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Thesis written by

Rachael M. German

B.S., Central Michigan University, 2009

M.S., Kent State University, 2013

Approved by

________________________________, Director, Thesis Committee
Kimberly Peer

________________________________, Member, Thesis Committee
Jeffrey Huston

________________________________, Member, Thesis Committee
Jacob Barkley

Accepted by

________________________________, Director, School of Health and Human Services
Lynne Rowan

________________________________, Dean, School of Education, Health, and Human Services
Dan Mahoney
INHIBITORY KINESIO® TAPE APPLICATION TO THE HAMSTRING MUSCLE GROUP: AN INVESTIGATION OF ACTIVE RANGE OF MOTION AND PERCEIVED TIGHTNESS OVER TIME (76 pp.)

Context: The purpose of this study was to determine the inhibition effects of Kinesio® tape on the hamstrings muscle group. Objective: Although liberal anecdotal support exists, there is a lack of scientific data reported relative to the use of Kinesio® tape.

Design: Within subject – repeated measures design. Random counterbalanced design.

Setting: The settings included Division I and high school athletic training facilities from varying Ohio schools. Patients: The subjects consisted of college and high school athletes who had limited range of motion as determined by straight leg raise and popliteal angle. There were a total of 29 subjects (21 males, mean age 17.191, SD= 1.750 and 8 females, mean age 17.750, SD= 2.493). Interventions: Subjects received both Kinesio® and sham taping methods with measures of dependent variables taken at baseline, immediate, 4 days, 8 days, and 12 days of taping. Tape was re-applied every 2 days.

Main outcomes measures: A 2 way ANOVA was used to analyze the outcome variables of range of motion and perceived stiffness. Results: A main effect of time for both taping conditions was revealed across all dependent variables. Significant increases for straight leg raise (p < .001), popliteal angle (p < .001), and perceived stiffness were observed (p < .001). A condition by time interaction was present for straight leg raise between 8 and 12 days (p = .046). Significance was present in the Kinesio® group (p
Conclusion: Everyone displayed improvements towards greater flexibility across time. Between 8 days and 12 days there was a greater improvement for straight leg raise for the Kinesio® group.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Rationale for the Study</td>
<td>1</td>
</tr>
<tr>
<td>Statement of Problem</td>
<td>3</td>
</tr>
<tr>
<td>Purpose</td>
<td>4</td>
</tr>
<tr>
<td>Research Questions</td>
<td>4</td>
</tr>
<tr>
<td>Assumptions</td>
<td>5</td>
</tr>
<tr>
<td>Delimitations</td>
<td>5</td>
</tr>
<tr>
<td>Operational Terms</td>
<td>6</td>
</tr>
<tr>
<td>Summary</td>
<td>6</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE</td>
<td>8</td>
</tr>
<tr>
<td>Introduction</td>
<td>8</td>
</tr>
<tr>
<td>Muscle Stiffness</td>
<td>15</td>
</tr>
<tr>
<td>Current Research on Kinesio® Tape</td>
<td>21</td>
</tr>
<tr>
<td>Conclusion</td>
<td>30</td>
</tr>
<tr>
<td>III. METHODOLOGY</td>
<td>32</td>
</tr>
<tr>
<td>Subjects</td>
<td>32</td>
</tr>
<tr>
<td>Materials</td>
<td>33</td>
</tr>
<tr>
<td>Design</td>
<td>34</td>
</tr>
<tr>
<td>Procedure</td>
<td>34</td>
</tr>
<tr>
<td>IV. ANALYSIS OF THE FINDINGS</td>
<td>40</td>
</tr>
<tr>
<td>Results</td>
<td>40</td>
</tr>
<tr>
<td>V. DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS</td>
<td>48</td>
</tr>
<tr>
<td>Discussion</td>
<td>48</td>
</tr>
<tr>
<td>Limitations</td>
<td>54</td>
</tr>
<tr>
<td>Future Research</td>
<td>55</td>
</tr>
</tbody>
</table>

v
APPENDICES ........................................................................................................................................56

APPENDIX A  HUMAN SUBJECTS APPROVAL FORM ...............................................................57

APPENDIX B  INFORMED CONSENT FORM ..............................................................................61

APPENDIX C  SUBJECT CHARTING FORM ..............................................................................68

APPENDIX D  VAS PERCEIVED STIFFNESS FORM ..............................................................71

REFERENCES .....................................................................................................................................73
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kinesio® shapes</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Tension application</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Tension application</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>Kinesio® method</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>Sham method</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>Popliteal angle range of motion over time</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>Perceived stiffness over time</td>
<td>43</td>
</tr>
<tr>
<td>8</td>
<td>Straight leg raise over time</td>
<td>45</td>
</tr>
</tbody>
</table>
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Subject Demographics</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Dependent Variable: PL Degrees of Flexibility</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Dependent Variable: Perceived Stiffness</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>Dependent Variable: SLR Degrees of Flexibility</td>
<td>46</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Rational for the Study

Injury rehabilitation in the clinical setting can incorporate many different treatments and therapeutic modalities including ultrasound, electrical stimulation, and taping methods. Typically in the United States injury prevention, treatment, and rehabilitation has followed a Western medicine approach (Yoshida & Kahanov, 2007). However, alternative treatments have emerged as practical options including the use of the brand Kinesio® Tex tape (Yoshida Kahanov, 2007). Kinesio® Tex tape is the actual manufactures terminology, however the term Kinesio® tape is used interchangeably.

Kinesio Taping® has been increasingly used in the rehabilitation and prevention of sports injuries (Kaya, Zinnuroglu, & Tugcu, 2010). Kinesio® tape’s popularity has been increasing since it was introduced to the United States in 1995, and is commonly seen in high profile athletic competitions (Kase, 2008). In sports medicine settings the use of Kinesio® tape as a supplemental treatment has increased (Stedge, Kroskie, & Docherty, 2012). In the United States in 2007, over fifty-one thousand practitioners purchased Kinesio® Tex Tape (Kase, 2008).

Kinesio® tape is growing in popularity as an option for treating athletic injuries. Kinesio® tape works with the body to allow normal range of motion and can be worn for three to five days. Kinesio® tape exhibits a thickness and weight similar to skin, is latex
free, and is made of acrylic heat activated adhesive. The tape is applied to a paper substrate with a ten percent stretch and when applied can stretch an additional forty to sixty percent of its resting length (Kase, 2008). Manufacturers have reported effects on skin, circulatory/lymphatic systems, fascia, muscle, and joints. Kinesio® tape lifts the skin, causing convolutions and enhances fluid exchange between tissues layers (Kase, 2008). Kinesio® tape believes and supports the following benefits: enhance circulatory system, reduce edema, decrease pain, increases range of motion, reduces fatigue, and enhances kinesthetic awareness (Kase, 2008). However, documented experimental research is limited supporting the claims by the manufacturer. Limited research has been conducted to evaluate the effectiveness and current results available have been inconsistent (Stedge et al., 2012). There is a need for further research to investigate the effectiveness of Kinesio® tape for varied effects and the role of helping with the rehabilitation of injured muscles. For treatment of muscles, Kinesio® tape can be applied to facilitate a weakened muscle or inhibit an over-contracted muscle (Kase, 2008). Differing levels of tension is placed upon the tape depending on the goal of the application. Kinesio® tape has many proposed benefits with a variety of taping methods, but further experimental research is needed to provide support for the use of Kinesio® tape. Therefore, the purpose of this study is to examine the effects of Kinesio® tape applications used to increase active range of motion of the hamstrings musculature and changes in perceived stiffness.
Statement of Problem

Although liberal anecdotal support exists, there is a lack of scientific data reported relative to the use of Kinesio® tape in the rehabilitative setting. Overall, the problem faced by Kinesio® tape is a lack of documented research. Kinesio® tape has only been used in the United States for sixteen years yet; little experimental research exists on the benefits with patient populations. Sixteen years is not very long compared to other methods of increasing range of motion that have documented research that support their use in the rehabilitative setting. Kinesio Taping® technically requires an additional certification to learn the appropriate application techniques. However, clinicians in many settings can still purchase and utilize Kinesio® tape without the certification. This leads to anecdotal support but a lack of consistency and training in clinicians also leads to a deficiency in experimental research. Research may be lacking because of the additional education, certification, time commitment to the seminars, and expense associated with Kinesio® tape. Anecdotal support seems to be shared throughout the health care community, but still leaves an absence of published research. Anecdotal support is plentiful, but published research is nominal. Of the existing literature, which cannot be generalized completely, most seems to be preliminary and predominantly involves individual case studies. (Garcia-Muro, Rodriguez-Fernandez, Herrero-de-Lucas, 2009). According to an article by Yoshida and Kahanov’s (2007) research is lacking regarding the use of Kinesio® tape as a feasible option for increasing flexibility. Further, while some preliminary work exists, the feasibility of this therapeutic intervention as a modality for increasing flexibility and range of motion needs further investigation.
Purpose

The purpose of this research is to investigate the Kinesio® tape inhibition taping method applied insertion to origin as a means to improve active hamstring range of motion and decrease stiffness perception immediately and long-term as measured at 12 days post-tape. Benefits have been documented immediately and up to 6 days in existing literature (Thelen et al., 2008). Previous research has focused on short-term effects, which evaluate measurements immediately and up to 6 days after application. This study will extend the length of time through 12 days of application with repeated applications.

Research Questions

1. Does the application of an inhibition strip of Kinesio® tape applied insertion to origin of the hamstring muscle group increase active range of motion as measured by straight leg raise in a healthy population?
   a. Will first time taping applications immediately increase active hamstring range of motion?
   b. Will repeated taping applications completed over 12 days increase active hamstring range of motion?

2. Does the application of an inhibition strip of Kinesio® tape applied insertion to origin of the hamstring muscle group increase active range of motion as measured by popliteal angle in a healthy population?
   a. Will first time taping applications immediately increase popliteal angle range of motion?
b. Will repeated taping applications completed over 12 days increase
popliteal angle range of motion?

3. Will the application of an inhibition strip of Kinesio® tape result in decreases
of perceived muscle stiffness measured by a VAS in a healthy population?
   a. Will first time measures decrease perceived muscle tightness measured
      by a VAS?
   b. Will repeated measures over 12 days decrease perceived muscle
tightness measured by a VAS?

