

COMPRESSIVE VERSUS DECOMPRESSIVE SOFT  
TISSUE THERAPY ON ACUTE HAMSTRING  
FLEXIBILITY AND PAIN IN MALE ATHLETES WITH  
PERCEIVED HAMSTRING TIGHTNESS

By

KRISTEN M BARGER

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University of Iowa

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Thesis Approved:

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Dr. Jennifer Volberding Thesis Adviser

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Dr. Jason DeFreitas

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Dr. Matthew O'Brien

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Dr. Aric Warren

Name: KRISTEN BARGER

Date of Degree: JULY, 2016

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THERAPY ON HAMSTRING FLEXIBILITY AND PAIN IN MALE ATHLETES  
WITH PERCEIVED HAMSTRING TIGHTNESS

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Abstract: INTRODUCTION: This study examined the effects of two different soft tissue therapies on hamstring flexibility, strength, and perceived pain and function. The compressive therapy, the Graston Technique (GT) was compared to the decompressive therapy, myofascial decompression (MFD). Twenty male athletes were recruited from the Oklahoma State University Cheer team who had complaints of hamstring pain and/or lack of flexibility and function. The subjects were randomly divided into two groups and received a single, 4-minute treatment of either the GT therapy (n=10) or the MFD therapy (n=10). Flexibility, strength and a Perceived Functional Ability Questionnaire (PFAQ) were measured both before and after the therapy, and a Global Rating of Change (GROC) scale was measured after the therapy. A paired samples t-test was used to determine if there were differences between the pre and post measurements regardless of group, while a two-way ANOVA was used to determine any differences between groups. RESULTS: Statistically significant differences were found for an overall improvement in range of motion and strength measurements regardless of the therapy that the subjects received. When comparing pre and post measurements, no significant findings were identified for all flexibility and strength measurements. Statistically significant differences were found when comparing perception of hamstring flexibility, pain in hamstrings and effect on sport performance on the PFAQ scale. CONCLUSION: The results of this study suggest that both GT and MFD are effective therapies for improving hamstring flexibility and strength and decreasing pain immediately following the therapy.

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## CHAPTER I

### INTRODUCTION

Hamstring injuries are very common among athletes and can quickly become problematic due to lengthy recovery times and an increased risk for reoccurrence.<sup>1</sup> Treatments such as manual massage and stretching are common when addressing soft tissue dysfunctions of the lower extremity.<sup>2</sup> However, a recent trend among sports medicine professionals is to utilize more advanced soft tissue therapies.

There are many soft tissue mobilization techniques, such as myofascial release (MFR), active release technique (ART), and other augmented soft tissue mobilization methods (ASTM) that clinicians use to eliminate pain. All of these therapies are considered compressive techniques because they place a positive pressure on the tissue and encompass similar treatment goals to that of traditional massage techniques. These goals include, but are not limited to, decreased muscle tension and stiffness, decreased muscle pain, swelling and spasm and increased joint flexibility and ROM.<sup>3-5</sup> While ASTM methods are commonly used, another form known as instrument assisted soft tissue mobilization (IASTM) is becoming increasingly popular. The Graston Technique® (GT) is a popular form of IASTM used by professionals toda



As the name suggests, IASTM uses instruments to achieve the same goals that manual therapy techniques do, utilizing instruments to provide the majority of the compression instead of a clinician's hands. GT uses six stainless steel tools with different bevels and edges to aid in the diagnosis and treatment of soft tissue dysfunction.<sup>6</sup> It has been found to produce a local inflammatory response, which promotes blood flow and healing, among other effects such as reducing scar tissue and eliminating soft tissue restrictions.<sup>7-9</sup> With proper training and certification, a clinician is able to use GT in conjunction with everyday therapy on patients with a wide range of injuries. It is currently being utilized in over 2,700 outpatient facilities and over 384 professional and amateur sports organizations.<sup>6</sup> Research has confirmed that the GT decreases perceived pain in patients, however these studies combine GT with other conservative treatment methods over a long period of time.<sup>5,7,10,11</sup> Subsequently, research is limited on GT's immediate effect of increasing flexibility of the hamstring muscle group when used as the only treatment method.

