Spring 5-1-2014

The Effect of Kinesiotape on Ankle Proprioception and ROM

Jenna L. Capps
Indiana State University

The Effect of Kinesiotape on Ankle Proprioception and ROM

A thesis

Presented to

The College of Graduate and Professional Studies

Department of Applied Medicine and Rehabilitation

Indiana State University

Terre Haute, Indiana

In Partial Fulfillment

of the Requirements for the Degree

Jenna Capps

---

by

Jenna Capps

May 2014

Keywords: Kinesio tape, Proprioception, Ankle, Biodex, Goniometer

COMMITTEE MEMBERS

Committee Chair: Leamor Kahanov, EdD, LAT, ATC

Department Chair of Applied Medicine and Rehabilitation Department

Indiana State University

Committee Member: Lindsey Eberman, PhD, LAT, ATC

Assistant Professor, Department of Applied Medicine and Rehabilitation

Indiana State University

Committee Member: Timothy Demchak, PhD, LAT, ATC

Associate Professor of Applied Medicine and Rehabilitation Department

Indiana State University

ABSTRACT

Ankle ROM and proprioception are components of rehabilitation. Kinesio Tape (KT) is theorized to increase ROM and proprioception. KT is lacking in the literature in regards to proprioception and ROM more specifically in the ankle area.

OBJECTIVE: To investigate the effects of KT on ankle proprioception and ROM.

DESIGN: Pretest-posttest randomized group design. Participants were assigned to one of two groups (with KT and without KT). Both groups ankle ROM was measured in all directions and 4 trials of 20 seconds. Then a five minute rest for the control group or have KT application within 5 minutes as the experimental group. ROM was then re-measured

PARTICIPANTS: 35 healthy subjects, ages 18-40 with no history of ankle surgeries or unexplainable falls volunteered to participate. Volunteers were randomly selected and divided into two groups. (control group= 18, KT group= 17) with 15 males and 20 females.

RESULTS: ANOVA results indicated no significance difference between groups of pre OSI scores and the post OSI scores ($p= 0.40$). The homogenous values, there was no significant difference in the total means of the pre KT application when compared to the KT application. Levine's test indicated there was no significant difference ($p= 0.198$, $p= 0.156$).

CONCLUSION: Results suggest that KT has no effect on ankle proprioception and ROM. More specifically, research suggests positive outcomes for healthy individuals however; future studies should investigate KT effects on individuals with injured ankles. In order to fully understand the effect of KT on proprioception, further research should investigate injured and

non-injured effects on healthy, injured and different joints may aid practitioners in appropriate use of KT for treatment and rehabilitation for ROM and proproceptive deficits.

ACKNOWLEDGMENTS

Dr. Kahanov has been a lifesaver and has been a tremendous pleasure to have as my committee chair. She has given me great advice and guided me in the right direction throughout this research study. I have visited her office numerous times, but she has always had a positive attitude and willing to help answer any questions regardless of how busy she was. I could not appreciate her enough for how much she has been patient with me and provided me her perspectives that have shaped this project into what it has become.

Dr. Eberman, one of my committee members has provided me with vast knowledge on statistics. Her contributions to my thesis have been valuable throughout the process. I have always been amazed on how much she knows about statistics. Throughout my thesis she has provided me with her expertise and perspective that has shaped this project to what it has become.

Dr. Demchak, my other committee member, has guided me and given me several different ideas from a different point of view. Those ideas from Dr. Demchak has opened my eyes and made me recognize aspects of my study that I wasn't seeing. Dr. Demchak has given me input throughout these past couple of years that has been helpful and positive.

All of my classmates have been supportive and excited about my study. Some of them participated in my study and came to my thesis proposal and defense. I'm grateful to have those classmates and I appreciate all who volunteered in my study. Without the willingness of participants to volunteer, this study would not have been possible.

My family and Ricky have had a major role in my educational and willingness to continue with my Masters degree. The days that I was very frustrated or needed encouragement, they were willing to listen to me and offer advice that kept me motivated. They have listened to every story and everything thesis related for the past 2 years, which another reason why I appreciate them.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In the 2008 Beijing Olympic, Kinesio Tape (KT) was named the mysterious "tattoo tape" due to the unique taping technique.[6,8] Different sport athletes wore KT at the Olympics, most famously Kerri Walsh a beach volleyball player, highlighting KT as a treatment modality.[12] Additional sports such as track and field, basketball, hockey also supported KT use.[17] The media attention highlighted the taping technique for health care professionals such as medical, chiropractic and physical therapists.[17] KT unlike other taping techniques is thought to mimic the characteristics of human skin and therefore is touted as a more beneficial mediator of injury.[5,6]

KT was created in 1973 by a Japanese Chiropractor, Kenzo Kase.[7] KT is thin, cotton, fabric stretching up to 130-140% of its original length and then contracting to a normal length after application.[1] Theoretically, KT aides in pain control, edema reduction, muscle re-education, injury prevention, range of motion increase, and increases circulation to aid in the healing process.[1,3,4,6,8] Clinical investigations of these KT theories have determined some benefits to edema reduction and increased circulation.[6] Investigations of ROM have determined some benefits in increasing ROM immediately following the application.[4,6,8,19,22] However, due to the lack of information on proprioception and KT, more research is needed to investigate the efficacy of KT enhancing proprioception. KT has also been theorized to aid in increasing ROM. Studies investigated how KT effected pain management and edema reduction and identified

increases in ROM with associated decreases in pain and edema.[6] KT is also effective in increasing trunk ROM.[8] KT has been ineffective for increasing ROM in the lower back and neck.[4,8] Additional clinical research is needed to determine whether KT's effectiveness changes for different joints based on differing mechanoreceptors.

KT increases circulation which increases lymphatic flow.[3, 11,12, 25] KT has been theorized to lift the skin, which provides promotion for blood flow. Therefore causing an increase in the interstitial space to improve circulation and lymphatic drainage.[3,11,12,25] The increase in circulation signals an increase in the healing process.[3,11,12,25] Increasing the interstitial space causes the pressure on the connective tissue to be eliminated and decreases the subcutaneous pain receptors. For instance, clinical research on shoulder impingement suggests that a decrease in pain is due to the KT principle of increasing circulation by increasing the interstitial space.[1,19] Increasing of the interstitial space also substantiates theorized effects of edema reduction.[1,3] The additional interstitial space provides better lymphatic drainage and an increase in the healing process.[1,3,11] Studies on KT and edema reduction demonstrate positive effects on breast cancer patients and on lower limb injuries.[3,11,20] These positive effects indicate the use of KT for edema reduction and could be considered for clinical use.

KT proponents theorize that the tape enhances perceptual-motor sensitivity and may have proprioception benefits.[9] The application of the tape applies pressure to the skin and causes cutaneous mechanoreceptors stimulation.[9,16] In theory, KT will help to detect the movement of the joint and the joints position.[16] Studies indicate that KT is ineffective for proprioception at the ankle.[9,16] Based on the inconsistent findings with ROM and muscular responses to KT, proprioceptive effects may too be joint specific and dependent on variable mechanoreceptors.[16]

Therefore, more research is needed to assess proprioception and KT benefits on specific joints. The purpose of this study is to investigate the effects of KT use on propriopception on the ankle.

Research Question

In subjects with no history of ankle injuries or pathologies, what effect does KT have on ankle proprioception?

CHAPTER 2

REVIEW OF LITERATURE

Kinesio Tape Theory

Kinesio tape (KT) is a taping technique developed over 20 years ago by Dr. Kenzo Kase to mimic the characteristics of human skin.[5,6] KT created in 1973, and was introduced into the United States in the 1990's.[7] The 2008 Summer Olympics in Beijing accentuated KT use worldwide. When Kerri Walsh, a US professional volleyball player participated with a strange design of webbed tape on her shoulder.[12] Since 2008, many other athletes such as track and field, hockey and badminton use KT tape as a therapeutic intervention.[17] KT has become defined by the media as a "tattoo tape."[12,17] Although positive media attention and athlete gravitate towards KT exists, consistent research is lacking and use is based predominantly on theoretical constructs.

KT theoretically provides support to musculoskeletal structures while enhancing the physiological healing process. KT theory suggests benefits that enhance the physiological effects of healing by increasing the interstitial space between the skin and underlying connective tissue. The increased interstitial theoretically enhances circulation and assist in the removal of edema and lymphatic fluid,[3,6] The application of KT may also assist in pain management by facilitating joint and muscle realignment and enhancing joint stability.[1,3,4,5,6] K-tape theoretically increases metabolic activity by recruiting fibroblasts to the injured area hastening in

the healing process.[1] KT tape thus aids in promoting normal muscular movement and aids in maximizing collagen alignment during the remodeling phases of the healing process.[1] Lastly, K-tape is proven to enhance proprioception, strength and Range of motion in joints.[4,6-9]

Clinical investigations of KT theories in pain management, muscular strength, edema reduction has been conducted however, investigations of additional theoretical uses such as, other theories such as Range of motion and proprioception need more investigation. Research in management suggest significant improvement in neck pain following the application of tape and at a 24-hour follow up.[4] The KT neck study on the cervical spine is the only such study employing a placebo and KT application which indicates appropriate use, yet additional studies would triangulate and verify positive effects.[4] An investigation of KT and on the shoulder suggest a reduction in pain suggesting that KT has an effect of pain reduction.

