The Therapeutic Effects Of Kinesio™ Tape On A Grade I Lateral Ankle Sprain

Carrie Rayette Hendrick

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In

Curriculum and Instruction

Dr. Richard Stratton, Chair

Dr. Kerry Redican

Dr. Billie Lepczyk

Dr. Andrew Rudins

December 6, 2010

Blacksburg, VA

The Therapeutic Effects OF Kinesio™ Tape On A Grade I Lateral Ankle Sprain?

Carrie Rayette Hendrick

ABSTRACT

Ankle taping and bracing are important components in the world of sports medicine and athletic training. There are different types of tape that are used for athletes by athletic trainers. However, little research has compared the performance of Kinesio™ Tape and an ASO ankle brace on a lateral grade I ankle sprain. The purpose of this study was to determine if there are therapeutic effects of Kinesio™ tape on a grade I lateral ankle sprain, using an ASO as the control group. The gold standard protocol for a grade I lateral ankle sprain is an ASO ankle brace.

Twenty five students from 9 different high schools in 2 sister counties participated in the study. These students were all athletes, who suffered a grade I lateral ankle sprain. Twelve student-athletes were in the Kinesio™ tape group and thirteen of the student-athletes were in the ASO brace group, also known as the control group. The student-athletes completed five functional tests; Single Leg Stance, Single Leg Squat, Single leg Hop, Box Drill , and the Illinois Test, at each of the three sessions 0, 4, and 8 weeks.

Results found there was no significant difference between the Kinesio™ tape group and the ASO™ ankle brace group when it came to pain level, single leg hop for distance, the box drill or the Illinois test, when tested at three different times; week 0, week 4, and week 8. However, results showed that there was a significant difference between the two groups on the single leg squat test. It was determined that the control group also known as the ASO™ ankle brace group, were able to perform more squats at week 4 and week 8, than the treatment groups also known as the Kinesio™ Tape group.

DEDICATION

I dedicate my dissertation to my family. My mom Rayette, she has always pushed me to be the best even as a child. My dad Kevin, a man of few words, it is his love that has kept me going. My brother John-Mark, he has been amazing, and has kept me grounded. I would also like to thank my Mamma "G" and my late Grandma Dora. The two strongest women that will ever touch my life!! I love you!

I don't care how poor a man is; if he has family, he's rich.

~ M.A.S.H.

ACKNOWLEDGMENTS

I would like to thank my committee members for their time and expertise to better my work. Dr. Redican and Dr. Lepczyk thank you for serving on my committee and for all of your input throughout this journey. I would like to thank Dr. Stratton for persevering with me as my advisor throughout the time it took me to complete this research and write the dissertation. To Dr. Rudins, I thank him for his contribution and good-natured support.

I am grateful for the support from the Pressley family, Sonia, Ken, Mckenzie, and especially Kaleb. Thank you for dealing with my varied "stress levels". Kaleb, I would not have made it this far without you!

My thanks must also go out to Crystal Shirk for her research assistance and patience. She consistently helped me keep perspective on what is important in life and showed me how to deal with reality.

I would like to thank all of the student-athletes who participated in the study. Lastly, I would like to thank all of the athletic trainers at Southeastern Sports Medicine for their support and confidence in me that I would finish!

TABLE OF CONTENTS

Chapter 1

Introduction

Injuries to lateral ligaments of the ankle complex are among the most common injuries incurred by athletes, over 23,000 a year (Hertel 2002). It is estimated that out of that 23,000, 55% do not seek medical treatment. The ligaments that are compromised during a lateral ankle sprain include the anterior talofibular ligament and the calcaneofibular ligament. In order to have a lateral ankle sprain the primary mechanism of injury must be inversion. Inversion is described as a motion of the foot so as to turn the sole of the foot inward (Bernier 2002). There are 3 grades that are used to determine a lateral ankle sprain. Grade I consists of stretching or slightly tearing of the ligament with mild tenderness, swelling and stiffness (Bernier 2002). The ankle feels stable, and it is usually possible to walk with minimal pain. Grade II is a larger but incomplete tear with moderate pain, swelling, and bruising (Bernier 2002). The ankle sometimes feels stable, but the damaged areas are tender to touch and walking is painful. Grade III is complete tear of the affected ligament or ligaments with severe swelling and bruising (Bernier 2002). The ankle is unstable and may feel "wobbly". Walking is usually not possible, because the ankle gives out and there is intense pain although initial pain may quickly subside.

Ankle sprains are also classified as an acute ankle sprain or a chronic ankle sprain. An acute ankle sprain refers to brief exposure, sudden, of short duration. This can be better described as short-term ankle injury. One who is playing basketball and suffers a first time ankle sprain. Chronic ankle sprains are described as gradual onset, an injury with long duration. For instance someone who suffers ankle sprains often is described in the medical field as having chronic ankle instability.

In recent history, ankle taping has been the principal means of preventing ankle sprains in sport (Robbins 1995). Despite the fact that ankle bracing is growing in popularity, anecdotal evidence suggests that ankle taping with white athletic tape is still very popular among athletes, athletic trainers, and physicians. For those ankle injuries that are evaluated and are determined to need treatment, there are multiple options to choose from. Studies compare the use of ace bandages; debate the use of cryotherapy, rehabilitation options, and bracing versus taping. When one in the athletic world mentions tape they think of white tape, but now athletic trainers options have expanded. Not only do they have white tape to work with, but they also have Kinesio™ tape.

There are a few differences between the two different types of tape. White athletic tape is primarily used for prevention of ankle injuries. There is limited wear time with this tape.

In most cases white athletic tape only lasts the length of a practice or a game. With this tape an athletic trainer also applies skin adherent and pre-wrap prior to applying the tape. There is no stretching in white athletic tape. It is a firm tape that a person can tear with the appropriate force. Most importantly white athletic tape is used to limit or assist range of motion. Kinesio™ tape on the other hand is primarily used for rehabilitation. It has a wear time of 3-5 days depending on the activity and the purpose. This tape includes tape only; the only prep that is used is an alcohol wipe in case the patient or athlete has lotion on the skin. Kinesio™ Tape unlike white athletic tape is applied with the intent of the tape working with body to allow normal range of motion. Kinesio™ Tape is a stretchy tape. This tape has paper on the back that must be removed prior to application. This tape is applied with specific tensions. Depending on the area being taped and the purpose of the tape determines the tension of the tape during application.

Kinesio™ Tape can be applied using four different cuts; X, Y, I and Fan. These all describe the type of cut you perform with the scissors. The choice of cut depends on the practitioner's goals and purpose of the tape. Generally the tape is applied to stretch tissue, with appropriate tension added to the tape. The tension percentage guidelines are as follows: Paper off (this means as soon as you remove the paper off the back of the tape) 10-15%, Light 15-25%, Moderate 25-50%, Severe 50-75%, and Full 75-100%. It is important to note that a practitioner will almost never use the Full application. Once you decide the tension of the tape the next goal is to decide whether to facilitate or inhibit the target area. Facilitation is defined as enhancement or reinforcement (Bernier 2002). To facilitate the area it is important to tape proximal to distal or origin to insertion. To inhibit the target area is to curb or restrain (Bernier 2002). In order to inhibit the area one must tape distal or proximal or insertion to origin.

Few studies have been done on the use of Kinesio™ Tape in response to an ankle sprain. Kinesio™ Tape was invented in 1973 by Dr. Kenzo Kase in Japan. 85% of applications are non-athletic. Studies on Kinesio™ tape have found that it can add muscle tone in the vastus medialis muscle (Hertel 2002), decrease pain and increase functional activity in various limbs after injury, decrease lymph and swelling such as that of breast cancer. Keri Walsh, Olympic Beach Volleyball player, wore Kinesio™ Tape on her shoulder to help assist the shoulder muscles that were deemed unstable by her orthopedic surgeon. When it comes to professional athletes the most common treatment area for Kinesio™ Tape is the shoulder. It is important to research the effects on other areas as well.

Current treatments of a lateral ankle sprain generally start with a regimen of cryotherapy, ace bandaging, elevation, and rest from activity. It is generally followed closely and in conjunction with therapeutic exercises. A return to play protocol is then activated as the

athlete becomes more comfortable with the activity. Throughout this typical protocol, very often some swelling remains as well as instability. Perhaps an added protocol utilizing Kinesio™ tape, with the benefits it has shown on other injuries, will bring this lingering instability and swelling out at a quicker pace.

Knowing this information, is there a difference between Kinesio™ Tape when used as a therapy from a grade I ankle sprain and an ASO™ ankle brace? Can it exume the post-injury lymph and swelling at a faster rate? As Kinesio™ Tape is becoming more popular, it is important to evaluate its clinical and therapeutic effects on different injuries to allow appropriate use.

The purpose of this study was to determine how the use of Kinesio™ Tape will affect the therapeutic recovery from a Grade I lateral ankle sprain. The specific research questions are: (a) Is there a difference between Kinesio™ Tape and an ASO™ ankle brace when used as therapy with an acute ankle sprain? (b) At the completion of the rehabilitation sessions involving the functional testing did the study group feel that the Kinesio™ Tape helped their progression in anyway? (c) Can it exume the post-injury lymph and swelling at a faster rate?

Definition of Terms

The purpose of this section is to clarify significant terms used in this study. The following is a list of such terms and their definitions.

1. *Assessment* refers to appraisal, evaluation, or measurement, particularly by objective means (Steadman).

2. *Lateral* refers to being on the side, farther from the median or midsagittal plane of the body. In this study it refers to the outside of the ankle (Steadman).

3. *Acute* refers to treatment or exposure, brief, intense, short-term. It is often used to describe an injury that will not take long to heal (Steadman).

4. *Functional Testing* refers to assessment of an individual's ability to move a body part actively, against resistance, and in a specific movement pattern (Steadman).

5. *Edema* refers to an accumulation of an excessive amount of watery fluid in cells, tissues, or serous cavities. This term is defining the swelling that the subjects have after suffering a Grade I lateral ankle sprain in this study (Steadman).

6. *Sprain* refers to an injury to a ligament when the joint is carried through a range of motion greater than normal, but without dislocation or fracture (Steadman).

7. *Chronic* refers to a health-related state, lasting a long time. The United States National Center for Health Statistics defines a chronic condition as one of three month's duration or longer (Steadman).

8. *Laxity* refers to looseness or freedom of movement in a joint (Steadman).

9. *Subjective* refers to symptoms that are perceived by the individual only and not evident to the examiner; pain (Steadman).

10. *Instability* refers to the abnormal tendency of a joint to subluxate or dislocate with normal activities and stresses (Steadman).

In general many athletes who sprain their ankles once go on to have chronic instability. It is important to evaluate if the use of Kinesio™ Tape in therapy after an initial acute ankle sprain would decrease the chances of chronic instability to let clinicians know if there is a better option available.

CHAPTER 2

Review of Literature

It has been estimated that 55% of individuals suffering ankle sprains do not seek treatment from a health care professional. Specifically, more than 23,000 ankle sprains are estimated to occur each day in the United States. This action results in frequent recurrence of ankle sprains and furthermore may result in chronic ankle instability. Chronic ankle instability is defined as the development of repetitive ankle sprains and persistent symptoms after injury. Studies have shown that despite rehabilitation and treatment, some people have objective mechanical laxity and subjective instability up to 1 year after an initial ankle sprain (Hubbard 2008). To prevent recurrent sprains due to this laxity, there are several options that can be utilized for stabilization.

Ankle Instability

In sports medicine there are a variety of methods used when dealing with ankle sprains and ankle instability. Once one has examined the ankle and determined the target area, the specific stabilization protocol can be implemented. The most important part of ankle support is the shoe. This is with or without a history of ankle instability. Without the proper equipment, ones chances of having an ankle injury are increased. For more than a century, ankle taping has been advocated as a means to protect the ankle ligaments from excessive strain. This option is very common due to low cost per use, but requires the presence of someone with a skill to tape. A one time expense for an ankle brace has been found to be a better option for some, especially for those who do not have taping as an option. Once the athletic trainer learns and masters the fundamentals of taping an ankle, they often customize it to theirs and the athlete's needs. It is important to note that as long as they have the appropriate steps, it does not matter what order they perform them in. Each athletic trainer is different. The purpose of the tape is to prevent the mechanism that caused the injury, also known most commonly as inversion or eversion, that must be stabilized due to being stretched during injury. The next option is an ankle brace. There are many different types of braces out there made by many different companies, all of which depend on a person's comfort as well as the target area of support. In sports medicine one is put into an ankle brace for return to play activities. This can be combined with ankle taping or by itself. In sports such as soccer and football, one may choose to tape and brace the ankle when returning to play for extra support. Once a person has suffered an ankle injury, it is important for them to continue to support the ankle for an extended period of time.