Another form of soft tissue mobilization that is growing in popularity is Myofascial decompression (MFD). Traditionally known as cupping therapy, MFD originated in Chinese medicine as a means to replace acupuncture to eliminate infections that are associated with the needles from the therapy.<sup>12</sup> MFD uses specific cups that suction a localized area of skin and are left in place for five to ten minutes to ensure hemodynamic changes to the affected area to enhance tissue metabolism by increasing

blood flow to the area and promote localized healing.<sup>12,13</sup> Although the origin of MFD is slightly unclear, it is believed that it dates back to as early as 3000 B.C. in an attempt to remove “foreign matter” from the body.<sup>14</sup> Healthcare professionals around the world have since utilized this technique for the treatment of many ailments including chronic pain, osteoarthritis, fibromyalgia, respiratory, gastroenterological and gynecological disorders.<sup>12,15</sup> Recently, MFD has re-emerged into the world of sports medicine and is used to treat pain from musculoskeletal disorders.<sup>14</sup> Like GT, it still lacks evidence to suggest that it’s effective in improving flexibility and other patient outcomes. It is important to note that while the GT and MFD seem similar in their treatment goals, they differ in their method of treatment. While GT is a compressive therapy in that it compresses the tissue to attempt to eliminate adhesions within the myofascia, MFD is a decompressive therapy in that it lifts the skin to achieve these same goals.<sup>7,12</sup>

### *Purpose*

MFD and GT are common techniques that are used in sports medicine facilities, but limited research exists to determine their immediate effectiveness. Since both of these techniques are generally used in combination with other treatment methods, the goal of this study was to determine if they provide significant results in hamstring flexibility when used as the only treatment modality, as well as determine which method produces greater changes in the perception of pain, function and differences in strength. Thus, the purpose of this study is to compare the acute effects of GT compared to MFD on hamstring flexibility, perceived function and pain, and strength in male subjects with a chief complaint of hamstring tightness. This is of clinical importance because it will

allow the clinician for better decision-making when it comes to the proper treatment method for their patients suffering from hamstring discomfort.

*Research Question:*

Does a compressive Graston Technique® (GT) or a Myofascial Decompressive (MFD) technique improve hamstring flexibility, perceived function and strength, as well as decrease perceived pain in patients with perceived hamstring tightness?

*Hypotheses*

1. An increase in hamstring flexibility will occur within GT group that is significantly greater than that of the MFD group immediately following the treatment.
2. A decrease in perceived hamstring pain will occur within MFD group that is significantly greater than that of the GT group immediately following the treatment.
3. A single-session of the GT will not exhibit significant increases in strength immediately following the treatment.
4. A single-session of MFD will not exhibit significant increases in strength immediately following the treatment.

*Delimitations*

1. All subjects will be male athletes from Oklahoma State University
2. Subjects will be recruited from the Oklahoma State University Cheer team
3. Subjects will be between the ages of 18-25

4. No surgeries to the affected hamstring within the last year
5. Subjects will only receive treatment during a single session

### *Assumptions*

1. All subjects will provide accurate information when being recruited for the study
2. All subjects will provide honest descriptions of their comfort levels
3. The primary investigator will be performing all Graston Technique® and Myofascial Decompression treatments
4. Subjects will answer all questions to the best of their abilities
5. The subjects will be randomly assigned to each treatment group by the primary investigator

### *Limitations*

1. The population sample will be a purposeful sampling group; subjects will be recruited from the cheer team at Oklahoma State University
2. There will not be any gender difference data recorded; all subjects will be males

## CHAPTER II

### REVIEW OF THE LITERATURE

The purpose of this study is to examine the immediate effects of a single-session GT and MFD therapy on hamstring flexibility, perceived pain and strength. A secondary purpose was to compare the two methods to determine if there is a significant difference in functional scores and immediate strength following the therapy. Therefore, this literature review will focus on what fascia is, how hamstring injuries affect athletes and how MFD and GT have been used in past studies, as well as how these methods are commonly used by sports medicine professionals.

