KINESIO TAPE AND ITS EFFECTS ON INTERNAL AND EXTERNAL RANGE OF MOTION OF THE SHOULDER

A Thesis
Presented to
The College of Graduate and Professional Studies
Department of Applied Medicine and Rehabilitation
Indiana State University
Terre Haute, Indiana

In Partial Fulfillment
of the Requirements for the Degree
Masters of Science in Athletic Training

by
Chelsea M. Renner

May 2012

© Chelsea M. Renner 2012

Keywords: kinesio tape, range of motion, shoulder, inclinometer, questionnaire
COMMITTEE MEMBERS

Committee Chair: Leamor Kahanov, Ed.D, LAT, ATC
   Department Chair of Applied Medicine and Rehabilitation Department
   Indiana State University

Committee Member: Lindsey Eberman, Ph.D, LAT, ATC
   Undergraduate ATEP Program Director of Applied Medicine and Rehabilitation Department
   Indiana State University

Committee Member: Timothy Demchak, Ph.D, LAT, ATC
   Associate Professor of Applied Medicine and Rehabilitation Department
   Indiana State University
ABSTRACT

The primary objective to this study was to determine the effects of kinesio tape (KT) on shoulder ROM arc pre and post KT treatment. The experimental design consisted of a pretest-posttest randomized-group. Independent variables were treatments with two levels: no KT and KT. Dependent variables were shoulder internal and external rotation. Shoulder internal and external rotation was measured with a digital inclinometer on 45 healthy subjects (control group = 22, KT group = 23), while perceptions of participation and KT efficacy was measured with an electronic post-experiment questionnaire. Results showed no significant differences between control and KT treatment groups for shoulder ROM arc pre and post intervention. Significant differences were identified between females (x=125°) and males (x=115°) within each group on day 4 pre tape removal. Overall, females displayed a significant increase in ROM arc with KT after 4 days of treatment, and returned to baseline arc upon tape removal.
ACKNOWLEDGMENTS

Dr. Kahanov has truly been a lifesaver on multiple occasions and it has been a tremendous privilege to work with such an extremely knowledgeable clinician. I have spent countless hours in her office and at her house on the weekends improving the content of my thesis, and making decisions for data collection. She has shown a lot of ambition to work with me on such a project when I wasn’t aware of some of the challenges I would face. Dr. Kahanov has guided and tolerated me over the past 2 years, especially when I would get frustrated and when I would have countless questions for her. This research process wouldn’t have been the same with out her, and as my chair member she always supported me with whatever decision(s) I made. I’ve learned a great deal from her and appreciate all the time and effort she has given me to achieve my goal of completing a thesis.

Dr. Eberman, one of my committee members, has been a trooper through this entire process with having to provide me with her vast knowledge of the shoulder and statistics. Her contributions to the methods of kinesio tape and the research project procedures have been valuable to this process. She has been positive throughout these past 2 years and has provided me with her perspectives that have shaped this project to what it has become.

Dr. Demchak, my other committee member, from the beginning was able to guide me in the direction for developing methods and use of instrumentation that I knew he would. He has helped me with the use of the inclinometer and provided me with information that has been essential to the data collecting process. Dr. D has given me his input throughout these past couple years that has been helpful and positive.
My main colleague and classmate, Ai Ujino, has been there for me through the entire process. We have spent countless hours in the research lab and at each other’s places working tirelessly on our writing, data collection, and providing each other advice on presentations. Ai has been a real friend not only in the scholarly aspect, but also in my personal life when things were stressful and tough for me. Her advice and listening skills have made this entire project much more tolerable than it would have been otherwise.

My coworkers, Greg & Mike, have done a wonderful job of working with my hectic data collecting schedule. The amount of time they spent covering my sport events and practices did provide them with extra stress to their schedules. Needless to say, I truly appreciated the extra work they did for me in order to finish my data collection on time.

My family and Andrew have had a major role in my education and willingness to continue on for my Masters degree. The days where I was very frustrated and needed encouragement, they were willing to listen to me and offer advice that kept me motivated. They have heard every story and everything about my research topic/data collection for the past 2 years, which is another reason why I appreciate them.

The participants for this research voluntarily gave their time and effort to this study. There were complications that we ran into within data collection, but the participants were very understanding and determined to continue the study. Without the subjects’ willingness to volunteer, this study could not have happened.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMITTEE MEMBERS</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Research Questions</td>
<td>3</td>
</tr>
<tr>
<td>Operational Definitions</td>
<td>3</td>
</tr>
<tr>
<td>Assumptions</td>
<td>4</td>
</tr>
<tr>
<td>Delimitations</td>
<td>4</td>
</tr>
<tr>
<td>Limitations</td>
<td>4</td>
</tr>
<tr>
<td>LITERATURE REVIEW</td>
<td>5</td>
</tr>
<tr>
<td>Search Strategies</td>
<td>5</td>
</tr>
<tr>
<td>Kinesio Tape Theory</td>
<td>6</td>
</tr>
<tr>
<td>Research in Kinesio Tape</td>
<td>9</td>
</tr>
<tr>
<td>Kinesio Tape on Proprioception</td>
<td>9</td>
</tr>
<tr>
<td>Kinesio Tape on Range of Motion and Strength</td>
<td>10</td>
</tr>
<tr>
<td>Kinesio Tape on Pain Perception</td>
<td>11</td>
</tr>
<tr>
<td>Shoulder Anatomy</td>
<td>12</td>
</tr>
<tr>
<td>Shoulder Biomechanics and Anatomy</td>
<td>12</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Shoulder Biomechanics and Injuries</td>
<td>17</td>
</tr>
<tr>
<td>Shoulder Range of Motion</td>
<td>18</td>
</tr>
<tr>
<td>Electronic Surveys</td>
<td>19</td>
</tr>
<tr>
<td>Conclusion</td>
<td>20</td>
</tr>
<tr>
<td>METHODS</td>
<td>21</td>
</tr>
<tr>
<td>Study Design</td>
<td>21</td>
</tr>
<tr>
<td>Participants</td>
<td>22</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>22</td>
</tr>
<tr>
<td>Inclinometer</td>
<td>22</td>
</tr>
<tr>
<td>Questionnaire</td>
<td>24</td>
</tr>
<tr>
<td>Protocols</td>
<td>25</td>
</tr>
<tr>
<td>Procedures</td>
<td>26</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>32</td>
</tr>
<tr>
<td>MANUSCRIPT</td>
<td>40</td>
</tr>
<tr>
<td>Introduction</td>
<td>40</td>
</tr>
<tr>
<td>Methods</td>
<td>41</td>
</tr>
<tr>
<td>Participants</td>
<td>41</td>
</tr>
<tr>
<td>Study Design</td>
<td>41</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>42</td>
</tr>
<tr>
<td>Inclinometer</td>
<td>42</td>
</tr>
<tr>
<td>Questionnaire</td>
<td>42</td>
</tr>
<tr>
<td>Procedures</td>
<td>42</td>
</tr>
<tr>
<td>Shoulder Internal-External Rotation Measurement</td>
<td>43</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1 .............................................................................................................................................5
Table 2 ...............................................................................................................................................26
LIST OF FIGURES

Figure 1. Tape Convolutions. .................................................................7

Figure 2. Y-shape Kinesio Tape (X-shape when proximal end is cut). .8

Figure 3. I-shape Kinesio Tape. .............................................................8

Figure 4. Posterior View of Shoulder and Scapula Anatomy. ...........13

Figure 5. Anterior View of Shoulder and Scapula Anatomy. ..........14

Figure 6. Lateral View of Scapula (Sagittal Plane). .........................14

Figure 7. Medial View of Scapula (Sagittal Plane). .........................15

Figure 8. Anterior View of Scapula (Frontal Plane). .....................15

Figure 9. Posterior View of Scapula (Frontal Plane). ....................16

Figure 10. CheckPoint Digital Inclinometer. .................................23

Figure 11. Neutral Position.................................................................28

Figure 12. External Rotation Measurement.................................28

Figure 13. Internal Rotation Measurement.................................28

Figure 14. Anterior View (1\textsuperscript{st} strip)..............................30

Figure 15. Posterior View (1\textsuperscript{st} strip).................................31

Figure 16. Anterior View (2\textsuperscript{nd} strip).................................31

Figure 17. Posterior View (2\textsuperscript{nd} strip).................................32

Figure 18. Demonstration of Cutting Loose Tape.........................74
CHAPTER 1

INTRODUCTION

Taping is widely used in the field of rehabilitation as both a means of treatment and prevention of sports-related injuries.\textsuperscript{1-6} The essential function of most tape is to provide support and restrict movement after acute phases of injury, which is most often conducted with non-stretch tape.\textsuperscript{1-9} However, kinesio tape is unique in that it was designed to mimic the characteristics of human skin with thin cotton, porous fabric that has acrylic adhesive, and is nonmediated and latex free.\textsuperscript{1-20} Kinesio tape resembles roughly the same thickness as the epidermis, and has the capability to stretch 130-140\% from its original size and contract back to normal length after application. Flexibility is a unique characteristic of kinesio tape that differs from normal tape.\textsuperscript{4,7} Kinesio tape can withstand stressors for 3-4 consecutive days because of its porous fabric that is air permeable and water resistant, unlike rigid tape that begins to stretch within 15-20 minutes after application.\textsuperscript{4,5,9} The tape applies a constant pull (shear) force to the skin that helps raise and fold layers of the epidermis.\textsuperscript{4,14} This constant pull force theoretically stimulates normal muscles movement and therefore provides the environment where proper alignment of collagen can be maximized to relax and facilitate in muscular contraction.\textsuperscript{2,5,8,12}

 Constant proprioceptive feedback and alignment correction, as well as the recruitment of specific muscle fibers demonstrates that taping effectively improves posture alignment, range of motion, and reduced pain and discomfort of joints.\textsuperscript{12} The continuous force of kinesio tape can aid
in cases where stabilization is a necessity in order for a joint to function properly (e.g. scapular stabilization). Scapular stabilization requires muscle activation patterns of the upper and lower trapezius and rhomboid muscles with the serratus anterior muscle. When these muscles become fatigued from repetitive use, muscle inhibition or weakness becomes common, which results in the potential for injury and will alter the glenohumeral joint and range of motion. Along with therapeutic rehabilitation, kinesio tape is recognized as a way to provide the constant therapy that has been long sought after for the past 20 years.