When it comes to testing and preventing ankle instability, it is important to understand fully the anatomy, pathomechanics, and pathophysiology of the ankle. The ankle complex comprises three articulations: the talocrural joint, the subtalar joint, and the distal tibiofibular syndesmosis (Hertel 2002). Among the articulations mentioned this study will discuss in depth the talocrural joint. Lateral ankle sprains are among the most common injuries incurred during sports participation (Hertel 2002). Lateral ankle instability refers to the existence of an unstable ankle due to lateral ligamentous damage caused by excessive supination or inversion of the rearfoot (Hertel 2002). In other words, excessive inversion and internal rotation of the rearfoot, coupled with external rotation of the lower leg, results in strain to the lateral ankle ligaments. The ligaments that are damaged during a lateral ankle sprain are: the anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament (Hertel 2002). There is little to no research that reports predisposition to first-time ankle sprains. After an acute injury, the ankle will typically become swollen, tender, and painful with movement and full weight bearing. Depending on the severity, function usually returns over the course of a few days to a few months.

Ankle Taping

For more than a century, ankle taping has been advocated as a means to protect the ankle ligaments from excessive strain. The skillful application of adhesive tape to the ankle of athletes remains strongly associated with the role of the athletic trainer today (Wilkerson 2002). In 2002, Wilkerson studied the Biomechanical and Neuromuscular effects of ankle taping and bracing. Through research he found that both types of ankle support provide beneficial protective effects. In addition, during the acute phase of ankle-sprain management, bracing offers advantages related to ease of repetitive removal of application, adjustability of strap or lace tension, and structural features that may facilitate edema resolution (Wilkerson 2002). Wilkerson concluded that future research on the effectiveness of various braced and taping procedures should use methods that assess rotary displacements of both the foot and lower leg within the transverse plane.

Cordova *et al* (2002) provided a comprehensive review of literature regarding the role of external ankle support on joint kinematics, joint kinetics, sensorimotor function, and functional performance. For the purpose of this article the authors used a meta-analysis approach to evaluate ankle-support effects on foot and foot range of motion before and after exercise. They evaluated 253 effects from 19 studies published between 1966 and 1997 (Cordova 2002). They used standardized effect size to establish the overall restrictive effect of each treatment condition (tape, lace-up braces, and semirigid braces) compared to the control condition with each study. The average range of motion restriction in degrees compared with the control

condition was calculated from the standardized effect sizes. Cordova came up with the following conclusions to be considered as a consensus regarding the effects of external ankle support on ankle-foot range of motion:

- Before exercise, semirigid braces restricted inversion ROM 21.3% more than tape and 26.2% more than lace-up braces.
- After exercise, semirigid braces restricted inversion ROM 72.1% more than tape and 59.5% more than lace-up braces.
- No significant difference existed in inversion ROM restriction between the tape and lace-up brace conditions before (15.9^{o} and 14.9^{o}, respectively) or after exercise (7.3^{o} and 10.6^{o}, respectively).
- Semirigid braces provided greater eversion ROM restraint compared with the tape and lace-up brace conditions before (19.8^{o} semirigid, 9.5^{o} tape, 14.4^{o} lace-up).
- Lace-up braces provided greater overall eversion ROM restriction (9.8^{o}) than tape (7.2^{o}).
- Dorsiflexion ROM was restricted 38.3% more with taping than with a lace-up brace.
- No significant difference existed between tape (9.1^{o}) and lace-up style braces (9.7^{o}) on overall plantar flexion ROM restriction.

Cordova concluded that the effects of ankle support on joint kinematics during static joint assessment and on traditional functional-performance measures (ie, agility, sprint speed, vertical jump height) are well understood, however, the potential effects of ankle support on joint kinetics, joint kinematics during dynamic activity (eg, a cutting maneuver), and various sensorimotor measures are not well known.

Role of Ankle Bracing

In the study done by Olmstead *et al* (2004), the researchers were comparing prophylactic ankle taping to prophylactic ankle bracing. They used previous studies that had been done between 1966 and 2002. They used key words to search for articles and they had excluded articles that did not address the effect of ankle taping or bracing on injury rates using an experimental design. They found that both ankle taping and bracing appear to be more

beneficial in preventing ankle sprains in athletes with a history of ankle sprains. This study dealt more with preventative ankle taping and bracing versus taping an ankle post sprain.

When it comes to taping an ankle with the common athletic tape, there are many steps that are involved: Heel and lace pads, Tufskin™, prewrap, and then tape. Older philosophies in this method lead to putting tape directly on the skin; they feel that this method allows the most support for the athlete. Now most athletic trainers use the preceding method to tape an ankle. Manfroy *et al* (1997) decided to test both theories in their study published in the American Journal of Sports Medicine. They used 10 healthy men and 10 healthy women to test their null hypothesis that maximal active and passive resistance to inversion developed by a near-maximally inverted and weight bearing ankle is not altered by 1) the use of prophylactic adhesive athletic tape, 2) the use of non-adhesive prewrap, or 3) 40 minutes of vigorous exercise. Half the testing sessions were performed with prewrap under the tape. Tests were also performed with and without athletic tape. The researchers also used the unipedal under weight bearing conditions to determine maximal ankle resistance to inversion. They found that although the use of ankle tape provided a 10% increase in maximal resistance to inversion, this increased diminished to insignificant levels after 40 minutes of vigorous exercise. The use of prewrap improved maximal resistance to inversion more than 10%.

Another study done by Hubbard *et al* (2009) measured the effects of ankle taping on mechanical instability in those with chronic ankle instability (CAI). This study only used that of the white athletic tape. The purpose of this study was to measure the effect of ankle tape on laxity in those with and without chronic ankle instability. The study used twenty subjects, 7 males and 13 females with unilateral CAI, and twenty healthy subjects. Both ankles were tested under two different conditions: 1) before the application of the tape and 2) immediately after 15 minutes of exercise with the tape still present on the ankle. Mechanical joint instability was measured with an instrumented ankle arthrometer (Hubbard 2009). The arthrometer measured the ankle joint motion for anterior/posterior translation and inversion/eversion angular displacement. For each dependent variable a two (group) x two (time) repeated measures ANOVA analysis was performed (Hubbard 2009). In conclusion, the study found mechanical laxity to significantly decrease in those with CAI after tape application. Specifically, tape application decreased posterior displacement, inversion and eversion rotation only in the CAI group (Hubbard 2009). Although there was still a significant difference in mechanical laxity between the involved ankle vs. the uninvolved ankle of the CAI group, and the matched healthy group, laxity did decrease in the CAI ankle after the application of tape. This suggests part of the benefit of ankle taping with regard to prevention of reinjury, may be due to decreased mechanical laxity at the ankle joint (Hubbard 2009).

All of the above studies dealt with taping as a form of rehabilitation and treatment. Shaw *et al* (2008) conducted a study to determine the type of ankle brace that may be more effective at providing dynamic stability after a jump-landing task during normal and fatigued conditions. The most common mechanism for an ankle injury in jumping sports is landing, which accounts for 58% of basketball injuries and 63% of volleyball injuries (Shaw 2008). In this study not only are they dealing with bracing and fatigue but also time to stabilization. Time to stabilization (TTS) is a measure of neuromuscular control that uses force plate measures to evaluate dynamic postural stability during jump landing (Shaw 2008). The participants completed three testing sessions applying a different bracing condition at each session. To quantify TTS, participants completed a single-leg landing from a height equal to 50% of his or her maximal jumping height and gained stability on this limb as quickly as possible (Shaw 2008). After determining the testing limb and their vertical, the functional fatigue protocol was explained. The functional fatigue protocol comprised of three stations: Modified Southeast Missouri (SEMO) agility drill, stationary lunges, and quick jumps. The findings indicated that without fatigue, the use of prophylactic ankle braces did not improve dynamic stability among the group being tested. It is important to note that a limitation to this study is that they only tested the dominant foot on each of the participants.

What happens when you have functional ankle instability? Hubbard *et al* (2002) answered just that. The objective of their study was to determine whether subjects with functional ankle instability suffered kinesthetic deficits in the injured ankle compared with the healthy ankle and to examine the effect of prophylactic ankle bracing on kinesthesia in uninjured and functionally unstable ankles (Hubbard 2002). The researchers obtain kinesthetic threshold-to-detection of passive range of motion measurements during passive inversion and eversion under four different bracing or taping conditions (unbraced, Swede-O Ankle Lok, Aircast Air-Stirrup, and tape). In conclusion threshold-to-detection of passive range of motion scores did not differ in uninjured ankles and those with functional instability; however, bracing with either the Ankle Lok or Air-Stirrup decreased the ability to detect passive motion when compared with the no-tape (unbraced) condition. The researchers also noted that further research is needed to determine the exact contributions of taping and bracing on ankle joint kinesthesia (Hubbard 2002).

Kinesio™ Tape

As discussed previously, ankle taping and bracing are among the most common interventions associated with athletic trainers. Yet very few authors have examined the effectiveness of the Kinesio™ Tape that just in recent years has surfaced in the United States. Kinesio™ Tape was invented in 1973, in Japan by Dr. Kenzo Kase, D. C. With the many different

applications for Kinesio™ Tape, no one research article is alike in the following review of literature. It is important to mention that throughout this article only the Kinesio™ Tape that was invented by Dr. Kenzo Kase will be discussed. There are many different products which are considered "knock off" brands. We will be testing the actual Kinesio™ Tape. Conditions that have been studied previously with Kinesio™ Tape range from brain injuries to ankle proprioception, which recognizes that there are many different purposes of Kinesio™ Tape. According to Dr. Kenzo Kase, the tape and taping method (1) corrects muscle function by strengthening weakened muscles, (2) improves circulation of blood and lymph by eliminating tissue fluid or bleeding beneath the skin by moving the muscle, (3) decreases pain through neurological suppression, (4) repositions subluxated joints by relieving abnormal muscle tension, helping to return function of fascia and muscle and (5) increases proprioception through increased stimulation to skin mechanoreceptors.

Muscle Function

Due to the fact that Kinesio™ Tape is fairly new to the world of sports, there has been little research done on the principle of Kinesio™ tape. Of all the purposes of Kinesio™ Tape, the most popular use would be in orthopedics and sports medicine. In 2007 a group of researchers in Europe published a study aimed at modern competitive sports as well as professional sports. Zajt-Kwiatkowska *et al* (2007), used the treatment method of the Kinesio™ Tape application to the upper and lower limbs as well as strains of the motor system. The study also specified that the researchers used the method suggested by Dr. Kenzo Kase. This study was a broad study in which many different applications of Kinesio™ Tape involved; treatment for an ankle sprain, epicondylagia of brachial biceps muscle, inflammatory condition of long head of brachial biceps muscle, syndrome tightness of the tibial front and lateral fascial compartment, and inflammation of the plantar aponeurosis. The clinical results showed that all injured persons pain decreased and visible edema resorption occurred. This study concluded that the Kinesio™ tape: (1) reduces the levels of pain suffered, (2) Increases the functional capabilities of the patient, (3) constitutes a good method supplementing a regular physiotherapeutic treatment.

Fu *et al* (2008) research involved examining the possible immediate and delayed effects of Kinesio™ taping on muscle strength in the quadriceps and hamstrings when taping is applied to the anterior thigh of healthy young athletes. This study only used fourteen healthy young athletes, seven males and seven females. The muscle strength was assessed by the isokinetic dynamometer under three conditions: (1) without tape; (2) immediately after taping; (3) 12 hours after taping. The results revealed no significant difference in muscle power among the three conditions. In conclusion, Kinesio™ taping the anterior thigh neither decreased nor increased muscle strength in the healthy young athletes that were tested. The researchers

used an isokinetic dynamometer to measure the muscle strength. The sampling population included the same number of females as there were males. The research design was a pre-test post-test design. As far as the sampling population and the testing procedure and outcome, the females and males had the same results. There is a known fact that when discussing muscle strength and comparing females in males most of the time the males are stronger in the lower extremity that females. This research did not mention the inclusion and exclusion criteria.