#### *Fascia*

Fascia has been termed as a fibrous band of connective tissue that wraps around muscles, organs and other soft tissue in the body.<sup>16</sup> For the purpose of this study, it will focus on the fascia surrounding muscle, which are characterized by both deep and superficial fascia.<sup>17</sup> Deep fascia, while previously overlooked, has recently been found to be a contributor to peripheral coordination of muscles due to the amount of force that is transmitted through their connective tissue during muscle activation.<sup>16</sup> The outer layer of fascia is responsible for promoting movement, which causes a greater susceptibility to

injury and can be altered due to external mechanical load, inflammation and spasms.<sup>16,17</sup> Following an injury or a period of immobilization, healing soft tissue can cause irregular collagen fiber arrangement, which ultimately leads to adhesion formation.<sup>18</sup> These adhesions can alter the way the muscle functions and can cause pain, limit range of motion, and cause muscular imbalances due to compensation. Without proper treatment, the adhesions are likely to remain, and will continue to limit the muscle from properly functioning, which is why it's important to understand what treatment option will work best in reducing the amount of restrictions found in a given muscle.

### *Hamstring Injuries*

The hamstrings are a large group of muscles spanning the posterior aspect of the thigh and are responsible for aiding in flexion of the knee joint, as well as assist in extension of the leg. They play a large role in a variety of movements including running, jumping, forward bending and postural control.<sup>19</sup> Due to their task-oriented nature, they have a tendency to shorten, even under normal circumstances, which adversely affects spinal and pelvic mechanics, and puts a greater stress on the lower extremity.<sup>20-22</sup> They are a complicated muscle group when injured, and can lead to chronic pain, recurrent injury and reduced sport performance.<sup>1</sup> Even though hamstring injuries have been recognized for over 100 years and are considered the third most common orthopedic problem behind ankle and knee injuries, researchers are still interested at looking at the role that the hamstring play and the importance of their flexibility.<sup>1,23</sup>

One study looked at trunk and pelvic angles during movement by examining a group of men lowering and lifting boxes using 2D imaging. Seventeen subjects were recruited to lift and handle a 15kg box while under video observation. Hamstring measurements were taken prior to the movement in each individual, and trunk and pelvic movements were analyzed and measured using the 2D imaging software. Their findings suggest that reduced hamstring flexibility is related to increased trunk angles, which can cause an increased stress on the spine.<sup>24</sup> Another study examined how hamstring tightness affects the plantar aspect of the foot in fifteen subjects (nine men and six women) with chronic plantar fasciitis. By locking out the hamstring group with a Don-Joy knee brace at varying degrees of extension, it was concluded that increases in knee flexion lead to a greater load placed on the forefoot. It can be implied from this study that the tighter the hamstring are, the more stress is placed on the forefoot, causing injuries such as plantar fasciitis and strain on the lower extremity.<sup>25</sup> There was also a correlation in decreased knee flexion and altered gait patterns, which suggests that tight hamstrings may limit everyday movements such as walking.<sup>25</sup> These studies are of important clinical significance because it allows a clinician to better understand the varying amounts of stress placed on the hamstrings, and how decreased flexibility affects other areas of the body. The clinician then must decide what treatment method to use to increase hamstring flexibility, where research is heavily geared towards traditional methods, such as static stretching and conservative dynamic warm-ups.<sup>26-28</sup>

A third study looked at the effectiveness of increasing hamstring flexibility to prevent lower extremity overuse injuries in military trainees. Two different companies

with trainees going through a basic military training program during the same 13-week period were recruited for the study. One company consisting of 148 trainees was used as the control group, where they proceeded through their normal training that incorporated a routine of stretching before physical activity in the morning. The other company consisting of 150 trainees added three hamstring stretching sessions to their training, which occurred after lunch, dinner and before bedtime. The hamstring stretch used in the intervention group was a basic, single-leg static stretch that was held for 30 seconds and performed five times per leg, per session. By adding these three hamstring stretches to their daily training routine, the trainees in the intervention group increased hamstring flexibility and had fewer lower extremity injuries than the group who did not do these hamstring stretches by the end of their 13-week basic training.<sup>26</sup>

