left extensors (122.50 ± 9.07 before, and 132.50 ±12.88 after the application of KT; $p = 0.004$) and the left flexors (59.88 ± 13.10 before and 74.13 ± 10.70 after the application of KT; $p = 0.043$). At 180° per second statistical significance existed for peak torque in the right flexors (50.75 ± 6.52 before, and 56.63 ± 9.67 after application of KT; $p = 0.024$), right extensors (86.00 ± 11.48 before, and 90.13 ± 12.65 after the application of KT; $p = 0.033$), left extensors (82.38 ± 10.32 before, and

88.63 ± 11.71 after the application of KT; $p = 0.002$), and left flexors (45.88 ± 7.376 before, and 56.00 ± 8.49 after the application of KT; $p = 0.002$).

Summary

Anterior knee pain and the methods used to treat it is one of the most studied focuses in sports medicine. Almost all of the research on taping conditions to treat anterior knee pain has been a direct application of KT on either the patella or vastus medialis although we now know the cause to be multi-factorial. To this date no research has been done to assess the effects of taping at the hip and its relationship to kinetics and kinematics at the knee, more specifically, sagittal plane motion.

The purpose of KT is to help with correct postural alignment and to support weakened muscles. Although these are purported effects, the research is questionable (Chang et al, 2013; Firth et al, 2013; Hyeyoung & Lee, 2013; Lee & Yoo, 2012; Merion-Marban, Mayorga-Vega, & Fernandez-Rodriguez, 2012; Shields et al, 2013; Yasukawa, Patel, Sisung, 2006). The root cause of pathology is not always at the site of pain and KT tape does not address that issue. As clinicians, when assessing the knee, it is important to perform a global evaluation including a postural assessment, as well as, evaluating the joints distal and proximal to the site of pain in order to provide a comprehensive rehabilitation plan Current research has shown that pathologies of the lower extremity involving dynamic malalignment of the knee can be attributed to the joints distal to the pain at the ankle and proximal at the hip. Therefore, the aim of this study is to investigate whether elastic taping, if applied to the hip, can decrease pain at the knee, increase force produced at the hip, and whether the increased force at the hip can decrease the force produced at the knee.

Chapter 3

Methodology

Participants

The aim of this study was determine if elastic taping can decrease vertical ground reaction forces, decrease varus moment at the tibiofemoral joint, decrease valgus collapse at the tibiofemoral joint, and decrease pain by applying elastic tape on the hip. Participants for this study consisted of 14 female collegiate students consisting of 11 traditional students and 3 student athletes attending a southeastern Florida university. Participants were recruited by a flyer located at multiple locations throughout campus. Upon recruitment, participants were screened by answering a set of qualification questions. Disqualification criteria included: under the age of 18, were currently on a rehabilitation program for the hip and/or knee, have had lower extremity surgery within the last 6 months, and if they have experienced wearing elastic tape as this may include bias. Early withdrawal during data collection did not affect the social status or attitudes towards the participant. Participants for this study must have been able to perform a single leg squat to a depth of 45° of knee flexion and not be on a rehabilitation program for the knee. Participants for this study were asked to report for testing times assigned by the principal investigator.

Instrumentation

For kinematic analysis, the dynamic plug-in gait model was used featuring 16, 25 mm retroreflective markers placed bilaterally on the anterior superior iliac spine (ASIS), posterior superior iliac spine (PSIS), lateral thigh at half the distance between the greater trochanter of the femur and joint line of the knee, the joint line of the knee, the fibula at approximately half the distance of the joint line of the knee and lateral malleolus, the lateral malleolus, the calcaneus, and dorsal aspect of the foot at approximately the base of the second metatarsal (Figure 1).