In addition to pain reduction, edema reduction may also benefit from KT.[3,11] In two studies KT has demonstrated positive effects for edema reduction.[11,12] Edema reduction theory states that the skin is elevated up by the application of KT. Skin elevation promotes blood flow and lymphatic fluid return. Thus, increases in the interstitial space improves circulation and lymphatic drainage.[3,11,12]

The principles of lymphatic drainage through positively affect healing for breast cancer patients as well. KT for breast cancer compared the effects of a short-stretch bandage and KT application on edema reduction suggests that KT was efficient in removing edema.[3] Breast Cancer patients that wore a standard protocol bandage for the management of lymphedema and the other group wore KT instead of the bandage.[3] No significant difference in the amount of edema diffused between these two groups exist; however, KT's effect was positive and indicates potential for use in edema reduction.

The application of KT to increase strength suggests that both positive and negative results occur. Two studies investigated the strength of the quadriceps muscle with and without KT application.[13-15] A significant increase in muscular strength exists with the application of KT; however, the significant difference only during eccentric contraction.[13,14] No significant results exist for peak torque during concentric contraction of the quadriceps muscle.[15] Thus KT for eccentric strength gains, particularly for prevention and rehabilitation, replication of taping procedures may be necessary to ensure repeated results. Positive results included application to the anterior iliac spine and the ended at the tibial tuberosity.[15] Application of the tape from origin to insertion is supportive, which is theorized to improve contraction and increase muscle strength.[14,15] Tension in the direction of the muscle fibers may facilitate the strength of the underlying muscle.[9] Contradictory research suggests that quadriceps muscle group produces no difference in the strength in healthy individuals.[9] Therefore, the effectiveness of KT on strength has made an impact however, specific relationships between muscle and specific muscle contractions have not been identified nor has strength related to injured muscles.

The effect of KT on ROM is minimally researched. Studies investigated ROM, specifically cervical ROM and trunk ROM include the majority of research on ROM.[4,8] Both studies stated that improved ROM may exist however, further research is needed to support these findings. Minimal research presents when comparing healthy and non-healthy individuals.

Table 1. Kinesio Tape Research.

Theories	Authors that Support KT	Lack of support for KT
Increased ROM	Iglesias 2009, *Kahanov 2007, Walsh 2009, *Murray 2000	
Decreased Pain	Inglesias 2009, Tasi, C 2010, Thelen 2008, Chang 2012, Kaya 2011	*Firth 2010
Increasing Strength	Aktas 2011, *Murray 2000, Siupik 2007,* Beneka 2010,	Cheng Fu 2007, * Murray 2000
Edema Reduction	Tsai 2009, Stockheimer 2008, Jaraczewska 2006	

* Indicates study done on unhealthy individuals

Kinesio Tape Properties

KT is different from other types of therapeutic and preventative tapes in that it is latex free and is worn up to 3-4 consecutive days without removal. KT is a thin porous cotton fabric that consists of an acrylic adhesive. This elastic tape can stretch up to 130-140% of its original length and then contract back to its normal length after application, which is intended to mimic the properties of skin.[1]

Kinesio Taping Techniques

Various KT techniques exist to apply the tape dependent on the shape and the size of the targeted muscles. One method of KT is intended to separate the fascia and the skin using the

tape elasticity to create convulsions on the skin. With the stretch held, the tape is applied to the skin without any stretching involved (Figure 1).[1] After the application of tape the muscles relax in their normal position and then convolutions are formed between the skin and the tape.

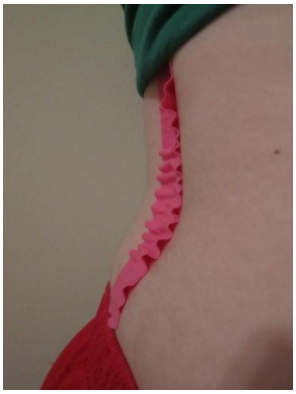

Figure 1. Tape Convolutions

The shapes and application techniques for KT differ depending on the purpose. KT taping requires similar techniques which include I,Y,X-shaped tape applications (Figure 2).[10] I-shaped tape is used for smaller areas such as teres minor, whereas, Y-shaped tape is used for larger muscle areas such as the deltoid muscle and X-shaped tape is used for large and long areas such as the triceps muscle.[10] Sometimes depending on the treatment or the shape or size of the muscle multiple strips or combined application techniques are required.[10]

Figure 2. X, Y, I-Shaped Tape

For optimal effectiveness, the skin should be dry and hairless. The skin should be devoid oils or lotion to enhance adhesion effectiveness.[10] K-tape anchors are applied at both ends of the targeted treatment area. KT is applied to the muscles insertion and origin without tension to avoid any skin irritation and decrease inflammation and pain. The desired level of tension in the tape should occur once the base is secured to the skin.[5,6] The application of KT for muscular support is applied with medium to maximal tension (50-100%) on the targeted area and the joint position should be maintained in a neutral, functional position.[10] The KT support technique may also limit the muscle elongation that contributes to pain.[10] The same KT support technique is used to enhance joint range of motion and inflammation. The application technique requires the practitioner to apply KT at the origin of the muscle and end at the insertion with a slight tension (15%).[10] To enhance range of motion the taping technique is done in the presence of muscle weakness.[10] Muscular strengthening requires light tension (15%) and will be applied from origin to insertion.[10] Following the application the theory is the tape contracts, providing support to weak muscles during movements of the joints that it spans.[10] Appropriate application of KT is essential to the desired outcomes. Furthermore, a trained clinician should apply the application of KT.

Research in Kinesio Tape Efficacy

Kinesio Tape on ROM

KT has been theorized to improve range of motion through the function of tape. Clinical research on KT has occurred in two categorical areas, health and non-healthy individuals. Research on healthy subjects suggests positive outcomes in the area of flexion. Two particular studies researched the effects of KT on cervical patients with neck pain and lower back range of motion on healthy individuals. In one study thirty healthy subjects that had no previous history of

lower trunk injury or pain in past six months.[8] Trunk range of motion was measured on healthy subjects with the application of KT and without the application of KT.[8] The Y-shaped tape was applied from the origin of the sarcospinalis to the insertion and after the application the trunk range of motion was measured. In healthy individuals, a significant difference in trunk range of motion existed.[8] Differences in range of motion were identified in flexion however, no significant differences were found for extension and lateral flexion.[8] The data suggest that significant differences in range of motion has been found exists, however, the disease and tissue healing process of non-healthy individuals may impact KT outcomes and therefore must be assessed to determine the veracity of KT theoretical models. Clinical investigation has been conducted on healthy individuals as in the case of trunk range of motion; however, more research is needed in order to compare healthy individuals with non- healthy individuals. Research on KT's effectiveness including injured individuals has also identified benefits.[4] Studies that focused on pain management and edema reduction indicate an increase in ROM secondary to pain and edema reduction.[6,19] The effects of Cervical KT for pain and for ROM in individuals with acute whiplash suggest that ROM will improve following a decrease in pain.[4] Researchers applied KT and a sham KT to applicants with whiplash. The results exhibited a significantly greater improvement in all directions of cervical range of motion both immediately following application of the tape and at a 24-hour follow-up, when compared to the placebo group receiving a non-tensioned KT application.[4] KT improving range of motion on healthy subjects demonstrates the effectiveness of KT in the clinical setting. The basis of ROM improvements using KT techniques in the foundation for the current research study to assess ankle range of motion when applying KT, particularly since the ankle joint has yet to be investigated.

Studies regarding cervical range of motion and shoulder pain have demonstrated the same improvements. KT had a positive effect on ROM when limited by musculoskeletal shoulder pain.[6] Shoulder ROM measurements forward flexion, abduction, and scapular plane elevation were assessed for individuals who had a primary complaint of shoulder pain. Results suggest that differences in pain reduction do not exist between the Sham KT group and the therapeutic group at baseline. However, difference at day one in shoulder abduction on the therapeutic group were significant.[6] Increased Range of motion for unhealthy individuals treated with KT suggests positive effects compared to healthy individuals. Research also suggests positive effects on ROM for healthy individuals that may be applied for performance enhancement.

Kinesio Tape on Pain Perception

KT use to control pain is a purported theatrical use that has been demonstrated effective through investigation of injured patient. Patients have exhibited significant improvements in neck pain following the application of KT.[4] Furthermore, the improvements in cervical pain are similar to those identified in a previous clinical study investigating effectiveness in subjects with shoulder pain.[6] Improving pain free ROM was identified for patients with shoulder pain to increase shoulder abduction immediately after the application of KT. No short term or long term benefits were identified to the decrease in pain.[6] Additional research had identified the same significant results on pain however, only in five patients having shoulder problems.[19] A study on baseball pitchers with medial epicondylitis indicates that KT raised the pain tolerance and reduces pain pressure.[22]

Two mechanisms of pain describe the decrease in pain in injured individuals. One mechanism includes the lifting effect by KT creates a reduction in pain by improving the circulation under the injury area.[2, 22] Another mechanism includes reducing the tension in the

muscles and myofasia when applying the KT. KT reduces the stimuli to the mechanoreceptors in the skin, and subsequently then relieves the pain.[2,22] Pain management on unhealthy individuals demonstrates that there are positive outcomes however one study on individuals with Achilles Tendinitis indicates that there is no improvement in pain. The evidence towards pain management performed on unhealthy subjects demonstrates a low level of support.[6] Pain is a complex system which may be affected by KT treatment differently on differing injuries, body locations and personal experiences. The need for further investigation is warranted however, the positive effects of the clinical studies demonstrate effectiveness on unhealthy subjects for cervical spine and shoulder. Research on KT and pain management on healthy individuals is difficult due to minimal studies on KT's pain reduction theories. The quantity of research on healthy individuals is lacking however, when comparing the two, unhealthy individuals demonstrates a significant improvement to substantiate pain reduction theory of KT.