Assumptions

First, it is assumed the Kinesio® tape application to the subject has been
completed by a person who is Kinesio Taping® certified. Second, written and verbal
consent will be obtained voluntarily by the participating subjects. Next, subjects will
honestly answer the ratings scale to determine muscle tightness and the effectiveness of
Kinesio® tape. Lastly, it is assumed that standardized goniometric procedures will be
followed to assess active range of motion of the hamstrings muscle group by a straight
leg raise in the supine position. The procedure will be completed by the same trained
professional each time who has experience with standardized goniometric techniques.

Delimitations

Subject’s participating in the study must be high school or collegiate athletes.
Subjects are required to have limited hamstring flexibility to less than 90 degrees of
straight leg raise and -30 degrees or greater of popliteal angle measured in the supine
position with a goniometer. This is to ensure subjects have relative tightness of the hamstring muscle group and all have the ability to improve the same amount in comparison to each other. Another exclusion criteria is if subjects have had a thigh, hip or knee injury within the last six months that could affect the integrity of the hamstring muscle and result in changes to their normal range of motion.

**Operational Terms**

1. Kinesio® tape- A uniquely designed elastic tape that works with the body to allow normal range of motion and enhances muscular, joint and circulatory function (Kase, 2008).
2. Facilitation- To strengthen a weakened muscle (Kase, 2008).
3. Inhibition- Stimulate relaxation of over-contracted muscle (Kase, 2008).

**Summary**

Kinesio® tape has grown in popularity and is being used for high profile athletic competitions. However, there is a lack of substantial research overall and specifically supporting the use of Kinesio® tape to increase active range of motion. Kinesio® tape has many potential benefits reported - one being increased range of motion. Further research is needed to support the benefits associated with the use of Kinesio® tape. Therefore, this study will investigate the use of an inhibition taping method to increase
active range of motion of the hamstrings muscle group and determine whether these techniques impact perceptions of stiffness.
CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

Kinesio® tape is a relatively new treatment technique that is believed to produce many therapeutic benefits; however research is lacking to support the proposed advantages. This review of literature will examine the foundational concepts of Kinesio-Taping®, common methods utilized in the application of Kinesio® tape, and indications for therapeutic uses of Kinesio® tape. The actual brand name is referred to as Kinesio® Tex tape but is used synonymously with the term Kinesio® tape. Specific emphasis on the literature regarding the use and effectiveness of kinesio-tape on improving ROM will be central to this review. Current research supports the use of stretching, heat, and massage to improve range of motion in patients with observed muscle tightness or stiffness (Starring, Gossman, Nicholson, Lemons, 1988; Funk, Swank, Adams, Treolo, 2001; Huang et al., 2010). Stretching has been found to increase hamstring muscle length (Starring et al., 1988; Chan, Hong, Robinson, 2001). Heat application has been beneficial to increase extensibility and hamstring flexibility (Prentice, 2006; Funk et al., 2001). Friction massage and soft tissue mobilization has documented increases in hamstring range of motion (Huang et al., 2010; Hopper et al., 2004). Studies have evaluated the use of Kinesio® tape to improve range of motion, but no documented studies have evaluated the hamstrings muscle group.
Defining Kinesio® Tape in Therapeutic Interventions

Injury rehabilitation in the clinical setting incorporates many different treatments and therapeutic modalities including ultrasound, electrical stimulation, and taping methods. Typically in the United States injury prevention, treatment, and rehabilitation has followed a Western medicine approach (Yoshida & Kahanov, 2007). However, alternative treatments have emerged as practical options including the use of the brand Kinesio® Tex tape or simply referred to as Kinesio® tape (Yoshida & Kahanov, 2007). Kinesio Taping® has been increasingly used in the rehabilitation protocols and prevention of sports injuries (Kaya et al., 2010).

Kinesio Taping® was invented in Japan in 1973 and first received international exposure in the 1988 Seoul Olympic games (Kase, 2008). Kinesio® tape is currently used by professional teams in North America, South America, Asia, the Middle East, South Africa, and Europe (Kase, 2008). Kinesio® tape’s popularity has been increasing since it was introduced to the United States in 1995, and is commonly seen in high profile athletic competitions (Kase, 2008). Kinesio® tape is popular among athletic competitions, but is also used in non-athletic applications (Kase, 2008). In the United States in 2007, over fifty-one thousand practitioners purchased Kinesio® Tex Tape (Kase, 2008).

Clearly, Kinesio® tape is a relatively new treatment option for athletic injuries. All documented research studies evaluating the use of Kinesio® tape references back to Dr. Kase and the manual of Kinesio tape. The manual states many claims and benefits but this a controversial issue because documented research has not evaluated or supported
every claim. Kinesio® tape works with the body to allow normal range of motion and is seen as an effective treatment between professional visits (Kase, 2008). One of the large benefits associated with Kinesio® tape is the constant wear time, so patients are receiving treatment 24 hours a day. Kinesio® tape has improved wear time due to water resistance and can be worn 24 hours a day for 3 to 5 days (Kase, 2008). Kinesio® tape exhibits a thickness and weight similar to skin, is latex free, and is made of acrylic heat activated adhesive (Kase, 2008). The tape is applied to a paper substrate with a ten percent stretch and when applied can stretch an additional forty to sixty percent of its resting length on the longitudinal axis (Kase, 2008).

The three common taping techniques used within rehabilitative settings and recognized within therapeutic communities include prophylactic athletic taping, Lueko tape, and Kinesio taping® (Kase, 2008). Each of these products has their own unique characteristics and advantages.

**Prophylactic Athletic Taping**

With traditional white athletic prophylactic tape there is limited wear time, possible skin irritation due to latex adhesive, and compression of the skin, joints, and muscles resulting in limited range of motion (Kase, 2008). Non-elastic tapes may provide a strong adhesion force which can lead to restriction of movement and cause skin discomfort (Huang, Hsieh, Lu, Su, 2011). Conventional tape can result in more mechanism constrains as compared to Kinesio® Tape (Fu et al., 2008). Prophylactic athletic tape is used liberally with the prevention and treatment of athletic injuries.
however the effectiveness remains controversial. White tape restricts range of motion and has been found to lose frontal plane ankle joint stability following exercise (Purcell, Schuckman, Docherty, Schrader, & Poppy, 2008).

**Lueko Tape**

Lueko Tape is another common type of tape that is extremely rigid and made from cotton mesh material (Kase, 2008). Lueko Tape requires pre-tape, is typically used for bracing techniques, and has a limited wear time due to skin irritation (Kase, 2008). A common use of Lueko tape includes being applied to the knee for patellofemoral alignment taping. This use of Lueko tape is known as McConnell taping. One study evaluating knee taping with Leuko Sportstape Premium Plus found minor skin irritations in 28% of participants however improvements in pain and disability were observed (Hinman, Crossley, McConnell, Bennell, 2003). The different taping methods have varied effects and are chosen based on the goal of treatment.

**Kinesio® Tape**

Kinesio® tape has many claims by the manufacturer seen in the taping manual, however these claims are not clearly supported in the literature. Kinesio® tape can be used in conjunction with other therapeutic modalities including cryotherapy, hydrotherapy, manual therapy, acupuncture, and electrical stimulation (Kase, 2008). The effects of Kinesio® tape can be seen on skin, circulatory/lymphatic systems, fascia, muscle, and joints (Kase, 2008). Kinesio® tape lifts the skin, causing convolutions and enhances fluid exchange between tissues layers (Kase, 2008). Kinesio® tape contends
that it is a method that aims to bring the body into homeostasis. 

Kinesio® tape has effects by moving and raising the skin in appropriate directions (Slupik, Dwornik, Bialoszewski, Zych, 2007). Kinesio® tape is said to exhibit the following benefits: enhance circulatory system, reduce edema, decrease pain, increases range of motion, reduces fatigue, and enhances kinesthetic awareness (Kase, 2008). Increased lymph drainage allows for decreased pressure on neural receptors under the skin and can therefore reduce pain (Kase, 2008). Again the proposed benefits of Kinesio® tape are provided from the manufacturer however experimental support is still lacking in the literature.

**Facilitation vs. Inhibition Taping Methods**

Kinesio® tape is applied to muscles in a stretched position and as the tape recoils it influences the position and distensibility of the skin (Kase, 2008). For treatment of muscles, Kinesio® tape can be applied to facilitate a weakened muscle or inhibit an over-contracted muscle (Kase, 2008). In the facilitation technique the tape is applied from the origin to insertion (proximal to distal) of the muscle and for the inhibition method it is applied from insertion to origin (distal to proximal) (Kase, 2008). Depending on facilitation or inhibition techniques, varying levels of tension are placed on the tape. A 15-25% stretch is used for inhibition techniques and a 25-50% stretch is used for facilitation techniques (Kase, 2008). The anchors of the tape are the two ends surrounding the therapeutic zone where the tension is applied. No tension is applied to the anchors so the patient’s skin is not sheared. It is important to understand the
therapeutic goal of the patient to determine what method and application of tape is necessary.

**Taping Shapes**

The process of applying Kinesio® tape has a certain systematic approach to ensure appropriate application and wear. An assessment of the patient’s condition is performed, tape application is completed, and a re-assessment is performed after tape application to ensure the tape is acting in the proper manner (Kase, 2008). The tape can be cut into and X, Y, I, or fan strips depending on the body structure being taped (Kase, 2008). For example, a Y-strip would be appropriate for an inhibition taping technique for the gastrocnemius. An X-strip could be used for a facilitation technique of rhomboid major. A simple I-strip can be used for inhibition of the lumbar spine musculature. A fan shape is typically used for lymphatic drainage and swelling associated with ecchymosis. A proper patient assessment is necessary because Kinesio® tape offers a variety of benefits. An understanding of the injury and goal for patient care are essential for effective use of Kinesio® tape.

*Figure 1: Kinesio® shapes*

Courtesy of Kinesio Taping® Association International
**Wear Time**

When performing Kinesio® tape application the skin should be dry and free of oils. Body hair may need to be shaved to maximize the results of Kinesio® tape and improve wear time. This is important to note because subjects will be notified of ways to help improve wear time such as shaving and avoiding the use of lotion. It is necessary for the tape to stay on for 2 consecutive days in the protocol, so wear time needs to be ensured. After application it is important to rub the tape activating the heat sensitive adhesive to ensure appropriate sticking (Kase, 2008). Applying tape 30 minutes before activity especially water sports will help improve wear time. If tape application is necessary during activity a tape adherent can be used. Care should be taken when removing Kinesio® tape in the direction of hair growth to guarantee patient comfort.