With rehabilitation of the muscles Kinesio™ Tape has also been known to modulate some physiological processes as well. In the study done by Slupik *et al*, the purpose was to determine the effect of Kinesio™ taping on changes in the tone of the vastus medialis muscle during isometric contractions. The Kinesio™ Tape was placed on the medical head of the quadriceps muscle and a transdermal EMG was used to test the bioelectrical activity of the muscle. It was noted that a standardized protocol was employed for the measurement of the muscle tone, which was recorded as the peak torque of the muscle. The sampling population included 27 healthy people. An examination was performed 24 hours after the placement of the Kinesio™ Tape which revealed significantly increased recruitment of the muscles motor units, as measure by peak torque. A second examination was performed 72 hours after the Kinesio™ Tape was applied and it showed statistically significant increases in bioelectrical activity of the muscle. The research stated that this was lower than the effect after 24 hours. When dealing with the group where the tape was removed after 24 hours, high torque was still maintained. From this research the researchers were able to come up with three conclusions: (1) Clinically significant effects of Kinesio™ taping in this study included an increase in the bioelectrical activity of the muscle after 24 hours of Kinesio™ taping and the maintenance of this effect for another 48 hours following removal of the tape. (2) The decrease in muscle tone to the baseline value, which was observed during the fourth day of Kinesio™ taping use, may have resulted from the time of effective use of the KT tape being shorter than previously believed and may restrict Kinesio™ taping use. (3) Kinesio™ taping used shortly before the motor activity it is supposed to support may fail to fulfill its function. This was a well thought out study, but it still left the reader with questions. The researchers did not go into detail on the protocol they used to test the muscle torque. They also never stated the age range of the sampling population. In this case there were 27 healthy persons, which mean the age range could be from 5 to 100. I think that this is an important factor in the results especially when measuring the bioelectrical activity of a muscle. It when doing this you would want everyone to be in the same age range due to the fact that the development of the muscle could also differ in results.

The effects of Kinesio™ Tape use in subjects with functional ankle instability (FAI) during functional task up until this point has been uninvestigated. Motte *et al* (2009) decided to do

just that. The objective was to determine if lower extremity kinematics differed in FAI subjects using Kinesio™ Tape during maximal reach on the Star Excursion Balance Test (SEBT). The test used twenty subjects with FAI and twenty uninjured subjects. The subjects with FAI were defined as repeated episodes of ankle "give way", and/or ankle "rolling over", regardless of neuromuscular deficits or pathologic laxity. The subjects also had to score a 26 or lower on the Cumberland Ankle Instability Tool to be considered for the study. SEBT reaches included the anteromedial, medial, and posteromedial directions. The researchers used the ANOVA method to analyze the effects of group, tape, tape method, and reach direction. In conclusion, FAI subjects used hip abduction while control subjects used hip abduction at maximal posteromedial reach (Motte, 2009). FAI subjects' hip abduction was significantly less with the Kinesio™ Tape/Kinesio™ condition, and closer to the hip adduction angles of control subjects (Motte, 2009). These results indicate that the use of Kinesio™ Tape at a distal joint can alter proximal joint movement in subjects with FAI (Motte, 2009).

Blood and Lymph Application

The second purpose of the Kinesio™ Tape according to Dr. Kenzo Kase, the creator of Kinesio™ Tape involves improving circulation of blood and lymph by eliminating tissue fluid or bleeding beneath the skin by moving the muscle. One good example of this technique was used by Tsai *et al* (2009), in their study "Could Kinesio™ Tape Replace the Bandage in Decongestive Lymphatic Therapy for Breast-Cancer-Related Lymphedema? This was a pilot study using forty-one patients who had unilateral breast-cancer-related lymphedema for at least 3 months. The subjects were randomly grouped into the DLY group (bandage group) or the modified DLT group (Kinesio™ Tape). The purpose of the study was to compare the treatment and retention effects between standard decongestive lymphatic therapy (DLT) combined with pneumatic compression (PC) and modified (DLT), in which the use of a short-stretch bandage is replaced with the use of Kinesio™ Tape combined with PC. The test involved 30 minutes of lymphatic drainage, one hour pneumatic compression therapy, application of Kinesio™ Tape for each group, and a 20 minute physical therapy exercise. These steps were given the same for every treatment session. Patient evaluation items included physical therapy assessment, limb size, and water composition of the upper extremity, lymphedema-related symptoms, quality of life, and patients' acceptance of the Kinesio™ Tape. The results showed that there was no significant difference between groups in all outcomes. Excess limb size and excess water composition were reduced significantly in the bandage group; excess circumference and excess water composition were reduced significantly in the tape group. The acceptance of the Kinesio™ Tape was better than the bandage, and benefits included longer wearing time, less difficulty in usage, and increased comfort and convenience. In conclusion

the researchers determined that these two treatment protocols are inefficient and cost time in application. They noted that a more efficient treatment protocol is needed for clinical practice.

Another interesting study was done by the inventor himself Dr. Kenzo Kase. He wanted to find out if there were changes in blood volume of the peripheral blood flow if you used Kinesio™ Tape. This study included nine subjects, five subjects had chronic disorders and poor circulation, and four subjects were relatively healthy. Based on the area being measured, Kinesio™ Tape was applied to the area's most likely to affect blood circulation. For example, if the volume was being measured at the radial artery, the pectoralis major muscle was then taped. If the dorsal artery of the foot was measured, mainly the gastrocnimeus muscle was taped with the popliteus fossa being taped as well due to the positive results. When it came to the superficial temporal artery, the sternocleidomastoid muscle was taped. The volume of the peripheral blood flow was first measured prior to the Kinesio™ Tape being applied. After recording those results Kinesio™ Tape was applied and the volume was measured immediately to see if a change in the volume flow was occurring. The results suggested that Kinesio™ Tape causes an alternation of the blood flow. More so the information that was gathered from this study was that, since the Doppler indicated no major changes in the healthy subject's blood flow after taping, one could say with come confidence that Kinesio™ Tape has no major adverse effects.

As these reports were either performed on healthy subjects or were case series, this literature represents low level of evidence; however it points to the need for further investigation. For the purpose of this study is it important to note that there have been only two studies found in the previous research involving Kinesio™ Tape and the ankle. This is an example of the need for more studies to be done. The Kinesio™ Tape method has gained significant popularity in recent years, but there is a paucity of evidence on its use.

Chapter 3

Methodology

The purpose of this study was to determine how the use of Kinesio™ Tape will affect the therapeutic recovery from a Grade I lateral ankle sprain. The specific research questions are: (a) Is there a difference between Kinesio™ Tape and an ASO™ ankle brace when used as therapy with an acute ankle sprain? (b) At the completion of the rehabilitation sessions involving the functional testing did the study group feel that the Kinesio™ Tape helped their progression in anyway? (c) Can it exume the post-injury lymph and swelling at a faster rate? This chapter is organized as follows: setting and participants, procedures, assessments, data sources and collection, and data analysis.

Setting and Participants

The subjects were 25 high school athletes with a Grade I lateral ankle sprain, ranging in age from 14-18. The exclusion criteria includes athletes with disorders/diseases affecting the musculoskeletal system or balance, athletes with fractures or other associated injuries to the ankle, knee, hip, athletes with deformities of the foot or ankle, and athletes with chronic instability. Subjects were randomly split into two groups, control group not using Kinesio™ Tape, and study group using Kinesio™ Tape. Determination of the ankle sprain was initially assessed by the certified athletic trainer at their high school, or a physical therapist at Southeastern Sports Medicine. Athletes assessed to have a Grade I lateral ankle sprain were then referred to the investigator for a re-evaluation within 24 hours of the injury to determine if in agreement with the assessment. The special tests that were used during the initial evaluation of the ankle injury to determine the degree of the lateral ankle sprain were the anterior drawer test and the talar tilt.

The anterior drawer test is testing the anterior talofibular ligament laxity. The test is performed with the athlete sitting, the knee should be flexed over the edge of the bench or table and the ankle should be allowed to fall into equinus (Wheeless). The examiner stablilizes the distal part of the leg with one hand, and applies anterior force to the heel with the other hand, in attempt to subluxate the talus anteriorly from beneath the tibia (Wheeless). It is important to allow the talus to rotate slightly medially which relaxes the deltoid ligament which is located on the medial side of the ankle, which otherwise might give a false negative test. A positive test will result in laxity and/or pain. The talar tilt test is used to examine the integrity of the calcaneofibular ligament or the deltoid ligaments depending on hand placement and direction of force used by the examiner. In the case of this study we used the talar tilt to test the integrity of the calcaneofibular ligament. This is done with the athlete seated comfortably

on the end of the table. The examiner grasps the foot and places it in anatomical position while stabilizing the tibia and fibula with the other hand. The examiner then adducted and inverted the calcaneous into a varus position. A positive test resulted in laxity and/or pain.

Once it is determined by the investigator that the athlete is suffering from a Grade I lateral ankle sprain the subject was then given a consent form to take home to be signed by their parents in order to have permission to participate in the study. The subject also signed a consent form to participate in the study. The study was performed at either the offices of Southeastern Sports Medicine or at the subject's individual high school. At the Southeastern Sports Medicine office the functional testing was performed in the gym area. At the high schools the primary investigator took each subject and put them through the functional testing the gymnasium of that particular high school. The surface for each test was the same for every subject; it was done on a gymnasium floor.

Assessments

The functional test that the subject was asked to perform was given at two different stages of the study. The basic-intermediate functional tests included the single leg stance and single leg squat test. Once the subject was screened to progress from those two tests the intermediate-advanced tests included the single leg hop for distance test, box drill and the Illinois agility test.

Before the test was implemented, the investigator ensured readiness to safely execute the test, ensured the joint is able to tolerate forces applied, and minimized the risk of re-injury or aggravation (Barber 1992). The single leg stance was performed with the athlete standing on the involved ankle, and without holding onto any object stand for as long as they can (Flynn 2008). An ideal result involved the subject performing the single leg stance for at least 45 seconds. The quantitative measurements included the subject's pain and the length of time he/she was able to stand on the involved leg. The single leg squat was performed with the athlete once again balancing on the involved ankle, and this time performing a squat. During this test it is important for the investigator to assess the squat to make sure that the technique is done correctly. The investigator assessed the range of motion involving the hip, knee and ankle; alignment involving the lumbar spine, hip, knee, and ankle; shoulder position, and center of gravity (Flynn 2008). All of this was done to minimize the risk of injury due to improper technique. Once the test was performed the data that will be collected includes the pain, the number of squats performed.

Once the subject has performed the prior two tests they progressed to the intermediate-advanced functional tests. The first test was the single leg hop for distance test.

The subject stood on one limb and then hopped a distance of 6 meters. The measurements included the subject's pain, the time that it took the subject to complete the test. During this test the investigator also documented a reproducible measurement when the subject was asked to perform the test on the uninvolved ankle, and then on the involved ankle, the two times will be divided and then multiplied by 100 to get the percent healthy of the injured ankle.

The next test to be performed by the subject was the box drill. There were four marker cones placed 10 yards apart in a square configuration, the subject started by getting down in a three-point stance next to Cone 1. On command "GO" the subject sprinted to Cone 2, then shuffled sideways to Cone 3. From there the subject backpedaled to Cone 4, and finishes by turning and sprinting through and finishing at Cone 1 (NFL Combine Testing). The measurements that were taken were the subject's pain, and the time that the test was completed in.

The final test that the subject was asked to perform was the Illinois Agility Test. The subject's started by lying on their front (head to the start line) and hands by their shoulders. On the command "GO" the stop watch was started, and the subject got up as quickly as possible and ran around the course in the direction indicated, without knocking the cones over, to the finish line, at which the timing was stopped. The measurements that were taken were the subject's pain, and the time that the test was completed in (NFL Combine Testing).

A pain scale assessment was also used as a measuring tool. The subject rated their pain before the functional testing and after the functional testing each time. At any time during the testing the subject was able to stop the tests for any reason, especially for pain. The investigator also had the authority if necessary to stop a test based on the athlete's performance, and based on observation of the athlete.