The origins of kinesio tape, developed by Kenzo Kase, dates back nearly 20 years in Japan. The kinesio taping method has become a more commonly used technique among health care professionals. The appearances of kinesio tape in athletic events, such as the Beijing 2008 Summer Olympics, professional games, collegiate sporting events, and even high school sport settings has increased visibility and therefore potential use. Although use appears to have increased, which may be due to increased visibility, research is thin regarding outcomes of kinesio tape use and treatment. The practical application of kinesio tape theory still requires investigation to determine the effectiveness of therapeutic benefits.

Kinesio tape is a fairly new therapeutic method that can augment treatment and rehabilitation in Western Medicine. Kinesio tape is employed for injury prevention, treatment, and rehabilitation techniques and may often be used in conjunction with other therapeutic techniques such as strengthening programs and muscle re-education. Kinesio tape is theorized to have several functions: restoring correct muscle function by supporting weakened muscles, improve the flow of blood and lymphatic fluid, decrease pain, and correct misaligned joints. When applied kinesio tape has benefited proprioception, musculature strength, and perceptions of pain. However, an investigation into the effects of kinesio tape on range of motion is
lacking in the literature. Therefore, the purpose of this study is to determine the effects of kinesio tape on shoulder internal and external rotation through quantitative measurements.

**Research Questions**

In subjects with no history of shoulder injury or pathologies, what effect does kinesio tape have on shoulder total arc? Did the use of kinesio tape affect perceptions of range of motion?

**Operational Definitions**

The subsequent definitions were used:

- **Shoulder Range of Motion** – Full shoulder range of motion, or total arc, is the maximum external rotation and maximum internal rotation (approximately $180^\circ$).\(^{22}\)

- **Shoulder Internal Rotation** – Internal rotation consists of the shoulder and elbow position starting at $90^\circ$ abduction and flexion, perpendicular to the ceiling, with maximal internal rotation, palm facing the floor, until scapula begins to rotate or acromion process begins to rise.\(^{22,32}\)

- **Shoulder External Rotation** – External rotation consists of the shoulder and elbow position starting at $90^\circ$ abduction and flexion, perpendicular to the ceiling with maximal external rotation, palm facing the ceiling, until scapula begins to rotate or acromion process begins to rise.\(^{22,32}\)

- **Inclinometer** – A digital measuring device used to measure range of motion joints in the body.\(^{23}\)

- **Kinesio Tape** – Tape that is thin, cotton, porous fabric with acrylic adhesive that consists of elastic properties, which is applied in a specific manner to either aid muscle function, increase circulation, decrease pain, or improve proprioception.\(^5\)
Assumptions

The following assumptions will be made for this study:

- Subjects will report their health history honestly and completely.
- Subjects will complete post-experiment questionnaire honestly and completely.
- Subjects will adhere to the directions.
- Practitioners and the researcher appropriately apply kinesio tape.
- Inclinometer will be placed appropriately on subject.

Delimitations

This study is delimited to:

- Subjects pertain to the general population.
- Subjects have no extreme shoulder deficits.
- Subjects will not be restricted to extracurricular activities while wearing tape.
- One researcher applying tape appropriately.
- Kinesio tape job serves as scapular stabilization.

Limitations

The following are limitations to the study:

- Anatomical differences of subjects; for example different shape of the scapula.
- Biomechanical differences of subjects due to personal anatomical differences.
- Researcher’s accuracy in tape placement on each individual subject.
- Researcher’s understanding of how to read and place the inclinometer accurately.
- Tape peeling may impact elasticity.
CHAPTER 2

LITERATURE REVIEW

Search Strategies

The CINAHL, EBSCOhost, Health-Source Consumer Edition, MEDLINE, PsycINFO, and SPORTdiscus databases (1995-2010) was searched, with emphasis on identifying articles written in English, in order to obtain information using the keywords in Table 1, singularly or combined. Studies are eligible for inclusion if they addressed any of the main issues mentioned in the following chapter: kinesio tape and the effects on proprioception, strength, range of motion, and inflammation; shoulder anatomy and biomechanics; electronic surveys; goniometry and inclinometry. The literature search revealed a total of 380 potentially eligible studies, 50 of which met selection criteria. Additional information was obtained from references cited.

Table 1

Terms Used for Database Searches

<table>
<thead>
<tr>
<th>Terms for Database Searches</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomy</td>
<td>Application</td>
</tr>
<tr>
<td>Clinical</td>
<td>Dyskinesis</td>
</tr>
<tr>
<td>Goniometry</td>
<td>Inclinometer</td>
</tr>
<tr>
<td>Measurement</td>
<td>Motion</td>
</tr>
</tbody>
</table>
Table 1 (continued)

Terms Used for Database Searches

<table>
<thead>
<tr>
<th>Terms for Database Searches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Answer</td>
</tr>
<tr>
<td>Shoulder</td>
</tr>
</tbody>
</table>

Kinesio Tape Theory

Kinesio taping method theory suggests that muscles are not only responsible for movements of the body, but also help manage the circulation of the venous and lymphatic systems.\textsuperscript{5,19} The main goal for the use of kinesio tape is to decrease pain and increase tissue healing associated with the musculoskeletal injuries and illnesses.\textsuperscript{1,5} Theoretically, kinesio tape may provide therapeutic benefits in one of many ways: increasing interstitial fluids between skin and underlying connective tissues, allowing increase in circulation for both venous and lymphatic fluid, decreasing pain with positional stimulus to the skin, muscle, or fascial structures, and by enhancing joint stability.\textsuperscript{1-5,7-11} One specific theory states that kinesio tape increases metabolic activity because fibroblasts are recruited to the injured area, which results in collagen synthesis and increases the healing process.\textsuperscript{5} The tape itself aids in promoting normal muscular movement and aids in the realignment of collagen synthesis during the repair and remodeling phases of the healing process.\textsuperscript{5} Furthermore, kinesio tape has also been theorized to improve proprioception, strength, and range of motion in multiple joints.\textsuperscript{1,2,7,10,15}

Application of kinesio tape has a variety of techniques, which depending on the amount of stretch applied and positioning of the tape creates various outcomes. When applied correctly, kinesio tape’s elastic ability essentially creates convolutions on the skin that separate fascia and
soft tissue, which help enhance circulation and metabolic activity.\textsuperscript{1,5,7,20} These convolutions are created when affected muscles and skin are stretched before the application of kinesio tape. With the stretch held, the tape is applied without any tension. After the application, the stretch is relieved and convolutions of the skin are formed that aid in the body’s response to the kinesio tape.\textsuperscript{5} (Figure 1) Three main shapes of kinesio tape are often used: I, Y, and X-shaped tape.\textsuperscript{6} I-shaped kinesio tape application is often used for smaller muscles, (e.g. teres minor) whereas Y-shaped is used for large areas (e.g. pectoralis major), and the X-shaped tape is for large, long areas (e.g. bicep or tricep muscle) (Figure 2 & Figure 3).\textsuperscript{6} Depending on the shape and size area, multiple strips and applications are combined to provide appropriate treatment.\textsuperscript{6} However, creating the convolutions in the skin is required in order for therapeudic benefits to occur.\textsuperscript{5}

\textit{Figure 1.} Tape Convolutions.
Optimal tape adherence is essential for effectiveness and occurs when the skin has no lotion or oil present and is hairless. Anchors are normally applied at both ends of the area that are to be treated and without tension, which helps prevent skin irritation from occurring. The tension of the tape and the direction in which to pull determines the appropriate use for whether to increase/decrease range of motion, decreasing inflammation, or decreasing pain. In the case
of decreasing inflammation and pain, kinesio tape is applied without tension from the insertion to the origin. For muscular support, moderate to maximum (50-100%) tape tension should be applied while the joint is within a normal functioning position, while muscular strengthening requires light tension (15%) and is applied from the origin to the insertion. While kinesio tape has been identified to reduce discomfort and enhance the process of rehabilitation, the application of this procedure as a viable treatment remedy is variable in the literature.

Research in Kinesio Tape

Kinesio Tape on Proprioception

Recent research has demonstrated kinesio tape’s effectiveness on specific cases. Research on the effects kinesio tape has on proprioception, indicated that kinesio-tape could enhance the perceptual-motor sensitivity of proprioception to perform small angle movements. However, from previous measurements in one study with traditional-tape, the knee was affected by this since the effects of the kinesio tape were still present, which gave investigators a variable error. Halseth et al investigated the effects of kinesio tape and ankle proprioception has suggested that individuals wearing kinesio tape can reproduce joint position sense with plantar flexion and lateral movements in order to enhance proprioception. Taped and non-tapped ankles were compared with both movements, and results suggest no change was produced with this measuring technique. Kinesio tape has also been identified as successfully treating patellar dislocation by assisting with range of motion, swelling, pain, and strength. Results indicated that with continuation of the tape regimen, the swelling, range of motion, and pain significantly changed. However, even though pain and strength didn’t return to initial status, reports of stability within the knee joint had subjectively improved, which suggests that mechanoreceptors could possibly be enhanced resulting in an increase in proprioception.
Kinesio Tape on Range of Motion and Strength

Strength and range of motion are two other theorized benefits from kinesio tape experts.\(^2,5,12,15\) In strength assessment experiments, when kinesio tape is applied under tension and in the direction of the muscle fibers, facilitation of strength to the underlying muscles occurs during muscle testing.\(^2\) This concept was examined for possible immediate and delayed effects of kinesio tape on the quadriceps and hamstring muscles.\(^2\) Fourteen subjects with no previous history of knee problems participated in this study.\(^2\) Assessment of muscle strength was measured by the isokinetic dynamometer under three conditions: without taping, immediately after taping, and 12 hours after taping with the tape remaining situation.\(^2\) Results indicated that no significant difference in muscular power within all three conditions, and kinesio taping on the anterior thigh neither enhances nor inhibits muscle strength.\(^2\) Healthy subjects may not have been the best subjects for strength assessment, but when injured athletes are investigated, results may show otherwise. The focus on specific muscles when applying kinesio tape is what creates an increase or decrease with range of motion possible, which is why we have specifically focused on particular scapular muscles for our study.