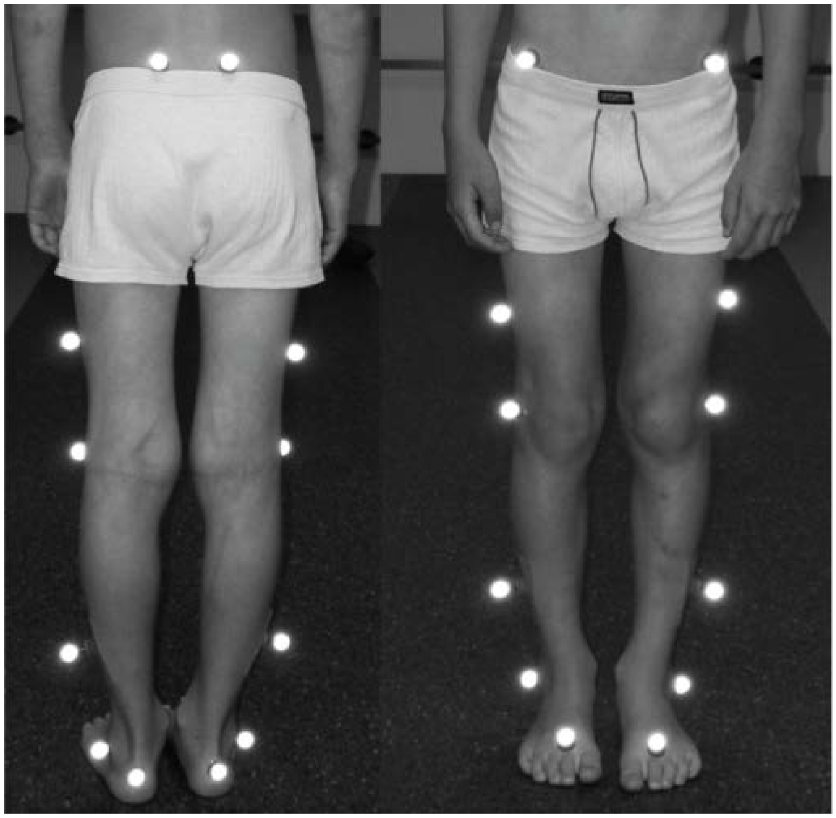

Figure 1. Model representation of the plug-in gait model

A 7-camera Vicon Nexus system (960 Hz, Vicon Nexus v. 1.8.5, Vicon Motions Systems, Oxford, UK) was used to collect 3 dimensional kinematic data. Data was processed using the Vicon Nexus software and presented with Vicon Polygon (Vicon Motions Systems, Oxford, UK) software. Data was smoothed using a Woltring quintic spline, low-pass filter with a cutoff frequency of 6 Hz.

Ground reaction forces and joint moments were collected using an in-ground force plate (240 Hz, Advanced Mechanical Technologies Inc., Watertown, MA) Additional data analysis was completed using Microsoft Excel. Comparison of knee varus and valgus, anterior knee pain, mean ground reaction force, and knee abduction and adduction moments were compared between the control and taped conditions.

Taping Method

The elastic tape was applied using the “Performance Lateral Chain” method as described by Agocs et al (2014). The participant was side-lying while a stretch was applied to the lateral side of the body. The tape was applied at a tension of 0% for the first 4 cm followed by 50% tension starting at the bottom of the foot and extending it laterally over the lateral malleolus, up the lateral side of the leg and knee and, lastly, the lateral side of the thigh up to the iliac crest. The tape was applied to each participant by the same certified clinician.

Procedures

All participants performed both the control and taping conditions. Each testing day was separated by approximately 7 days. Upon arrival participants were allotted a 10-minute warm-up on a stationary bicycle on their own. Following the warm-up all participants were provided with standard instructions on how to complete the single-leg squat task. Participants performed the SLS task barefoot to eliminate any contributing factors associated with footwear and were asked to stand on one leg on an in-ground force plate. Participants were then instructed to fold their arms across their chest and to squat down to an angle of 45°, 5 times consecutively, in a slow, controlled manner maintaining their balance, at approximately 1 squat per 2 seconds. A single investigator demonstrated the single-leg squat procedure. All participants were allowed up to 3 practice attempts to familiarize themselves with the task at hand. If the participants lost balance or placed the non-stance leg on the floor that trial was considered “failed” and reattempted immediately. Following this, the contralateral leg was tested in the same manner following the same protocol.

Standardized grading criteria of active kinematics and kinetics of the hip and knee joint were determined from previous research (DiMattia et al., 2005). There were 3 grading criteria during the SLS: 1) Hip adduction moment should not exceed 10% from the contralateral side, 2) Hip adduction should not exceed 10° from the starting position when compared bilaterally, and 3) Knee valgus should not exceed 10° from the starting position when compared bilaterally. A final score was given for each trial. A grade of "excellent" was given if all three of the criteria were met, a "good" if 2 out of 3 criteria were met, a "fair" if 1 out of 3 were met, and "poor" if 0 out of 3 were met or if the participant was unable to perform the task. Those who did not meet the selection criteria did not continue with the investigation.

Numeric Pain Rating Scale

Subject assessment of pain was provided using the numeric pain rating scale system following the performance of the SLS task with the elastic tape. The rating scale system was an 11 number numeric scale from 0 (no pain) to 10 (worst possible pain) (Appendix D) (Farrar, Young, LaMoreaux, Werth, Pool, 2001).