Procedures

Once the consent form was signed by the parent or legal guardian, and the subject consent forms signed by the subjects, the subjects were then randomly chosen to be in the test or control group. All ankle measurements on all subjects were assessed using the circumference measurement at the ankle joint. This is done by take a tape measure and measuring around the ankle joint from the lateral malleolus to the medial malleolus. This measurement was taken before and after the functional tests were performed.

Subjects in the test and control groups reported for rehabilitation appointments three times per week for 4 weeks with their certified athletic trainer at the therapeutic setting. The

subjects worked with their certified athletic trainer to rehabilitate their ankle, utilizing only ice and compression for modalities. Subjects chosen for the test group had Kinesio™ Tape applied at the start of each rehabilitation session as well as at the start of each testing session; the investigator met the subject for application. The functional tests were administered three times for each patient. At the time of the initial evaluation, 4 weeks post injury, and 8 weeks post injury. The results taken at these times were the only recorded results for this study. It is important to note that the Kinesio™ Tape was reapplied prior to each rehabilitation visit and testing session by the investigator.

The tape was applied on the lateral aspect of the ankle. The tape inhibited the ligaments involved in the lateral ankle sprain. The function of the Kinesio™ Tape for the purpose of this study was used to: (a) Decrease inflammation and pressure on mechanical receptors, (b) Enhance fluid exchange between tissue layers, (c) Reduce edema, (d) Decrease stress on the ligaments and tendons that are damaged, (e) To improve the proprioception of the ankle. It is important to note that ligaments take longer to heal than muscles or tendons.

Data Analysis

The analysis used to gather data in this study was the 2x3 ANOVA. The 2 being Kinesio™ Tape or an ASO™ ankle brace and the 3 being the time ; 0,4,and 8 weeks. This was run on each of the five dependent variables. Those variables included: pain level, single leg squat, single leg hop, box drill, and the Illinois test.

Chapter 4

Results & Discussion

The purpose of this study was to determine how the use of Kinesio™ Tape will affect the therapeutic recovery from a Grade I lateral ankle sprain. The data that was collect on each subject was based on 5 variables; pain level, single leg squat, single leg hop, box drill, and the Illinois test. Each subject has three different measures for each variable. The participant sample was 25 high school student-athletes from 9 high schools.

Analysis

The first analysis looked at the differences between Kinesio™ Tape and an ASO™ ankle brace and the difference in pain level before therapy and functional testing and after. The pain level is the difference of the two numbers at each session. The second looked at the difference between Kinesio™ Tape and an ASO™ ankle brace and the single leg squat functional test. The third analysis focused on the difference between Kinesio™ Tape and an ASO™ ankle brace and the single leg hop functional test. The next analysis looked at the difference between Kinesio™ Tape and an ASO™ ankle brace and the box drill. The last analysis looked at the difference between Kinesio™ Tape and an ASO™ ankle brace and the Illinois agility test. Analysis were done utilizing 2 (Treatment: Kinesio™ Tape, ASO™ Ankle Brace) x3 (Time: 0,4,8) ANOVA ($p < .05$).

Pain Level

The results indicate that there is no statistical difference between the effect of Kinesio™ Tape on pain, and an ASO™ ankle brace on pain with an F-value of 0.312, and the p-value of .582. The estimated margin of means for the Kinesio™ Tape group being (M=4.0) and the estimated margin of means for the ASO™ ankle brace group being (M=3.641).

Regarding the subject's pain level throughout the study, it was determined that there was a significant decrease in the subject's pain across time (F= 75.300, p= .000) (see Appendix F). The pain level was a subjective measure in that, before and after the tests the subject's were asked their pain level, and the data was recorded based on the response. There is no real way for the investigator to measure their pain other than subjectively. The decrease in pain over time occurred with both the treatment group being Kinesio™ Tape and the control group being ASO™ ankle brace, making time a significant factor with the pain variable.

Single Leg Squat

The same analysis was used to determine the difference between the Kinesio™ Tape and the ASO™ ankle brace and the single leg squat was not significant. The single leg squat treatment main effect included an F-value of .250, and a p-value of .622. The Kinesio™ Tape group had a mean of 2.556, and the ASO™ ankle brace group had a mean of 2.949.

The amount of squats performed by each subject increased significantly over time with both the Kinesio™ Tape and the ASO™ ankle brace (F= 26.791, p= .000) (see Appendix G). Some were unable to perform the task but most were able to perform at least 1. At week 0 a total of 11 subjects were unable to perform the test; 7 in the ASO™ ankle brace group, and 4 in the Kinesio™ Tape group. By week 4 only 3 subjects were unable to perform the test; 1 in the ASO™ ankle brace group and 2 in the Kinesio™ Tape group. There was no change between week 4 and week 8 as all of the subjects were able to perform the test by week 8. There was a notable difference between the two treatment groups at weeks 4 and 8. The ASO™ ankle brace group were able to perform more single leg squats as compared to the Kinesio™ Tape group.

The ASO™ ankle brace group's outcomes sky rocketed over the Kinesio™ Tape group over the life of the study. It is noted that over time both groups increased the number of squats performed. The ankle brace group performed better than that Kinesio™ Tape group at both weeks 4 and 8. Regarding the subject's number of single leg squats performed throughout the study, it was determined that there was a significant interaction of treatment by time (F= 4.382, p= .018).

Single Leg Hop for Distance

The data collected was the time the subject took to complete the single leg hop for distance test. The measurement was reproduced when the subject was asked to perform the same test on the uninvolved ankle and the two times were divided and multiplied by 100 in order to get the percent health of the injured ankle, as compared to the uninjured ankle. The results indicate that there is no statistical difference between the effect of Kinesio™ Tape on the single leg hop for distance test, and the ASO™ ankle brace on the single leg hop for distance test with an F-value was 1.166, and a p-value of.291. The estimated margin of means for the Kinesio™ Tape was 66.378, and for the ASO™ ankle brace was 73.718.

At week 0, 9 subjects; 6 in the ASO™ ankle brace group and 3 in the Kinesio™ Tape group were unable to perform the single leg hop for distance test due to the amount of pain, as well as the amount of discomfort coming from landing on the involved ankle. This test involved critical thinking when it came to leading with one foot and landing on the other. Many subjects were hesitant to land on their involved (injured) ankle. Regarding the subjects performance

with the single leg hop for distance test there was a significant increase in performance across time (F= 39.105, p= .000) (see Appendix H). In comparing the data between weeks 4 and 8, only 1 subject was unable to perform the test at week 4, out of the Kinesio™ Tape group, and all of the subjects were able to perform the test by week 8. Noting that most grade I lateral ankle injuries have healed by week 4.

Box Drill

The results indicate that there is no statistical difference between the effect of Kinesio™ Tape on the box drill, and an ASO™ ankle brace on the box drill with an F-value of .879, and the p-value of .358. The estimated margin of means for the Kinesio™ Tape group being (M=6.818) and the estimated margin of means for the ASO™ ankle brace group being (M=7.478).

The box drill was determined to be a great introduction to the Illinois test. Regarding the subjects performance throughout the study, it was determined that there was a significant increase over time (F= 37.528, p= .000) (see Appendix I). Only 7 subjects; 4 in the ASO™ ankle brace group and 3 in the Kinesio™ Tape group, were able to perform this test at week 0 due to the amount of cutting involved. With a grade I lateral ankle sprain, the inversion and eversion movements will cause the subject the most discomfort. In order to functionally cut on the field, inversion and eversion are the main range of motions. Comparing the data between weeks 4 and 8, there was only 1 subject unable to complete the test at week 4, out of the Kinesio™ Tape group, all subjects were able to complete the test at week 8. However, due to the subjects being unable to perform the task at week 0, there was a notable difference in the data between week 0 and week 4 as well as between week 0 and week 8, being that week 4 and week 8 were very similar.

Illinois Agility Test

The final analysis looked at the difference between the Kinesio™ Tape and an ASO™ ankle brace and the Illinois Agility Test. Once again at week 0, most subjects in both the Kinesio™ Tape group and the ASO™ ankle brace group were unable to perform this test. Only 7 subjects were able to perform the test at week 0; 4 in the ASO™ ankle brace group and 3 in the Kinesio™ Tape group. Although there is a jump between week 0, and week 4, due to the fact that most of the subjects were unable to perform this test at week 0, there was no apparent improvement between week 4 and week 8. Only 3 subjects; 2 in the Kinesio™ Tape group and 1 in the ASO™ ankle brace group, were unable to perform the test at week 4, and all of the subjects were able to complete the test at week 8. The results indicated that there was no

statistical difference between the Kinesio™ Tape on the Illinois test and the ASO™ ankle brace on the Illinois test with an f-value of .024, and a p-value of .878.

This test was found by the subjects to be most difficult out of the functional test implemented. Not only is speed a factor, but remembering the path, was an obstacle for the subjects. It was observed that the subjects performance of the box drill throughout the study, increased over time (F= 33.208, p= .000) (see Appendix J). There was not a large difference in times between week 4 and week 8, although the subjects were familiar with the path by week 8.

CHAPTER 5

Summary & Conclusion

The purpose of this study was to determine how the use of Kinesio™ Tape will affect the therapeutic recovery from a Grade I lateral ankle sprain. The first research question stated is there a difference between Kinesio™ Tape and an ASO™ ankle brace when used as a therapy on an acute grade I lateral ankle sprain? The second research question asked, at the completion of the rehabilitation sessions involving the functional testing, did the study group feel that the Kinesio™ Tape helped their progression in any way? And the final research question, can the Kinesio™ Tape exhume the post-injury lymph and swelling at a faster rate?

The first analysis was the comparison between the Kinesio™ Tape and an ASO™ ankle brace on the difference of pain level each subject had. The subject was asked before the testing their pain level and after the testing. The difference in the pain level was documented. This was done at each of the three testing times. There was no significant difference in the pain level between the Kinesio™ Tape group and the ASO™ ankle brace group. However there was a notable difference over time with both groups experience a decrease in pain levels. As the tissue that is injured heals, pain decreases. It can be observed that for a grade I lateral ankle sprain by week 4 most of the healing has occurred. The next 2 weeks involve proprioception training and muscle re-education. This study demonstrated just that. By week 8 subjects in both groups experience little to no pain.

The single leg squat functional test was the second analysis performed. The subjects were tested on the number of squats that they could perform on the involved ankle. The range was between 0 and 10 and no subject in either grouped performed 10. There was evidence of significance between the two groups with this functional test. Comparing the estimated margin of means on the plot is showed that the ASO™ ankle brace group performed higher than the Kinesio™ Tape group. The number of squats performed by the ASO™ ankle brace group at week 4, and week 8 on average was 3 and 4.9 as compared to 2.4 and 3.45 respectively. Over time however, both groups significantly increased in the number of squats performed. When performing the single leg squat proprioception plays a big factor. All of the subject's weight is on that one ankle. The ligaments that support the ankle are working at their hardest, if they are injured they are unable to support the ankle and the single leg squat cannot be performed. The ASO™ ankle brace is very rigid and primary purpose is to stabilize the ankle. The Kinesio™ Tape is a thin layer of tape that works with the ankle's natural range of motion, there is no support.

The third analysis was done comparing the two groups to the Single leg hop test. It showed that there was no significant difference among the two groups. At this time the Kinesio™ Tape group also was asked if they felt that the Kinesio™ Tape helped with their progression in any way during this particular functional test. All 12 subjects were unable to tell if the Kinesio™ Tape had any effect on their performance. This test was performed on both ankles; the times were divided and multiplied by 100 to give the percent healthy the injured ankle as compared to their healthy ankle. This allows for the comparison of healthy versus unhealthy to be consistent by using the same subject. It is important to note most subjects were unable to complete this task at week 0. The results demonstrated a significant increase between week 0 and week 4 with both groups. Due to the fact that most of the subjects were unable to perform the test at week 0, there was a jump at week 4, where all of the subjects were able to perform the test. Noting once again that by week 4, grade I lateral ankle sprains have already gone through the healing process.

This test involves jumping and landing on the ankle. If someone has just experienced the trauma, they are going to be experiencing and pain and discomfort. The ankle is not stable enough to perform the test correctly with either the Kinesio™ Tape or the ASO™ ankle brace. By week 8 all of the subjects were able to perform the test out of both groups. This confirms that with the combination of the therapy (Kinesio™ Tape or ASO™ ankle brace) and the normal healing process there is improvement in the performance.