**Contraindications**

According to the marketing materials Kinesio® tape has many benefits but does have some contraindications. Kinesio® tape is not to be used over active malignancy sites of active infections (Kase, 2008). Kinesio® tape should also not be applied over open wounds or a deep vein thrombosis (Kase, 2008). Precautions are also to be used if the patient has diabetes, kidney disease, congestive heart failure, coronary artery disease, or fragile skin (Kase, 2008). Tape should be removed immediately if the patient experiences any irritation or pain after tape application. Tape should be removed to avoid any further patient discomfort. Claims by the manufacturer are made only for Kinesio® brand tape no other competing brands of tape.
Kinesio® tape manufacturers claim a benefit of increased range of motion, however limited experimental research is available to support this claim. There are limited published randomized clinical trials that evaluate the effects of Kinesio® tape for multiple different musculoskeletal complaints (Thelen, Dauber, & Stoneman, 2008). Further research needs to examine the relationship between the inhibition taping method and improved range of motion which could result in reduced risk of injury.

**Muscle Stiffness**

Resistance of tissue as it lengthens is related to the possible extensibility of the tissue (McNair & Stanley, 1996). Both neural and mechanical factors determine resistance to stretch in muscle tissue (McNair & Stanley, 1996) Improving flexibility is increasing a joint’s ability to move through a full range of motion (Prentice, 2006). Athletes who have restricted range of motion or muscle stiffness can have decreased performance and be predisposed to injury (Prentice, 2006). A muscle that is relatively stiff has an increased risk of damage in response to a sudden stretch (McNair & Stanley, 1996) A muscle that is not stiff can extend to a greater degree and the forces can be absorbed over a greater range and longer time (McNair & Stanley, 1996). The result of reducing muscle stiffness on injured muscles is uncertain (Cross & Worrell, 1999). However, through elongation of the musculotendinous unit throughout the normal range of motion the potential for injury is reduced (Cross & Worrell, 1999).
Current Methods to Improve Range of Motion

There are currently many supported methods in the research known to increase range of motion. Although there are many techniques used, the most common methods include stretching, heat application, and massage.

**Stretching**

Completing stretching over time it is possible to increase the elasticity or the length a muscle can be stretched (Prentice, 2006). Different stretching methods exist including dynamic stretching, static stretching, and proprioceptive neuromuscular facilitation techniques. When a muscle is stretched the muscle spindles are stretched and the central nervous system sends an impulse to reflexively contract, resisting the stretch (Prentice, 2006). If the stretch is maintained for a period of time, the golgi tendon organs fire off sensory impulses and cause a reflex relaxation of the muscle (Prentice, 2006).

When soft tissue is stretched it elongates and plastic or elastic deformation may occur (Turner et al., 1988). Elastic stretching is reversible and the tissue will return to original length however, plastic stretching results in an irreversible tissue elongation (Turner et al., 1988). For improved range of motion especially during or after rehabilitation of an injury plastic stretching would be the desired gain. Prolonged stretching results in more plastic elongation in which the tissue will not return to its original length when the load is removed leading to increased range of motion (Turner et al., 1988). Plastic elongation would be beneficial for athletes participating in sport. Improvements in flexibility need to be present during functional sporting activities to better prevent future injuries.

Increasing range of motion is important in all sports to reduce injury but particularly
important in sports where extreme ranges of motion are necessary (McNair & Stanley, 1996).

Increasing hamstring resting length can be completed by comparing passive cyclic stretching with sustained stretching using a mechanical device (Turner et al., 1988). Results show that both cyclic and sustained stretching substantially increase hamstring muscle length (Turner et al., 1988). Prolonged stretching results in plastic deformation that equals an increase in range of motion and may create a reduction in muscle spindle activity (Turner et al., 1988). Among an athletic population increases to hamstring range of motion can be beneficial for both the prevention of injuries and enhancing athletic performance. It has been seen that statistically significant knee extension range of motion gains were recorded after completing a static stretching program (DePino, Webright, Arnold, 2000). Also, both four and eight week static stretching protocols resulted in improved hamstring flexibility (Chan, Hong, Robinson, 2001). Stretching has shown improvements, but takes time and consistency to see optimal gains. The duration of stretching that needs to take place for improved flexibility can vary. However, loading for more than 20 minutes should be practiced for adequate soft tissue lengthening to occur (Bohannon, 1984). The incorporation of a static stretching program was seen to correlate to a decrease in musculotendinous strains (Cross & Worrell, 1999). Decreasing the potential for injury to the hamstring muscle group is largely valuable for athletic populations, in which hamstring injuries are prevalent. Stretching is seen as a confirmed way to increase range of motion and thus help prevent injury and rehabilitate after injury has occurred.
Moist heat

Moist heat application is thought to be beneficial for enhancing flexibility however; there is limited empirical evidence (Funk et al., 2001). Collagen tissues are affected by heat application through an increase in the viscous flow of collagen fibers resulting in relaxation of the tension (Prentice, 2006). Muscle spasms caused by a lack of blood flow can be relieved by heat which increases blood flow and extensibility of the tissue (Prentice, 2006). Heat application is also believed to release bradykinin, and histamine which cause vasodilation (Prentice, 2006). Results have supported the use of moist heat application, by showing significantly more hamstring flexibility with the use of heat compared to stretching alone (Funk et al., 2001). However, the extent to which flexibility benefits from heat last throughout sporting activities could be further evaluated. A method to increase range of motion that can be worn throughout a sporting event could therefore be very beneficial. For increasing ankle dorsiflexion there was found to be similar results between hot packs prior to stretching and stretching alone (Knight, Rutledge, Cox, Acosta, Hall, 2001). In some examples heat has not been found to show improved range of motions compared to just stretching. For practical purposes it could be viewed best to couple moist heat application with stretching to maximize increased hamstring flexibility (Funk et al., 2001).

Massage

Massage, which is defined as the manipulation of soft tissues, can be used as a treatment modality to increase range of motion (Prentice, 2006). Mechanical responses
to massage include venous and lymphatic drainage, increased circulation, and stretching of connective tissue (Prentice, 2006). Using friction massage, applying a penetrating pressure to the distal portion of the hamstring musculotendinous junction has shown a significant increase in hip flexion range of motion (Huang et al., 2010). The increased effect on hamstring flexibility was thought to be caused by a mechanically induced decrease in muscle-tendon stiffness (Huang et al., 2010). The length of time flexibility benefits may last after massage may need to be further evaluated. Dynamic soft tissue mobilization on an area of muscle tightness involves moving the treatment area longitudinally under different muscle contraction parameters (Hopper et al., 2004). Significant increases in hamstring range of motion have been observed when completing dynamic soft tissue mobilization techniques (Hopper et al., 2004). Manual therapy techniques can be implemented to see beneficial effects on soft tissue. However, manual therapy takes more hands on time than other options to increase range of motion and can be tedious on the practitioner completing the treatment. One study found the utilization of healthy subjects but not athletes as a limitation (Hopper et al., 2004). Athletes are frequently troubled by hamstring tightness so they will constitute the subject population of this study (Hopper et al., 2004). Previous support of stretching to increase hamstring flexibility could lead to future studies evaluating the combined effect of friction massage and stretching.

Previous research supports the use of stretching, superficial heating, and massage to increase range of motion. Kinesio tape is also suggested to improve range of motion, but further research is needed to provide support (Kase, 2008). Utilizing another
therapeutic modality to help increase range of motion and reduce muscle spasms would be extremely beneficial in the health care profession. Kinesio® tape unlike other mentioned modalities allows patients to have constant treatment 24 hours a day. Taping is a quick intervention that does not require a time commitment from the athlete or practitioner and does not require tedious manual therapy. Kinesio® tape has extended wear time and may show benefits for multiple days before new tape has to be applied. There are new and exciting possibilities that Kinesio® tape may offer the health care community. Limited previous research has investigated the effects of Kinesio tape on pain, proprioception, muscle strength, and range of motion showing varying results. There is a need to demonstrate the state of the literature and the impact of published effects of Kinesio tape applications currently available. There is limited research available concerning Kinesio® tape and a focus on abilities to increase active range of motion should be further evaluated.

**Measuring Range of Motion**

Measuring hamstring range of motion can be completed by doing an active straight leg raise. Actively having the patient flex their hip is an indicator of hamstring range of motion. Passive range of motion would not accurately assess the patient’s range of motion they will have during functional movement and is more difficult to measure reliably when compared to active range of motion (Gajdosik & Bohannon, 1987). When measuring hamstring flexibility it is important to note straight leg raise involves movement of the pelvis and may not always be accurate if low back tightness is involved.
Another method to measure hamstring muscle tightness is through popliteal angle or active knee extension test. Popliteal angle or the active knee extension test is a reliable tool for measuring hamstring tightness when under controlled conditions (Gajdosik & Lusin, 1983). A common device used by clinicians to measure range of motion is a goniometer. Goniometers are generally accepted as valid clinical tools (Gajodosik & Bohannon, 1987). To ensure validity of goniometric measurements the clinician uses anatomical knowledge, visual inspection, palpation skills, and accurate alignment of the goniometer (Gajodosik & Bohannon, 1987). Validity of goniometers is especially true with simple measures such as the knee (Gajodosik & Bohannon, 1987).

Current Research on Kinesio® Tape

Muscular Strength

Applying Kinesio tape from origin to insertion is intended to facilitate a weakened muscle (Kase, 2008). Facilitation of a muscle could be necessary post operatively or during a rehabilitation protocol after injury. A recent study examined muscle strength, EMG, and scapular motion on baseball players with shoulder impingement (Hsu, Chen, Lin, Wang, Shih, 2008). The Kinesio® tape was cut into a Y-strip and applied to encompass the lower trapezius muscle with minimal tension (Hsu et al., 2008). Results showed no significant change in scapular displacement but taping tended to increase muscle activation of serratus anterior and upper trapezius (Hsu et al., 2008). A facilitating effect was noted on the lower trapezius during the lowering phase of scaption tasks between 30 and 60 degrees (Hsu et al., 2008). Facilitation of the lower trapezius
muscle could be valuable in a variety of shoulder rehabilitation protocols following injury. In another study, Applying a Y-strip to the common wrist flexor muscles from insertion to origin with a 15-20% stretch was evaluated to determine the effect on maximal grip strength (Chang, Chou, Lin, Lin, Wang, 2010). Subjects who had Kinesio® tape applied displayed significant improvements in force sense errors (Chang et al., 2010). Force sense errors utilized a hand dynamometer and was the ability to replicate a target force after receiving visual feedback (Chang et al., 2010). In comparison to placebo groups, no effective short term change in maximal grip strength was observed (Chang et al., 2010). Research regarding the facilitation techniques of Kinesio® tape seem to vary but no significant increases in muscle strength have been noted.