Data Collection and Statistical Analysis

Participants were required to attend 2 separate testing days. Each testing day was separated by at least 7 days (Appendix B). On the first day of testing, each participant was screened by filling out the screening questionnaire (Appendix C). Following the questionnaire, if approved for the study, the participant was screened for the SLS for hip weakness. On the second day of testing the participants were taped on the affected hip and again screened for hip muscle weakness and pain rating. Pain rating was assessed before the taped condition upon arrival and immediately after the SLS.

Collected data was processed and analyzed using a One-Way MANOVA with repeated measures (v. 21, IBM Inc., Chicago, IL, USA) to find interactions in hip and knee ranges of motion in the frontal plane, anterior knee pain, and total ground reaction force produced by the participant. The participant's information was noted by a 2-digit identifier. A master roster of the participant's true identity and corresponding identifier is locked in a filing cabinet in the principal investigator's office. This study used the identifier when referring to their given data. Scores will be published in terms of group means. The identity of the individuals will never be made public. Data of the participant will be given to them upon their request.

Chapter 4

Results

The aim of this study was to determine if elastic taping at the hip could decrease vertical ground reaction forces, increase valgus moment at the tibiofemoral joint, decrease valgus angle at the tibiofemoral joint, and decrease anterior knee pain.

Fourteen participants (n = 14) volunteered to participate in this study. Means and standard deviations are presented in table 1.

Table 1. Descriptive statistics (*M* ± *SD)*

	Participants (n = 14)
Age (y)	20.87 ± 2.03
Mass (kg)	76.65 ± 37.11
Height (cm)	163.82 ± 5.20

A one-way MANOVA was conducted to determine the effects of taping on anterior knee pain, knee valgus angle, medial-lateral knee moment, and mean vertical ground reaction force (GRF). Results of the MANOVA indicated that the taping condition [$F(1, 22) = 300.74$, $p < .001$] significantly affected the combined dependent variables. Four post-hoc Univariate ANOVAs were conducted as follow-up tests. ANOVA results indicated that there was a significant difference between the taping conditions in knee valgus angle [$F(1, 22)$, = 5.90, $p = .024$, $\eta^2 = .221$] (Table 2)(Figure 2). There was also a significant difference between the taping condition and medial-lateral knee moment [$F(1, 22)$, $p < 0.001$, $\eta^2 = .777$] (Table 2) (Figure 3). There were no significant differences between the taping condition on mean vertical GRF or pain (Figures 4 and 5).

Table 2. Mean condition comparisons for knee biomechanical kinetic and kinematic variables (*M* ± *SD)*

Variable	No Tape	Tape
Knee Frontal Plane Angle [1](°)	-0.11 ± 7.42	8.14 ± 9.12*
Knee Frontal Plane Moment[+] (N•m)	12.86 ± 15.68	-46.85 ± 17.71**
Pain	3.92 ± 1.08	3.00 ± 1.59
Total GRF (N)	610.18 ± 100.90	610.56 ± 100.31