Some researchers believe that static stretching alone can negatively influence muscle strength and power and may result in decreased functional performance.<sup>27,28</sup> As an alternative to static stretching, dynamic warm-up routines were investigated to determine their effectiveness in increasing hamstring flexibility. In this particular study, 45 participants were recruited and separated into three different groups, one serving as a control group. One group completed a dynamic warm-up consisting of five-minutes on a stationary bike, followed by dynamic stretching, agility and plyometric exercises, acceleration run and a short recovery jog. This was compared to a group performing a ten-minute static stretching protocol for the lower extremity following five-minutes on a stationary bike. Measurements were taken before and after each protocol, and the study found that the dynamic warm-up had a significant increase in hamstring flexibility, while



the control group and the static stretching group did not have a significant affect on hamstring flexibility. While these traditional methods are still widely used by the athletic population, there is still much debate on their effectiveness, which is why sports medicine professionals are turning to more advanced methods of treatment.

### *The Graston Technique®*

The Graston Technique® (GT) is a form of therapy known as Instrument Assisted Soft Tissue Mobilization (IASTM). The technique uses six stainless steel instruments that are used for the reduction of scar tissue, fascial restrictions, soft tissue fibrosis and chronic inflammation.<sup>29</sup> Each instrument has beveled concave or convex treatment edges that allow the tools to shape to different body parts, and vary in the depth of tissue penetration.<sup>6</sup> A certified GT provider must complete a standardized course to learn the different strokes that are used, as well as the treatment protocols for different injuries or areas of the body. The typical protocol for the GT instrument includes warm-up exercises, GT treatment, strengthening, stretching and ice.<sup>29</sup> The physiological goals for GT include increased blood flow, increased skin temperature, increased cellular activity and increased histamine.<sup>6</sup> It has been proven to be an effective treatment method when in combination with other, conservative rehabilitation protocols and is typically not used in isolation.<sup>10</sup>

Much of the research varies on the number of treatment sessions performed per patient and per case. In an attempt to increase posterior shoulder range of motion, one study used GT on eighteen collegiate baseball players in just one session.<sup>7</sup> Another

believed that two sessions per week for five weeks in combination with tissue heating, eccentric training, static stretching and cryotherapy would reduce the pain in patients that presented with chronic Achilles tendinopathy.<sup>5</sup> Howitt et al<sup>30</sup> combined GT and Active Release Technique to complete a protocol of treatment twice a week for a total of six weeks, while another case report used many methods of conservative treatment in conjunction with GT for patients with lateral epicondylopathy over an 8-week period<sup>11</sup>. It can be inferred that the varying number of sessions among the studies above is due to an unknown of the number of sessions that are effective.

There also seems to be a common theme in the sessions incorporating another method of treatment along with GT, making it difficult to assume that GT is the sole effective method of treatment. Schaefer et al<sup>10</sup> found that over a 4-week period when combined with a dynamic-balance-training program, GT had improved scores in ROM, pain and disability in patients who presented with chronic ankle instability. However, the control group that did not receive GT and only participated in the dynamic-balance-training-program also showed improved symptoms and measurements, although not as much as the group receiving GT.<sup>10</sup> While this study was a step in the right direction, it still did not give a definitive answer when asked if GT is effective on its own.

Another important note to take away from the research on GT is the many different injuries and areas of the body that the treatment is used on, in addition to the treatment outcome goal. Papa<sup>11,31</sup> published two case studies using the GT, both in an attempt to decrease pain using a verbal pain scale and a disability/symptom scale. The initial study involved one patient with De Quervain's stenosing tenosynovitis and the

other, as previously mentioned, had two patients with lateral epicondylopathy. Another case study focused more on decreasing edema and pain due to a tibialis posterior strain, and found that the triathlete was able to return to his training rather quickly following the injury, and had decreased edema that was confirmed by ultrasound on the eighth day.<sup>30</sup> Solecki and Herbst<sup>32</sup> focused on increasing range of motion and reducing the amount of fibrotic adhesions and hypertonicity on a patient who had surgical reconstruction on a completely ruptured ACL and a bucket-handle tear of the medial meniscus. Following the proper 12-week rehabilitation protocol, GT was incorporated at the 5-week mark, and the patient noted improved functionality.<sup>32</sup> As shown by these studies, GT has been used on a variety of injuries and had different protocols for each study, which infers that the proper protocol may be unknown or controversial.