Kinesio Tape on Proprioception

The effectiveness on KT has been presented in many cases in healthy individuals. Research demonstrates that KT enhances the perceptual- motor sensitivity of proprioception.[9] The application of KT applies pressure to the skin, stretching the skin causing a stimulation in the cutaneous mechanoreceptors. In addition to stimulating the mechanoreceptors, KT is anticipated to provide a facilitory effects in detecting joint movement and joint position.[16] The effects of proprioception on 30 healthy individuals and investigated individuals wearing KT and reproduce joint position sense with plantar flexion and lateral movements suggests that there will be an increase in the cutaneous stimulation that is received from the KT.[16] The reproduction of the position sense was measured in the subject's ability to actively recreate a targeted position.[16] Taped and non-taped ankles were compared for both movements and the results suggest that

there was no change in either of these measurements of plantar flexion or inversion.[16] No significant differences in joint replication of 260 degrees of plantar flexion and 80 degrees of dorsiflexion, suggesting that proprioception is not significantly affected by KT.[21] Although only two studies exists assessing proprioception in healthy individuals there is currently not any studies clinical researched on unhealthy individuals. Research that is based on proprioception is limited however, more sufficient information will be needed in the future.

Balance

Ankle sprains are among the most common type of injury in athletics.[24] Proprioceptive deficits occur when there is trauma to the sensory nerve fibers along with ligament damage.[24] Proproceptive damage can cause an injury to become chronic ankle instabilities. Proprioceptive deficits is a component of an evaluation and may answer numerous questions about the effects of an injury.[26] Balance consists of static balance and dynamic categories. Most research in the literature investigates static balance. Static balance is obtained under stable conditions in which no motion occurs; however, many athletic activities create a dynamic environment. Therefore, dynamic balance is defined as the body creating an equilibrium under conditions which causes the center of gravity to move in response to the body's muscular activity.[24] In response to dynamic balances the body's gravity, ground reaction forces and momentum on the ankle are affected. The ability to engage both static and dynamic balance is necessary for activities of daily living and athletic performance.

Biodex medical system launched a stability system that presents as a device that measures and records an individual's ability to measure and maintain joints in a dynamic stress position on an unstable surface.[24,27] The unstable surface is a circular platform that can tilt 20 degrees in any direction. The directions that the platform is free to move are anterior- posterior

(AP) and medial-lateral (ML) axes simultaneously.[24,27,28] These actions permit the ankle joint mechanoreceptors to stimulate to the maximal potential. During dynamic conditions the Biodex Balance System (BSS) measures in degrees, the tilt in each axes and calculates a medial-lateral stability index (MLSI), anterior-posterior stability index (APSI), and an overall stability index (OSI).[24,27,28] These indexes represent a fluctuation around a zero point rather than around a group mean.[24,28]

In addition, to the movement of the axes and degrees in the tilt, the stability of the platform can vary by the resistance force applied to the platform. Springs apply force to underside of the platform. Eight springs are located at the perimeter of the balance platform.[24,27-29] Each spring was made from music wire and was 13.97 cm in length (Figure 3). The springs can be adjusted to provide a resistance level of 1 to a resistance level of eight. The order of the resistance would decline from the most amount of resistance to the least amount of resistance. Therefore, the lower amount of resistance present, the less stable the platform will be.

Figure 3. Biodex® Balance System

To this date, only a few studies exist on BSS validity and reliability.[24,26] Pincivero et. al suggests that the BBS system is a reliable device across test trials in healthy college students.[26] The resistance was set at level two out of 8 possible, the interclass correlation coefficient for the OSI was R=.60 when testing on the dominant and nondominant leg.[26] The interclass correlation

coefficient at the highest level of stability was R=.95 for the dominant leg and R=.78 for the non-dominant leg.[26] When compared to Cachupe reliability increases across eight trials of active college-aged men and women.[24] This study found that reliability estimates were higher for OSI measurements when compared to Pincivero.[24] The overall stability index measuring a reliability of R=.94 for all eight trials.[24] While measures for APSI were spread out at R=.56-.90 and MLSI measures were reliability is R=.76-.88 throughout all eight tirals.[24] Looking at the other two indexes when using the BSS (medial-lateral and anterior-posterior), Schmitz and Arnold indicates that the intratester reliability of R=.80 for APSI and R=.43 for MLSI.[28] The intratester reliability for the OSI reports at R=.82, while the intertester reliability reports at R=.70.[28] Therefore, when observing the indexes, Schmitz and Arnold concludes that the most reliable index measured is the OSI. The measurements taken for the OSI were significantly higher than those of APSI and MLSI. This information demonstrates that at level 2 there is high reliability of the BSS measures of dynamic balance. In addition the validity of the BSS has yet to be assessed. More information is needed on the validity of the BSS. In conclusion, the BSS is a reliable balances system in regards to the OSI then in regards to the MLSI and APSI.

Goniometer

Range of Motion refers to "the number of degrees of motion that are present in a joint."[30] The need to assess range of motion (ROM) was first identified after World War 1, the disability and pension boards demanded specific criteria for determining injuries among soldiers. Since that time, medical professions use goniometers and other instruments to assess the baseline limitations of motion, assess dysfunction, decide on therapeutic interventions, and evaluate treatment effectiveness.

Obtaining joint ROM measurements can be obtained through many instruments.[33] However, they fall into two general classifications. The first goniometer is a universal goniometer. The universal goniometer measures all joints of the body to obtain the range of motion.[33] The universal goniometer is described as a protractor and at the center is two long slender arms or projections are attached.[33] One of these arms may be movable and will be placed parallel to anatomical lever arm of the location of the body. The protractor will be located over the joint axis of motion. The range of motion will be read from the protractor at the point where the moving arm bisects.[33] For the purpose of this study the universal goniometer will be used when obtaining measurements primarily because it is currently the gold standard.

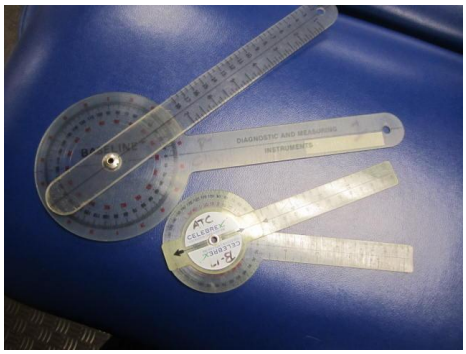

Figure 4. Universal Goniometer

Objective measurements of ROM and interpretation of the result can have a substantial impact of the scientific basis of therapeutic interventions. Therefore, reliability in goniometry is the consistency or repeatability of the ROM measurements and whether the application of the instrument and procedures are consistent under the same conditions.[32] Articles published in 1949 demonstrated the importance of the goniometer and the standardized clinical procedures for measuring ROM.[32] The goniometer is reliable based on past research; however standardization of procedures is required.[32] Differences among motions measured are impacted by the methods

of application, and variations among different patient types.[32] Intratester reliability is higher than intertester reliability and therefore consistency in tester is optimal. The data suggests that intratester reliability of the goniometer is R=.90 and intertester reliability is R=.70 in subjects testing with knee and ankle ROM.[32] A study regarding the goniometer and orthoranger demonstrates that measurements with the goniometer indicate a higher ICC than the Orthoranger for all motions except hip lateral rotation.[31] The data indicating that the ICC of the goniometer is greater than .90 for most of the measurements.[31] All this data suggests that the goniometer is reliable however, other factors may influence the reliability.

Clinicians using the goniometer, must be confident that the goniometer and measurement procedures are accurate and that clinicians understand measurement result meanings. Measurement procedures must therefore be consistent with in clinicians interpretation of the results.[32] Validity of a measurement is the degree to which an instrument measures what the instrument was intended to measure and the validity of ROM measurements are specific to application techniques. For example, in the extremities ROM is recorded in degrees, whereas factors that affect ROM will be measured by different methods with different measurement units.[32] In order for goniometer measurements validity, the measurements must be reliable. If the measurements are not reliable then the measurements ensure the fact the measurement is not valid. Further research is needed to investigate the amount of validity on the goniometer. However, the information presented many clinicians base the reliability on the accurate alignment of the goniometer. With the accurate alignment and application of knowledge and skills, and interpretation of the results provides evidence to ensure the validity of the goniometer and therefore the goniometer will be used in the current study to assess ROM.[32]

Conclusion

KT application may improve multiple functions of the body such as pain, inflammation and ROM. KT use and the effect on acute and chronic cases vary in the literature based on healthy or unhealthy individuals. KT studies provide evidence of the need to investigate the tape, particularly on multiple joints and for healthy compared to injured individuals. Limited research in the theoretical implications of KT application suggests a need for further assessment, particularly when respect to different joints to ensure that positive or negative outcomes are not relegated to joint mechanoreceptors or articulations.