1: Negative angle = Valgus
* $p < .05$
** $p < .001$

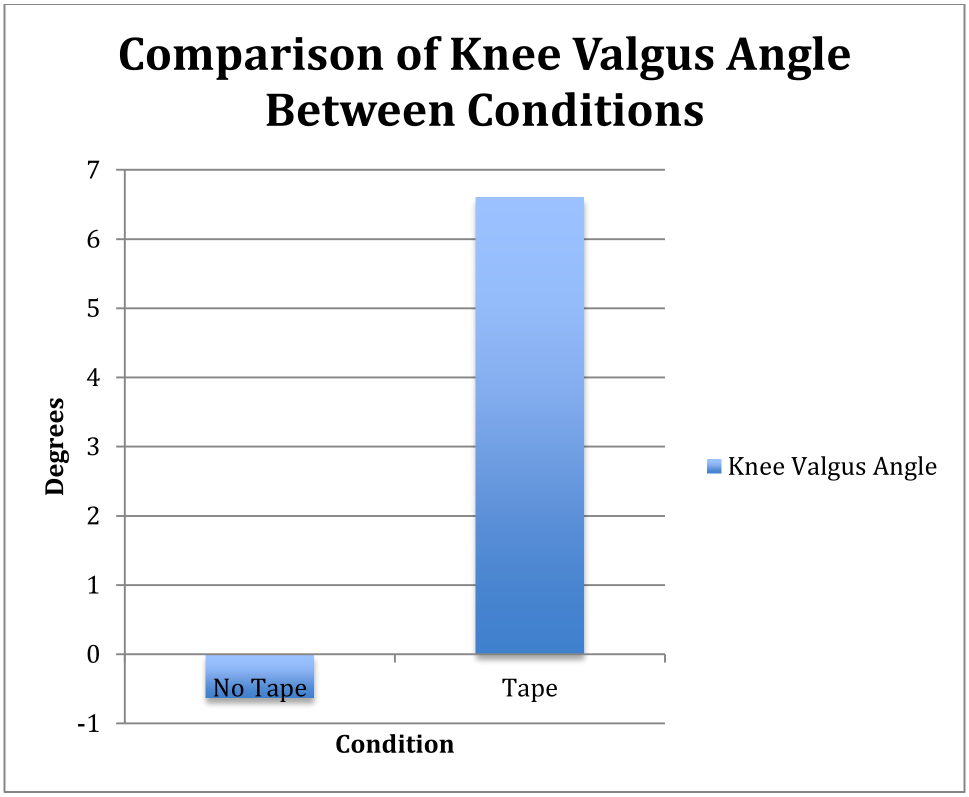

Figure 2. Comparison in knee valgus angle when taped versus untaped. Results indicate that there is a decrease in knee valgus angle when the participant was taped.

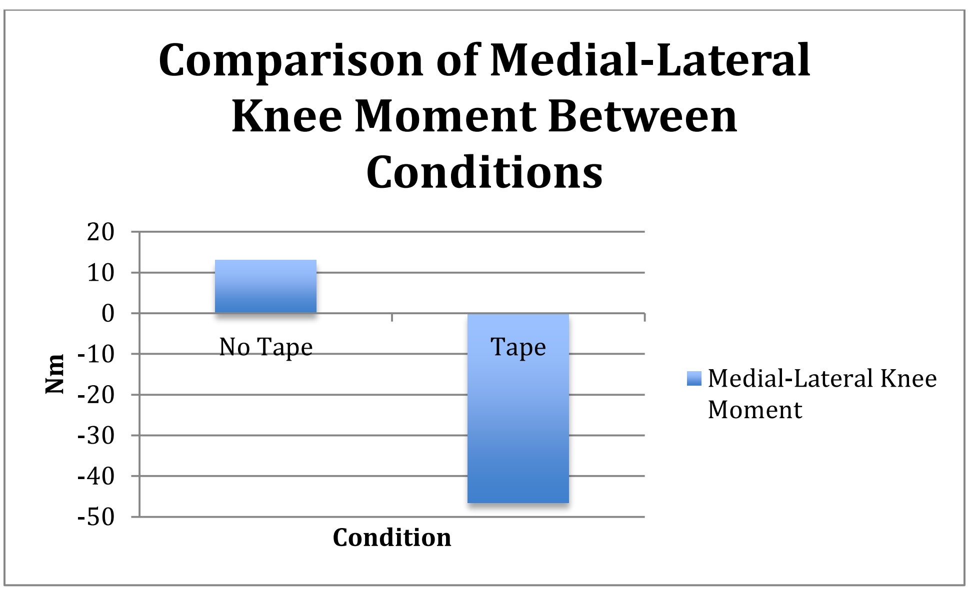

Figure 3. Comparison in medial-lateral knee moment when taped versus untaped. Results show that there is an increase in valgus moment when the participant was taped.

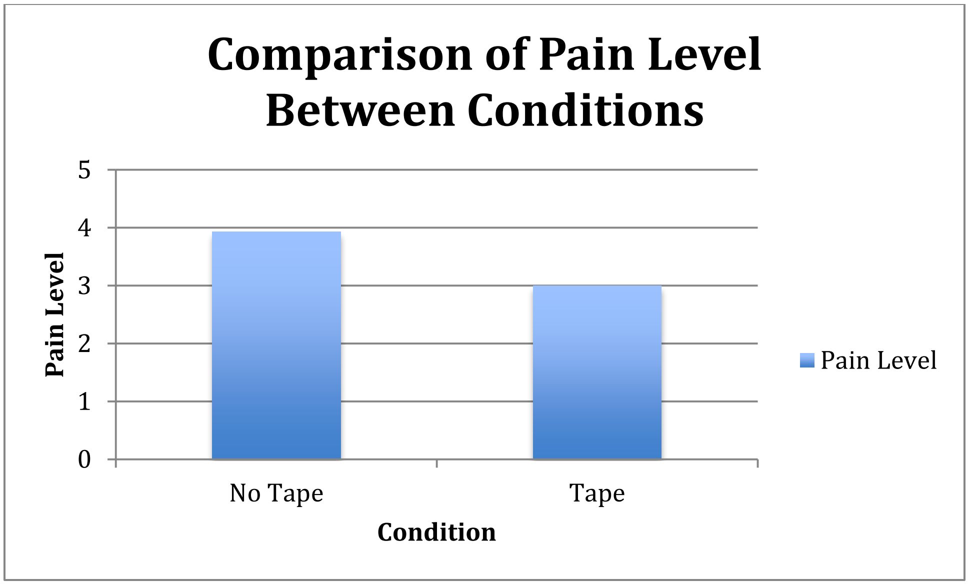

Figure 4. Comparison of pain level when taped versus untaped. Results show that there was a decrease in pain although no statistical significance was shown.