### *Myofascial Decompression*

Myofascial decompression (MFD), or cupping, is an ancient form of therapy that is popular in Traditional Chinese Medicine and utilizes vacuum-like cups to suction a localized area of skin.<sup>12,14</sup> There are many different theories that attempt to explain the effects of cupping, one being that it increases the circulation around the affected area, which allows toxins to escape from the deep layers of soft tissue, as well as loosen adhesion, lifting connective tissue and stimulating the peripheral nervous system.<sup>14,33</sup> It is believed that the earliest record of cupping therapy was in 3000 B.C. where it was used for the removal of ‘foreign matter’ from the body.<sup>14</sup> Since then, MFD has been utilized for the treatment of chronic pain, osteoarthritis, fibromyalgia, and respiratory, gastroenterological and gynecological disorders.<sup>12,15</sup> While MFD has been used for a

variety of ailments for thousands of years, it seemed to have disappeared in Western medicine during the late 20<sup>th</sup> century; however, it has recently re-emerged into the world of sports medicines as a means to treat pain associated with musculoskeletal disorders.<sup>14</sup>

There are two forms of MFD therapy that are being used today, wet and dry cupping. Dry cupping is the basic and most common form of the therapy, which utilizes plastic or glass cups to suction a localized area of skin. The negative pressure is vacuumed using a specialized pump, and the cups are left on the skin for a short period of time, ranging anywhere from 2-10 minutes.<sup>33,34</sup> Typically, the patient will notice local edema, ecchymosis and/or minor capillary vessel bleeding following a cupping treatment.<sup>14</sup> Wet cupping uses the same methodology as dry cupping does, only the skin is punctured with a scalpel or needle and the cups are replaced to allow bloodletting into the cup.<sup>33</sup> By allowing this local bloodletting, it is believed that B-Endorphins are released and the opioid system is activated, which could have a positive effect on the immune system via the central nervous system, leading to a reduction in pain.<sup>14,33</sup>

In a recent study, 40 participants with knee osteoarthritis (OA) were randomly divided into two groups.<sup>13</sup> The 20 participants in the control group were instructed to take 650 mg of acetaminophen three times per day, while the other group received MFD, both in an attempt to relieve pain, inflammation and joint stiffness. After 11 treatment sessions within a 15-day period, the participants in the MFD therapy group demonstrated a significant reduction in all variables, which included reduction in edema, stiffness, pain, crepitus and tenderness. The control group also demonstrated a significant decrease in all variables, but the decrease was not as large as in the MFD treatment group.<sup>13</sup> It can be

inferred from this study that while medicine is proven to be effective in the treatment of OA, there are other, less aggressive treatment methods that are more effective in relieving symptoms. While these results were not extremely significant, it's encouraging to note that the use of MFD was in fact effective in its attempt to eliminate symptoms associated with knee OA.

MFD has also been found to be an effective tool in decreasing back and neck pain.<sup>35,36</sup> One study attempted identify if MFD could be utilized to decrease low back pain in 50 postpartum women.<sup>36</sup> MFD was performed for 15-20 minutes everyday for four days. A Visual Analog Scale (VAS) and a pain questionnaire were given before the therapy and immediately, 24 hours and two weeks after. Pain scores significantly decreased in all measurements following the treatment, proving that it is an effective treatment method for decreasing low back pain.<sup>36</sup> A second study looked at 50 patients with chronic, non-specific neck pain. The treatment group received five cupping treatments over a two-week period, and self-reported measurements were taken before and after the two weeks.<sup>35</sup> Pain scores significantly decreased after the cupping therapy, again providing valuable results to the effectiveness of cupping in reducing musculoskeletal pain.<sup>35</sup> While these studies only focused on eliminating perceived pain, the results were still significant and promising for clinicians who are unsure of the proper course of treatment for reducing back and neck pain, which are common complaints among athletes and the general population.<sup>35,36</sup>

## *Conclusion*

Following a review of the literature pertaining to GT and MFD therapies, it was determined that there is very little, if any, research on the immediate effects of these two modalities in increasing hamstring flexibility. As previously stated, GT is generally used in combination with other conservative treatment methods, and while MFD has a broad range of ailments that it treats, there was no evidence of research conducted on its effects of increasing flexibility.<sup>5,7,10,11,35,36</sup> This study examined the effects of a single-session GT or MFD therapy on hamstring flexibility in patients with perceived hamstring tightness. It also attempted to determine what method of treatment is more effective in decreasing pain, increasing functional scores, and whether or not the therapies affect immediate strength.