Scapular kinematics and kinesio tape was also investigated for effects on musculature balance when assisting with scapular stabilization.\(^{12}\) Baseball players from amateur baseball teams diagnosed with shoulder impingement syndrome received both elastic taping (Kinesio tape) and placebo taping (Micropore tape) over the lower trapezius.\(^{12}\) Scapular motion was measured 3-dimensionally and by electromyographic activities of the upper and lower trapezius, as well as the serratus anterior.\(^{12}\) A baseline measurement and post-application of kinesio tape and placebo tape were taken.\(^{12}\) Kinesio taping increased the scapular posterior tilt and lower trapezius muscle activity in the arm-lowering phase compared to placebo taping.\(^{12}\) Muscle
performance can have positive outcomes from this therapeutic method, as well as joint motion. The lower trapezius and serratus anterior muscles aid in the effect of scapular positioning, which will be used in the proposed study. However, infraspinatus, supraspinatus, and teres minor play a major role in the effects of internal and external rotation of the shoulder joint and are primary movers of the glenohumeral joint, which is why those muscles will be a main focus in our study as well.

Range of motion and recruiting of specific muscles correlate with improved joint stability or the function of a specific anatomical feature. Liu, et al. used sequences of ultrasonic to assess motion tracking in the elbow in order to determine if muscle activation was effected by kinesio tape.\textsuperscript{15} Kinesio tape was used in subjects that exhibited a case of lateral epicondylitis.\textsuperscript{15} The ultrasonic image sequences were recorded to track motion tracking of bony landmarks, which estimates the motion of the muscle.\textsuperscript{15} Motions, with and without kinesio tape, were compared and the results indicated that kinesio tape creates a larger ultrasonic image, which means performance of the muscle improved.\textsuperscript{15} Kinesio tape suggests an effect on the injured areas because of its ability to enhance natural muscular/movement activity.\textsuperscript{3,4,5,7,8,10} The effects of kinesio tape can help aid in the proper biomechanical function by recruiting specific muscles, which is what we hope for in our study by focusing on the rotator cuff muscles and scapular stabilization to improve shoulder range of motion.

**Kinesio Tape on Pain Perception**

Decreased and increased range of motion has posed a problem in nerve impingement and muscle weakness, which can influence why injuries occur.\textsuperscript{24} In cases where injuries are caused by forced excessive range of motion, kinesio tape may provide proper sensory feedback to patients in order to decrease fear of movement, which can improve pain and range of motion.\textsuperscript{10}
Cervical neck injuries and the short-term effects of kinesio tape were examined to understand sensory feedback.\textsuperscript{10} Two groups were created where one received kinesio taping with applied tension to the cervical spine, and one wore a sham kinesio tape application that required no tension, all for 24 hours.\textsuperscript{10} Results suggest that application with proper tension does exhibit significant improvements in pain and cervical range of motion.\textsuperscript{10} A more long-term study on sensory feedback was conducted on participants with shoulder pain. Subjects, one group with the real application and one with a sham application, were measured after two 3-day sessions of kinesio tape.\textsuperscript{7} The therapeutic kinesio tape group had improvements in range of motion and exhibited pain free symptoms.\textsuperscript{7} Kinesio taping has also shown to effect the lower trunk range of motions, and found through evaluation of the scores that trunk flexion was the only one that showed significant signs of improvement.\textsuperscript{1} Kinesio tape does exhibit some therapeutic benefits. The benefits of kinesio tape with range of motion may be due to decreases in pain therefore allowing the patient to increase range of motion. The proposed study would eliminate the pain quotient and investigate range of motion in isolation.

**Shoulder Anatomy**

**Shoulder Biomechanics and Anatomy**

Movements of the shoulder represent a complex, dynamic relationship of multiple muscles, ligaments, and bony articulations.\textsuperscript{25} The static and dynamic stabilizers are what allow the shoulder the greatest range of motion in the body.\textsuperscript{25,26} However, the scapula is just as anatomically and biomechanically involved with shoulder function as is the humerus by itself\textsuperscript{27-29} (Figure 4 & Figure 5). The importance of the scapula, shoulder, and arm working in sync is clinically important in order to generate, absorb, and transfer forces that achieve the task.\textsuperscript{27} A primary role of the scapula is its integral articulation with the glenohumeral joint.\textsuperscript{27,28} The axis of
rotation in the humeral head must move in coordination with the scapula in order to allow optimum function of both the bony constraints and rotator cuff muscles \textsuperscript{27,30} (Figure 6 & Figure 7). Scapular movement also aids in shoulder stabilization when absorbing loads through the long lever or extended arm \textsuperscript{27} (Figure 8 & Figure 9). For this reason, the relationship between the humerus and the ball-and-socket joint (the scapula) must correlate in order to compensate for the lacking bony articulations that are often seen with this joint.\textsuperscript{27-31}

\textit{Figure 4.} Posterior View of Shoulder and Scapula Anatomy.
Figure 5. Anterior View of Shoulder and Scapula Anatomy.

Figure 6. Lateral View of Scapula (Sagittal Plane).
Figure 7. Medial View of Scapula (Sagittal Plane).

Figure 8. Anterior View of Scapula (Frontal Plane).
Unlike the normal “ball and socket joint” where bony articulations provide the main support of the joint, the architecture of the glenohumeral joint has a large articulating humeral head and a smaller glenoid surface making ligamentous and muscular structures largely responsible for stability.\textsuperscript{25} The lack of bony components to the shoulder is supported by the following static and dynamic ligamentous structures: the glenoid labrum, the capsule and its ligaments, the rotator cuff, the deltoid, and the long head of the biceps.\textsuperscript{25,26} If these structures become damaged from trauma or overuse, the shoulder is at risk for unnecessary stressors and may pre-dispose an individual to injury, which accounts for nearly 8-20\% of sports-related injuries.\textsuperscript{25} Injuries that occur through repetitive overhead motions are often caused by increases in external rotation, which decreases internal rotation; this why our study is focusing on ways to aid the shoulder and scapula to reduce biomechanical injuries that are preventable.

Repetitive overhead motions in time can cause adaptive changes to occur that result in a shift of the shoulder’s range of motion.\textsuperscript{32} Often when shoulders are compared bilaterally, range of motion is the most affected component because of pain, decreased performance, or shoulder
injuries.\textsuperscript{32,33} Chronic adaptations result in softening of the osseous tissues within the glenohumeral joint.\textsuperscript{33} Unique adaptations from chronic injuries occur most often result in posterior tightness of the joint and glenohumeral internal rotation deficit (GIRD).\textsuperscript{34} Therefore an assessment of ROM and potential affect of kinesio tape may have benefits for patients and athletes.

**Shoulder Biomechanics and Injuries**

GIRD’s defining characteristics display an excessive increase in external rotation and a decrease in internal rotation.\textsuperscript{24,32,33} The abnormal range of motion (ROM) is due to biomechanics occurring from the stretching of the anterior glenohumeral capsule during the point of late cocking and early acceleration that occurs within the deceleration phase in the overhead throw.\textsuperscript{22,32} With the sudden transition from external to internal rotation, the forces placed on the shoulder and elbow is incredibly high, and can result in an altered total arc of motion.\textsuperscript{22,24} Full ROM, from maximum external to maximum internal rotation, should be approximately 180°.\textsuperscript{22} For every external rotation degree gained, an internal rotation degree can be lost and not affect the function of the shoulder.\textsuperscript{22} However, ROM changes can become problematic when the amount of glenohumeral internal rotation loss exceeds any external rotation gains.\textsuperscript{22} The reason for this altered ROM exists with microtrauma to static and dynamic stabilizers, contracture and thickening of the posteroinferior joint capsule, and osseous adaptation of the humeral head.\textsuperscript{22} Instability of the glenohumeral joint, when referring to GIRD, can result in internal and external impingement, bursitis, and tendonitis.\textsuperscript{22,26}

Glenohumeral deficiencies are well researched because of their common occurrences in overhead athletes.\textsuperscript{22,24,33} One theory that influences the vast differences in ROM is handedness.\textsuperscript{35} In one study, handedness was compared bilaterally to determine if it had an effect on passive
shoulder ROM. Participants were not involved in any strenuous overhead activities and all happened to be right handed. Measurements were taken with a goniometer for flexion, abduction, horizontal adduction, extension, and external/internal rotation. Results suggest that rotational ROM, when compared, displayed an increase in external rotation and decrease in internal rotation with the subject’s dominant arm. Adaptive characteristics occur with the dominant arm rather than in the non-dominant arm when a constant stressor favors one anatomical side from another. Since measuring becomes such an important factor in identifying differences in shoulder ROM with both arms, having an accurate position of the subject and joint is essential.

**Shoulder Range of Motion**

The shoulder is a complex and yet unique joint in the body with a wide variety of movement and structures that support these movements. Internal and external rotation of the shoulder may be measured in a supine or side-lying position. However, scapular stabilization can be an issue in the supine position because it may restrict a subject’s natural motion from occurring. Lack of accurate hand positioning on the scapula can alter measurements and lead to poor reliability, when measuring in the supine position. Another study used a seated technique and compared the measurements to a supine position. Results showed no extreme differences and both were reliable. Experts from other studies suggest the use of the supine position most often and are still able to record accurate readings. Reasons for possible favoring of the supine position may have to do with keeping the scapula stabilized. Accurate readings were obtained while the scapula was stabilized, especially during internal rotation, and detection of movement of the acromion process and glenohumeral joint is more recognizable. With
various techniques available for subject and hand positioning, using positions that give accurate data is what becomes important when supporting kinesio tape and the effects on ROM.