Enhancing muscular strength through Kinesio® tape and its effect on vertical jump performance has also been evaluated (Huang et al., 2011). A Y shape applied insertion to origin of the triceps surae muscle was used to assess vertical jump height, vertical ground reaction force, and electromyographic activity (Huang et al., 2011). Results showed increases in vertical ground reaction force and EMG activity of medial gastrocnemius (Huang et al., 2011). There was no statistically significant improvement in vertical jump height, although there was a trend of minor improvements in height (Huang et al., 2011). Minor improvements can be positively noted when it comes to sport performance where even small enhancements can make a difference (Huang et al., 2011). No positive effects were noted for the tibialis anterior or soleus muscles vertical ground reaction force or EMG activity (Huang et al., 2011).
Another study evaluated EMG measurements with Kinesio® tape placed origin to insertion of the vastus medialis muscle (Slupik et al., 2007). Results showed significant increases in peak torque and bioelectrical activity of the muscle 24 hours and 72 hours after tape application (Slupik et al., 2007). However, a measurement 10 minutes after tape application and 96 hours after application both did not show changes in peak torque (Slupik et al., 2007). A second group showed an initial peak torque increase after 24 hours of tape application, then after removal of the tape and a time period of 48 hours there was a further increase in peak torque (Slupik et al., 2007). Kinesio® tape had lasting benefits up to 48 hours after removal (Slupik et al., 2007). Improvements even after tape removal is a very interesting fact that has not been studied by many researchers, current research is simply looking at values while the tape is applied. The increases in peak torque may be due to an increase in the number of motor units recruited during maximal contraction or the tone generated from individual units (Slupik et al., 2007). Conversely, another study evaluating quadriceps muscle power using the Cybex NORM isokinetic dynamoteter found that Kinesio® tape neither enhanced nor inhibited muscle strength (Fu et al., 2008). Subjects were tested without tape, immediately after application, and 12 hours after application (Fu et al., 2008). Authors suggested the tactile input of Kinesio® tape may not be strong enough to enhance muscle power (Fu et al., 2008). Two separate studies evaluating Kinesio® tape effects on quadriceps muscle strength and power found varying results.

Research with Kinesio® tape has also evaluated circulation and endurance of the gastrocnemius muscle. Methods evaluated a Kinesio® taping method, sham method, and
no tape method effects on blood flow, circumference and volume measurements, and endurance ratio (Stedge et al., 2012). Measures were tested 24 and 72 hours after tape application (Stedge et al., 2012). Results showed no effect on circulation, endurance ratio, or volumetric water displacement (Stedge et al., 2012). Relative to strength, research indicates some small increases in muscle activation and force sense errors but no strong findings of increased strength or muscle performance.

**Pain Reduction**

Studies have also evaluated the effects of Kinesio® tape on reducing pain and disability (Kaya, et al., 2010). A study evaluated the short term effects of Kinesio® tape application on reducing pain and disability in subjects with shoulder pain (Kaya, et al., 2010). Kinesio® tape was applied to the supraspinatus, deltoid, and teres minor muscles with a 15-25% tension (Kaya, et al., 2010). Use of the disability of arm, shoulder, and hand scale as well as a visual analog scale showed a decrease in rest, night, and movement pain scores one week after taping as compared to the baseline (Kaya et al., 2010). Kinesio® tape conforms to the body providing sensorimotor feedback and patients tend to report a relief of symptoms and improved stability of the joint (Kaya et al., 2010). After a second week of treatment, differences in movement pain scores were not noted between the Kinesio® taped group and the control group (Kaya et al., 2010). This study looked at a longer wear time in comparison to most other studies but did not prove enhanced results with an extended wear time. Another study evaluating shoulder pain associated with rotator cuff tendonitis/impingement found immediate pain reduction
after Kinesio® tape application (Thelen et al., 2008). However, no long term benefits were seen with pain reduction over a six day taping period (Thelen et al., 2008). Again, immediate benefits were seen involving pain reduction but not improvements with an extended wear time. Research studies have not shown increases in pain after applying Kinesio® tape, if changes were noted on subjective scales it involved decreases in rated pain. An individual case study found no decrease in shoulder pain caused by myofascial pain immediately after tape application (García-Muro et al., 2009). However, there was a noticeable improvement in the pain visual analog scale 2 days after treatment (García-Muro et al., 2009). Another study evaluating patients with acute whiplash injury and found improvements in neck pain immediately after tape application and at a 24 hour follow up (González-Iglesias, Fernández-De-Las-Peñas, Cleland, Huijbregts, Gutiérrez-Vega, 2009). However, the changes were small and not clinically significant (González-Iglesias et al., 2009).

Kinesio® tape has been shown to have immediate abilities to decrease pain, but has had varied results with long term effects. Sensory feedback is likely a reason for immediate decreases in pain, but further research should examine long term effects with pain reduction. The subject population for this study has tight hamstring musculature, so perceived tightness will be evaluated instead of perceived pain. A traditional likert scale of perceived tightness will help subject’s rate their perception of hamstring tightness.
Proprioception

Assessing the effect of Kinesio® tape on ankle proprioception and reproducing joint position sense has also been evaluated (Halseth, McChesney, DeBeliso, Vaughn, Lien, 2004). Subjects received Kinesio® tape for a lateral ankle sprain (Halseth et al., 2004). The results did not show any difference in absolute or constant error between the Kinesio® tape group and the no-tape group (Halseth et al., 2004). Kinesio® tape did not enhance proprioception when measured by active ankle reproduction of joint position sense (Halseth et al., 2004). Having tape on your skin could lead to enhancements in proprioception but this particular area of study needs to be researched further. Kinesio® tape has also been studied to investigate the effect of activation of the fibularis longus muscle during inversion perturbation (Briem et al., 2011). Kinesio® taping for muscle activation of fibularis longus consists of a single strip applied origin to insertion (Briem et al., 2011). When compared to no tape and non-elastic athletic tape, Kinesio® Tape had no effect on any of the measured variables of stability (Briem et al., 2011). Results showed no facilitation, muscle activation, or improved sense of stability with the use of Kinesio® tape (Briem et al., 2011). Kinesio® tape may not pull aggressively enough on the skin to enhance muscle response and therefore may not be a good option for prevention of inversion ankle sprains (Briem et al., 2011). Kinesio® tape has a different consistency compared to other taping materials and with the variety of taping techniques and ability to stretch more could be studied to evaluate joint proprioception. An article evaluating acute whiplash injury discussed a sensory feedback that Kinesio® tape can provide patients, which could lead to decreases in fear of movement (González-Iglesias et
al., 2009). Obtaining a visual analog scale or subjective feedback from patients about their opinion of Kinesio® tape could lead to a better understanding about possible decreases in fear of movement.

Kinesio® tape is believed to have benefits in association with proprioception and kinesthetic awareness; however current research does not support this claim. Studies have evaluated proprioception and have not seen changes when Kinesio® tape is applied to the lower extremity, specifically the ankle. Proprioception does not seem to be the big area of current research interest involving Kinesio® tape. More studies have to assess the indications and effects Kinesio® tape has on proprioception.

**Range of Motion**

Some early preliminary research regarding Kineiso® tape and effects on range of motion has been completed. Kinesio® tapes ability to improve shoulder mobility caused by pain and myofacial trigger points has been assessed (Garcia-Muro, Rodriguez-Fernandez, Herrero-de-Lucas, 2009). A deltioid muscle taping application applied in addition to a reinforced transverse strip has demonstrated improvements in shoulder mobility (Garcia-Muro et al., 2009). Two days after treatment abduction and flexion range of motion improved and pain decreased (Garcia-Muro et al., 2009). Improvements in shoulder range of motion could be very valuable for shoulder injuries and as a treatment post operatively. The application of Kinesio® tape improved pain and range of motion in relation to the inhibition of the deltid muscle myofacial trigger points (Garcia-Muro et al., 2009). Myofacial tightness can reduce range of motion and lead to
pain and discomfort. Kinesio® tape providing pain relief and allowing increases in range of motion could be very valuable for the treatment of our athletes. Another study looked at subjects complaining of shoulder pain with signs of impingement and supraspinatus involvement (Kaya et al., 2010). The taping method included a Y-strip for the supraspinatus, applied insertion to origin with paper off tension, a Y-strip for the deltoid applied insertion to origin, and an I mechanical correction strip applied at the region of perceived pain (Kaya et al., 2010). Benefits seen with this Kinesio® tape application indicated improving pain free shoulder abduction immediately after application (Kaya et al., 2010). Short and long term benefits were not observed at re-assessment three and six days after tape application (Kaya et al., 2010). Immediate improvements were noted however with extended wear time further benefits were not detected. This study will measure active hamstring range of motion for up to 12 days to evaluate if a long term improvements in range of motion are observed. The immediate improvements observed in the past research for abduction range of motion could have been related to motor unit recruitment and increased proprioceptive stimulus (Kaya et al., 2010). Further investigation into long term changes in range of motion need to be assessed.

Trunk range of motion using a Y-tape method for the sacrospinalis muscle has been evaluated in healthy subjects (Yoshida & Kahanov, 2007). Immediate changes in trunk flexion, extension, and lateral flexion were measured (Yoshida & Kahanov, 2007). Results showed significant improvements in flexion range of motion immediately following tape application (Yoshida & Kahanov, 2007). Immediate measures showed increases in range of motion and pain reduction in a healthy population. The purpose of
Kinesio® tape is to have a therapeutic effect 24 hours a day for an extended time period, so further investigation into the long term effects should be studied. Measuring hamstring range of motion for up to 12 days will help provide insight into the possible long term effects of Kinesio® tape. No change was identified for trunk extension or lateral flexion (Yoshida & Kahanov, 2007). The improvement seen only in trunk flexion may have to do with the pull of tape application and stretching of the muscle as the tape was applied (Yoshida & Kahanov, 2007).