CHAPTER 3

METHODS

Kinesio tape (KT) use for treatment and rehabilitation has expanded over the past 10 years for use by occupational therapists, physical therapists, athletic trainers, and other trained health professionals to achieve positive outcomes through the treatment of joint sprains, joint instability, soft tissue inflammation, muscle weakness and pain.[20] Theoretical effects of KT include edema reduction, pain reduction, muscular strength, the circulation of blood and the effects on the healing process.[1,4,6,8] KT has also been suggested to improve proprioception however, studies describe KT as an increase in proprioception through an increase in stimulation of the cutaneous mechanoreceptors.[16] Little evidence exists to justify the use of KT for proprioceptive benefits however, theoretical effects of the mechanoreceptors may be of benefit for balance.[16,20] Mechanoreceptors stimulation occurs through the application of pressure and stretching the skin, much like the properties of KT application.[16] The sense of stretching is thought to possibly signal information of joint movement and sense.[16] Therefore, the purpose of this study is to determine the effects of KT application on ankle proprioception and ROM.

Study Design

A pretest-posttest randomized groups design is going to be used to assess KT effects on ankle proprprioception. The independent variable is KT application. The dependent variables

are ankle ROM measured by a goniometer and proprioception measured by the Biodex® balance system (Figure 5).

Figure 5. Biodex® Balance System

Participants

Thirty healthy subjects will be screened using a health questionnaire (Appendix B), which requests the age gender and pertinent health history to exclude those with medical issues related to vertigo and heart conditions. Additional exclusion criteria includes subjects with a previous history of ankle injuries or surgeries. Subjects in the researcher's classes will also excluded from the study. Participants for the following study will be recruited through the placement of fliers/ads on the Indiana State University campus. An approved informed consent (Appendix D) from Indiana State University Institutional Review Board will be provided to the complete subjects prior to the study.

Instrumentation

Balance

The Biodex® Balance System BBS measures and records a subject's ability to maintain stability under dynamic stresses. The system uses a circular platform that moves anterior-posterior and medial- lateral simultaneously (Figure 6).

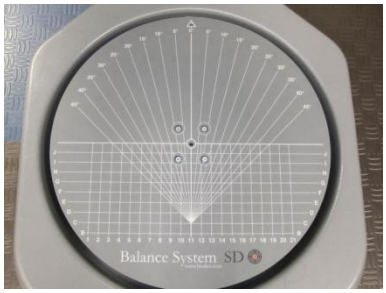

Figure 6. Biodex® Circular Platform

The BBS has 20° of foot platform tilt and then calculates three separate measures: Medial-Lateral Stability Index (MLSI), Anterior-Posterior Stability Index (APSI), Overall Stability Index (OSI). The stability can be adjusted by the level of resistance of the springs underneath and around the edges of the platform.[24] The reliability of measures indicates that the OSI was the most reliable measure of dynamic balance.[24] The ICC for OSI measures was R=.60 for testing on the dominant and non dominant leg. Another study concluding that the OSI for eight trials was reliable with a R=.94.[24]

Range of Motion

The primary purpose of a goniometer is to measure the ROM of the musculoskeletal system of the human body.[32] The goniometer is currently the preferred clinical instrument for ROM.[33] Comparing the intra and intertester reliability, the data suggests that the intratester reliability was R=.90 and intertester reliability of R=.70.[32] The clinical information demonstrates that the goniometer is a reliable instrument to take ROM measurements. The validity of ROM measurements is very specific to the type of measurements are being taken. There are many factors that can affect ROM and if the goniometer is reliable then due to the information the goniometer must be valid. The goniometers design was based off of the protractor that represents accurately the degree intervals of a circle. A relationship with concurrent validity establishes that even though systemic errors occur with the goniometer proper adjustments can

be made. The goniometer is limited to the degree units of a circle however, clinicians accept the movements that fixed axes of motion of which movement occurs.[32] ROM measurements are closely approximate around a central point and therefore ROM measurements with a goniometer are clinically valid.[32] Other factors that make ROM valid is the anatomical knowledge of the visual inspection, palpation of bony landmarks, and accurate alignment of the goniometer.[32] Accurate application of knowledge and skills with the interpretation of the results provide evidence to ensure content validity of the goniometer.[32] Accurately locating anatomical landmarks and aligning the goniometer with the correct landmarks will manipulate the reliability and validity to an extent.[32] For the purpose of this study the clinician will be knowledgeable and will have accurate alignment of the goniometer to demonstrate the most accurate and precise validity. The clinician will try to minimize the limitations of validity for the goniometer.

Kinesio Tape

KT is a different type of therapeutic and preventative tape in theoretically KT provides support to the musculoskeletal system. This specific type of tape enhances the physiological healing process by increasing the interstitial space between the skin and the underlying connective tissue. KT is latex free and is worn 3-4 consecutive days without removal. KT is a thin cotton fabric that consists of acrylic adhesive.[1] Studies in the past indicate that KT has been used for pain management, edema reduction, muscular strength.[1,3-6,11] For the purpose of this study, KT will be used for proprioception at the ankle.

The shapes and application techniques for KT will differ depending on the purpose. KT taping techniques include I,Y,X-shaped tape applications.[10] I-shaped tape is used for smaller areas such as rhomboid minor, whereas, Y-shaped tape is used for larger muscle areas such as

pectoralis major and X-shaped tape is used for large and long areas such as the biceps muscle.[10] Four I-shaped strips will be used to provide ankle stability during the study.

The purpose of this application was to provide the ankle with stability and support the muscles of the ankle upward till the shin. Subjects will be taped for a lateral ankle sprain in accordance to the Kinesio Taping Association. The stability will provide a increase or change in the cutaneous sense of the ankle joint position.[16] The theory behind providing stability was proprioception following an orthopedic injury is a major clinical rehabilitation goal. The increase in the somatosensory stimulation may assist proprioceptive input through the KT. These actions may enhance the athlete's or patient postural control system and facilitate an earlier return to play.[16]

Procedures

IRB approval will be obtained before the recruitment of the participants. Advertisement for the study will consist of displaying a flier throughout campus and in classrooms. Visiting classrooms and asking for volunteers is an alternate approach to obtaining subjects that we might use if 30 volunteers are not obtained after 2 weeks of advertising. The goal is to recruit 30 subjects for two groups of 15. Subjects will be randomly assigned using an automated computer system where each subject was given an automated identification number that the researcher will use throughout the study to maintain confidentiality and anonymity. On the first day of the study, participants complete the health history forms and consent forms prior to assigning to a group. Participants who have not had an ankle injury in the last five years or individuals with balance or heart disease will be excluded. The researcher will then assess the subjects ankle ROM using a goniometer in both groups.

Range of Motion

ROM measurements will include a goniometer that will take measurements on the subjects ankle in all areas of motion. The goniometer is an inexpensive instrument that requires the greatest degree of technical proficiency, due to aligning the axis with the joint fulcrum and positioning the two arms with reference points .[35] For the purpose of this study dorsiflexion, plantarflexion, inversion and eversion will be measured before and after the application of KT and the use of the BSS.

Maximal dorsiflexion will be measured in a weight bearing position (lunge) using a standard 7 inch, flat, clear plastic goniometer with 2 degree increments.[35,36] The weight bearing lunge will be performed with the subject in a standing position with the heel in contact with the ground, the knee will be aligned with the second toe and finally the great toe will be 10 cm from the wall.[35] The balance of the subject will be maintained by allowing two fingers from each hand to maintain contact with the wall. Participants will be asked to lunge forward, directing their knee to the wall until their knee touches the wall. This position will be tested three times and recorded. Prior to measurement the goniometer will be zeroed out relative to the horizontal by aligning the goniometer with the wall that was perpendicular to the floor (90 degrees). The stable arm will be aligned with the floor and the mobile arm will be aligned with the shaft of the fibula by bisecting the lateral malleolus and the fibular head.[35] (Figure 7) Measurements will be made on the participants dominant leg.

Figure 7. Maximal Dorsiflexion

The positions of inversion and eversion will be measured in the prone position. The researcher will position the subject prone and then align the goniometer with the longitudinal midline of the posterior calcaneus. The researcher will then ask the subject to maximally invert their ankle (Figure 8). The measurement of inversion will be taken three times. The researcher will then position the goniometer again and ask the subject to maximally evert the ankle (Figure 9). Measurements will then be performed three times and recorded. (Figure 8, 9)

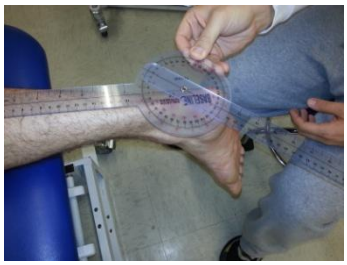

Figure 8. Maximal Inversion.

Figure 9. Maximal Eversion.