**Electronic Surveys**

Researchers have several options available for collecting information through surveys. Electronic surveys have become common in perception research. Web-based surveys provide the researcher and participant ease of use when a text message, Word® document, or electronic survey needs distribution to large populations and in various geographical locations. Human, time, and material resources are also fewer for researchers and participants. Accuracy and validity of results during data collection is another advantage to the use of electronic surveys. The proposed study will use an online survey tool (Qualtrics®) to deliver a short perception of kinesio-tape efficacy survey.

A Web-based survey increases responses rates and decreases cost creating a benefit from traditional paper methods. Electronic survey responses displayed more truthful, “insightful” answers to questions and an increase in response rate in comparison to paper-based surveys when evaluating training and support needs in a social welfare organization. However, Croteau et al also tested differences in electronic versus paper-based surveys to determine the quality of responses. Results indicated that data quality was equivalent across both methods, but employees who did complete the questionnaires indicated that the electronic-based survey was easier to use and more enjoyable than paper-based. For research purposes, an electronic-based survey has proven to be easier for participants to complete with only having to click a mouse versus filling in circles and will be used for this study.
Conclusion

Kinesio tape, through research and experiments, suggests improving multiple functions of the body, such as sensory, ROM, and inflammation. The acute and chronic effects of kinesio tape variable in the literature, as well as the combined use of other therapeutic methods with the tape. Kinesio tape, in addition to other therapeutic methods, can offer alternatives in providing the necessary care to types of injuries where biomechanics or tissue damage has become the stressor. Kinesio tape studies are needed to assess the possibility of a placebo effect and focus on the body’s natural reaction to only the tape. With limited research, evidence based medicine and practical implications are restricted for use in health care professions. However, future studies will elucidate uses and effects this tape has on anatomical and physiological responses of the human body. The present study proposes to add to the body of literature by assessing the effects of kinesio tape. By expanding on common pathologies (e.g. GIRD, posterior [internal] impingement), and using kinesio tape to aid in improving ROM for these issues, the use of kinesio tape for therapy can be evaluated in future studies. Therefore, the purpose of the proposed study is to assess whether the application of kinesio tape affects ROM in young adults.
CHAPTER 3

METHODS

The addition of kinesio tape (KT) into Western Medicine has benefits as a therapeutic technique with its unique qualities and proposed multiplicity of use.\textsuperscript{1-20} However, research addressing efficacy of KT is lacking. Although anecdotally KT appears to benefit athletes, evidence is needed to substantiate current practices. ROM specifically requires the appropriate proprioceptive feedback, proper alignment corrections, and specific muscle fiber recruitment in order for therapeutic benefits to take place. KT provides a constant pull force that theoretically stimulates normal muscles movement and therefore provides the environment where proper alignment of collagen can be maximized to relax and facilitate in muscular contraction.\textsuperscript{2,5,8,12} For this reason, KT and its effects on ROM were investigated to understand the effects on shoulder ROM. The study’s design, participants, instrumentation, protocols, procedures, and statistical analysis sections that explain how the study was conducted are addressed in this chapter.

Study Design

A pretest-posttest randomized-groups design was used for this study. Independent variable was treatment with two levels, no KT and KT. The dependent variables were shoulder internal and external rotation as measured in the supine technique with an inclinometer.
Participants

Forty-five participants were screened using a health questionnaire, which asked for details on age, gender, and medical history in order to exclude those with health issues (Appendix A). A power analysis was considered in the recruiting portion of this study. To complete 2 groups using an ANOVA, and aiming for a medium effect size \( (f=0.25) \) and moderate power \( (1-\beta=.7) \), a total sample size of 102 or 51 people was needed in each group.

Both males and females, and athletes and non-athletes were encouraged to volunteer for the study. The age of these volunteers was between 18-40 years old. Volunteers for the study were recruited from the Indiana State University student/faculty body. The researcher has no teaching responsibilities and therefore had no conflict of interest with participants. Individuals with a history of any previous shoulder injury or surgery, and/or those who currently had shoulder pathology, or had sensitive skin allergies were excluded from this study. In addition, potential participants with heart conditions and/or chronic disease pathologies were excluded to eliminate any potential complications unforeseen by the researcher. An approved informed consent from Indiana State University Institutional Review Board (Appendix B) was provided to participants prior to participating in the study after completion of health history questionnaire. Consent was acquired prior to any data collection.

Instrumentation

Inclinometer

Measurements for shoulder internal and external rotation were conducted using a digital inclinometer (Figure 10; CheckPoint Professionals Manufacturer, Digital Inclo-Matic Series). We conducted baseline testing for both groups (KT and non-KT) and post-application of KT for the experimental group. Participants reported for measurements on the last day of the study,
where the control group was re-measured and the experimental group was re-measured pre and post-removal of the KT. For our study, the inclinometer was the preferred choice in order to read a digital accurate measurement. In cases where a bony prominent or landmark are not available or if examiners are unable to have any hands free for like the case for a goniometer, the inclinometer is also suggested for the use of measuring ROM.47,48

![Checkpoint Digital Inclinometer](image)

*Figure 10. CheckPoint Digital Inclinometer.*

With the supine measurement technique, two investigators are necessary. The primary investigator measured shoulder internal and external rotation with a digital inclinometer (Figure 10; CheckPoint Professionals Manufacturer, Digital Inclo-Matic Series), while the secondary investigator palpated the appreciable end-feel. Statistical analysis indicates strong intra-reliability (ER ICC[2,3]=0.869; IR ICC[2,3]=0.879). We conducted baseline testing for both groups (KT and non-KT) and post-application of KT for the experimental group.

The reliability of inclinometry for ROM has been previously investigated on multiple occasions in various situations.47-50 Reliability in Clapis, et. al. for inclinometer use was r = 0.91-0.93,49 while Kolber, et al. reported reliability results of r = 0.925-0.994.48 In one study, goniometry and digital levels were compared for reliability of shoulder ROM.47 Shoulder flexion, external rotation, and internal rotation were measured bilaterally in patients with
unilateral pathology with both devices. Reliability established for shoulder ROM for both the goniometer and inclinometer were both very similar. Intratester correlations ranged from 0.91 to 0.99, and limits of agreement ranged from 3° to 9° measurements with the goniometer and inclinometer on a 95% agreement. Intertester correlations ranged from 0.31 to 0.95, and limits of agreement ranged from 6° to 25° with both instruments; same as above. Bierma-Zeinstra, et al. compared these two devices with hip motions and found results to vary. Nine subjects had active and passive movements measured with both devices, but in various positions such as flexion, extension, and internal/external rotation. The inclinometer was found to be more reliable with rotation motions, but only by a small margin (internal rotation supine – goniometer 39.9° & inclinometer 37.5°; external rotation supine – goniometer 34.2° & inclinometer 33°) and therefore was used in the proposed study to assess ROM of the shoulder.

**Questionnaire**

An electronic questionnaire (Qualtrics®) was distributed to all 30 participants, after completion of the study, to gain information on their perceptions of participation in the study and KT efficacy (Appendix C & D). The primary and secondary researcher created the questionnaire with a Likert-scale (1-5 point scale) format where participants can rate their experience within the following sections: (1) kinesio tape effectiveness, (2) kinesio tape manageability, (3) comfort, (4) effect on activities of daily living, (5) effect on activity or athletic performance, (6) general perception of kinesio tape. The questionnaire was evaluated for face validity to determine appropriateness of questions and style variations that may improve the instrument. Three athletic training clinicians/practitioners (age=30-41 years; experience=14.6 ± 6.5 years) evaluated the questionnaire for face and content validity to determine appropriateness of questions and style variations that may improve the instrument. Changes were made based upon
feedback. A quantitative perspective on the subjects’ perception of KT efficacy will be provided by the responses to the questionnaire.

**Protocols**

Data collection occurred in the athletic training research lab during specified hours. Specified hours are dependant on the participating group. Specific appointment times for the control group and the experimental (KT) group was provided to the subjects to minimize the participants’ time waiting for the researcher. Since participants were randomly assigned into their groups, they were also randomized into time slots through the use of a computer generator. Measurements began in the morning and ran through the afternoon, where subjects attended the specific appointment times provided. Specific assignments, such as distribution of health history questionnaire, KT application, placement of the inclinometer while taking subjects through a passive ROM, and supervising post-experiment computer questionnaires, were assigned to only one researcher in order to prevent testing error and have an accurate inter-tester variance.

After participants volunteered for the study, they were provided with a date, individual appointment time and location to meet the researcher. The first day of the study entailed completion of a health history questionnaire and the informed consent before glenohumeral ROM is measured. The questionnaire identified any significant risks (heart disease, respiratory problems, etc.), shoulder injuries, and any allergies (specifically skin allergies). Subjects with any of the previously mentioned concerns were excluded from the study.

Collecting baseline measurements for the control group began at 7:00am and lasted all day. There was a one-hour break in between groups to provide confidentiality. The KT group measured pre & post-application of the KT on a different day from 7:00am through the entire day. All participants, after measurements, signed up for re-measuring appointments three days
later. Between days 1 and 4, participants within the KT group were provided home KT care instructions (Appendix E). This is the same for the control group, where check-in is not required.

On the fourth day, the control group required ROM measurements and a post experiment questionnaire to gain perspective on ROM differences throughout the experiment. The experimental group measured pre & post-removal of KT to evaluate pathological changes and lasting effects. Questionnaire completion was also required for the KT group to give a perception of their experience. An iPad or other laptop computer was present for students in a private location to complete the online questionnaire. The questionnaire was anonymous and confidential.

**Procedures**

Approval from IRB was established before recruitment of participants. Advertisement included posted paper flyers throughout campus and distribution in classrooms (Appendix F). Personal recruiting methods by visiting classes and requesting volunteers was a follow up method while informing potential participants about the study. The goal was to recruit 51 volunteers per group, making a total of 102 participants. Subjects were randomly assigned to groups through an automated computer program where they had an individual identification number. Participants were informed through e-mail as to which group he/she was assigned to and what time they were to come in for measurements. Participants were also provided a reminder card, in case the e-mail method fails to work. Accommodations were made for participants who had conflicts with assigned appointment times. Participants proceeded through similar procedures as displayed in Table 2.