The effects of Kinesio® tape application to improve neck range of motion with patients suffering from acute whiplash-associated disorders have also been studied (González-Iglesias et al., 2009). A-Y strip of tape was placed over the posterior cervical extensor muscles from insertion to origin with paper off tension (González-Iglesias et al., 2009). The patient’s neck was placed in cervical contralateral side-bending and rotation with a space-tape placed perpendicular over the midcervical region (González-Iglesias et al., 2009). Both pain and range of motion were measured immediately after application and at 24 hours post treatment (González-Iglesias et al., 2009). Results indicated statistically significant improvements immediately after application and at 24 hour follow up for both neck pain and cervical range of motion (González-Iglesias et al., 2009). Statistically, improvements were significant but for practical purposes the changes were of minimal clinical significance (González-Iglesias et al., 2009). If significant improvements were noted at 24 hours after tape application, the chance of increased benefits with longer wear time should be further studied and measured.
The implementation of Kinesio® tape could decrease pain through inhibitory mechanisms and allow sensory feedback that decreases the subject’s fear of movement (González-Iglesias et al., 2009). Immediate increases in range of motion have been seen in both the trunk and neck. Long term effects of inhibition taping methods have not been evaluated in depth. A focus on evaluating long term changes in range of motion would be beneficial. Also studied a new area of the body such as the hamstrings which is commonly injured in the athletic population could be valuable to the health care community.

**Conclusion**

Current research regarding the use of Kinesio® tape to improve range of motion has multiple identifiable limitations. First, the majority of the research has only evaluated short-term effects of Kinesio® tape. Studies have evaluated immediate effects and up to six days after tape application. With the use of any therapeutic treatment, effects should be monitored for a greater range of time so all possible benefits can be measured. Kinesio® tape application can last for two to three days and be re-applied to test long term effects. This study will evaluate changes in range of motion immediately and up to 12 days.

Also, studies typically divide subjects into two treatment groups and only one group receives the therapeutic taping method while the other group receives a placebo taping. The between subjects design makes it difficult to account for other extraneous variables between the subjects. A within design would allow patients to receive both the
placebo and therapeutic Kinesio® tape application to help control other variables.

Studies have utilized a sham taping method for a control group; this methodology will be used in this research evaluating hamstring range of motion.

Kinesio® tape application has multiple proposed uses and benefits. Research is starting to evaluate the effects associated with muscle facilitation, pain reduction, proprioception, and effects on range of motion. Of the existing research, which is limited, current results tend to vary and show little or limited significance. As Kinesio® tape use increases and more research is published a greater understanding for any effects of Kinesio® tape will become clear.
CHAPTER 3

METHODOLOGY

Subjects

Twenty nine healthy subjects were used for the study (21 males, mean age 17.19 and 8 females, mean age 17.75). The subjects were high school or college aged athletes from varying sports. Baseline information including age, height, weight, gender, in-season or out-of-season participation, and involvement in a strength or stretching program was taken. Popliteal angle or active knee extension and straight leg raise were measured for inclusion criteria on both legs. Popliteal angle and straight leg raise were measured using standard goniometric measures described later. When measuring the extremities the goniometer is the preferred instrument to assess range of motion (Gajdosik & Bohannon, 1987). A popliteal angle of minus 30 degrees or greater and a straight leg raise of less than 90 degrees were required as inclusion criteria. Subjects who reported a pre-existing hip, thigh, or knee injury within the last 6 months were also excluded from the study. The subjects were willing to shave the hamstring area and slightly inferior to the popliteal angle to ensure adherence for an extended time period.

Subjects were identified as potential participants by speaking with athletic training and coaching personnel at a Division I University in Ohio. Those sports teams that were interested were then contacted through email or at an in person meeting with the team as requested by some coaches. Participation was completely voluntary; those
who expressed interest contacted the researcher following the team meeting. The study was also presented to the principal, athletic director, and coaches at a division VI high school in Ohio. The researcher was employed as the athletic trainer at this high school and had relationships with the athletes and coaching staff that allowed for good compliance and adherence with the research protocol. Various other high school athletic trainers were contacted to help recruit subjects. One high school teacher/athletic trainer at a different high school in the area offered to allow the researcher to speak with a group of student athletes. The teacher has a vocational sports medicine class that has students from various high schools coming together for class each day in the afternoon. Participation was offered to multiple athletes as a group and those who wanted to voluntarily participate submitted the appropriate consent forms. Those who did not wish to participate simply didn’t contact the researcher or turn in the forms. There was no penalty for non-participation.

**Materials**

The materials used for the study included: Kinesio® tape, scissors, a standard 12-inch plastic goniometer, and a Swanson Tool Company angle finder. A visual analog scale of perceived tightness was also used on a scale of 0 to 10 (0 being not tight at all and 10 being extremely tight). To ensure consistency, the researcher met with a Kinesio Taping® instructor who specifically trained the researcher on the proper application. Although the researcher was Kinesio Taping® certified, the meeting with the instructor
and the supervised practice served to increase the consistency of the taping procedures to control for potential variations.

**Design**

The study was a within subject – repeated measures design. A random counterbalanced design was used for the first taping assignment. The independent variables were condition and time. Condition included both a Kinesio® and a sham taping method. Time included 5 time points: baseline, immediate, 4 days, 8 days, and 12 days. The dependent measures were perceived stiffness, straight leg raise angle, and popliteal angle. Significance was set a priori at $p \leq .05$.

**Procedure**

Interested subjects returned the consent form and the parental consent form, if considered a minor. Basic baseline information was taken such as age, height, weight, gender, in-season or out-of-season participation, and strength or stretching program involvement. The subjects had baseline measurements of straight leg raise angle, popliteal angle, and perceived tightness. Each subject was instructed to lie on his or her back and slowly lift up one leg while keeping the other leg straight on the table. The subject was asked to keep his knee straight and go up as far as possible. The measurement was taken 3 times with the use of a standard, 12 inch plastic goniometer by a trained and experienced certified athletic trainer. The researcher was positioned at the side of the table and had the fulcrum at the greater trochanter, the stationary arm parallel
along the trunk and the movable arm along the lateral shaft of the femur. While measuring popliteal angle or active knee extension subjects were placed in a 90-90 degree position with the hips flexed to 90 degrees and the knees flexed to 90 degrees. The subject was then asked without moving the hip to extend their knee as much as possible. An angle finder was used to ensure a starting position of 90-90. The goniometer was placed with the fulcrum on the lateral aspect of the knee on the lateral condyle with both arms perpendicular and extending upward from the knee. Once the subject straightened the knee the movable arm was placed along the longitudinal axis of the leg along the lateral aspect of the fibula pointing toward the lateral malleolus (Gajdosik & Lusin, 1983). This method of measuring helped limit motion in the hip and low back and is reliable for measuring hamstring tightness (Gajdosik & Lusin, 1983). Again three measures were taken and averaged for increased reliability (Yoshida & Kahanov, 2007). In between each measure the subjects were placed back into the 90-90 starting position. A visual analog scale from 0 (no stiffness) to 10 (extremely stiff) then subjectively measured perceived stiffness. Subjects were shown the scale and asked how tight they felt.

After all the baseline information was taken on the right leg the subjects were randomly assigned to a taping group or sham group and received the assigned taping on the right limb. Group assignment was random and utilized a counterbalance design so an even number of subjects received the Kinesio and sham method on the right leg. Then taping was performed on the left limb, so all subjects were given both the taping and sham taping methods. In the taping method, according to the Kinesio® taping manual
the Kinesio® tape was applied insertion to origin with a 15-25% tension on the tape. The subjects lay prone and were in a stretched position with the knee in extension and the hip flexed to place a stretch on the hamstrings muscle group. The tape was cut in a Y shape and had 2 tails that started inferior to the popliteal space and crossed the knee joint becoming 1 strip of tape about an inch superior to the popliteal space and ran up the hamstring muscle ending near the gluteal folds (Figure 2). No tension was placed on the anchors of the tape, which included the 2 tails of the tape and the last inch of the tape near the gluteal fold. To ensure a tension of 15-25% the tape was applied and the paper backing was used to compare the difference in length. By counting the original amount of 1 inch squares and then stretching the tape length and looking for an increase in the tape that was applied to the skin. For example if 5 squares were on the original paper backing and the tape was applied when comparing the paper there should be an increase of roughly ¾ of a square to a square and a half (Figure 3).

Figure 2: Tension application  
Figure 3: Tension application
If the proper tension was not placed then the tape could be readjusted with a new amount of tension. Sham taping methods have been described differently among various researchers. One method used on the lower trapezius muscle did not use Kinesio® tape instead used Micropore tape with no stretch force (Hsu et al., 2008). Applying Kinesio® tape transversely around the desired muscle such as the forearm or bicep with no tension has also been used (Chang et al., 2010; Fratocchi et al., 2012). Another method utilized Kinesio® tape in simple I strips along the cervical region with no tension applied (González-Iglesias et al., 2009). The Kinesio® and sham method looked very similar aside from no tension being applied to the tape. In the sham method used for this study, the tape had no tension applied and did not cross the knee joint. Using a completely different type of tape would have been difficult for extended wear time on the hamstring muscle group and a transverse strip would not allow much tape to be in contact with the desired muscle group. Therefore, Kinesio® tape was still used along the hamstring muscle group but with a shorter strip of tape and no tension. The tape was still cut into a Y shape with 2 tails about 2 inches long. A paper off tension could not be used because this would still allow some tension on the tape, so the tape was removed from the paper and gently placed directly on to the skin. The height of the tape still reached the gluteal folds (Figure 3). The researcher utilized the paper backing as much as possible to limit contact with the tape that could decrease the adherence to the skin.

The subjects were placed in the prone stretched position for both taping groups. After baseline measures were obtained subjects were taped with the assigned method and immediately measured again. This was done to evaluate for immediate changes similar
to previous studies, which implemented this method of immediate measures (Kaya et al., 2010; Yoshida & Kahanov, 2007). Subjects were then taped every 2 days for 12 consecutive days and measured every 4 days before the previous taping was removed. A length of twelve days was selected to exceed previous research which looked at up to 6 days of wearing tape application (Thelen et al., 2008). Measurements were taken 3 times for both popliteal angle and straight leg raise and subjects were asked perceived stiffness.

*Figure 4: Kinesio® method*

*Figure 5: Sham method*
once. Reliability of taking only one measure varies among research, to allow for alignment errors or small variance in the subject’s ability to perform the given task the average of 3 measures was taken (Rothstein, Miller, & Roettger, 1983). Also, similar methods of 3 measures to ensure reliability of range of motion was followed in a study by a Yoshida & Kahanov (2007). An increase in range of motion should not be noted because of the repeated technique of 3 measures. Findings have supported loading for more than 20 minutes is adequate or soft-tissue lengthening to occur (Bohannon, 1984). Subjects were also asked to make a comment at one point during the 12 day taping cycle to allow for additional subjective feedback. In some instances subjects could not make it every 2 days so the tape was kept on for an additional third day. Also, some subjects had difficulties with tape sticking inferior to the popliteal space.
CHAPTER 4

ANALYSIS OF THE FINDINGS

Results

There were a total of 29 subjects (21 males, mean age 17.191 +/- 1.750 and 8 females, mean age 17.750 +/- 2.493). Descriptive statistics are presented in Table 1.