The final position that measurements will be taken is plantar flexion. The subject will be sitting with the passively knee flexed to at least 30 degrees. The researcher will align the fulcrum over the lateral mallelous, making sure that the fulcrum is centered. The stationary arm of the goniometer will then be aligned with the long axis of the fibula. The movement arm will be parallel with the long axis of the fifth metatarsal. The subject will then be asked to push their foot down as if pushing onto a gas pedal as far as they can go (Figure 10). The measurement will then be taken, the subject will relax and three more measurements will occur and will be recorded.

Figure 10. Maximal Plantarflexion.

Balance Assessment

The Biodex® Balance System (BSS) is a multiaxial device that objectively measures a subjects ability to stabilize the involved joint under dynamic stress.[24] The BBS uses a circular platform that measures the anterior-posterior and medial-lateral axes simultaneiously.[24] To begin, prior to the balance testing the BBS will be calibrated and information on the participants dominant foot will be gathered. Participants will then stand on their dominant leg while the platform is locked. The platform will then be unlocked to allow motion of the platform. Subjects will adjust the supporting foot until they identify where platform stability is maintained.

The subjects will be instructed that the platform will be moving and will indicate to the researcher when they believe they have found a stable position. The researcher will describe a stable position as feeling that they feel centered without holding onto the side railings. Subjects will then be instructed that prior to stepping on the BSS that balance will be maintained through a visual cue on the screen of the BSS. The platform will then be locked again. The trial will began when the platform releases and subjects maintain an upright standing-position on their dominant leg. The unsupported leg will be in a comfortable flexed position. In order for the trial to be completed the subject had to maintain their balance for 20 seconds. If the subjects unsupported leg was put down on the platform, the trial started over and no information will be recorded. Testing will be repeated for four trials with a minute rest in between each trial. The subjects will then have five minutes to either rest as the control group or have KT applied as the experimental group. The five minutes will allow the KT adhesive glue to activate and trigger cutaneous mechanoreptors to convey information regarding joint movement and position.[16] Testing will repeat for another four trials or until the subject reports they are fatigue and do not wish to continue. The subjects scores will be assessed through the Biodex® system and the subjects scores will be printed and recorded. The participants range of motion will then be measured again after the use of the BSS.

KT Application

For treatment, four strips will be applied to the subjects' dominant ankle to stabilize the joint. KT application will be performed by the same clinician during the span of the experiment. However, KT application will occur after the first four trials on the Biodex® system for the experimental group. KT application will not occur for the control group.

KT Preparation

Before the application of tape, KT will be cut into appropriate shapes and lengths for each of the subjects' in the KT group. Each corner of the tape will be rounded and make a I-shape. Four I- shaped strips will be used in order to provide ankle stability.

KT Application

KT will be applied by a trained clinician after four trials on the Biodex® Balance System. Before the tape application, the anterior, posterior, medial and lateral aspects of the ankle will be cleaned with gauze soaked in rubbing alcohol. The subjects legs will be shaved for both men and women on the anterior portion of the lower leg and ankle area. For the four I-shaped strips of KT, the subject's foot will be placed in a relaxed position on the taping table with the ankle in slight plantar flexion. First an "I" strip of 16 inches will be placed from the anterior midfoot with approximately 115-120% of the maximal length and then attached just below the tibial tuberosity over the tibilais anterior muscle.[16,34] After the application of the KT, the researcher will gently rub over the tape to activate the glue.

Second, another "I" strip of 16 inches will be applied just above the medial malleolus and will wrap around the heel like a stirrup and attach just lateral to the first strip of tape. The second strip will extend to the outer side of the calf.[34] The foot will still be in a relaxed position while applying the second KT strip. The third "I" strip of 6 inches will be stretched across the anterior front of the foot with the pointing of the great toe. The strip will cover both the medial and lateral malleolus and will be stretched with the same stretch as the first two strips.[34] Finally, the fourth "I" strip will be 12 inches in length and will originate at the arch of the subject. The strip will then be slightly stretched, lifting the arch of the foot in an upward direction.[34] The final

"I" strip will measure approximately 4 to 6 inches above both the medial and lateral malleolus. The strips will then be rubbed gently again to activate the glue.

The purpose of this application was to provide the ankle with stability and support the muscles of the ankle upward till the shin. Subjects will be taped for a lateral ankle sprain in accordance to the Kinesio Taping Association. The stability will provide a increase or change in the cutaneous sense of the ankle joint position.[16] The theory behind providing stability was proprioception following an orthopedic injury is a major clinical rehabilitation goal. The increase in the somatosensory stimulation may assist proprioceptive input through the KT. These actions may enhance the athlete's or patient's postural control system and facilitate an earlier return to play.[16]

Figure 11. First "I" Strip.

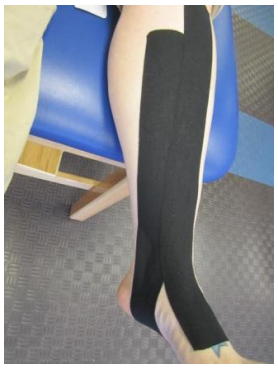

Figure 12. Anterior Second "I" Strip.

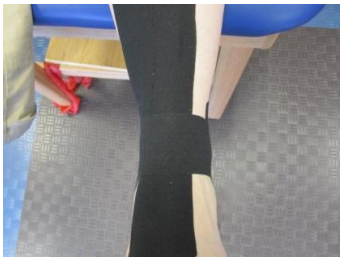

Figure 13. Third “I” Strip.

Figure 14. Lateral 4th “I” Strip.

Statistical Analysis

Descriptive analysis of the pre and post-test measurement information will be assessed using mean, frequency, and standard deviation. In addition, descriptive analysis will be used for personal characteristics of the participants such as age and gender. ROM and proprioception between the two groups will be analyzed using means and standard deviation. An ANOVA will be used to assess the significance between ankle proprioception with and without KT. Significance will be set at $p<.05$.

CHAPTER 4

MANUSCRIPT

Introduction

Kinesio Tape (KT) is a therapeutic taping technique developed as a treatment and rehabilitation technique for orthopedic injury.[7] KT is theorized to improve a variety of maladies associate with injury, including decreased range of motion, proprioception and pain.[8,16] Specifically, KT is theorized to aid in pain control, edema reduction, muscle re-education, injury prevention, range of motion increase, and increased circulation to aid in the healing process.[1,3,4,6,8] Clinical investigations suggests benefits of KT include edema reduction and increased circulation.[3,6,11,12,25] Research regarding ROM suggest some increases immediately following application, mainly related to pain reduction,[4,6,8,19,22] however; due to the lack of empirical evidence regarding KT related proprioception increases, more research is warranted to assess efficacy.

Current research on KT effect on ROM have included pain management and edema reduction to identify increases in ROM with associated decreases in pain and edema.[6] KT is also effective in increasing trunk ROM.[8] KT has been ineffective for increasing ROM in the lower back and neck.[4,8] Additional investigation is warranted to determine whether KT's effectiveness is related to differences in anatomical joints.

KT proponents theorize that the tape enhances perceptual-motor sensitivity and may have proprioception benefits.[9] The application of the tape theoretically applies pressure to the skin and causes mechanoreceptors stimulation.[9,16] In theory, KT assists in detection of the joint position.[16] The literature indicates that KT is ineffective for proprioception at the ankle.[9,16] Based on the inconsistent findings regarding ROM increases relative to anatomical joint, proprioceptive effects may be joint specific and dependent on variable mechanoreceptors.[16] Therefore, this study investigated the effects of KT use on proprioception on the ankle.

Methods

To assess the effect of kinesio tape on ankle proprioception, a pretest-posttest randomized-groups design assessed KT effects on ankle proprioception using a Biodex® balance system (BSS). Thirty five subjects, 15 male and 20 females volunteered to participate in the study. Participants with previous ankle surgery or balance issues were excluded. The research was approved by the Institutional Review Board at Indiana State University and all participants signed an informed consent form prior to the experiment.

Instrumentation

The BSS recorded measurements of a participant's ability to maintain stability under dynamic stresses. The BSS provides three separate measures: Medial-Lateral Stability Index (MLSI), Anterior- Posterior Stability Index (APSI), Overall Stability Index (OSI). The OSI was is identified as the most reliable of dynamic measures and therefore used for statistical analysis in this study.[24] The OSI for eight trials indicated a R=.94 and therefore we choose to conduct eight trials on each participant for balance.[24]

We employed a goniometer to measure ankle dorsiflexion, plantar flexion, inversion and eversion. The goniometer is currently the preferred clinical instrument for ROM.[33] Previous studies indicate that the intratester reliability is R=.90 and intertester reliability is R=.70.[32] The reliability of the instrument justified use in the study to assess ankle ROM by one researcher.

Procedures

Prior to measurement sessions, participants were randomly assigned identification numbers and an experimental group. A computer program which randomly assigned identification generated the identification numbers and the random placement into two groups, control (n= 18), and KT groups (n= 17). Participants selected an appointment time and date from an available range for a session with the researcher. During the appointment the ankle ROM was assessed for each participant regardless of group, using a. For the purpose of this study, dorsiflexion, plantarflexion, inversion, and eversion were measured before and after the application of KT and the use of the BSS for both groups. After the removal of the KT and the use of BSS, measurements were taken and recorded.