The next analysis looked at the difference between the Kinesio™ Tape and an ASO™ ankle brace and the box drill. Once again there was no significant difference between the two groups. The Kinesio™ Tape group did not feel that the tape helped nor hurt their progression during this exercise at any of the three times, although it is important to note that most subjects out of either group were unable to perform the box drill at week 0. Due to the amount of cutting that this test involved, and with the ankle injury involving the ligaments that help stabilize the ankle during those specific motions, the subjects were unable to perform the test pain free, and some not at all. By week 4 all of the subjects were able to complete the test. There was notable improvement with both treatment groups over time. This test confirmed the utility that the Kinesio™ Tape does as well as the ASO™ ankle brace with this particular performance due to the results being neck and neck (see Appendix I).

The final analysis was comparing the Kinesio™ Tape and the ASO™ ankle brace on the Illinois agility test. This analysis was very similar to the outcome of the box drill. There was no statistical difference between the two groups, and the Kinesio™ Tape group could not tell whether the Kinesio™ Tape helped or hurt their progression. This test involved not only cutting as did the box drill but also sprinting. All 25 subjects were unable to perform the test at week

0. There was an apparent difference between week 0 and week 4 with both the Kinesio™ Tape, and the ASO™ ankle brace. Once again it is noted that the Kinesio™ Tape group and the ASO™ ankle brace group had very similar outcomes at week 0, week 4, and week 8.

In answering the third research question about whether Kinesio™ Tape can exhume the post-injury lymph and swelling, it was not determined in this study due to lack of measurements. One of the original measurements that were to be recorded was circumference of the ankle, which tells the investigator the amount of swelling versus the uninjured ankle. What was discovered during the study is that with a grade I lateral ankle sprain there is not a lot of swelling, in other words post-injury lymph. Therefore this measurement was thrown out due to the fact that there insufficient data. The research question was not able to be answered with this particular study.

It is also important to note that the single leg stance was not included in the analysis. This was not a very consistent functional test. This test was measured by pass/fail. If the subject could stand in the involved ankle for more than 1 minute then the subject passed. All of the subjects in each group passed this test. The validity of this test was low.

The research study was conducted on a Grade I lateral ankle sprain. The normal protocol with rehabilitation states that within 2-4 weeks depending on the athlete, the ankle should be healed and the athlete should be released for full participation. This brings up the point that throughout the study there were no apparent differences among tests with either the Kinesio™ Tape, or the ASO™ ankle brace when it came to comparing the findings between week 4 and week 8.

Recommendations for Future Research

Future research should include more participants. It would also be beneficial to study a grade II or possibly grade III ankle sprain. There is quite a bit more damage to the ligaments as the grade goes up, therefore the therapeutic effects may stand out more. With a higher grade the researcher will also have a higher degree of swelling to compare. With this research one could make the functional tests sport specific and group the subjects by sport. Once could also use a dynamometer in the future to test the subject's strength levels.

Conclusion

In conclusion, based on the findings of the study, the only difference between Kinesio™ Tape and an ASO™ ankle brace is the single leg squat functional tests. It is also been determined by this study that the subject's in the Kinesio™ Tape group were unable to determine if the tape helped or hindered their progression in any way throughout the 8 week study. It was interesting that all the subjects lacked swelling. One of the main claims of Kinesio™ Tape is that the tape will increase interstitial lymphatic fluid flow and reduce edema. This study was unable to determine that with such an acute injury being studied. This opens the door for future research.

With the ASO™ ankle brace, the same brace can be used throughout one season. It is applied by the athlete, or patient. Once it starts to wear down depending on the purpose of the ankle brace, one can purchase another brace. The ASO™ ankle brace is thirty dollars per brace. When it comes to the Kinesio™ Tape at this point in time it is not available in stores. People must go through a physical therapy clinic, chiropractor, etc. in order to purchase the tape. Kinesio™ Tape must be applied by a professional. Some physical therapists will have three to four sessions with a patient, educate the patient and then allow the patient to purchase the tape and apply it to themselves. With the Kinesio™ Tape the most important part is the patient education. It is important to educate the patient on the application process, what not to do while the tape is on the skin, and the proper steps in the tape removal process. The patient must understand the indications and contraindications as well. The cost of the Kinesio™ Tape for 1 small roll is eleven dollars. Per box it can range from sixty to seventy dollars. Not only is a patient paying for the tape application they are also paying for the practitioner's time and ability to apply the tape.

It seems that both the Kinesio™ Tape and the ASO™ ankle brace are useful therapeutic methods when dealing with a grade I lateral ankle sprain. Athletic Trainers and Physical Therapists alike can use either tool in treating and rehabilitating a grade I lateral ankle sprain.

References

Aiken AB, Pelland L, Brison R, Pickett W, Brouwer B. "Short-term Natural Recovery of Ankle Sprains Following Discharge From Emergency Departments", *The Journal of Orthopedic Sports Physical Therapy,* Vol. 38, No. 9, 2008.

Bernier JN. Quick Reference Dictionary for Athletic Training. New Jersey: SLACK, 2002.

Boyce SH, Quigley MA, Campbell S. "Management of Ankle Sprains: A Randomized Controlled Trial of the Treatment of Inversion Ankle Injuries Using an Elastic Support Bandage or an Aircast™ Ankle Brace", *Journal of Sports Medicine,* Vol. 39, No. 2, 2008, pp.91-96.

Burks R, Bean B, Marcus R, Barker H. " Analysis of Athletic Performance with Prophylactic Ankle Devices", *The American Journal of Sports Medicine,* Vol. 19, No. 2, 1991, pp. 104-106.

Cordova M, Ingersoll C, Palmieri R. "Efficacy of Prophylactic Ankle Support: An Experimental Perspective", *Journal of Athletic Training,* Vol. 37, No.4, 2002, pp. 446-457.

de la Motte SJ, Arnold BL, Ross SE, Pidcoe PE. "Kinesio Tape At The Ankle Increases Hip Adduction During Dynamic Balance In Subjects With Functional Ankle Instability", *Supplement to Journal of Athletic Training,* Vol.44, No. 3, 2009, pp. S-27.

Fong D, Chan Y, Mok K, Yung P, Chan K. " Understanding Acute Ankle Ligamentous Sprain Injury in Sports", *Sports Medicine, Arthroscopy, Rehabilitation, Therapy and Technology,* Vol.1, 2009, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2724472/?tool=pmcentrez.

Fu TC, Wong AM, Pei YC, Wu KP, Chou SW, Lin YC. "Effect of Kinesio Taping on Muscle Strength in Athletes-A pilot Study", *Journal of Science Medicine Sport,* Vol. 11, No.2, 2008, pp.198-201.

Garrick JG, Requa RK. " Role of External Support in the Prevention of Ankle Sprains", *Medical Science in Sports,* Vol. 5, 1973, pp. 200-203.

Hals T, Sitler MR, Mattacola CG. "Effect of a Semi-Rigid Ankle Stabilizer on Performance in Persons With Functional Ankle Instability", *Journal of Orthopedic Sports Medicine and Physical Therapy,* Vol.30, No.9, 2000, pp. 552-556.

Halseth T, McChesney JW, Debeliso M, Vaughn R and Lien J. "The Effects of Kinesio Tape on Proprioception At The Ankle", *Journal of Sports Science and Medicine,* Vol. 3, 2004, pp. 1-7.

Hertel J. "Functional Anatomy, Pathomechanics, and Pathophysiology of Lateral Ankle Instability", *Journal of Athletic Training,* Vol. 37, No. 4, 2002, pp. 364-375.

Hintermann B. "Biomechanics of the Unstable Ankle Joint and Clinical Implications", *Medicine & Science in Sports & Exercise,* Vol. 31, No. 7, 1999, pp. S459-S469.

Hsu YH, Chen WY, Lin HC, Wang WT, Shih YF. "The Effects of Taping on Scapular Kinematics and Muscle Performance in Baseball Players with Shoulder Impingement Syndrome".

Hubbard TJ, Cordova ML. "Effects of Ankle Taping on Mechanical Stability in Those with Chronic Ankle Instability", *Supplement to Journal of Athletic Training,* Vol. 44, No.3, 2009, pp. S-29.

Hubbard, TJ, Denegar CR. " Does Cryotherapy Improve Outcomes With Soft Tissue Injury?" *The Journal of Athletic Training,* Vol. 39, No. #, 2004, pp. 278-279.

Hubbard TJ, Hicks-Little C. "Ankle Ligament Healing After an Acute Ankle Sprain: An Evidence-Based Approach", *Journal of Athletic Training,* Vol. 43, No. 5, 2008, pp. 523-529.

Hubbard T, Kaminski T. "Kinesthesia is Not Affected by Functional Ankle Instability Status", *Journal of Athletic Training,* Vol. 37, No. 4, 2002, pp. 481-486.

Jerosch J, Thorwesten L, Bork H, Bischof. "Is Prophylactic Bracing of the Ankle Cost Effective", *Orthopedics,* Vol. 19, No. 5, 1996, pp. 405-414.

Kase K, Hashimoto T. " Changes in the Volume of the Peripheral Blood Flow by Using Kinesio Taping", *www.kinesiotaping.com/blood-flow-kt.php.*

Liu YH, Chen SM, Lin CY, Huang CI, Sun YN. "Motion Tracking on Elbow Tissue from ultrasonic Image Sequence for Patients with Lateral Epicondylitis",

Lynch SA, Renstrom PA. " Treatment of Acute Lateral Ankle Ligament Rupture in the Athlete. Conservative Versus Surgical Treatment", *Sports Medicine* , Vol. 27, No. 1, 1999 pp. 61-71.

Manfroy P, Ashton-Miller J, Wojtys E. "The Effect of Exercise, Prewrap, and Athletic Tape on the Maximal Active and Passive Ankle Resistance to Ankle Inversion", *American Journal of Sports Medicine,* Vol.25, No. 2, 1997, pp. 156-163.

McCaw S, Cerullo J. "Prophylactic Ankle Stabilizers Affect Ankle Joint Kinematics During Drop Landings", *Medicine & Science in Sports & Exercise,* Vol. 31, No. 5, 1999, pp.702-707.

Olmsted L, Vela L, Denegar C, Hertel J. " Prophylactic Ankle taping and Bracing: A Numbers-Needed-to-Treat and Cost-Benefit Analysis", *Journal of Athletic Training,* Vol. 39, No. 1, 2004, pp. 95-100.

Pienkowski D, McMorrow M, Shapiro R, Caborn D, Stayton J. " The Effect of Ankle Stabilizers on Athletic Performance", *The American Journal of Sports Medicine,* Vol. 23, 1995, pp. 757-762.

Robinson J, Frederick E, Cooper L. "Systematic Ankle Stabilization and the Effect on Performance", *Medicine & Science in Sports & Exercise,* http://journals.lww.com/acsm-msse.com .

Ross S, Guskiewicz K, Gross M, Yu B. "Assessment Tools for Identifying Functional Limitations Associated With Functional Ankle Instability", *Journal of Athletic Training,* Vol. 43, No. 1, 2008, pp. 22-50.

Shapiro M, Kabo J, Mitchell P, Loren G, Tsenter M. " Ankle Sprain Prophylaxis: An Analysis of the Stabilizing Effects of Braces and Tape", *The American Journal of Sports Medicine,* Vol. 22, 1994, pp. 78-82.

Shaw M, Gribble P, Frye J. "Ankle Bracing, Fatigue, and Time to Stabilization in Collegiate Volleyball Athletes", *Journal of Athletic Training,* Vol. 43, No. 2, 2008, pp.164-171.

Silter M, Ryan J, Wheeler B, McBride J, Arciero R, Anderson J, Horodyski M. " The Efficacy of a Semirigid Ankle Stabilizer to Reduce Acute Ankle Injuries in Basketball", *The American Journal of Sports Medicine,* Vol. 22, No. 4, 1994, pp. 454-461.

Simoneau G, Degner R, Kramper C, Kittleson K. "Changes in Ankle Joint Proprioception Resulting From Strips of Athletic Tape Applied Over the Skin", *Journal of Athletic Training,* Vol.32, No. 2, 2007, pp.141-147.