Table 1: Subject Demographics

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<td>Height</td>
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<td>15.059</td>
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</table>

Subject’s mean age, weight, height by sex

Approximately 38% were in-season during data collection for this study. Subjects participated in the following sports: football, baseball, softball, basketball, swimming, golf, soccer, track and field, wrestling, and volleyball. Some subjects were on lifting or stretching programs depending on sport participation and were instructed to maintain the current program with no changes. Three subjects began the experiment but were dropped due to various reasons related to compliance of taping schedule. One additional subject
was dropped due to skin irritation, which resolved clinically without treatment within 1 day of tape removal. A 2 x 5 repeated measures ANOVA revealed a main effect of time with both taping conditions Kinesio® and sham across all 3 types of measures (perceived stiffness, straight leg raise, and popliteal angle). Regardless of taping method a significant increase in range of motion for both straight leg raise \((p < .001)\) and popliteal angle \((p < .001)\) (Figure 6, Table 2) was noted. A significant decrease in perceived stiffness over time was also observed \((p < .001)\) (Figure 7, Table 3). There was a condition by time interaction revealed for straight leg raise between 8 and 12 days. Post hoc tests of between subject effects revealed no sex differences.

**Figure 6:** Popliteal angle range of motion over time
Table 2: *Dependent Variable: PL - Degrees of Flexibility*

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<td>Immediate</td>
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<td></td>
<td>4 days</td>
<td>35.609</td>
<td>10.005</td>
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<tr>
<td></td>
<td>8 days</td>
<td>34.022</td>
<td>9.417</td>
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<td></td>
<td>12 days</td>
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<td></td>
<td>Total</td>
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<tr>
<td>Total</td>
<td>Baseline</td>
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<td>Immediate</td>
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<tr>
<td></td>
<td>4 days</td>
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<td>8 days</td>
<td>34.442</td>
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<td>Total</td>
<td>36.034</td>
<td>8.640</td>
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</table>

Popliteal angle means across time
Measures of stiffness over time ($p < .001$)

*Figure 7:* Perceived stiffness over time

When analyzing the straight leg raise there was significance found with a condition main effect ($p = .025$). There was no overall condition and time interaction. There was a difference for the Kinesio® condition but not over time. Table 2 displays the straight leg raise main effect of condition. The Kinesio® method group started off with a more flexible straight leg raise at baseline and maintained this difference throughout the 12 day time period. The Kinesio® method continued to have increased range of motion measures for the straight leg raise from baseline through all 12 days. The mean baseline value for the Kinesio Taping® method started off higher at 76.977° +/- 9.447° while the mean baseline value for the sham taping method was lower at 74.575° +/- 8.596°. All time points combined the overall Kinesio® average value for straight leg raise was 80.349°, +/- 9.385° and the sham average value was 77.625°, +/- 7.648°. Again, overall among all 5 time points there was no condition and time interaction.
Table 3: Dependent Variable: Perceived Stiffness

<table>
<thead>
<tr>
<th>Condition</th>
<th>Time</th>
<th>X</th>
<th>SD</th>
<th>N</th>
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<td>Sham</td>
<td>Baseline</td>
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<td>Immediate</td>
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<tr>
<td></td>
<td>4 days</td>
<td>5.517</td>
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<td></td>
<td>8 days</td>
<td>5.276</td>
<td>1.412</td>
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<td>12 days</td>
<td>4.828</td>
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<td>Total</td>
<td>5.559</td>
<td>1.015</td>
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</tr>
<tr>
<td></td>
<td>4 days</td>
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<td></td>
<td>8 days</td>
<td>5.069</td>
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</tr>
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<td></td>
<td>12 days</td>
<td>4.724</td>
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<td>Total</td>
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<td>Baseline</td>
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<td>4 days</td>
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<td>0.780</td>
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</tr>
<tr>
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<td>8 days</td>
<td>5.172</td>
<td>1.080</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>12 days</td>
<td>4.776</td>
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<td>5.514</td>
<td>0.837</td>
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</tbody>
</table>

Perceived stiffness means across time

However, after observing the graphed data points which showed a difference taking place between the 2 conditions across time between 8 and 12 days for SLR an ANOVA revealed a significant condition by time interaction present ($p = .046$) (Figure 8, Table 4). Post hoc paired samples T tests between 8 and 12 days showed significance in the Kinesio® group ($p = .027$) and no significance in the sham group ($p = .764$). Between 8 days and 12 days there was a greater improvement for straight leg raise for the Kinesio® group while the sham group decreased slightly. The Kinesio® group continued
to improve between 8 and 12 days from 81.874° to 83.666° while the sham group went from 79.896° to 79.643°.

Subsequent T tests were used to reveal average changes in perceived stiffness, straight leg raise, and popliteal angle between all combinations of time points. When comparing all 5 time points to each and every time point using a fan method there is a total combination of 10 time points to evaluate. Perceived stiffness showed decreases between 9 of the time points. Decreases in perceived stiffness were noted between all

![Figure 8](image-url)

Measures of degrees over 12 days ($p < .001$).

*Figure 8: Straight leg raise over time*
Table 4: Dependent Variable: SLR - Degrees of Flexibility

<table>
<thead>
<tr>
<th>Condition</th>
<th>Time</th>
<th>X</th>
<th>SD</th>
<th>N</th>
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<tbody>
<tr>
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<td>4 days</td>
<td>78.207</td>
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</tr>
<tr>
<td></td>
<td>8 days</td>
<td>79.896</td>
<td>8.757</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>12 days</td>
<td>79.643</td>
<td>8.327</td>
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<td>8 days</td>
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<td>12 days</td>
<td>83.667</td>
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<td>80.349</td>
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<td>Immediate</td>
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<td>4 days</td>
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<td>8 days</td>
<td>80.885</td>
<td>9.168</td>
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</tr>
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<td></td>
<td>12 days</td>
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</tr>
<tr>
<td>Total</td>
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<td>78.987</td>
<td>7.983</td>
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</table>

Straight leg raise means across time comparisons except 4 days to 8 days ($p = .143$). The mean change in perceived stiffness between baseline and 12 days was $1.41 \pm 1.02$ ($p < .001$). Straight leg raise showed increases between 8 out of 10 time points. Significance was found for all-time points except between 4 days to 8 days ($p = .063$) and 8 days to 12 days ($p = .236$). The mean increase in straight leg raise between baseline and 12 days was $5.88^\circ \pm 5.53$ ($p < .001$).

Popliteal angle showed increases in between 7 out of 10 time points. Significance was found for all-time points except immediate and 4 day ($p = .228$), 4 day and 12 day ($p = .163$), 8 day and 12 day ($p = .236$),
.089), and 8 day and 12 day ($p = .264$). The mean increase in popliteal angle between baseline and 12 days was $2.97^\circ +/- 4.35$ ($p = .001$).

Subjective feedback was asked of subjects during each taping condition. They could say they felt more flexible, no change, or if they preferred one method to the other. A Chi square analysis was used to analyze the subjective feedback for taping method preference. Sixteen subjects revealed no preference of taping methods, 9 preferred the Kinesio® method, and 4 preferred the sham method ($p = .023$). With an equal distribution of preference between Kinesio Taping® and sham method when excluding the no preference option, it was predicted that 50% would choose the Kinesio® tape method as the preferred method. However, more than expected chose Kinesio® and fewer than expected chose sham.
CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Discussion

This study found that over time regardless of taping method Kinesio® or sham there was a decrease in perceived stiffness ($p < .001$), an increase in straight leg raise ($p < .001$), and a decrease in popliteal angle ($p < .001$). There was no significant difference between the taping methods; rather everyone displayed improvements towards greater flexibility. It was hypothesized that the Kinesio Taping® method would be more effective at decreasing perceived stiffness and increasing straight leg raise and decreasing popliteal angle however that was not observed in the study. Perhaps the sham taping method did not produce a neutral effect as anticipated. The sham taping method still utilized Kinesio® tape but the length of the tape was shorter and there was no tension placed on the tape. The subjects were still placed in a prone stretched position and the tape was placed about an inch superior to the popliteal space and ran up to the gluteal folds with no tension. There may have been similar effects on the skin in both methods leading to decreased perceived stiffness and increases in range of motion.

Although there are many possible mechanisms for increases in range of motion, the mechanoreceptors appear to be the most plausible in this study. The literature reflects that Kinesio® tape lifts the skin creating a fluid pathway in which inhibition of over-contracted muscles can take place. According to Kaya et al. (2010), taping provides
immediate sensorimotor feedback that could explain increases in range of motion especially in the immediate measurement taken after Kinesio® tape was first applied. In this study the subsequent time measurements of 4, 8, and 12 days were all measured after the Kinesio® tape had been on the skin for 2 days. Therefore, an emphasis was then placed on long term effects rather than immediate effects. In their study of the upper extremity, Kaya et al. (2010), also reported improvements in the supraspinatus muscle pain and disability scores could have been due to an increased recruitment in motor units from an increased proprioceptive stimulus on the skin. It seems reasonable then that in this study, an increased proprioceptive stimulus on the hamstrings muscle group could have led to decreases in perceived stiffness and increases in range of motion. Other authors studying the upper extremity report similar findings and proposed mechanisms. Thelen et al. (2008), also reported improvements in shoulder range of motion likely because of increased motor units due to increased proprioceptive stimulus following Kinesio® tape.

In this study when evaluating both taping methods, perhaps Kinesio® tape being on the skin regardless of tension or length could be enough to cause a proprioceptive stimulus that can lead to increases in range of motion. According to Gonzalez-Iglesias et al. (2009) it is possible that Kinesio® tape provides a proper sensory feedback to patients to create this change. This sensory feedback regardless of tension and length may be enough to cause changes in range of motion in patients when placed along the hamstrings muscle group.
In this study, the sham taping ran longitudinally along the hamstring muscle but did not place any tension on the tape. Another method of sham taping used in other research focusing on the upper extremity utilized transverse strips of Kinesio® tape along the deltoid muscle. This study found no significant changes in outcome measures indicating a truly neutral treatment (Thelen et al., 2008). In the study by Thelen et al. (2008) both the sham and Kinesio® groups showed near identical improvements which could indicate that tape application may or may not have been beneficial regardless of application technique. Applying the sham tape in the same direction as the Kinesio® tape along the muscle belly could have contributed to desired effects taking place regardless of the taping technique. Even with no tension the sham taping was still placed on the hamstrings muscle group and could have affected the sensory feedback. The sham taping method may have not been as neutral as originally desired.