The use of dorsiflexion was measured using the knee-to-wall principle in which the participants performed a weight-bearing lunge (Figure 7).[35] The weight bearing lunge was performed with the participants in a standing position with the heel in contact with the ground, the knee aligned with the second toe and the great toe 10 cm from the wall.[35] Participants were asked to lunge forward, directing their knee to the wall until their knee touched the wall. This position was tested three times and recorded.

The positions of inversion and eversion were measured in a prone position (Figure 8,9). The researcher positioned the participant prone, aligned the goniometer and then asked the participant to maximally invert their ankle. The researcher then positioned the goniometer again

and asked the participant to maximally evert the ankle. Measurements were conducted three times and recorded.

To measure plantarflexion ROM, the participant was seated position with the knee passively flexed to at least 30 degrees. The participant was asked to push their foot down as if pushing down onto a gas pedal as far as they can go to assess ROM. The measurement was taken, the participant relaxed and three more measurements were obtained and recorded.

Balance Assessment

Participants then stood on their dominant leg while the platform was locked. The platform was then unlocked to allow motion. While the participants adjusted the supporting foot until they identified where platform stability was maintained. Participants were instructed that the platform would be moving and that they needed to indicate to the researcher when they believed they had found a stable position. The platform was then relocked. The trial began when the platform released and participants maintained an upright standing-position on their dominant leg. To complete the trial, participants had to maintain balance for 20 seconds. If the participant's unsupported leg was placed back on the platform, the trial started over and no information was recorded. Testing was repeated for four trials with a minute rest between each trial. Participants had five minutes of rest for the control group or have KT application within 5 minutes as the experimental group in order to maintain time consistency. Testing was repeated for another four trials with both groups or until the time the participants reported they were fatigued and did not wish to continue. Balance scores were saved in the BSS computer system and transferred to SPSS for statistical analysis. After balance testing, range of motion was then re-measured for both groups.

KT Application

Participants were taped for a lateral ankle sprains in accord with the Kinesio Taping Association guidelines based on the supposition that the technique provides ankle joint stability and position sense.[16]

Prior to application, KT was cut into appropriate shapes and lengths for each of the participants in the KT group. Each corner of the tape was rounded and made four I-shaped strips which were used to provide ankle stability.

Before the application, the anterior, posterior, medial and lateral aspects of the ankle were cleaned with gauze soaked in rubbing alcohol. Both male and female participants' legs were shaved on the anterior portion of the lower leg and ankle area. Each participant's ankle was then placed in a relaxed position on the taping table with the ankle in slight plantar flexion. First an "I" strip of 16 inches was placed from the anterior midfoot with approximately 115-120% of the maximal length and then attached just below the tibial tuberosity over the tibialis anterior muscle.[16,34] After the KT application, the tape was gently rubbed to activate the glue.

Second, another "I" strip of 16 inches was applied just above the medial malleolus and wrapped around the heel like a stirrup and attached just lateral to the first strip of tape. The second strip extended to the outer side of the calf.[34] The third "I" strip of 6 inches was stretched across the anterior front of the foot with the pointing of the great toe. The strip covered both the medial and lateral malleolus and was stretched with the same stretch as the first two strips.[34] Finally, the fourth "I" strip was 12 inches and originated at the arch of the participant. The strip was then slightly, stretched, lifting the arch of the foot in an upward direction.[34] The final "I" strip measured 4 to 6 inches above both the medial and lateral malleolus. The strips were then rubbed gently to activate the glue.

Results

The average age of participants in the control group was 22.40 ± 2.38, and the average age of the experimental group was 22.43 ± 2.64 (Table 2). The average height of participants was a range of 65-71 inches. Results indicated that the average plantarflexion and dorsiflexion total arc were similar for both measurements of the control (mean= 84.81) and experimental group (mean=88.98) (Table 3).

An ANOVA of the means between groups indicated no significant difference between groups of the pre OSI scores and the post OSI scores ($F_{1,34}$=.003, p=0.95). The overall range for the pre OSI score between groups was 2.480 and for post OSI was .623. These values represent the OSI scores of participant's average trials on the BSS. The scores representing the overall deviation in degrees from a stable zero that was established prior to the release of the platform. The lower the score indicates a greater BSS stability.

A comparison of the homogenous values indicated no significant difference in the total means of the pre KT application when compared to the KT application. Levine's test indicated no significant difference between any of the groups (P=.073) suggesting homogeneity of groups. The data also indicated no significant difference between the range of motion in the beginning of the trials and the ROM measurements at the end (P=.198, P=.156). Therefore, when analyzing the data there was no change from the control group to the experimental group in any areas of this study.

Discussion

Results indicated no significant differences in OSI scores, and ROM between no-tape and Kinesio taped conditions in all measurements suggesting that proprioception and ROM are not affected by the application of KT. Our results are similar to a previous study indicating no significant differences in joint position sense when compared to an increase in ankle ROM.[16] Our results indicating that Kt has no effect on proprioception adds to the inconclusive literature.[16,21] Results on ankle proprioception and KT are-varied, yet literature regarding muscle and joint mechanoreceptors contribute to proprioception when taping and bracing are used, suggesting that some benefits of superficial stimulation exists.[16,21,39,41] Our findings however, do not substantiate the global literature on superficial stimuli affecting proprioception. Although previous studies on healthy individuals are inconclusive[16,21] KT proprioceptive effects on injured individuals and should be further investigated

ROM results suggest a lack of ROM affect with the use of KT on the ankle, which is consistent with some of the literature.[16,42,43] Research on KT enhanced ROM on multiple anatomical joints indicate that joints such as the spine and neck improve incur improved ROM with KT, yet joints such as the ankle and knee do not. Potentially, the mechanoreceptor present in different joints may explain KT effects on certain joints. Currently KT has been identified as affecting ROM in the neck, shoulder and back where ruffini endings (RE) are present.[39] Ruffini endings (RE) play a role in the maintenance of muscle tone and awareness of static joint position and are generally present in superficial joint capsules in joints that control posture and locomotion. The reaction time of REs are slow and prolonged particularly with tension which maximizes response. Long prolonged stimulus, such as KT, may therefore affect RE and contribute the findings where ROM is most affected in the neck and spine.[4,5,8]

Like RE, Pacinian corpuscle (PC) are also identified in the neck and spine and respond to static conditions and an increase in the joint capsule tension.[39] PCs are inactive when a joint is immobilized and are present in joints with fine motor control such as the foot, hand and lumbar spine[39], where KT activation appears to affect ROM greater (Table 4). Our findings that ankle ROM and proprioception are not affected by KT which adds to the vassilate literature solidifying that KT effects on the ankle are currently inconclusive.[4,8,16,42,43]

Likewise Golgi tendon endings (GTE) which are mechanoreceptors that primarily react to quick and fast changing input may contribute to an explanation as to why KT, a long stimulus is ineffective on the ankle. GTE are present in intrinsic and collateral ligaments and therefore contribute to dynamic stabilization.[39] GTE generate neural impulses about ligament tension, direction of joint movement and joint position during active or passive stretching.[39] Theoretically, some joints react to certain types of mechanoreceptors based on the anatomical position of the joint. Empirical data related to mechanoreceptor activation and KT theoretical underpinnings is lacking and thus should be further investigated. The possibility exists that static mechanoreceptors are activated more effectively by KT than dynamic mechanoreceptors.

Studies investigating ROM coupled with pain identified compounding variables between pain and ROM whereby a clear delineation that ROM increased without a reduction in pain in inconclusive.[3,4,12] When compared to this current study healthy participants were assessed solely on ROM and proprioception without any pain assessment. Current literature where ROM is assessed without compounding variables indicate a lack of increase[8,16,19,43], much like our current study suggesting that ROM may have multiple components. Based on the literature individuals suffering from pain that impacts ROM may benefit from KT, but our findings did not indiciate the KT as effect on ROM increases on healthy pain free individuals. Reflecting on this current

study with regards to ROM, KT did not have an impact on ROM after the assessment on the BSS. One previous study that investigated the combination of ROM and proprioception at the ankle with KT and identified an increase in joint position sense however, this study was done on healthy individuals, thus the combination of KT and proprioceptive benefits is inconclusive.[42]

The therapeutic benefits of KT will be appropriate to increase ROM in injured individuals identified in previous literature.[1,4,6,8,10,19] Future studies should provide an understanding or what may occur in injured individuals. Current research is inconclusive on the use of KT for ankle proprioception and ROM on healthy individual and therefore should be used on an individual basis. A lack of literature exists on KT ROM and proprioception. We suggest a meta-analysis on KT to delineate which anatomical areas are best affected by KT.

Conclusion

Results suggest that KT has no effect on proprioception and ROM in healthy individuals through the use of BSS. KT may have some beneficial properties that were no assessed in this study such as the specific type of mechanoreceptors being used on each joint. More specifically, research suggests positive outcomes for healthy individuals however; future studies should investigate KT effects on individuals with injured ankles. In order to fully understand the effect of KT on proprioception, further research should investigate injured and non-injured effects on healthy, injured and different joints may aid practitioners in appropriate use of KT for treatment and rehabilitation for ROM and proproceptive deficits.

Table 2. Participant Demographic Information (n=35).