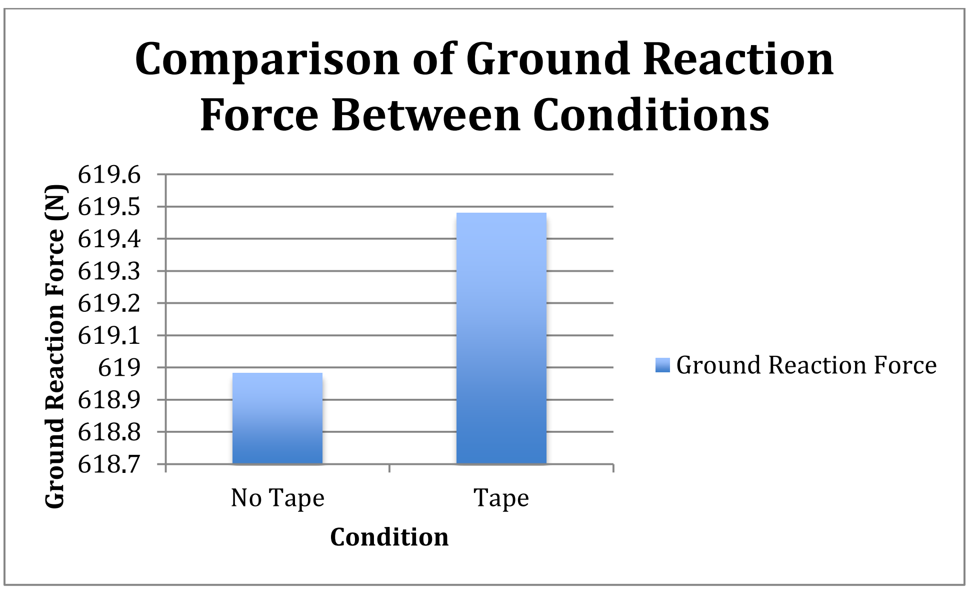

Figure 5. Comparison of ground reaction force when taped versus untaped. Results show that there were no changes between the two conditions.

Chapter 5

Discussion

The aim of this study was to determine if elastic taping could decrease vertical ground reaction forces, increase valgus moment at the tibiofemoral joint, decrease valgus angle at the tibiofemoral joint, and decrease anterior knee pain by applying elastic tape on the hip. The independent variable was the taping condition. The independent variables included: mean vertical GRF, anterior knee pain, frontal plane knee angle, and frontal plane knee moment.

It is well known that weakness of the hip muscles is a contributing factor to valgus collapse at the tibiofemoral joint and thus leads to PFP (Crossley et al, 2011; Hollman et al, 2014). This study set out to find whether applying elastic tape at the hip rather than at the knee would have an effect on the knee. Investigating the first hypothesis that elastic taping will decrease valgus knee angle when compared to a controlled condition found that there was a significant decrease in valgus joint angle. This is in contrast to what Mills, Knight, and Mulligan (2015) found when determining whether Kinesio Tape and compression garments altered lower extremity kinematics during a "functional movement lunge." The authors found that kinesio tape, when applied to the hip and knee, actually increased knee valgus. While the authors found significance with an increase in knee valgus, there are a few flaws to their research. Firstly, the participants had to warm-up 5 minutes on the treadmill followed by 3 rotational lunges. This was followed by a 10-minute bout of running at 70% of their perceived maximal exertion followed by another 3 rotational lunges. Following a pre-determined rest period, the participants followed the same protocol for all of the conditions on the same day. It can be deduced that the participants were fatigued, thus leading to an increase in knee valgus collapse. Secondly, there were only 8 participants who volunteered for the study thus producing a small effect size.

Lee and Yoo (2012) found similar results in the reduction of pain in a case study on the effects of Kinesio Tape on sacroiliac joint dysfunction. The patient presented with chronic low back pain caused by an anterior pelvic inclination of 17.5° and 19° on the right and left sides, respectively. After applying a posterior pelvic tilting tape for 2 weeks every day in 9-hour intervals it was revealed that the patient presented with a decreased anterior pelvic inclination of 11° and 12° on the right and left sides. Similar results were found in a case report of a patient with Scapular Depression Syndrome (Lee & Yoo, 2012). It was found that applying the Scapular Elevation Technique with Kinesio Tape 4 days-per-week, for 8 weeks elevated the coracoids process of the scapula when compared to the initial X-rays. In contrast, the findings of the present study may be the result of the tactile stimulation created with the elastic tape. The tension created by the elastic tape may resist the end position of knee valgus. The perception of this increased tension by the cutaneous mechanoreceptors may cause the normalization of joint position.