Slupik A, Dwornik M, Bialoszewski D, Zych E. "Effect of Kinesio Taping on Bioelectrical Activity of Vastus Medialis Muscle. Preliminary Report", *Orthopedic Traumatol Rehabilitation,* Vol. 9, No.6, 2007, pp. 644-651.

Stone K, Helal B. "A Method of Ankle Stabilization", *Clinical Orthopedics and Related Research: Symposium,* 1991, http://journals.lww.com/corr/1991.com.

Thacker S, Stroup D, Branche C, Gilchrist J. "The Prevention of Ankle Sprains in Sports; A Systematic Review of the Literature", http://aja.sagepub.com/content/27/6/753.com.

Thelen MD, Dauber JA, Stoneman PD. “The Clinical Efficacy of Kinesio Tape for Shoulder Pain: A Randomized, Double-Blinded, Clinical Trial”, *Journal of Orthopedic Sports Physical Therapy,* Vol. 38, No.7, 2008, pp.389-395.

Tochigi Y, Rudent J, Saltzman C, Amendola A, Brown T. “Contribution of Articular Surface Geometry to Ankle Stabilization”, *The Journal of Bone and Joint Surgery (American),* Vil. 88, 2006, pp. 2704-2713.

Tropp H, Askling C, Gillquist J. “Prevention of Ankle Sprains”, *American Journal of Sports Medicine,* Vol. 13, 1985, pp. 259-262.

Tsai HJ, Hung HC, Yang JL, Huang CS, Tsauo JY. “Could Kinesio Tape Replace the Bandage in Decongestive Lymphatic Therapy for Breast-Cancer-Related Lymphedema? A Pilot Study”, *Support Care Cancer,* 2009 Feb 8.

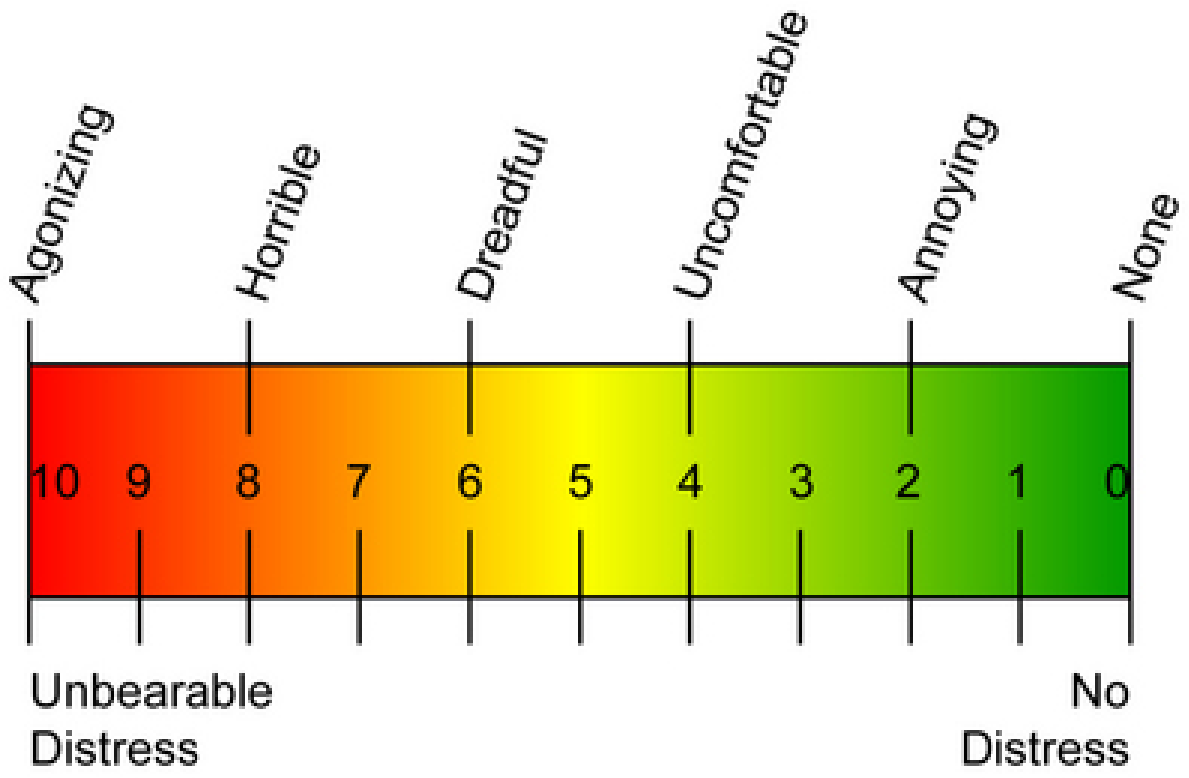
Wilkerson G. “Biomechanical and Neuromuscular Effects of Ankle Taping and Bracing”, *Journal of Athletic Training,* Vol. 37, No.4, 2002, pp. 436-445.

Yasukawa A, Patel P, Sisung C. “Pilot Study: Investigating the Effects of Kinesio Taping in Acute Pediatric Rehabilitation Setting”, *American Journal of Occupational Therapy,* Vol.60, No.1, 2006, pp.104-110.

Yoshida A, Kahanov J. “ The Effect of Kinesio Tape on Lower Trunk Range of Motions”, *Research in Sports Medicine,* Vol. 15, No. 2, 2003, pp. 103-112.

Zajt-Kwiatkowska J, Rajkowska-Labon E, Skrobot W, Bakula S, Szamotulska J. “Application of Kinesio Taping for Treatment of Sports Injuries”, *Research Yearbook,* Vol.13, No. 1, 2007, pp. 130-134.

APPENDIX A



Task _____

Date _____ *Start* _____ *End* _____

APPENDIX B

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Parental Permission for Child's Participation

Title of Research Project: The Therapeutic Effect of Kinesio™ Tape on A Acute Lateral Grade I Ankle Sprain.

Investigators: Richard Stratton and Carrie Hendrick

Purpose:

The purpose of this study is to test the effects of Kinesio™ on an acute lateral ankle sprain. Very little research has been done on this topic.

Procedures:

With your permission we would like to collect health information about your child, including information about your general health (height, weight, blood pressure, medications). We will then evaluate his/her ankle injury. Once it is determined that they have an acute ankle injury with no fractures they will then be given the consent form to participate in the study. There will be four different evaluations where he/she will be taped and given functional test to perform with the Kinesio™ tape. At 2 weeks after the initial injury, 4 weeks out, 1 month out and then finally at 2 months out. At each visit they will perform the same functional tests. They will be tested with being taped with the Kinesio™ tape or wearing an ASO ankle brace. There will be two test groups. At the end of the study we will compare the two.

Risks:

There should be no more than minimal risks to your child from participating in this study including:

- Skin reaction to the tape, it is important to note that the tape is Latex Free.
- Skin breakdown from tape application.
- Local hair loss, when removing the tape.

Only the researchers will have access to the results of the functional tests, and to your child's medical history. He/she can also stop at any point during the testing. His/her personal responses will never be shared with anyone, including other athletes, the coaches, or parents.

Benefits:

There are no direct benefits to your child. However, his/her participation in this research might help us understand the effects of Kinesio™ tape, and add to the small list of studies that have been done on this particular tape.

Extent of Anonymity and Confidentiality:

At no time will the researchers release the results of this study to anyone other than individuals working on this project without your written consent. It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subject's involved in research.

Compensation: None

Freedom to Withdraw:

Your child is free to withdraw from participation in this study at any time without penalty. The decision to participate or not participate has no connection to participation on this athletic team. Your child can refuse to answer any questions with no penalty at all. If you sign now to permit your child to participate and realize later that you want to withdraw your permission, just inform the researcher or call one of the others listed at the bottom of this page.

By signing below, you indicate that you have read and understood the informed consent and conditions of this project, that you have had all of your questions answered, and that you give your voluntary permission for your child to participate in this project. You will be offered a copy of this form.

_____

Child's name

_____

Parent's Signature Date

Investigators:

Richard K. Stratton 540-231-5617 rstratto@vt.edu

Carrie Hendrick 540-797-0612 hen2004@vt.edu

IRB Chair: David Moore 540-231-4991 moored@vt.edu

APPENDIX B1

Virginia Polytechnic Institute And State University

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project: The Therapeutic Effects of Kinesio™ Tape on A Acute Lateral Grade I Ankle Sprain.

Investigators: Dr. Richard Stratton, Carrie Hendrick

Purpose of This Research/Project: You are invited to participate in a study on the effects of Kinesio™ tape on acute ankle injuries. From the information collected and studied in this project we hope to learn more about the effects of Kinesio™ tape on acute ankle injuries.

Procedures: With your permission we would like to collect health information about you, including information about your general health (height, weight, blood pressure, medications). We will then evaluate your ankle injury. Once it is determined that you have an acute ankle injury with no fractures you will then be given the consent form to participate in the study in you wish. There will be four different evaluations where you will be taped and given test to perform with the Kinesio™ tape. At 2 weeks after you initial injury, 4 weeks out, 1 month out and then finally at 2 months out. At each visit you will perform the same functional tests. You will be tested with being taped with the Kinesio™ tape or wearing an ASO ankle brace. There will be two test groups. At the end of the study we will compare the two.

Risks: There should be no more than minimal risk to you from participating in this study. The risk from using the Kinesio™ tape include:

- Skin reaction to the tape, it is important to note that the tape is Latex Free.
- Skin breakdown from tape application.
- Local hair loss, when removing the tape.

Only researchers will have access to the final data, and you can refuse to be part of the study. You can also stop at any point during the study. Your results will never be shared with other athletes or coaches.

Benefits: You may receive direct benefit from this study. We cannot and do not guarantee that you will receive any benefits from this study.

Extent of Anonymity and Confidentiality:

At no time will the researchers release the results of this study to anyone other than individuals working on this project without your written consent.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subject's involved in research.

Compensation: You will not be paid to participate in this study.

Freedom to Withdraw: Your decision whether or not to participate in this study will not affect medical care. Your decision to participate or not participate has no connection to your participation on your athletic team. If you read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue your participation at any time without penalty. Your identity will not be disclosed in any published and written material resulting from the study.

Subject's Responsibilities:

I voluntarily agree to participate in this study. I have the following responsibilities:

- Report to my test sessions on time.
- Report to each test session as scheduled.
- Complete the testing as described to me to by the investigator the best of my ability.
- Be honest about my pain scale to the investigators at the time of testing.
- To be honest about my medical history.

Subject's Permission:

I have read the Consent Form and the conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent.

_____ Date_____
Subject signature

Should I have any pertinent questions about this research or its conduct, and research subjects' rights, and whom to contact in the event of a research related injury to the subject, I may contact:

Investigators:

Richard K. Stratton	540-231-5617	rstratto@vt.edu
Carrie Hendrick	540-797-0612	hen2004@vt.edu

IRB Chair:

David Moore	540-231-4991	moored@vt.edu

APPENDIX B2

Virginia Polytechnic Institute And State University

Assent for Participants in Research Projects Involving Human Subjects that are Minors

Title of Project: The Therapeutic Effects of Kinesio™ Tape on A Acute Lateral Grade I Ankle Sprain.

Investigators: Dr. Richard Stratton, Carrie Hendrick

Purpose of This Research/Project: You are invited to participate in a study on the effects of Kinesio™ tape on acute ankle injuries. From the information collected and studied in this project we hope to learn more about the effects of Kinesio™ tape on acute ankle injuries.

Procedures: With your permission we would like to collect health information about you, including information about your general health (height, weight, blood pressure, medications). We will then evaluate your ankle injury. Once it is determined that you have an acute ankle injury with no fractures you will then be given the consent form to participate in the study in you wish. There will be four different evaluations where you will be taped and given test to perform with the Kinesio™ tape. At 2 weeks after you initial injury, 4 weeks out, 1 month out and then finally at 2 months out. At each visit you will perform the same functional tests. You will be tested with being taped with the Kinesio™ tape or wearing an ASO ankle brace. There will be two test groups. At the end of the study we will compare the two. You can ask questions about this study at any time. If you decide at any time not to finish, you can ask us to stop.

Risks: There should be no more than minimal risk to you from participating in this study. The risk from using the Kinesio™ tape include:

- Skin reaction to the tape, it is important to note that the tape is Latex Free.
- Skin breakdown from tape application.
- Local hair loss, when removing the tape.