	Gender	**N**	**Mean Age**	**SD**
Control Group	M	8	23.38	±2.45
(W/out KT)	F	10	22.00	±2.05
		18		
Experimental	M	7	22.43	±2.64
Group	F	10	22.00	±2.58
(With KT)		17		
Overall	Total	35	22.40	±2.38

Table 3. Difference in Means Between Groups.

	No KT	**KT**
Pre DF/PF Total arc	84.81± 19.94	88.98 ± 13.42
Post DF/PF Total arc	87.20 ± 13.23	90.61 ± 11.03
Pre IN/EV Total arc	32.81 ± 9.81	33.31 ± 9.93
Post IN/EV Total arc	33.41 ± 9.49	34.78 ± 8.18
Pre OSI	2.19 ± 2.09	1.73 ± 0.69
Post OSI	1.71 ± 0.94	1.64 ± 0.59

Table 4. Differences in ROM of Anatomical Joint in Healthy vs. Non-Healthy Participants.

Anatomical Joint	**Increase in ROM**	**Healthy**	**Un-healthy**
Cervical Spine	Yes		1
Shoulder	Yes/No	1	1
Lumbar Spine	Yes	1	
Ankle	Yes		1

REFERENCES

1. Kahanov L. Kinesio taping, part 1: An overview of its use in athletics. *Athlet Ther Today.* 2007; 12(3): 17-18.
2. Chien-Tsung T, Jen-Pei L, Wen-Dien C. Effects of short-term treatment with kinesiotaping for plantar fasciitis. *J Musculoskelet Pain.* 2010; 18(1): 71-80.
3. Tsai H-J, Hung H-C, Yang J-L, Huang C-S, Tsauo J-Y. Could Kinesio tape replace the bandage in decongestive lymphatic therapy for breast-cancer-related lymphedema? A pilot study. *Supportive Care In Cancer: Official Journal Of The Multinational Association Of Supportive Care In Cancer.* 2009;17(11):1353-1360.
4. González-Iglesias J, Fernández-de-Las-Peñas C, Cleland JA, Huijbregts P. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. *J Orthop Sport Phys.* 2009;39(7):515-521.
5. Walsh S. Treatment of a brachial plexus injury using kinesiotape and exercise. *Physiotherapy Theory and Practice.* 2010; 26(7): 490-496.
6. Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. *J Orthop Sport Phys.* 2008;38(7):389-395.
7. Osterhues D. The use of kinesio taping in the management of traumatic patella dislocation. A case study. *Physiotherapy Theory and Practice.* 2004; 20: 267-270.
8. Yoshida A, Kahanov L. The effect of kinesio taping on lower trunk range of motion. *Research in Sports Medicine.* 2007; 15(2): 103-112.
9. Tieh-Cheng F, Wong A, Pei Y, Wu K, Chou S, Lin Y. Effect of kinesio taping on muscle strength in athletes- A pilot study. *Journal of Science and Medicine in Sport.* 2008; 11(2):198-201.
10. Kahanov L. Kinesio taping: An overview of use with athletes, part ll. *Athlet Ther Today.* 2007; 12(4): 5-7.
11. Kinesio Taping for Lymphoedema and Chronic Swelling. *Massage Magazine.* 2008(142):114-114.
12. Osbourn K. Tape it up: Kinesio taping facilitates movement, while offering support. *Massage Bodyw.* 2009;24:52-58.
13. Murray H. Effects of kinesio taping on muscle strength after acl-repair. *J Orthop Sport Phys.* 2000;30(1).

14. Słupik A, Dwornik M, Białoszewski D, Zych E. Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. *Ortopedia, Traumatologia, Rehabilitacja.* 2007;9(6):644-651.
15. Vithoulk I, Beneka A, Malliou P, Aggelousis N, Karatsolis K, Diamantopolous K. The effects of kinesio taping on quadriceps strength during isokinetic exercises in healthy non-athlete women.
16. Halseth T, McChesney J, DeBeliso M, Vaughn R, Lien J. The effects of kinesio taping on proprioception at the ankle. *Journal of Sports Science and Medicine.* 2004;3(1):1-7
17. Palmar C. Let's look at the tape. *ESPN Magazine.* 2009; 12(23): 85-85.
18. Parker-Popw, T. A quirky athletic tape gets its Olympic moment. *New York Times.* August 19,2008, http://well.blogs.nytimes.com/2008/08/19/a-quirky-athletic-tape-gets-its-olympic-moment.
19. Kaya E, Zinnuroglu M, Tugeu I. Kinesio taping compared to physical therapy modalities for the treatment of shoulder impingement syndrome. *Clinical Rheumatol.* 2011;30:201-207.
20. Jaraczewska E, Long C. Kinesio taping in stroke: Improving functional use of the upper extremity in hemiplegia. *Topics in Stroke Rehabilitation.* 2006;13(3):31-42.
21. Murray H, Husk J. Effect of kinesio taping on proprioception in the ankle. *J Orthop Sports Phys.* 2001;31(1): A-37.
22. Chang H, Wang C, Chou K, Cheng S. Could forearm kinesio taping improve strength, force sense, and pain in baseball pitchers with medial epicondylitis? *Clin J Sports Med.* 2012;22(4): 327-333.
23. Firth B, Dingley P, Davies E, Lewis J, Alexander C. The effect of kinesiotape on function, pain, and motoneuronal excitability in healthy people and people with Achilles tendinopathy. *Clin J Sports Med.* 2012;20(6): 416-421.
24. Cachupe W, Shifflett B, Kahanov L. Reliability of biodex balance system measures. *Measurement in Physical Education And Exercise Science.* 2001; 5(2): 97-108.
25. Stockheimer K. Kinesio taping & lymphoedema. *Advance Healing.* 2006
26. Pincivero D.M, Lephart S.M, Henry T.J. Learning effects and reliability of the biodex stability system. *J Athl Trainin.* 1995; 30:35.
27. Perron M, Hebert L, Mcfadyen B, Belzile S, Regniere M. The ability of the biodex stability system to distinguish level of function in subjects with a second-degree ankle sprain. *Clincial Rehabilitation.* 2007;21: 73-81.
28. Arnold B.L, Schmitz R.J. Examination of balance measures produced by the biodex stability system. *J Athl Training.* 1998;33(4):323-327.
29. Schmitz R, Arnold B. Intertester and intratester reliability of a dynamic balance protocol using the biodex stability system. *J Sport Rehabil.* 1998;7:95-101.
30. Kendall F, McCreary E, Provance P, Rodgers M, Romani, W. *Muscles testing and function with posture and pain.* Baltimore: Lippincott Williams & Wilkins; 2005.

31. Clapper M.P, Wolf S.L, Comparison of the reliability of the orthoranger and the standard goniometer for assessing active lower extremity range of motion. *J Phys Therapy.* 1988;68(2):214-218.
32. Gajdosik R.L, Bohannon R.W. Clinicial measurement of range of motion; Review of goniometry emphasizing reliability and validity. *J Phys Therapy.* 1987;67(2):1867-1872.
33. Moore M. The measurements of joint motion; Part 1- introductory review of the literature. *Phy Ther Review.* 1949; 29(5): 195-205.
34. Kinesio Tape Association. *Kinesio taping perfect manual: amazing taping therapy to eliminate pain and muscle disorders.* 1996.
35. Konor M, Morton S, Eckerson J, Grindstaff T. Reliability of three measures of ankle dorsiflexion range of motion. *Int J Sports Phys Ther.* 2012; 7(3): 279-287.
36. Elveru R, Rothstein J, Lamb R. Goniometric reliability in a clinical setting; subtalar and ankle joint measurements. *J Phys Ther.* 2012; 68(5); 672-677.
37. Houglum P. *Therapeutic exercise for musculoskeletal injuries*. Champaign: Human Kinetics; 2010.
38. Starkey C, Brown S, Ryan J. *Examination of orthopedic and athletic injuries.* Philadelphia: F.A. Davis Company; 2010.
39. Kahanov L, Kato M. Therapeutic effect of joint mobilization: joint mechanoreceptors and nociceptors. *Athlet Ther Today.* 2007; 12(4): 28-31.
40. Robbins S, Waked E, Rappel R. Ankle taping improves proprioception before and after exercise in young men. *Br. J. Sports Med.*1995; 29(4): 242-247.
41. Docherty C, Moore J, Arnold B. Effects of strength training on strength development and joint position sense in functionally unstable ankles. *J Athl Training.* 1998; 33(4): 310-314.
42. Merino-Marban R, Mayorga-Vega D, Fernandez-Rodriquez E. Effect of kinesio tape application on calf pain and ankle range of motion in duathletes. *J Hum Kinet.* 2013; 5(37): 129-135.
43. Williams S, Whatman C, Hume P.A, Sheerin K. Kinesio taping in treatment and prevention of sports injuries. *Sports Med.* 2012; 40(2): 153-164.

APPENDIX A: STUDY PARAMETERS

A: Operational Definitions

Participant: Any subject who has volunteered and is between the ages of 18-40.