Our second hypothesis was that elastic taping would decrease AKP. Although our finding for pain was not significant, there was a decrease in pain during the SLS activity. This is in accordance with Campolo et al (2013) who found no significance while investigating whether there would be a decrease in pain during stair climbing and weighted squat conditions even though it was less. Aytar et al (2011) also found similar results while trying to determine the acute effects of Kinesio Tape. The authors found no significance in the reduction of pain although there was a decrease when using a Visual

Analogue Scale. In contrast, Freedman et al (2014) found that when using elastic tape around the patella there was a significant decrease in AKP in individuals with patellofemoral pain for functional tasks such as stair ascent, stair descent, and the single-leg triple jump test. This can be attributed to the elastic tape stimulating the cutaneous mechanoreceptors. The Gate Control Theory of pain control proposes that Aδ and C fibers are responsible for nociception. In order to decrease the excitability of these nociceptors, Aβ mechanoreceptors must be stimulated to increase afferent feedback to the central nervous system resulting in pain reduction.

Our third hypothesis was supported in that elastic taping would increase valgus moment at the tibiofemoral joint increasing the force needed to decrease valgus angles. Our finding is in contrast with Merino-Marban et al (2012) who found that applying Kinesio Tape to the forearm did not significantly increase strength in a study investigating the acute and 48-hour effects of Kinesio Tape on the strength of wrist flexors muscles. Although their research focused on whether Kinesio Tape could increase strength, they applied the elastic tape in the wrong fashion. To assist with weakened muscles, Kinesio Tape must be applied from origin to insertion at a tension of 15- 20%. Merino-Marban applied the elastic tape from insertion to origin. Even though they decided to randomize which arm they chose for testing it would have been better to test both arms for weakness and use the affected side as both the control and taped condition. Chang et al (2012) also found no significant increase in grip strength when comparing healthy subjects to those with medial epicondylar tendinopathy (MET). Although the authors found no statistical significance in increased strength, the MET group did see an increase in strength.

Our finding is supported by Hyeyoung and Lee (2013) who assessed whether KT applied to the quadriceps and hamstring groups on 8 horse-racing jockeys which had an effect on strength and power during isokinetic dynamometer testing. The results showed at 60° per second there was a significant difference in peak torque for the right extensor, a significant difference in peak torque for the right flexor, a significant difference in the left extensors and the left flexors. At 180° per second statistical significance existed for peak torque in the right flexors, right extensors, left extensors, and left flexors. Lee, Yoo, and Lee (2010) found similar results with an increase in grip strength when Kinesio Tape was applied to the forearm of the dominant hand. Our findings with the increase in force may be explained by the cutaneous fusimotor reflex theory, which states that when the skin is stimulated, in this case with the tape, the muscles below are induced to contract by increasing the intensity and frequency of muscle activity (Hyeyoung & Lee, 2013).

Lastly, our hypothesis that there would be a decrease in mean GRF was not supported. In contrast, Chen et al (2008) found that when Kinesio Tape was applied for patellofemoral pain they a found statistically significant decrease in GRF during stair descent and did not find significance in decreasing GRF during stair ascent. Our study did not differentiate between the concentric and eccentric aspects of the squat.

In conclusion we found that by applying elastic tape to the hip we were able to decrease varus moment at the knee and decrease knee valgus. Although we did decrease pain it was not statistically significant. This shows that applying elastic tape at the source of the pathology and not the source of the pain we are able to decrease valgus collapse. As clinicians it is imperative that we do full static and dynamic analysis when evaluating patients to determine the source of the pathology. This allows us to better treat and be more effective with our treatment options.

Limitations

This study had several limitations. First, the sample size was small. Two participants were lost during the data collection process due to an unrelated injury and failure to complete the study. Increasing the sample size would have increased our effect size and possible found significance with pain. Secondly, data for the taped condition was collected immediately after the application of the tape. The effects of elastic tape supposedly increase the longer the tape is applied.

Suggestions for Future Research

Future research on this subject matter should focus on electromyography of the hips during the SLS to determine whether elastic taping increases bioelectrical activity. If the elastic taping does increase bioelectric activity then we can deduce that it can be a good augment for decreased neuromuscular activation. Secondly, future research should focus on the amortization phase of the SLS. Most of the valgus collapse during the squat occurs in this transition period between the eccentric and concentric phase. Lastly, future research should determine whether elastic taping can augment traditional rehab versus rehab alone and elastic taping alone.