Only researchers will have access to the final data, and you can refuse to be part of the study. You can also stop at any point during the study. Your results will never be shared with other athletes or coaches.

Benefits: You may receive direct benefit from this study. We cannot and do not guarantee that you will receive any benefits from this study.

Extent of Anonymity and Confidentiality:

At no time will the researchers release the results of this study to anyone other than individuals working on this project without your written consent.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subject's involved in research.

Compensation: You will not be paid to participate in this study.

Freedom to Withdrawal: Your decision whether or not to participate in this study will not affect medical care. Your decision to participate or not participate has no connection to your participation on your athletic team. If you read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue your participation at any time without penalty. Your identity will not be disclosed in any published and written material resulting from the study.

Subject's Responsibilities:

I voluntarily agree to participate in this study. I have the following responsibilities:

- Report to my test sessions on time.
- Report to each test session as scheduled.
- Complete the testing as described to me to by the investigator the best of my ability.
- Be honest about my pain scale to the investigators at the time of testing.
- To be honest about my medical history.

Subject's Assent:

Please talk about this study with your parents before you decide whether or not to participate. I will also ask your parents to give their permission for you to participate. Even if your parents say "yes" you can still decide not to participate.

I have read the Assent Form and the conditions of this project. I have had all my questions answered. If you sign this paper, it means that you have read this and that you want to be in the study. If you don't want to be in the study, don't sign this paper. Being in the study is up to you, and no one will be upset if you don't sign this paper or if you change your mind later.

_____ Date_____
Subject signature

Should I have any pertinent questions about this research or its conduct, and research subjects' rights, and whom to contact in the event of a research related injury to the subject, I may contact:

Investigators:

Richard K. Stratton	540-231-5617	rstratto@vt.edu
Carrie Hendrick	540-797-0612	hen2004@vt.edu

IRB Chair:

David Moore	540-231-4991	moored@vt.edu

APPENDIX C

This is an example of an ASO ankle brace. This is a lace up ankle brace. The primary mechanism responsible for preventing ankle sprains is the ability of ASO ankle braces to restrict ankle inversion and eversion movements.

APPENDIX D

This picture demonstrates the Kinesio™ tape method that was used in the study. The taping method used was a criss-cross fan. This gave the optimal reduction of edema for that target area. The student-athletes were taped on the lateral side of the ankle, being that it was a grade I lateral ankle sprain. The Kinesio™ tape group performed each functional test with the tape applied by the investigator.

APPENDIX E

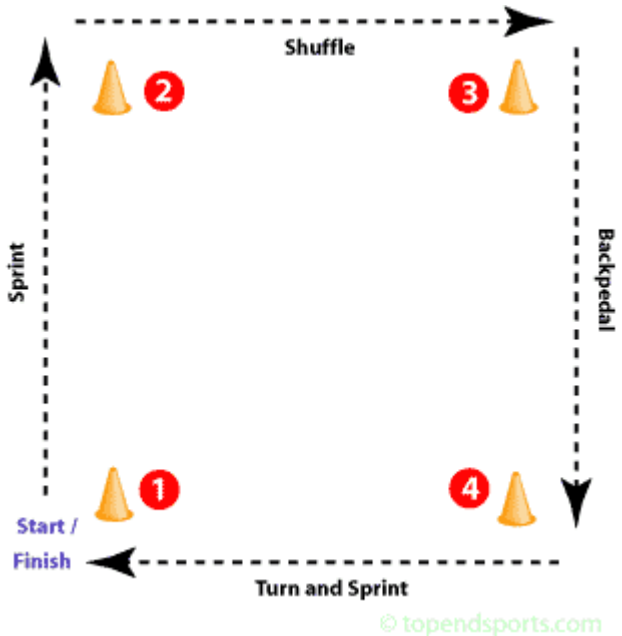
FUNCTIONAL TESTS

The subject above is performing the single leg squat test. This is done by balancing one ankle, and in this case the involved or injured ankle, and performing a squat.

APPENDIX E1

FUNCTIONAL TESTS

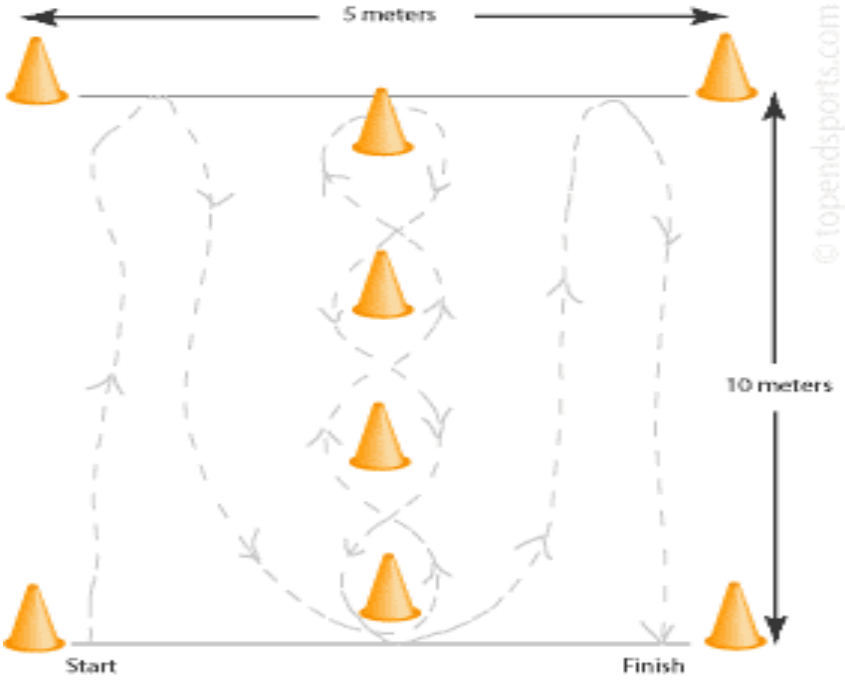
Above demonstrates the single leg hop for distance test.



The map above illustrates the box drill.

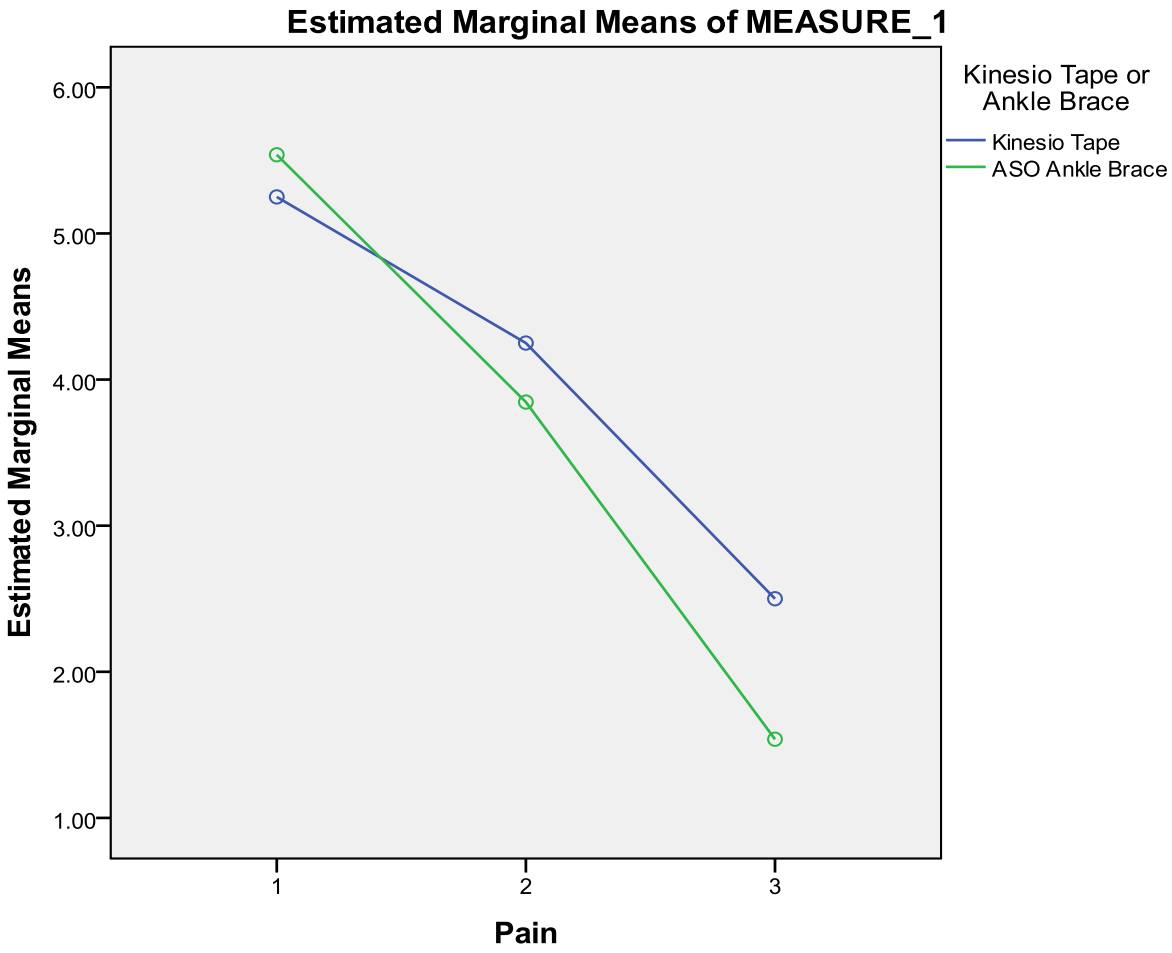
APPENDIX E2

FUNCTIONAL TESTS

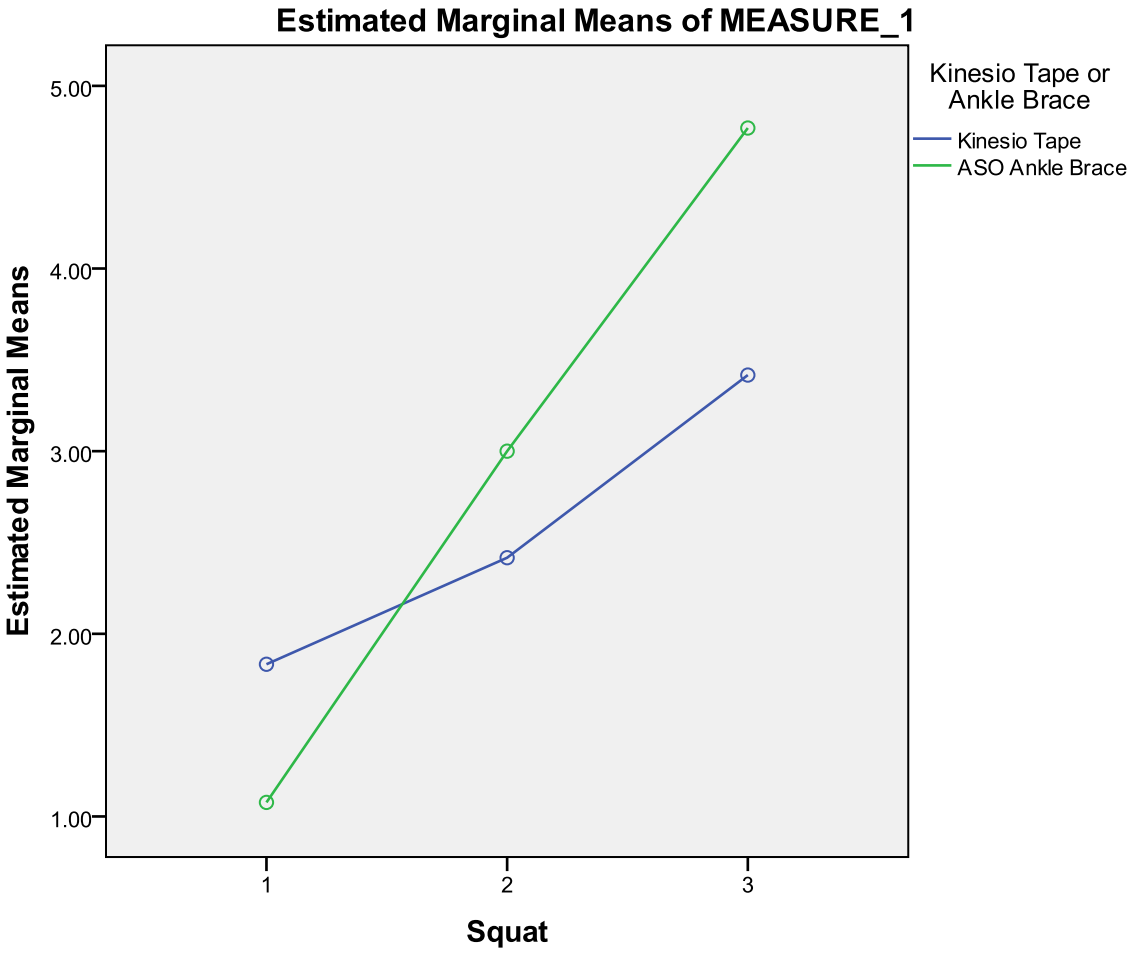


The Illinois Test was the final test that was completed by each subject.