There was a condition main effect noted for straight leg raise measures in which the Kinesio® group had higher overall values. When analyzing the baseline measures it was revealed that the Kinesio® method had higher baseline values than the sham method. It is important to note that this was maintained throughout the 12 days but indicates if the baseline values started off higher then the main effect of condition was not likely due to differences in the taping method especially if differences were not observed in popliteal angle or perceived stiffness. The other variation in the sham taping methods may be a possible explanation. Unlike the sham, the Kinesio Taping® method did have tension placed along the tape and crossed two joints because it ran distal to the popliteal space whereas the sham did not. There could have been a subtle element in this taping method
that allowed for increased range of motion in the straight leg raise measurement. However, if this were the case popliteal angle and perceived stiffness would likely have shown main effects of condition as well. The hamstrings are 2 joint muscles and the Kineiso® method essentially crossed 2-joints in comparison to the sham method. With the popliteal angle measure, there wasn’t an effect from one method over the other at the knee which is measured by popliteal angle. With straight leg raise, which placed more of an emphasis in the muscle belly proximal to the popliteal space a difference between the taping methods was noted. The Kinesio® method which crossed the knee had more of an effect on the proximal aspect of the muscle and allowed for more improved range of motion than the sham method. The Kinesio® method had higher baseline values for straight leg raise and maintained higher values throughout the 12 days. The taping assignment was randomized so why the Kinesio Taping® method had overall higher baseline values for straight leg raise is unknown.

There was a condition and time interaction present for straight leg raise between 8 days and 12 days. There was a greater improvement for the Kinesio® group while the sham group did not show improvement between these time points. Previous research has focused on immediate and short-term effects for improvements in range of motion with the use of Kinesio® tape. However, there are two studies that have evaluated application of six and nine days. One study evaluated shoulder impingement and utilized three taping sessions for three days for a total of nine total days of application measured at weekly intervals (Kaya et al., 2010). However, the tape was not on for nine consecutive days because of the weekly interval measuring. Results showed Kinesio® tape to be
effective after the first three day taping for a disability scale but measures were similarly effective to the no tape group at the second week (Kaya et al., 2010). Another study evaluated Kinesio® tape on rotator cuff tendonitis worn for two consecutive days for three day intervals (Thelen et al., 2008). Immediate improvements for the Kinesio® group were limited to shoulder abduction (Thelen et al., 2008). Even when evaluating longer intervals of Kinesio Taping® immediate effects have been the focus of the findings.

Immediate improvements were noted in this study but the change that took place from 8 days to 12 days warrants future studies to evaluate the increased length of time associated with tape application. In this study with the decrease in the straight leg raise sham group from 8 to 12 days the max effect may have been reached prior to 8 days. With the continued improvement in the Kinesio® group between 8 and 12 days the max effect or benefit may not yet have been reached. This could lead for a strong recommendation to have a minimum amount of time for tape application to observe all benefits including long-term benefits after 12 days of application.

A further benefit of Kinesio® tape is the extended wear time. Patients can keep Kinesio® tape on for 3-5 days without restricting joint range of motion. Based on clinical experiences, Kinesio® tape provides some degree of support and cutaneous inputs with minimal movement restriction (Hsu et al., 2008). Unlike other types of taping products that limit joint range of motion, Kinesio® tape allows for normal joint range of motion with extended wear time.
Significance was found in the study for improvements for both conditions across time. These improvements can also be carried over and viewed as clinically significant. There was a large enough subject population with enough degree of change. Straight leg raise can be viewed as a practical and functional measure of range of motion. Including both taping methods the average change from baseline to 12 days was 5.879º +/- 5.535º. Clinically, a potential change of 11° could definitely make a difference for athletes participating in sport. This could be helpful for injury prevention and rehabilitation after injury occurs. A potential increase in 11° of hamstring range of motion could lead to functional improvements and enhanced performance.

With subjective feedback those subjects who revealed a preference between the two taping conditions more preferred the Kinesio® tape method over the sham method. This is potentially helpful because both methods showed improvements with time. Even with 16 subjects not revealing a preference both methods worked about the same so it’s not surprising that most participants had no preference. However, excluding no preference there is a higher preference for the Kinesio Taping® method from the athletes themselves. With an equal distribution more than expected reported a subjective preference for the Kinesio Taping® method. This is important because of patient compliance and possible psychological benefits of therapeutic interventions. If patients feel that Kneissio® tape is helping and feels good then they will likely comply and utilize this as a therapeutic intervention. This could have been simply because they felt it made them more flexible than the sham method or they could have felt a better tape adherence with the longer tape that used in the Kinesio Taping® method. The Kinesio® tape
method was placed distal to the popliteal space and could have allowed for better tape adherence on the skin and been less of an annoyance which could have affected preference. The shorter sham method had more issues with adherence to the skin and being pulled during activity or dressing. But again, if both Kinesio® and sham methods showed improvements across time then the subjective preference of Kinesio® tape may be a reason to utilize this particular method.

**Limitations**

A limitation of the study could have been no use of a true control group who did not receive any taping method. A focus on the proper implementation of Kinesio® tape was desired so a sham method was utilized instead of having no tape. Also, psychological effects of taping were taken into account and using a within design there may have been psychological effects if the conditions were Kinesio® tape and no tape. Using two different taping methods was used to control subject bias or placebo effect.

Another limitation was the controlling of extraneous variables. The subjects were required to be athletes at some point during the year, some were in season and some were out of season. Those athletes who were in season could have been affected by in season workouts or strengthening schedules. Athletes were instructed to continue with their normal routine and not make any additional changes. With the subjective feedback from participants they were instructed to say anything regarding how they felt about the tape. They could say if they felt more flexible or compare the two methods if they desire.
Forcing subjects to choose a preference of one taping method over the other would have been more meaningful.

A final limitation was that due to commitment of the taping schedule, some participants went three days before taping was changed at various time points during the study. However, recommendations say that Kinisio® tape can last for 3-5 days so this likely didn’t have much of a negative outcome on effects of the tape or adherence for participants. Three subjects did discontinue the study due to commitment issues of changing the tape every two days.

**Future Research**

Future research should continue to examine Kinesio Taping® methods for an extended time period because a condition and time interaction was noted between 8 and 12 days. An emphasis should be placed on long term effects up to 12 days and beyond for longer effects. A focus should not just be placed on immediate effects. Future research should also consider a true control group so more can be learned about the mechanoreceptors and sensory feedback associated with Kinesio® tape and a no tape conditions. Kinesio® tape can be used for a variety of reasons and the tape itself has endless possibilities. Future studies should continue to evaluate the effects of Kinesio® tape on multiple body areas and should also aim to target injured populations. Kinesio® tape can be used to help rehabilitate injuries so use on an injured population would be beneficial to the literature.
APPENDICIES
APPENDIX A

HUMAN SUBJECTS APPROVAL FORM
APPENDIX A

HUMAN SUBJECTS APPROVAL FORM

Kinesio Taping® Standard Clinical Trial Agreement

CLINICAL STUDY AGREEMENT TITLE

THE KINESIO TAPEING ASSOCIATION INTERNATIONAL, (hereinafter referred to as "KTAI"), and Rachael German, of Ohio USA (hereinafter referred to as "Principal Investigator") agree that Principal Investigator will provide for KTAI a clinical study (hereinafter referred to as "the Study") in return for complimentary use of Kinesio Tex Gold™, (hereinafter referred to as Product).

1. INVESTIGATOR. Principal Investigator, Rachael German, will be responsible for conducting the Study.

2. TERM. This Agreement begins upon signing and ends May 25, 2013. At this time the Principal Investigator will provide KTAI, the final study in its completion. KTAI shall not have rights over study and may not suggest, imply, or demand recommendations to favor the outcome within said study.

3. SPONSORED PRODUCT(S). KTAI shall provide Principal Investigator the necessary agreed upon amount of Product for performance of the Study, to be delivered immediately upon signed Kinesio Taping® Standard Trial Agreement.

4. TERMINATION. Either party may terminate this Agreement upon thirty (30) days written notice to the other party. Primary Investigator shall reimburse and/or return KTAI for all Products that was provided for said study. If Principal Investigator is unable to complete said study to the best of its efforts, for whatever reasons, KTAI has the option to collect MSRP ($14.95 per roll) of the amount provided for said study.

5. CONFIDENTIALITY. KTAI shall not disclose confidential information unless it is necessary to the Study. Any confidential information provided by KTAI to the Principal Investigator will be clearly marked by KTAI, in writing, as “Confidential” or if disclosed orally, written notice will be provided within thirty (30) days of disclosure. Principal Investigator shall protect KTAI’s confidential information with the same degree of care as Principal Investigator's own confidential information. The Principals Investigator’s obligation of confidentiality will exist during the performance of this Agreement and for three (3) years following termination or expiration of this Agreement, unless disclosure is required by law or regulation, or such information (i) is known by the Principal Investigator without restriction prior to disclosure under this Agreement; (ii) is disclosed to the Principal Investigator by a third party without an obligation of confidentiality; (iii) is available to the public through no fault of the Principal Investigator; or (iv) is independently developed by Principal Investigator without knowledge or use of confidential information disclosed by KTAI under this Agreement.
6. PUBLICATION. Principal Investigator may disseminate Study results through either publication or presentation, but will not disclose KTAI's confidential information without permission. Principal Investigator will provide manuscripts or presentation materials for review thirty (30) days before publication. KTAI shall not have editorial rights over manuscripts or presentations, but may comment on implications of publication timing for multiple site studies or request deletion of KTAI's confidential or proprietary information.

7. PATENTS AND INVENTIONS. To the extent that KTAI is providing Confidential Information to the Principal Investigator, and to the extent that the KTAI has authored the Protocol to be conducted under this Agreement, and has designed and structured the manner in which the work is to be conducted, all inventions made in the direct performance of the Protocol and that necessarily incorporates KTAI's device, including new uses, shall be the sole property of KTAI. In instances in which the KTAI desires to secure protection on such inventions, the Principal Investigator will cooperate with the KTAI, for the purpose of filing and prosecuting patent applications, the cooperation to include the execution of any and all lawful papers which may be deemed necessary or desirable by KTAI for the filing and prosecution of applications and for assignment of the same to the KTAI.