Range of Motion: The number of degrees of motion that are present in a joint.[30]

Kinesio Tape: Tape that is thin, cotton, porous fabric that has a acrylic adhesive which allows the tape an elastic property. KT requires a special technique to increase the effects of improving circulation, pain reduction, increase circulation, aid in muscular function or improve proprioception.[1]

Balance: The body's ability to maintain an equilibrium by controlling the body's center of gravity over its base of support.[37]

Proprioception: The body's ability to transmit afferent information regarding position sense, to interpret the information, and to respond consciously or unconsciously to stimulation through appropriate execution of posture and movement.[37]

B: Assumptions

The following assumptions will be made for this study:

- Subjects will answer and report accurate and honest health history questionnaires.
- Subjects will listen and follow directions.
- The researcher will appropriately apply the kinesio tape.
- The goniometer will be used and placed appropriately on the subject.

C: Delimitations

The study is delimited to:

- Subjects between the ages of 18-40
- Subjects have acute ankle surgeries.
- One researcher that applies the tape correctly.
- Kinesio taping technique that supports as a lateral ankle sprain stability

D: Limitations

The following are limitations to the study:

- The accuracy of the ROM measurement technique before and after KT.
- Researcher's accuracy of tape placement on subjects.
- The researcher's understanding of how to use the Biodex® Stability System correctly and accurately.
- Subjects innate balance ability

APPENDIX B: HEALTH HISTORY QUESTIONNAIRE

Kinesio-Tape Research Health History Questionnaire 2012-2014

Subject Number:_____ Todays Date:___/___/____ Age:_____ Year:____

MEDICAL HISTORY (Explain all YES answers)

1. Have you ever been hospitalized?.....	**YES**	**NO**
2. Have you ever had surgery?.....	**YES**	**NO**
3. Are you presently under a doctor's care?.....	**YES**	**NO**
4. Are you presently taking any medications or pills?.....	**YES**	**NO**
5. Do you have any allergies (medicine,bees, or other stinging insects)……	**YES**	**NO**
6. Do you have any skin problems with tape or bandage?.....	**YES**	**NO**
7. Have you ever had any fainting spells?.....	**YES**	**NO**
8. Have you ever had any type of epileptic conditions?.....	**YES**	**NO**
9. Have you ever had any heart conditions?.....	**YES**	**NO**

Explain all "YES" answers:_____

ORTHOPEDIC HISTORY (Explain all YES answers)

10. Have you had an ANKLE injury that bothered you for more than a week? (Sprain, strain, fracture)… ……	**YES**	**NO**
11. If so, how long ago did the injury occur?.....	**YES**	**NO**
12. Do you currently have an ankle injury?.....	**YES**	**NO**
13. Have you had an ANKLE sprain, dislocation or other ankle problem in the past five years?.....	**YES**	**NO**
14. If so, how long ago did the injury occur?.....	**YES**	**NO**

Explain All "YES" answers:_____

If you answered "YES" to any question or you are unsure about your answers you will be asked for more detail to help the investigator determine if your condition increases the risk for participation. The questions and responses will be recorded below. Your responses will be kept confidential and only reviewed by the researcher and medical director.

I certify that all the information is correct.

_____ _____

Participant Signature Date

FAAM Sports Scale

Because of your foot and ankle how much difficulty do you have with:

	Side	No Difficulty	Slight Difficulty	Moderate Difficulty	Extreme Difficulty	Unable to do	N/A
Running	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Jumping	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Landing	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Starting and stopping quickly	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Cutting/lateral movements	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Low impact activities	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Ability to perform activity with your normal technique	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐
Ability to participate in your desired sport as long as you would like	Right	☐	☐	☐	☐	☐	☐
	Left	☐	☐	☐	☐	☐	☐

How would you rate your current level of function during your usual activities of daily living from 0 to 100 with 100 being your level of function prior to your foot and ankle problem and 0 being the inability to perform any of your usual daily activities?

RIGHT: ☐.0% **LEFT:** ☐.0%

Overall, how would you rate your current level of function?

	Normal	Nearly Normal	Abnormal	Severely Abnormal
RIGHT:	☐	☐	☐	☐
LEFT:	☐	☐	☐	☐

R FAAM NUMBER: 0 0.00 %
L FAAM NUMBER: 0 0.00 %

APPENDIX C: RESEARCH FLIER

Research!

Please Help! Volunteers Needed

"Effects of Kinesiotape on Proprioception on the Ankle"

ISU Applied Medicine & Rehabilitation Department- Student Services Building

WHO: Indiana State University students ,faculty, & staff between 18-40 years old. Subjects with past/current ankle injuries, Ankle surgery, or sensitive skin allergies Will be excluded.

WHAT: Participants will wear Kinesiotape during one session of balance exercises on a Balance on Biodex System. Measurements will be taken during a 20 minute session. Four trials will occur with a one minute rest in between tirals. Then a five minute rest and another four more trials

WHEN: Determined by your schedule

WHERE: Measurements will be taken in the Applied Medicine Research Center in the Student

WHY: Kinesio tape is a new taping taping technique in the health care field. The benefits are theorized to include decreases in pain, swelling, Increases in balance and range of motion.

Those interested in participating may contact the primary investigator using the information below. Thank you for your consideration.

Contact Information:
Jenna Capps, LAT, ATC

APPENDIX D: INFORMED CONSENT FORM

The Effect of Kinesiotape on Ankle Proprioception

You are being asked to participate in a research study conducted by Jenna Capps, LAT, ATC and Lindsey Eberman, ATC, PhD, from the Department of Applied Medicine and Rehabilitation at Indiana State University. This study is being conducted as part of a graduate student thesis. Your participation in this study is entirely voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether or not to participate.

- **PURPOSE OF THE STUDY**

The purpose of this study is to investigate the benefits of Kinesio Tape on ROM and proprioception or your sense of balance.

PROCEDURES

If you volunteer to participate in this study, you will be asked to do the following things:

You will arrive according to your selected appointment time and we will review this document so that you know everything that is expected. If you choose to participate you will be asked to complete the health history questionnaire. Prior to measurements, you will be placed into one of two groups. These groups include: a control group and a Kinesio Tape (KT) group. You are deemed eligible if you meet the following criteria:

- No previous history of heart conditions
- No previous history of unexplainable falls
- No adhesive allergy

After all the forms are filled out you will then have your ankle range of motion measured three times by an examiner in dorsiflexion (ankle moves up), plantar flexion (ankle moves down), inversion (ankle turned in) and eversion (ankle turned out). You will be asked to lie on your stomach and also turn-over to a seated position for ankle measurements. All measurements will be taken at the time of the scheduled appointment. After the initial measurement, you will wait five minutes before moving on to the balance portion taking place on the Biodex Balance System (BSS). The control group will have no KT placed on their ankle. The KT group will have KT applied to their ankle. Before the application of the KT, your dominant leg will be shaved on the front portion of your lower leg and ankle area. The shaved area will be cleaned with gauze soaked in rubbing alcohol. The KT will be cut into appropriate shapes and lengths for each of you prior to application. Each corner of the tape will be rounded to make four I-shaped strips. KT will be applied after your first four trials on the Biodex Balance System (BSS).

After you have gone through the previous instructions you will be instructed on how to perform single leg balance on the BSS, which will take approximately 3 minutes. Once instructed, you will adjust your foot position until stability is determined. The BSS platform will then lock. You will be asked to perform eight 20 second trials measured by the BSS. (See instructions)

At the end of the trials, you will have your ankle range of motion measured again three times. After the range of motion measurements are completed, the study will be done and if you are in the KT group, you can take the tape off. If you are in the control group you will be dismissed immediately following your range of motion measurements. We anticipate that you will spend 20-30 minutes during your participation in the research.

- **POTENTIAL RISKS AND DISCOMFORTS**

There are no known risks if you decide to participate in this research study. There are no costs to you for participating in this study. The information you provide will not only benefit you but will give a better look into the possible benefits of KT. The data collection will take about approximately 20- 30 minutes to complete. The information collected may not benefit you directly, but the information learned

in this study should provide more general benefits. Although rare, participants may incur discomfort or injury due to:

- Falling off or onto the Biodex Balance System (8 inches off the ground)
- Tape irritation or rash which may be due to an unrecognized allergy
- Ankle injury due to fatigue (loss of balance subsequent falling)

The likelihood that these injuries or discomforts occur is low and should be prevented with the health history questionnaire and exclusion criteria. There are no major risks involved in this research. However, if someone loses their balance during the trial there will be hand rails for you to hold on to as long as the examiner will be behind spotting the volunteer participant.

If injured during the study, you are expected to financially support the expenses associated with evaluation or treatment.

- **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

There are no direct benefits for you to participate in this study. The societal benefits include a better understanding of how KT can affect range of motion and balance.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of keeping the medical records in a locked file cabinet in a locked room by the principal investigator. You will be identified by a random ID number throughout the study and therefore your information is anonymous and confidential. Individuals from the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.

- **PARTICIPATION AND WITHDRAWAL**

You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits to which you are otherwise

entitled. You may also refuse to answer any questions you do not want to answer. There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about this research, please contact Jenna Capps at Jcapps6@sycamores.indstate.edu or Dr. Lindsey Eberman at Lindsey.Eberman@indstate.edu

- **RIGHTS OF RESEARCH SUBJECTS**

If you have any questions about your rights as a research subject, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN 47809, by phone at (812) 237-8217, or e-mail the IRB at irb@indstate.edu. You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with ISU. The IRB has reviewed and approved this study.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____

Printed Name of Subject

_____ _____

Signature of Subject Date