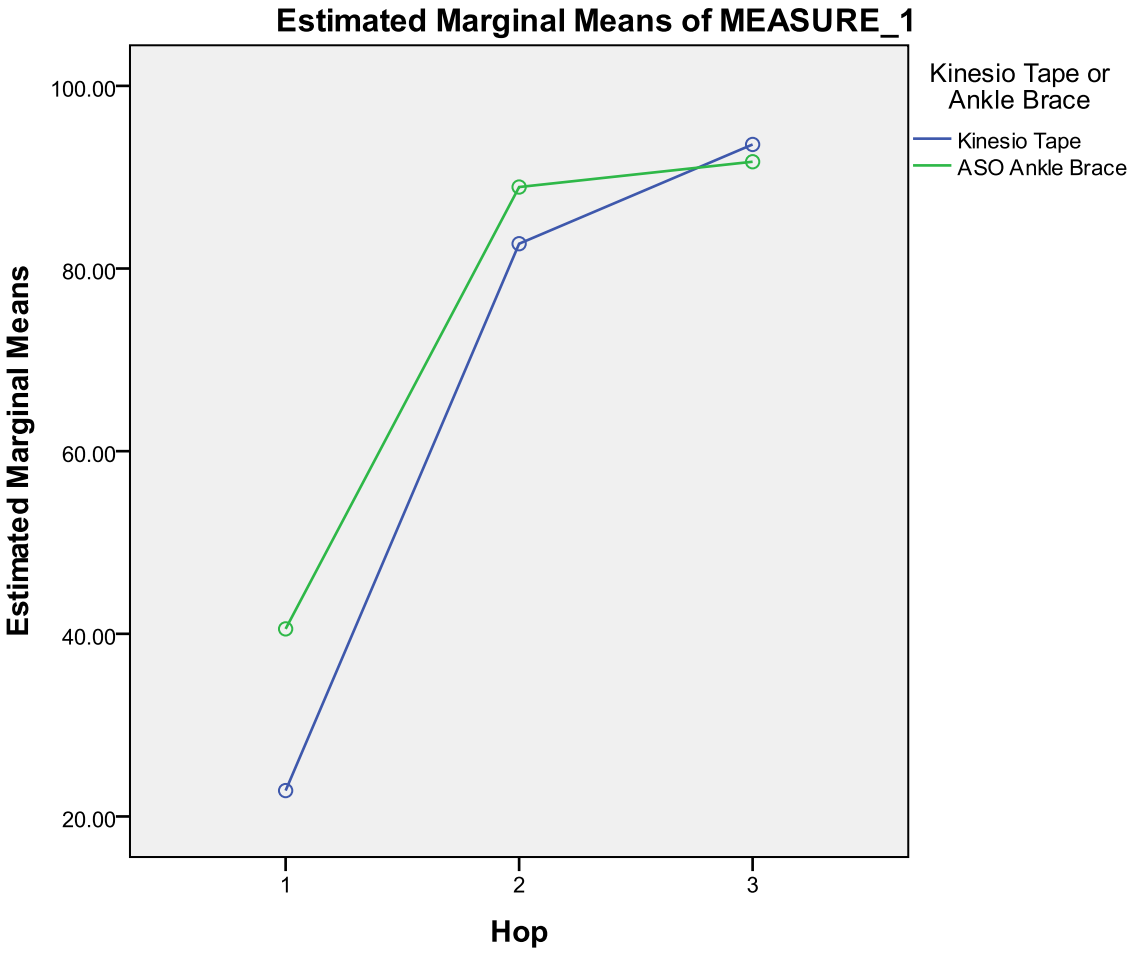
APPENDIX F


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
6.00
5.00
4.00
3.00
2.00
1.00
1
2
3
Pain
Kinesio Tape or Ankle Brace
Kinesio Tape
ASO Ankle Brace

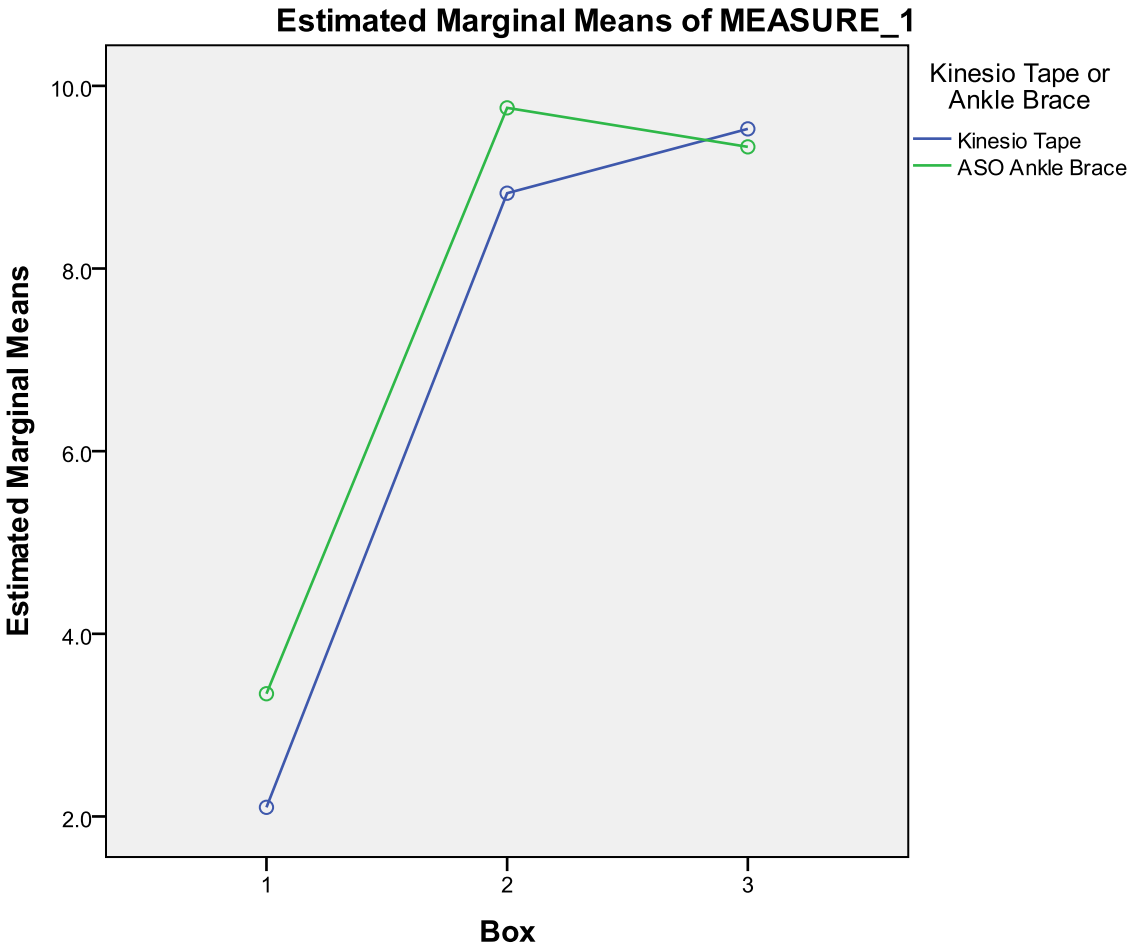
APPENDIX G


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
5.00
4.00
3.00
2.00
1.00
1
2
3
Squat
Kinesio Tape or Ankle Brace
Kinesio Tape
ASO Ankle Brace

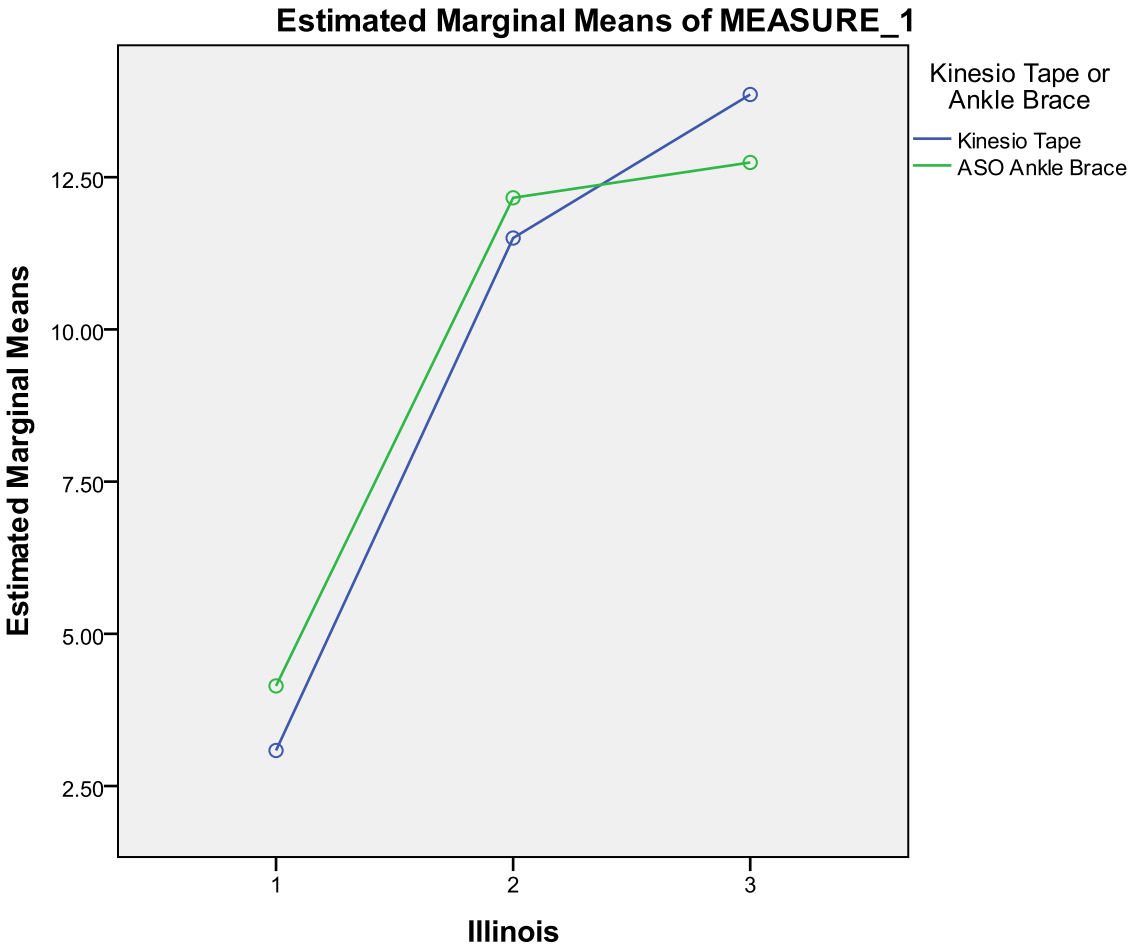
APPENDIX H


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
100.00
80.00
60.00
40.00
20.00
1
2
3
Hop
Kinesio Tape or Ankle Brace
Kinesio Tape
ASO Ankle Brace

APPENDIX I


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
10.0
8.0
6.0
4.0
2.0
1
2
3
Box
Kinesio Tape or Ankle Brace
Kinesio Tape
ASO Ankle Brace

APPENDIX J


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
12.50
10.00
7.50
5.00
2.50
1
2
3
Illinois
Kinesio Tape or Ankle Brace
Kinesio Tape
ASO Ankle Brace