Table 2

Participant Procedures
Chronologic Order

1. Report to the Applied Medicine Research Center in Student Services (room A-15)
2. Complete the health history questionnaire
3. Sign the informed consent
4. Participants will proceed to their assigned group for measurements (Group 1 or 2)
5. Three measurements (internal & external rotation)
6. Subjects in group 1 will only have measurements taken once
7. Group 2 (KT) subjects will have measurements completed, tape applied and then re-measure immediately, and will leave with a KT Care Instructions Handout
8. All subjects before leaving will schedule for an appointment two days later for the three measurements again
9. Group 1 will re-measure the same as day 1 and complete a post-experiment questionnaire
10. Group 2 will re-measure pre and post-removal of KT, and will also complete a post-experiment questionnaire
11. After completion of measurements and the questionnaire, participants are free to go

On the first day of the study, participants completed the health history questionnaire prior to measurements. After completion of questionnaire and signing of informed consent, three measurements were taken for both internal and external rotation with the inclinometer. The inclinometer was aligned with the olecranon process along the shaft of the ulna in order to keep accurate measurements in neutral position (Figure 11) and during internal and external rotation measurements (Figure 12 & Figure 13).
Figure 11. Neutral Position

Figure 12. External Rotation Measurement.

Figure 13. Internal Rotation Measurement.
One researcher measured glenohumeral ROM three times (measurements were averaged). Calibration of the inclinometer was conducted by the same person who was measuring, as followed in the manual methods. (CheckPoint Digital Inclinometer®). Order of measurement followed as three internal rotations and immediately proceeded into three external rotations. Measurements were entered directly into a computerized analysis program, SPSS version 18, during data collection and were not read aloud. The measurements taken were used to calculate the total arc of the subject through a similar method that is used to calculate total arc for patients with GIRD.33 Supine position with scapular stabilization was used for measuring internal and external shoulder rotation through a passive ROM, which was conducted by one examiner.38,39 Group one (control group) was measured without KT and then immediately schedule for a convenient time on day four to re-measure. Group two (KT group) had baseline measurements pre-application of KT and post-application (using the same procedures as described above).

The chosen configuration for how the KT was applied to assist with scapular stabilization. Scapular stabilization requires muscle activation patterns of the upper and lower trapezius and rhomboid muscles with the serratus anterior muscle.27 Normal scapula positioning is in a posterior tilt and slight external rotation; however, the muscles become fatigued from repetitive use, resulting in muscle inhibition or weakness, which results the potential for injury.27,29-31 In order to increase the glenohumeral ROM, scapular stabilization was maintained through the use of KT, which imitates the lower trapezius, infraspinatus, supraspinatus, and teres minor muscles.

Two strips of KT, one I-shaped and one Y-shaped, were used in our application. The first strip, I-shaped, was attached to the anterior glenoid (insertion of rotator cuff) with 0% tension. Then the tape was stretched 50% over posterior glenoid following the lateral border of the
scapula past the inferior border to the lower trapezius. The tape was laid with 0% tension to avoid irritation to the skin (Figure 14 & Figure 15). With the subject’s arm in external rotation (hand on hip position) the second strip, Y-shaped, started at the origin of infraspinatus/teres minor and was applied with 0% tension. The top portion of the tape followed the supraspinatus and the bottom portion followed the infraspinatus both with 50% tension. Each piece was laid down at the starting point of the 1st strip with 0% tension (Figure 16 & Figure 17). For the KT group, the participants were informed to leave KT intact and were provided written instructions on how to care for the KT during the next two days. If the tape should come off, the participants were still required to report back on the fourth day for measurements.

*Figure 14. Anterior View (1st strip).*
Figure 15. Posterior View (1\textsuperscript{st} strip).

Figure 16. Anterior View (2\textsuperscript{nd} strip).
After three days, including the first day, both groups returned during their scheduled appointment. Three measurements were conducted again for both internal and external rotation within both groups. The KT participants were measured prior to and following tape removal. Measurements were immediately entered into the computer, and calculated after all measurements were recorded. When measurements were obtained, an iPad or laptop computer was available in another room for participants to complete the questionnaire individually. Individuals were identified by numbers only.

**Statistical Analysis**

Descriptive analysis of demographic information and the survey instrument was assessed using mean, frequency, percentages (male and female), and standard deviations. In addition, ROM information between groups was analyzed using means and standard deviations. An ANOVA was used to assess statistical significance between the ROM of shoulders with and without KT, and for the power analysis. Significance will be set at $p<.05$ a-priori.
REFERENCES


CHAPTER 4
MANUSCRIPT

Introduction

Kinesio tape (KT) is a relatively new therapeutic intervention in western medicine that is used to augment treatment and rehabilitation. The tape is purported effectiveness is linked to its properties that resemble human skin elasticity with thin cotton porous fabric that has acrylic adhesive, and is nonmediated and latex free. KT is theorized to have several functions: restoring correct muscle function by supporting weakened muscles, improve the flow of blood and lymphatic fluid, decrease pain, and correct misaligned joints. Literature indicates that proprioception, musculature strength, and decreased perceptions of pain are positive outcomes of the therapeutic intervention. KT is also employed for injury prevention, treatment, and rehabilitation and may often be used in conjunction with other therapeutic techniques, such as strengthening programs and muscle re-education, yet an understanding of efficacy with combined therapeutic techniques is lacking.

Movements of the shoulder represent various complex structures and cohesive relationships between the articulating bones, ligaments, and muscles. Static and dynamic stabilizers of the shoulder allow for the greatest range of motion in the body. Scapular movements also aid in shoulder stabilization when absorbing loads through the long lever or extended arm. Prevention of unnecessary shoulder stressors with overhead motions are minimized with synced humeral and scapular movements. Lack of humeral and scapular
movement relationships can lead to compensation and concomitant injuries. Repetitive overhead motions may then result in microtrauma that decreases in glenohumeral external rotation (ER) and increases in glenohumeral internal rotation (IR), which is why therapeutic aids like KT may be beneficial in helping to increase glenohumeral ROM and reduce injuries.\textsuperscript{1} Therefore, the purpose of this study is to determine the effects of KT on glenohumeral internal and external range of motion (ROM).

**Methods**

**Participants**

Forty-five (37.8%, (N = 17) males; 62.2% (N = 28) females) healthy participants, 21.3 ± 2.8 years, at a midsized Midwestern university volunteered and completed the study in one of two groups: control group (N = 22, 48.9%) or KT treatment group (N = 23, 51.1%) (Table 1). Individuals with a history of any previous shoulder injury or surgery, and/or those who currently have shoulder pathology, or have sensitive skin allergies were excluded from the study. The Human Subjects-Institutional Review Board approved the research protocol, and all participants completed health history questionnaires and an informed consent form prior to participation.

**Study Design**

A pretest-posttest randomized-groups design was used for this study. Independent variable was treatment with two levels, no KT and KT. The dependent variables were glenohumeral internal and external rotation as measured in the supine technique with an inclinometer.
Instrumentation

Inclinometer

We measured glenohumeral internal and external rotation using a digital inclinometer (Figure 1).

The digital inclinometer provides an accurate measurement based on interrater reliability in previous studies.\textsuperscript{31,32} We further established strong inter-rater reliability between two investigators for IR ($r = 0.90$) and ER ($r = 0.96$). In cases where a bony prominence or landmark were not available, the inclinometer was suggested for the use of measuring ROM and in particular rotational motions.\textsuperscript{28-30} For this study, the inclinometer was aligned with the olecranon process along the shaft of the ulna (Figure 2 & Figure 3).

Questionnaire

We used an electronic questionnaire (Qualtrics\textsuperscript{®}) among all participants after completion of the study to assess their perceptions of participation in the study and KT efficacy (Figure 4 & Figure 5). The questionnaire was constructed with a Likert-scale (1-5 point scale) for participants to rate their perceptions of: (1) kinesio tape effectiveness, (2) kinesio tape manageability, (3) comfort, (4) effect on activities of daily living, (5) effect on activity or athletic performance, (6) general perception of kinesio tape.

Procedures

We assessed the effect of KT on the internal and external range of motion (ROM) of the shoulder. We used a computer program to randomly assign qualified participants to two groups (control group and KT treatment group) and we emailed instructions to schedule appointments for familiarization and data collection. Each participant signed up for time slots on an electric calendar web link for two ROM measurement sessions despite the treatment assigned.
We measured the control group only once on the first day, and then participants returned the fourth day for follow-up measurements. After data collection on the fourth day, participants completed a post-experiment questionnaire alone in a separate room on an iPad®. On the first day in the KT treatment group, we completed baseline measurements and re-measured after the KT was applied. The KT group returned on day four and we re-measured ROM pre and post KT removal KT. The participants also completed a post-experiment questionnaire in the same manner as the control group to evaluate perceptions of KT.

**Shoulder Internal-External Rotation Measurement**

We measured glenohumeral ROM with an inclinometer. We positioned the participants supine and used a two researchers measurement technique. We asked participants to place the humerus in 90° of abduction and the elbow 90° of flexion. We placed a bolster under the midshaft of the humerus to keep the shoulder in a neutral horizontal position. Once investigator placed the inclinometer along the ulnar shaft, aligned with the olecranon process of the ulna and the ulnar styloid process with the digits palm up. The second investigator stabilized the superior portion of the scapula with one hand, and held the participant’s wrist with the other while either externally rotating the shoulder. When the second investigator confirmed when the spine of the scapula rose off the table. For IR, the primary investigator placed the inclinometer in the same osition, but the secondary investigator placed a hand on the superior portion of the scapula to palpate for the appreciable end-feel of the coracoid process. We completed three measurements for both internal and external rotation.