Clinical Application

The investigation shows that under a controlled setting such as in a rehabilitation clinic, elastic tape may be a good augment to traditional treatment of AKP consisting of exercise and pain control modalities. Although we taped the hip we found that pain decreased at the knee. We believe that elastic tape, if applied at the site of pain, would be more beneficial to decrease pain as explained by the Gate Control Theory of pain control and the Fusimotor Reflex Theory. We believe these results would not carry over to the athletic setting as movement patterns are more explosive and randomized.

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Appendices

Appendix A

Consent Form

Barry University
Informed Consent Form

Your participation in a research project is requested. The title of the study is The Effects of Elastic Taping on Knee Kinematics and Kinetics When Applied on the Hip. The research is being conducted by Aliks Lorie ATC, LAT, CSCS, a student in the Biomechanics department at Barry University, and is seeking information that will be useful in the field of Athletic Training. The aims of the research is to determine if elastic taping can decrease vertical ground reaction forces, decrease valgus torque at the tibiofemoral joint, decrease adduction torque at the femoralacetabular joint, and decrease pain by applying elastic tape on the hip. In accordance with these aims, the following procedures will be used: You will be performing both the control and taping conditions. Each testing day will be separated by approximately 7 days. Upon arrival you will be allotted a 10-minute warm-up on a stationary bicycle on their own. Following the warm-up you are going to be provided with standard instructions on how to complete the single-leg squat task. You will be barefoot to eliminate any contributing factors associated with footwear and will be asked to stand on one leg on an in-ground force plate. You will be instructed to fold their arms across your chest and to squat down to an angle of 45°, 5 times consecutively, in a slow, controlled manner maintaining your balance, at approximately 1 squat per 2 seconds. A single investigator will demonstrate the single-leg squat procedure. You will be allowed up to 3 practice attempts to familiarize yourself with the task at hand. If you lose balance or place the non-stance leg on the floor then that trial will be considered "failed" and reattempted immediately. Following this, the contralateral leg will be tested in the same manner following the same protocol. We anticipate the number of participants to be 50.

If you decide to participate in this research, you will be asked to do the following: Approximate time for your participation is 60 minutes. You will arrive 15 minutes before your scheduled testing time. Upon arrival, you will fill out a screening questionnaire. Upon completion of the questionnaire, if applicable, you will *(Include an estimation of the time which will be required to complete the research procedures).*

Your consent to be a research participant is strictly voluntary and should you decline to participate or should you choose to drop out at any time during the study, there will be no adverse effects on your social status.

The risks of involvement in this study are minimal and include a possible increase in discomfort. The following procedures will be used to minimize these risks: Instruction of the correct technique of the single leg squat. The benefits to you for participating in this study may include a decrease in pain when the elastic tape is applied.

As a research participant, information you provide will be held in confidence to the extent permitted by law. Any published results of the research will refer to group averages only and no names will be used in the study. Data will be kept in a locked file in the researcher's office. Your signed consent form will be kept separate from the data. All data will be destroyed after 7 years.

If you have any questions or concerns regarding the study or your participation in the study, you may contact me, Aliks Lorie ATC, LAT, CSCS, at (305) 899-3572, my supervisor, Dr. Sue Shapiro, at (305) 899-3574, or the Institutional Review Board point of contact, Barbara Cook, at (305)899-3020. If you are satisfied with the information provided and are willing to participate in this research, please signify your consent by signing this consent form.

Voluntary Consent

I acknowledge that I have been informed of the nature and purposes of this experiment by Aliks Lorie ATC, LAT, CSCS and that I have read and understand the information presented above, and that I have received a copy of this form for my records. I give my voluntary consent to participate in this experiment.

_____________________ __________
Signature of Participant *Date*

______________________ __________ ________________ _________
Researcher *Date* *Witness* *Date*

Appendix B

Sign Up Sheet

Sign Up Sheet
Aliks' Study

Date	Name	Phone Number
Feb 20		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Feb 23		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Feb 24		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Feb 25		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Feb 26		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Feb 27		
8:00 am		
9:00 am		
10:00 am		
11:00 am		
Mar 2		
8:00 am		
9:00 am		
10:00 am		
11:00 am		