8. PRINCIPAL INVESTIGATOR NAME. KTAI shall not use Principal Investigator's name(s), for any advertising or promotional purposes without prior written approval from Principal Investigator.

9. MARKS AND USEAGE OF TRADEMARKED AND COPYRIGHTED INFORMATION. Principal Investigator understands that the use of the name Kinesio®, Kinesio Taping®, Kinesio Taping® Method, Kinesio® Tex Gold™, is protected under international copyright and trademark laws, and will place the proper marks to insure the protection of its identity. The use of Kinesiotaping, Kinesiotape, KT, etc. is prohibited.

9. APPLICABLE LAW. The laws of the State of New Mexico will govern this Agreement. By signing this agreement both parties agree to the terms mentioned.

THE KINESIO TAPING ASSOCIATION INTERNATIONAL
By_____________________
(signature)
By_____________________
Title_____________________
Date_____________________

Rachael German
By_____________________
(signature)
By_____________________
Title_____________________
Date_____________________
Re: #12-403 - “Inhibitory Kinesio Tape Application to the Hamstring Muscle Group: An Investigation of Active Range of Motion and Perceived Tightness Over Time”

Thank you for your IRB submission. The Kent State University Institutional Review Board reviewed your protocol at its September 19, 2012 meeting. Protocol has been approved upon appropriation of the following contingencies:

- Language in the procedures section of the consent form is too technical and should be modified to an appropriate reading level.
- Participants and parents are being consented; no assent is needed.
- The consent form should state that “application of the tape may identify you as a member of the study.”
- The consent form should advise of potential skin irritation from the adhesive and from shaving the area as well as allergy precaution.
- The consent form should include pictures showing placement of the tape and of the leg flexion.
- The consent form should identify that the Kinesio Tape Association is donating the tape for use in the study.

What should you do now?

Please send the revised materials to me via email using your protocol number subject line so that our office can quickly append your file and proceed with the approval process.

Federal regulations require that “An IRB shall conduct continuing review of research...at intervals appropriate to the degree of risk, but not less than once per year....” An annual review and progress report will need to be submitted one year after final approval of this protocol. Please submit review materials (annual review form and copy of current consent form) one month before the expiration date.

HHS regulations and Kent State University Institutional Review Board guidelines require that any changes in research methodology, protocol design, or principal investigator have the prior approval of the IRB before implementation and continuation of the protocol. The IRB must also be informed of any adverse events associated with the study. The IRB further requests a final report at the conclusion of the study.

Kent State University has a Federal Wide Assurance on file with the Office for Human Research Protections (OHRP); FWA Number 00001853.
APPENDIX B

INFORMED CONSENT FORM

Informed Consent to Participate in a Research Study

Study Title: Inhibitory Kinesio Tape® Application to the Hamstring Muscle Group: An Investigation of Active Range of Motion and Perceived Tightness Over Time

Principal Investigator: Rachael German, AT CKT1&2

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision. You will receive a copy of this document to take with you. Tape is being provided by The Kinesio Taping® Association International. A picture of the taping and measuring method has been provided.

Purpose:
The purpose of this research is to investigate the Kinesio® tape inhibition taping method technique applied insertion to origin as a means to improve active hamstring range of motion and decrease stiffness perception immediately and long-term.

Procedures
The participants will be required to be high school or college athletes. Basic information like height, weight, gender, sport involvement, strength program, and flexibility program will be asked. Range of motion measurements will be assessed for possible participation. Hamstring tightness is needed for participation in the study. Participants must also have not suffered a thigh, hip, or knee injury within the last 6 months. Participants should be willing to shave hamstring area for better tape adherence. Participants hamstring range of motion will be measured and they will be asked to fill out a perceived tightness form. Participants will then receive a taping method on both the right and left leg. There will be 2 methods of taping completed. In the taping method, the Kinesio® tape will be applied from behind the knee (insertion) to the gluteal fold or underwear line (origin). Participants range of motion and perceived tightness will be measured every 4 days and the taping method will be re-applied every 2 days. Participants will be taped and followed for 12 consecutive days.
Benefits
The potential benefits of participating in this study may include an increase in hamstring range of motion. An increase in hamstring range of motion could lead to enhanced athletic performance and decrease the potential for injuries. Society will gain knowledge regarding Kinesio® tape and the ability to increase range of motion. Research may also help increase the knowledge for the general population who may use Kinesio® tape and health care professionals who use it in their practice.

Risks and Discomforts
A potential discomfort would be a skin reaction to the tape itself due to allergy or from shaving if subjects are not used to shaving the area. If a subject has any type of negative reaction to the tape they can remove it immediately.

Privacy and Confidentiality
Your study related information will be kept confidential within the limits of the law. Any identifying information will be kept in a secure location and only the researchers will have access to the data. Research participants will not be identified in any publication or presentation of research results; only aggregate data will be used.

Voluntary Participation
Taking part in this research study is entirely up to you. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. You will be informed of any new, relevant information that may affect your health, welfare, or willingness to continue your study participation. Application of the tape may identify you as a member of the study.

Contact Information
If you have any questions or concerns about this research, you may contact Rachael German at 734-890-1844 or Dr. Kim Peer at 330-672-0231. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330.672.2704.
**Consent Statement and Signature**

I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to participate in this study. I understand that a copy of this consent will be provided to me for future reference.

_________________________________  ______________________
Participant Signature                Date
Parental Consent to Participate in a Research Study

Study Title: Inhibitory Kinesio Tape® Application to the Hamstring Muscle Group: An Investigation of Active Range of Motion and Perceived Tightness Over Time

Principal Investigator: Rachael German, AT CKT1&2

Your child is being invited to participate in a research study. This consent form will provide you with information on the research project, what your child will need to do, and the associated risks and benefits of the research. Your child’s participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision. You will receive a copy of this document to take with you. Tape is being provided by The Kinesio Taping® Association International. A picture of the taping and measuring method has been provided.

Purpose:
The purpose of this research is to investigate the Kinesio® tape inhibition taping method technique applied insertion to origin as a means to improve active hamstring range of motion and decrease stiffness perception immediately and long-term.

Procedures
Your child’s participation will be require him/her to be high school athlete. Basic information like height, weight, sport involvement, strength program, and flexibility program will be asked. Range of motion measurements will be assessed for possible participation. Hamstring tightness is needed for participation in the study. Participants must also not have suffered a hamstring injury within the last 6 months. Participants should be willing to shave hamstring area for better tape adherence. Participants hamstring range of motion will be measured and they will be asked to fill out a perceived tightness form. Participants will then receive a taping method on both the right and left leg. There will be 2 methods of taping completed. In the taping method, the Kinesio® tape will be applied from behind the knee (insertion) to the gluteal fold or underwear line (origin). Participants range of motion and perceived tightness will be measured every two days and the taping method will be re-applied. Participants will be taped and followed for 12 consecutive days.
Benefits
The potential benefits of participating in this study may include an increase in hamstring range of motion. An increase in hamstring range of motion could lead to enhanced athletic performance and decrease the potential for injuries. Society will gain knowledge regarding Kinesio® tape and the ability to increase range of motion. Research may also help increase the knowledge for the general population who may use Kinesio® tape and health care professionals who use it in their practice.

Risks and Discomforts
A potential discomfort for your child would be a skin reaction to the tape itself due to allergy or from shaving if subjects are not used to shaving the area. If a subject has any type of negative reaction to the tape they can remove it immediately.

Privacy and Confidentiality
Your child’s study related information will be kept confidential within the limits of the law. Any identifying information will be kept in a secure location and only the researchers will have access to the data. Research participants will not be identified in any publication or presentation of research results; only aggregate data will be used.

Voluntary Participation
Taking part in this research study is entirely up to you and your child. You and/or your child may choose not to participate or may discontinue their participation at any time without penalty or loss of benefits to which he/she is otherwise entitled. You will be informed of any new, relevant information that may affect your child’s health, welfare, or willingness to continue participation in this study. Application of the tape may identify your child as a member of the study.

Contact Information
If you have any questions or concerns about this research, you may contact Rachael German at 734-890-1844 or Dr. Kim Peer at 330-672-0231. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330.672.2704.
**Consent Statement and Signature**
I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to grant permission for my child to participate in this study. I understand that a copy of this consent will be provided to me for future reference.

Parental Signature ___________________________ Date ___________________________
APPENDIX C

SUBJECT CHARTING FORM
APPENDIX C

SUBJECT CHARTING FORM

Inhibitory Kinesio Tape Application to the Hamstring Muscle Group: An Investigation of Active Range of Motion and Perceived Tightness Over Time

Subject ID: ___________________________________

Height: __________

Weight: __________

Male/female: ________________

Sport: ________________________________

In season/off season: __________________

Are you on any type of strength training program? If so describe.

Are you on any type of stretching program? If so describe.

<table>
<thead>
<tr>
<th>Charting 1st method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time line</td>
</tr>
<tr>
<td>Baseline</td>
</tr>
<tr>
<td>Immediate</td>
</tr>
<tr>
<td>2 days (just tape)</td>
</tr>
<tr>
<td>4 days</td>
</tr>
<tr>
<td>6 days (just tape)</td>
</tr>
<tr>
<td>8 days</td>
</tr>
<tr>
<td>10 days (just tape)</td>
</tr>
<tr>
<td>12 days</td>
</tr>
</tbody>
</table>
### Charting 2\(^{nd}\) method

<table>
<thead>
<tr>
<th>Time line</th>
<th>Popliteal angle (degrees)</th>
<th>Straight leg raise (degrees)</th>
<th>Perceived tightness (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 days (just tape)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 days (just tape)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 days (just tape)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>12 days</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Additional comments:
- Immediate:
  - 2 days
  - 4 days
  - 6 days
  - 8 days
  - 12 days

---

### Charting 1\(^{st}\) method

- Immediate:
  - 2 days
  - 4 days
  - 6 days
  - 8 days
  - 12 days

---

### Charting 2\(^{nd}\) method

### Additional comments:
- Immediate:
  - 2 days
  - 4 days
  - 6 days
  - 8 days
  - 12 days
APPENDIX D

VAS PERCEIVED STIFFNESS FORM
APPENDIX D

VAS PERCEIVED STIFFNESS FORM

Perceived Tightness

0  1  2  3  4  5  6  7  8  9  10
Not tight at all  Extremely Tight
REFERENCES
REFERENCES