**KT Application**

In order to increase the glenohumeral ROM, KT provided scapular stabilization imitating the lower trapezius, infraspinatus, supraspinatus, and teres minor muscles. We prepped the skin
with a pre-tape spray to increase adhesion. We used two strips of KT, one I-shaped and one Y-shaped. We applied the I-shaped strip to the anterior glenoid (insertion of rotator cuff) with 0% tension. Then we stretched the tape 50% over posterior glenoid following the lateral border of the scapula past the inferior border to the lower trapezius. We laid the tape was laid with 0% tension to avoid irritation to the skin (Figure 6 & Figure 7). With the participant’s arm in IR (hand on hip position), we applied the Y-shaped strip at the origin of infraspinatus/teres minor with 0% tension. The top portion of the tape followed the supraspinatus and the bottom portion followed the infraspinatus both with 50% tension. We laid each strip with 0% tension (Figure 8 & Figure 9). We rubbed the tape to activate the glue within the KT following application.

Statistical Analysis

We used SPSS Statistics Student Version 18.0 for all statistical analyses with \textit{a-priori} p<0.05. We analyzed descriptive statistics for demographic information and the survey instrument resulting in means, frequencies, percentages (male and female), and standard deviations. We acquired ROM means and standard deviations prior to performing separate ANOVAs to identify the differences between genders for ROM arc (one-way), and between time and group for ROM arc (2x2).

Results

The average internal and external rotation (Table 2) and ROM arcs (Table 3) were similar for day 1 both pre (mean=112.8°) and post treatment (mean=112.8°) as well as on day 4 both pre (x = 121.3°) and post treatment (x = 126.7°). The total glenohumeral arc range was also relatively similar for day 1 (baseline = 84.3°-154.3°; post-treatment = 88.3°-128.7°) and day 4 pre and post treatment (pre = 95.7°-149.3°; post = 94.7°-143.3°). Total glenohumeral arc measurements, were similar between groups on either day (day 1 control group = 109.7°, KT
treatment group = 115.7°; day 4 control group = 120.5°, KT treatment group = 122.0°) (Table 4). An ANOVA assessing day one and four indicated no differences at a p = 0.05 a priori between the control and KT treatment groups. An ANOVA on gender did indicate significant differences between genders (Table 5). A Bonferroni indicated that the significant change with range of motion among females occurred upon arrival back on day four (F = 7.75; P < 0.05). Although gender was statistically significant in ROM increases, gender only accounted for 1.7% (η²) of the variance in the data. Thus, 98.3% of the variance is unknown, meaning that variables that account for increases in were largely undetermined or unassessed.

Perception assessment of the KT treatment group was evaluated through a Pearson correlation between the mean questionnaire score and internal and external rotation (Table 6). We had the control group complete the post-experiment questionnaire as well to maintain the same procedures, but did not report the findings. Correlations from the KT treatment group indicated a poor and insignificant relationship between the mean questionnaire score and IR (r = 0.26, p = 0.24) and ER (r = 0.18, p = 0.42). This signifies that even though there were positive perceptions of the KT, there were no physical gains in internal and external rotation. Gender also did not impact perception, even though women still had an increase in ROM. Means and standard deviations for each question with the KT treatment group indicated average to good ranking in perceptions were for the various questions asked (Table 7). A Chi-squared of gender, ROM, pre and post measurements in both groups indicated that gender and ROM was not a contributing factor to the participant perception of KT effectiveness (p < 0.05). General perception of KT was overall good (Table 8).
Discussion

An assessment of internal and external ROM measurement and ROM arc do not appear to have variability with the exception of ROM arc in females pre-tape removal. Results of the study suggest that KT had no significant increase in ROM across genders after the completion of the treatment with removal of the tape. Although the intent of the study was not to differentiate between males and females, the data suggested an evaluation of the difference was necessary. Interestingly, statistical analysis of ROM arc suggests that females demonstrated significant increases with KT after the 4 days of treatment prior to tape removal. However, ROM for females returned to pre-treatment arc after tape removal. A theoretical basis as to why a gender difference exists pre-tape removal is not evident in the literature and therefore should be investigated in the future. KT literature suggests that increases in blood circulation, or inhibition of neural receptors to the shoulder may affect ROM and perhaps gender differences on these factors should be evaluated based on KT theory. Increase in blood flow may have a physiological change in the muscle and myofascial functions in that area. Various studies have indicated that KT may improve muscle activation on select joints compared to others. The increased blood flow and concomitant increase in female ROM does not account for the lack of significant changes in ROM for male participants. Clearly the increased ROM is only noticeable while KT is actively present. Once the KT treatment is removed the benefits cease. Potential exists to use KT for ROM and theorized blood flow and/or neural benefits during rehabilitation to either maintain advances when the patient returns home between treatments, or to augment treatment, but further assessment is warranted.

The specific taping method for the KT treatment group was an I-strip that attached at the inferior border of the scapula and stretched across to the anterior portion of the glenohumeral
joint, which would posteriorly tilt and externally rotate the scapula. However, with this taping technique some participants experienced adverse effect such as blisters, rashes, and itching. KT has been identified as a catalyst to reduce pain on participants with rotator cuff tendonitis/subacromial impingement and increase pain free ROM with the KT treatment group. The taping technique varied slightly from the current study indicating that additional taping techniques need to be investigated to determine which are most beneficial. The taping technique applied to participants in this study may have been a limiting factor in the lack of ROM increases. KT peeling may have also been due to the amount of tension initially applied. Too much stretch on the tape may have created tension that with glenohumeral movement could not be overcome.

The benefits of KT are predicated on the tape’s properties and the effects on circulatory and neurological activation of the area being treated. KT creates convolutions in the skin in order to increase the interstitial space between the skin and connective tissue. These convolutions occur when the muscle and skin are stretched before tape is applied, and then the body returns to the relaxed position. Convolutions are therefore theorized to promote normal muscular movements, tissue nutrition, increase in blood and lymphatic fluids, and pain reduction from decompression of subcutaneous pain receptors. The effect of KT may be minimized in healthy volunteers who are not experiencing pain or discomfort prior to application. Previous studies assessed participants with pathologies consisting of pain and decrease in ROM with the glenohumeral joint and investigated the effects KT would have over a longer period of time. Pain free ROM was consistent in both study outcomes, and an increase in ROM was also identified before and after application of KT. A comparison between the current study and previous studies is difficult given that the populations differ between healthy
and injured participants. The benefits of KT may only be visible on injured patients given the physiological benefits of pain and edema reduction. Thus the current study may simply indicate that KT on healthy shoulders has little effect.

**KT Perception on ROM**

Clinicians often rely on patient subjective pain and ROM evaluations in order to assess readiness for therapeutic interventions and advancements, yet this study indicates that an association between the perception of pain and ROM may not be congruous. Previous studies involving cervical and shoulder pathologies have found correlations between pain and ROM issues, which were resolved with KT application\(^\text{14,17}\). With our study, glenohumeral ROM did not have an impact on perceptions in addition to other factors such as gender and pain perception. Regardless of group, participation in this study with regard to perception of ROM increases was not affected by gender or the treatment. This study may not be applicable for injured patients given that pain perception and outlook may be altered. Results indicated that participation in the study did not affect participant opinion of the study; therefore, there was a healthy psychological outlook that does not appear to have impacted the ROM measurements.

**Future Studies**

The therapeutic benefit of KT may be appropriate to increase ROM in injured individuals based on the reduction of pain and increases in blood, venous and lymphatic flow identified in previous literature.\(^\text{8-27}\) Future studies should investigate gender differences in ROM identified in this study in addition to potential long-term effects of KT beyond a 4-day period. Differences in ROM with the various taping method should also be evaluated in future studies. Differences in other KT brands and the original KT should also be assessed to determine whether effectiveness varies among each tape.
Conclusion

Results suggest that KT has no effect on the total glenohumeral arc in healthy individuals after tape removal. Interestingly, females displayed a significant increase in ROM arc with KT after the 4 days of treatment, returning to a non-ROM-effect upon tape removal. KT may have some beneficial properties while on the patient, however differences in male and female glenohumeral arc pre tape removal should be assessed in addition to the effect of tape placement or physical activity. Although KT use for ROM may not be effective in healthy participants, KT effect on blood flow and pain, which may be the basis for increases in ROM on unhealthy shoulders.
REFERENCES


LEGEND TO TABLES & FIGURES

Table 1. Participants’ demographics
Table 2. Day 1 & day 4 IR and ER differences
Table 3. Mean ROM arc measurements for pre and post treatment
Table 4. Mean ROM arc measurements between groups for day 1 and day 4
Table 5. ANOVA on ROM and control group/gender
Table 6. KT treatment group correlations between mean questionnaire score and IR & ER
Table 7. Group two questionnaire questions & answer averages
Table 8. Overall questionnaire score
Figure 1. CheckPoint Digital Inclinometer
Figure 2. Neutral Position
Figure 3. External Rotation Measurement
Figure 4. Internal Rotation Measurement
Figure 5. Post-Experiment Questionnaire (Group One)
Figure 6. Post-Experiment Questionnaire (Group Two)
Figure 7. Anterior View (1st Strip)
Figure 8. Posterior View (1st Strip)
Figure 9. Anterior View (2nd Strip)
Figure 10. Posterior View (2nd Strip)
Table 1. Participants' demographics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean Age</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(without KT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8</td>
<td>20.9</td>
<td>± 1.9</td>
</tr>
<tr>
<td>F</td>
<td>14</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td><strong>Experimental Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(with KT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>21.6</td>
<td>± 3.3</td>
</tr>
<tr>
<td>F</td>
<td>14</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>45</td>
<td>21.3</td>
<td>± 2.8</td>
</tr>
</tbody>
</table>