Mar 3
8:00 am
9:00 am
10:00 am
11:00 am

Mar 4
8:00 am
9:00 am
10:00 am
11:00 am

Mar 5
8:00 am
9:00 am
10:00 am
11:00 am

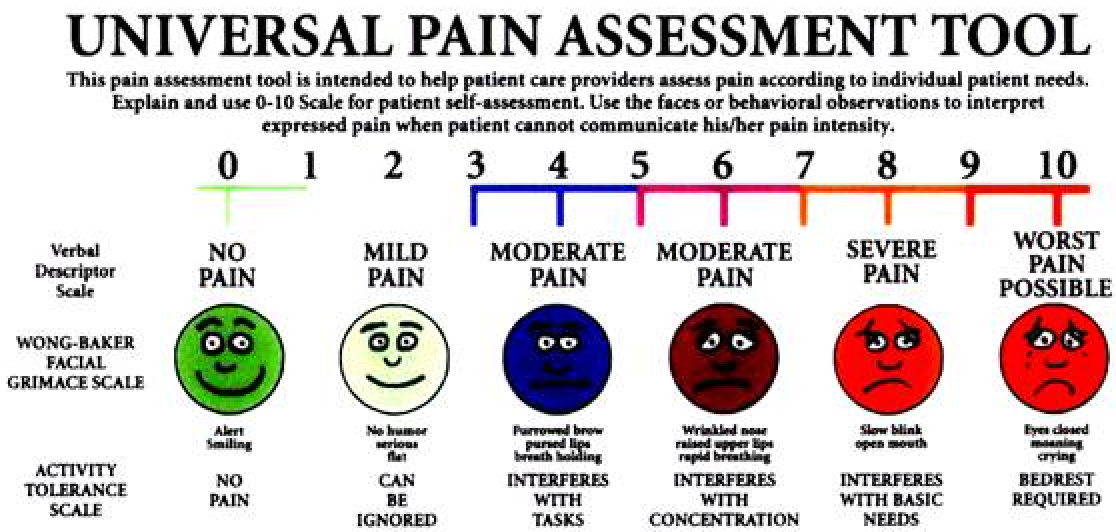
Mar 6
8:00 am
9:00 am
10:00 am
11:00 am

Appendix C

Pre-Participation Screening Questionnaire

Participant No. ____________
Date: _________

1. Do you have knee pain?
2. How long have you experienced knee pain?
3. Rate your pain:

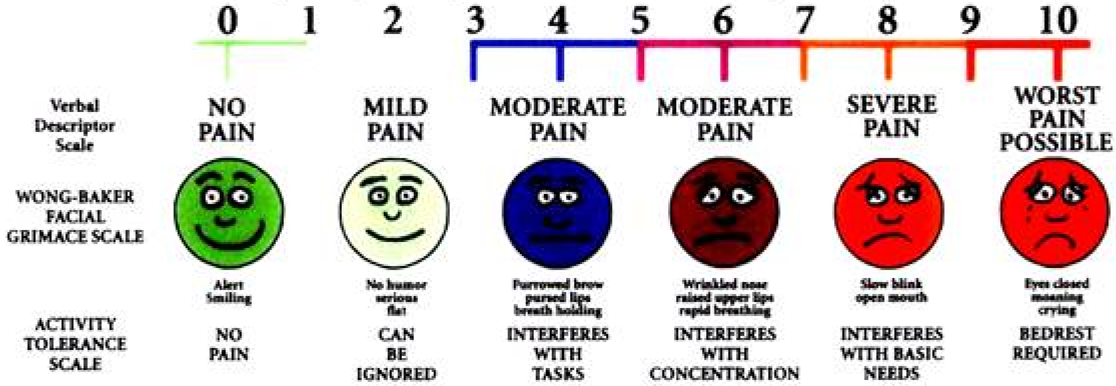


4. Have you had knee or hip surgery within the last 6 months?
5. Have you ever worn elastic tape (Kinesio Tape, Rock Tape, etc.)?
6. Are you currently on a rehabilitation program for your hip and/or knee?

Appendix D
Post-Participation Pain Assessment

UNIVERSAL PAIN ASSESSMENT TOOL

This pain assessment tool is intended to help patient care providers assess pain according to individual patient needs. Explain and use 0-10 Scale for patient self-assessment. Use the faces or behavioral observations to interpret expressed pain when patient cannot communicate his/her pain intensity.



Appendix E
Recruitment Flyer

DO YOU SUFFER FROM KNEE PAIN?

SHHHHHHHHH AHHHHHHHHHH

YOU MAY BE ELIGIBLE TO PARTICIPATE IN A RESEARCH STUDY IF YOU:

- Have Anterior Knee Pain?
- Can meet on 2 separate occasions for maximum of an hour each at the Biomechanics Lab in HPLS 139?
- Can Perform a Single Leg Squat?
- Have **NEVER** used a Kinesiology tape before including but not limited to:
  - Rock Tape, KT Tape, Spider Tech tape

Contact ALIKS LORIE at ALORIE@BARRY.EDU