Table 2. Day 1 & day 4 IR and ER differences

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 Internal Rotation Pre-</td>
<td>93</td>
<td>47.9677</td>
<td>7.55048</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 1 Internal Rotation Post-</td>
<td>71</td>
<td>46.2817</td>
<td>7.85981</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 1 External Rotation Pre-</td>
<td>93</td>
<td>69.4946</td>
<td>11.49634</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 1 External Rotation Post-</td>
<td>71</td>
<td>73.2113</td>
<td>9.37766</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 Internal Rotation Pre-KT</td>
<td>93</td>
<td>48.8925</td>
<td>8.37110</td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 Internal Rotation Post-KT</td>
<td>49</td>
<td>50.4286</td>
<td>7.48331</td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 External Rotation Pre-KT</td>
<td>93</td>
<td>72.3656</td>
<td>10.21379</td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 External Rotation Post-KT</td>
<td>49</td>
<td>75.9388</td>
<td>9.42605</td>
</tr>
</tbody>
</table>
### Table 3. Mean ROM arc measurements for pre and post treatment

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1 baseline arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>17</td>
<td>113.9</td>
<td>17.2</td>
<td>4.2</td>
<td>105.1</td>
<td>122.8</td>
<td>94.7</td>
<td>154.3</td>
</tr>
<tr>
<td>F</td>
<td>28</td>
<td>112.1</td>
<td>14.6</td>
<td>2.8</td>
<td>106.4</td>
<td>117.7</td>
<td>84.3</td>
<td>139.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>112.8</td>
<td>15.5</td>
<td>2.3</td>
<td>108.1</td>
<td>117.4</td>
<td>84.3</td>
<td>154.3</td>
</tr>
<tr>
<td><strong>Day 1 post treatment arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>114.0</td>
<td>12.7</td>
<td>4.2</td>
<td>104.2</td>
<td>123.7</td>
<td>88.3</td>
<td>127.3</td>
</tr>
<tr>
<td>F</td>
<td>14</td>
<td>112.0</td>
<td>11.5</td>
<td>3.0</td>
<td>105.4</td>
<td>118.6</td>
<td>92.3</td>
<td>128.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23</td>
<td>112.8</td>
<td>11.7</td>
<td>2.4</td>
<td>107.7</td>
<td>117.8</td>
<td>88.3</td>
<td>128.7</td>
</tr>
<tr>
<td><strong>Day 4 return/pre removal of tape arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>17</td>
<td>115.1</td>
<td>11.2</td>
<td>2.7</td>
<td>109.3</td>
<td>120.9</td>
<td>98.3</td>
<td>137.3</td>
</tr>
<tr>
<td>F</td>
<td>28</td>
<td>125.0</td>
<td>11.7</td>
<td>2.2</td>
<td>120.5</td>
<td>129.5</td>
<td>95.7</td>
<td>149.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>121.3</td>
<td>12.4</td>
<td>1.8</td>
<td>117.5</td>
<td>125.0</td>
<td>95.7</td>
<td>149.3</td>
</tr>
<tr>
<td><strong>Day 4 post removal of tape arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>123.3</td>
<td>13.3</td>
<td>4.4</td>
<td>113.0</td>
<td>133.5</td>
<td>94.7</td>
<td>141.7</td>
</tr>
<tr>
<td>F</td>
<td>14</td>
<td>129.0</td>
<td>8.4</td>
<td>2.3</td>
<td>124.1</td>
<td>133.8</td>
<td>115.7</td>
<td>143.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23</td>
<td>126.7</td>
<td>10.7</td>
<td>2.2</td>
<td>122.1</td>
<td>131.4</td>
<td>94.7</td>
<td>143.3</td>
</tr>
</tbody>
</table>

### Table 4. Mean ROM arc measurements between groups for day 1 and day 4

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1 baseline arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group KT</td>
<td>22</td>
<td>109.7</td>
<td>15.0</td>
<td>3.2</td>
<td>103.0</td>
<td>116.4</td>
<td>84.3</td>
<td>137.7</td>
</tr>
<tr>
<td>Treatment</td>
<td>23</td>
<td>115.7</td>
<td>15.7</td>
<td>3.3</td>
<td>108.9</td>
<td>122.5</td>
<td>91.0</td>
<td>154.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>112.8</td>
<td>15.5</td>
<td>2.3</td>
<td>108.1</td>
<td>117.4</td>
<td>84.3</td>
<td>154.3</td>
</tr>
<tr>
<td><strong>Day 4 return/pre removal of tape arc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group KT</td>
<td>22</td>
<td>120.5</td>
<td>10.4</td>
<td>2.2</td>
<td>115.9</td>
<td>125.1</td>
<td>105.0</td>
<td>142.7</td>
</tr>
<tr>
<td>Treatment</td>
<td>23</td>
<td>122.0</td>
<td>14.3</td>
<td>3.0</td>
<td>115.8</td>
<td>128.2</td>
<td>95.7</td>
<td>149.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>121.3</td>
<td>12.4</td>
<td>1.8</td>
<td>117.5</td>
<td>125.0</td>
<td>95.7</td>
<td>149.3</td>
</tr>
</tbody>
</table>
Table 5. ANOVA on ROM and Control Group/Gender

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 baseline arc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>37.452</td>
<td>1</td>
<td>37.452</td>
<td>.153</td>
<td>.697</td>
</tr>
<tr>
<td>Within Groups</td>
<td>10506.064</td>
<td>43</td>
<td>244.327</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10543.516</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 1 post treatment arc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>21.109</td>
<td>1</td>
<td>21.109</td>
<td>.147</td>
<td>.705</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3007.877</td>
<td>21</td>
<td>143.232</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3028.986</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 return/pre removal of tape arc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>1033.035</td>
<td>1</td>
<td>1033.035</td>
<td>7.747</td>
<td>.008</td>
</tr>
<tr>
<td>Within Groups</td>
<td>5733.542</td>
<td>43</td>
<td>133.338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6766.578</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4 post removal of tape arc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>175.257</td>
<td>1</td>
<td>175.257</td>
<td>1.570</td>
<td>.224</td>
</tr>
<tr>
<td>Within Groups</td>
<td>2344.511</td>
<td>21</td>
<td>111.643</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2519.768</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. KT treatment group correlations between mean questionnaire score and IR and ER

<table>
<thead>
<tr>
<th></th>
<th>Zscore (IR)</th>
<th>Zscore (ER)</th>
<th>Zscore: Mean Questionnaire Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zscore (IR)</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.453 *</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.030</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Zscore (ER)</td>
<td>Pearson Correlation</td>
<td>.453 *</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.030</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Zscore: Mean Questionnaire Score</td>
<td>Pearson Correlation</td>
<td>.255</td>
<td>.176</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.241</td>
<td>.423</td>
</tr>
</tbody>
</table>
Table 7. Group two questionnaire questions & answer averages

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesio tape increased my range of motion</td>
<td>3.000</td>
<td>.79772</td>
</tr>
<tr>
<td>Kinesio tape was cumbersome</td>
<td>2.454</td>
<td>1.01076</td>
</tr>
<tr>
<td>Kinesio tape was comfortable to wear</td>
<td>3.304</td>
<td>1.22232</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform my daily activities</td>
<td>4.521</td>
<td>.59311</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform in my athletics/activities</td>
<td>4.347</td>
<td>.775511</td>
</tr>
<tr>
<td>My overall perception of kinesio tape</td>
<td>3.636</td>
<td>.72673</td>
</tr>
</tbody>
</table>

Table 8. Overall questionnaire score

<table>
<thead>
<tr>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>2.7</td>
<td>4.5</td>
<td>3.726</td>
<td>.5136</td>
</tr>
</tbody>
</table>

Mean Questionnaire Score
Figure 1. CheckPoint Digital Inclinometer.

Figure 2. Neutral Position
Figure 3. External Rotation Measurement.

Figure 4. Internal Rotation Measurement.
Do you feel that participation in this study effected range of motion?

Yes or No
If yes, did it...

(*If the participant answers ‘Yes’, the options provided are ‘increase’ or ‘decrease’)

Figure 5. Post-Experiment Questionnaire (Group One).

Please rate each separate subject on a scale of 1 to 5 (1 = very poor and 5 = exceptional):

<table>
<thead>
<tr>
<th></th>
<th>1 very poor</th>
<th>2 poor</th>
<th>3 average</th>
<th>4 good</th>
<th>5 exceptional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesio tape increased my range of motion</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Kinesio tape was cumbersome</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Kinesio tape was comfortable to wear</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform my daily living activities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform in my athletics/activities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>My overall general perception of kinesio tape</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Did you have to cut the tape?

Yes or No
If ‘yes’, how many times?

Figure 6. Post-Experiment Questionnaire (Group Two).
Figure 7. Anterior View (1st Strip).

Figure 8. Posterior View (1st Strip).
Figure 9. Anterior View (2\textsuperscript{nd} Strip).

Figure 10. Posterior View (2\textsuperscript{nd} Strip).
APPENDIX A: HEALTH HISTORY QUESTIONNAIRE

Kinesio-Tape Research Health History Questionnaire  2011-2012

Subject Number:  ____________________  Today's Date  /  /  Age  ______  Year  ______

MEDICAL HISTORY  (Explain all YES answers)

1. Have you ever been hospitalized? ................................................................. Yes  No
2. Have you ever had surgery? ......................................................................... Yes  No
3. Are you presently under a doctor's care? .................................................... Yes  No
4. Are you presently taking any medications or pills? ..................................... Yes  No
5. Do you have any allergies (medicine, bees, or other stinging insects)? ...... Yes  No
6. Do you have any skin problems with tape or bandages? ......................... Yes  No
7. Have you ever had a stinger, burn, or pinched nerve? .............................. Yes  No

Explain all
"Yes" answers:

ORTHEPEDITIC HISTORY  (Explain all YES answers)

8. Have you had a NECK injury that bothered you for more than a week? (sprain, strain, fracture) ................................................................. Yes  No
9. If so, how long ago did the injury occur? .....................................................
10. Do you currently have a NECK injury? ..................................................... Yes  No
11. Have you had a SHOULDER sprain, separation, dislocation or other shoulder problem? ................................................................. Yes  No
12. If so, how long ago did the injury occur? .....................................................
13. Have you ever been advised to have SHOULDER surgery? .................. Yes  No
14. Do you currently have a SHOULDER injury? ........................................... Yes  No
15. Have you had a CLAVICLE fracture? ............................................................ Yes  No
16. If so, how long ago did the injury occur? .....................................................
17. Do you currently have a CLAVICLE injury? ................................................ Yes  No
18. Do you have other current or severe injuries not already listed? ........... Yes  No

Explain all
"Yes" answers:

If you answered "YES" to any question or you are unsure about your answers, you will be asked for more detail to help the investigators better assess whether your condition increases your risk for participation. The questions and responses will be recorded on below. Your responses will be kept confidential and only reviewed by the research investigators and the Medical Director.

I certify that all the information provided is correct.

Participant Signature  ____________________  Date  ______
APPENDIX B: IRB INFORMED CONSENT

PAGE 1:

*Kinesio Tape and its Effects on Internal and External Range of Motion of the Shoulder*

You are invited to participate in a research study investigating the effectiveness of kinesio tape on range of motion. This study is conducted by Chelsea Renner, LAT, ATC and Leamor Kahanov, EdD, ATC, in the Department of Applied Medicine and Rehabilitation at Indiana State University. You were selected or volunteered as a possible participant in this study because of your medical history and willingness to comply with instructions that will be given for the next four days.

There are no known risks or benefits if you decide to participate in this research study. There are no costs of benefits to you for participating in the study. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits towards the use of kinesio tape.

Your Medical Records will be kept in a locked file cabinet in a locked office and will only be viewed by the Principal Investigator and Co-Investigator. You will only be identified by a random subject number assigned to you specifically. The subject number will be used with the health history questionnaire and assigning appointments for measurements so that the forms are confidential. Individuals from the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.
Your participation in this study is voluntary. By providing your medical records and signing below, you are voluntarily agreeing to participate. You are free to decline to answer any particular question you do not wish to answer for any reason.

If you have any questions about the study, please contact Chelsea Renner at crenner3@indstate.edu or the faculty supervisor Leamor Kahanov EdD, ATC at leamor.kahanov@indstate.edu.

If you have any questions about your rights as a research subject or if you feel you’ve been placed at risk, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN, 47809, by phone at (812) 237-8217, or by e-mail at irb@indstate.edu.

Chelsea Renner, LAT, ATC
Graduate Assistant Athletic Trainer
Indiana State University
crenner3@indstate.edu

PAGE 2:

Kinesio Tape and its Effects on Internal and External Range of Motion of the Shoulder

PROCEDURES: (Group 1)

Participants will arrive according to their given appointment times and complete health history questionnaire and IRB inform consent form prior to baseline measurements. Subjects will be measured by a qualified examiner three times in both internal and external rotation. After measurements, subjects that are designated to the control group will have no kinesio tape applied to their shoulder. The participants will schedule for a convenient time two days later to have measurements taken.
On day four, participants will arrive for measurements during their scheduled appointment. The group without kinesio tape will have the same measurements as day one. After measurements are obtained, the group without kinesio tape will have the post-experiment questionnaire distributed to them that pertains to their specific group, which will take five minutes.

PROCEDURES: (Group 2)

Participants will arrive according to their given appointment times and complete health history questionnaire and IRB inform consent form prior to baseline measurements. Subjects will be measured by a qualified examiner three times in both internal and external rotation. After measurements, subjects that are designated to the experimental group will have kinesio tape applied and re-measure both internal and external rotation again. All participants will schedule for a convenient time on day four to re-measure. For the kinesio tape group, they will be informed to keep the tape intact and will be provided written instructions on how to care for the kinesio tape during the next two days. If the tape should fall off, participants are still required to report back on the fourth day as scheduled.

On day four, participants will arrive for measurements during their scheduled appointment. The group with kinesio tape will have two measurements: pre and post-removal of kinesio tape. Measurements will be taken the same as day one as well. For the kinesio tape group, after measurements are obtained the post-experiment questionnaire will be distributed to them that pertains to their specific group, which will take five minutes.
I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

________________________________________
Printed Name of Subject

________________________________________
Signature of Subject

________________________________________
Date
APPENDIX C: POST-EXPERIMENT QUESTIONNAIRE (GROUP ONE)

Identification Number:

You are invited to participate in a research study investigating the effectiveness of kinesio tape on range of motion. This study is conducted by Chelsea Renner, LAT, ATC and Leamor Kahanov, EdD, ATC, in the Department of Applied Medicine and Rehabilitation at Indiana State University. You were selected or volunteered as a possible participant in this study because of your medical history and willingness to comply with instructions that will be given for the next four days.

This survey constitutes the completion of your participation in this study. There are no known risks or benefits if you decide to participate in this portion of the research study. There are no costs of benefits to you for participating in this portion of the research study. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits towards the use of kinesio tape.

Your survey will be kept on a password-protected computer and will only be viewed by the Principal Investigator and Co-Investigator. There are no identifiers and you will only be anonymous. We will not collect IP addresses; however, absolute anonymity cannot be guaranteed over the Internet. Individuals from the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.

Your participation in this study is voluntary. By clicking on "I agree to participate", you are voluntarily agreeing to participate. You are free to decline to answer any particular question you do not wish to answer for any reason.

If you have any questions about the study, please contact Chelsea Renner at crenner3@indstate.edu or the faculty supervisor Leamor Kahanov EdD, ATC at leamor.kahanov@indstate.edu.

If you have any questions about your rights as a research subject or if you feel you've been placed at risk, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN, 47809, by phone at (812) 237-8217, or by e-mail at irb@indstate.edu.

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

☐ I agree to participate
☐ I do not agree to participate

Select Gender

☐ Male
☐ Female
Do you feel that participation in this study effected range of motion?

<table>
<thead>
<tr>
<th>Yes or No</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>If yes, did it...</td>
<td></td>
</tr>
</tbody>
</table>

(*If the participant answers ‘Yes’, the options provided are ‘increase’ or ‘decrease’*)
APPENDIX D: POST-EXPERIMENT QUESTIONNAIRE (GROUP TWO)

Identification Number

You are invited to participate in a research study investigating the effectiveness of kinesio tape on range of motion. This study is conducted by Chelsea Renner, LAT, ATC and Leamor Kahanov, EdD, ATC, in the Department of Applied Medicine and Rehabilitation at Indiana State University. You were selected or volunteered as a possible participant in this study because of your medical history and willingness to comply with instructions that will be given for the next four days.

This survey constitutes the completion of your participation in this study. There are no known risks or benefits if you decide to participate in this portion of the research study. There are no costs of benefits to you for participating in this portion of the research study. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits towards the use of kinesio tape.

Your survey will be kept on a password protected computer and will only be viewed by the Principal Investigator and Co-Investigator. There are no identifiers and you will only be anonymous. We will not collect IP addresses; however, absolute anonymity cannot be guaranteed over the Internet. Individuals from the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.

Your participation in this study is voluntary. By clicking on "I agree to participate", you are voluntarily agreeing to participate. You are free to decline to answer any particular question you do not wish to answer for any reason.

If you have any questions about the study, please contact Chelsea Renner at crenner3@indstate.edu or the faculty supervisor Leamor Kahanov EdD, ATC at leamor.kahanov@indstate.edu.

If you have any questions about your rights as a research subject or if you feel you’ve been placed at risk, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN, 47809, by phone at (812) 237-0217, or by e-mail at irb@indstate.edu.

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

- [ ] I agree to participate
- [ ] I do not agree to participate

Select Gender:

- [ ] Male
- [ ] Female
Please rate each separate subject on a scale of 1 to 6 (1 = very poor and 5 = exceptional):

<table>
<thead>
<tr>
<th></th>
<th>1 very poor</th>
<th>2 poor</th>
<th>3 average</th>
<th>4 good</th>
<th>5 exceptional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesio tape increased my range of motion</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>Kinesio tape was cumbersome</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>Kinesio tape was comfortable to wear</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform my daily living activities</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>The kinesio tape allowed me to perform in my athletics/activities</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>My overall general perception of kinesio tape</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
</tbody>
</table>

Did you have to cut the tape?
Yes or No
If 'yes', how many times?

(*If the participant answers ‘Yes’, the options provided are numbers ‘1-20’ & ‘21+’)

Please write below any other comments on your experiences with kinesio tape.
APPENDIX E: KINESIO TAPE CARE INSTRUCTIONS HANDOUT

The group with kinesio tape will receive the following handout that explains the characteristics of the tape and specific rules of how to take care of the tape in order to keep the tape from falling off.

Instructions:

Kinesio tape has the ability to withstand stressors for 3-5 days. Due to its 100% medical-grade acrylic adhesive and gentle cotton fiber, it is able to stay on the skin longer periods of time. For this reason, subjects are able to go about their day like normal. Listed below are rules and ways to take care of the kinesio tape, which should be followed throughout the study.

1. Go through the day and activities like normal (as though its only a band-aid that you’re wearing)
2. Showering is fine and doesn’t require the tape to be covered
3. Don’t pick at the tape! (if the tape should start to come off, use scissors to cut ONLY the loose piece off [as shown in Figure 18. below])

Figure 18. Demonstration of Cutting Loose Tape
APPENDIX F: ADVERTISEMENT FLYERS

Research!
WE NEED VOLUNTEERS - PLEASE HELP!!

“Kinesio Tape/Stretching Effects on Internal and External Range of Motion of the Shoulder”

Who: Indiana State University students, faculty, & staff between the ages of 18-40 years old. Participants with past/current shoulder injuries, shoulder surgery, or sensitive skin allergies will be excluded.

What: You wear the kinesio tape for 3-4 days, participate in various shoulder stretches, and are required to report back for measurements on a maximum of 2 occasions. Measurements will take 10 minutes per session.

When: Determined by your schedule

Why: Kinesio tape is a fairly new therapeutic technique in the health care field. We are studying how the tape and stretching effect shoulder range of motion.

*Those interested in participating may contact the primary investigators using the information below.

Thank you for your consideration.

Contact Information:
Chelsea Renner, LAT, ATC
Ai Ujino, LAT, ATC
crenner3@sycamores.indstate.edu
aujino@sycamores.indstate.edu

ISU Applied Medicine & Rehabilitation Department – Student Services Building, Room 201
(812) 237-8232 / www.indstate.edu/amr/