## CHAPTER III

### METHODOLOGY

Myofascial decompression (MFD) was compared to the Graston Technique® (GT) for hamstring flexibility and strength, as well as perceived pain and function, which was determined by digital goniometry measurements using a passive straight leg raise, handheld dynamometry measurements using a manual muscle test of the hamstring, a PFAQ (Perceived Functional Ability Scale) Questionnaire and a GROC (Global Rating of Change) Scale in Division I male athletes between the ages of 18-25.

#### *Subjects*

Twenty Division I collegiate athletes from Oklahoma State University were recruited to participate in this study. All subjects were male members of the Oklahoma State Cheer team with complaints of perceived hamstring tightness and pain, lack of flexibility and/or decreased strength. Upon receiving approval from the Oklahoma State University Institutional Review Board, the PI recruited subjects and gave each individual an overview of the study as well as explained the risks associated with it. The subjects were then required to read and sign an informed consent prior to any testing, and were verbally asked whether they were willing to be randomly assigned to either group. If agreed, they were considered accepted into the study and were then randomly placed into

the experimental groups; ten subjects were placed in the group receiving the GT treatment and ten subjects were placed in the group receiving MFD therapy. All subjects that were recruited for data collection completed this study.

### *Materials*

Subjects assigned to The Graston Technique® group received treatment applied by the GT1 instrument (Fig. I and II) was used with a layer of cocoa butter to serve as a medium between the instrument and the skin. The Steady Ease standard kit of 24 plastic valve cups was used for the group receiving the MFD therapy, along with a pump for suctioning the skin and cocoa butter to serve as the medium between the cups and the skin. Strength measurements were taken with the Lafayette Manual Muscle Tester, and the range of motion measurements were taken using a Mitutoyo Pro 360 digital protractor.

### *Pre-test Measurements*

The subjects were invited to the athletic training clinic at Oklahoma State University, where both pre and post-test measurements were taken in a single session. Pre-test measurements included measuring flexibility and strength, as well as perceived pain and function. After standard measurements of age, weight and height were taken, the subjects were asked to fill out the Perceived Functional Ability Questionnaire (PFAQ)<sup>38</sup>, which consisted of a series of eight questions based on their functional ability at that moment in time, which included assessing their health, flexibility, muscular strength, pain, restriction from sport, and performance level (See Appendix A).<sup>37</sup> To test the



reliability of the PFAQ, Levine used 60 patients who had surgery to improve their carpal tunnel syndrome. The Vardiman study<sup>38</sup> followed the protocol by Levine<sup>37</sup> to assess the reliability of the PFAQ instrument in 60 college-aged students. The test-retest reliability of the PFAQ instrument was determined to be good to excellent (Chronbach's alpha = .856).<sup>38</sup> Hamstring flexibility was measured using the Mitutoyo Pro 360 digital protractor with a passive Straight Leg Raise (SLR). The digital protractor was placed at the midline of the femur, halfway between the lateral epicondyle and the greater trochanter. The PI palpated these bony landmarks, and the digital protractor remained in its place for the entirety of the measurement. The subject was instructed to lay supine, and allow the PI to gradually lift their affected leg until the subject began to compensate by lifting at the hip or bending at the knee, or until they verbally indicated that their stretching limit was reached. This measurement was taken twice for investigator reliability purposes, but only the first measurement was used for data analysis. Strength was measured using the Lafayette Manual Muscle Tester and a manual muscle test of the hamstring muscle on the affected leg. The subject was asked to lay prone with their affected knee flexed to a 90-degree angle. The handheld dynamometer was placed at the musculotendinous junction where the calf musculature meets the Achilles tendon. The subject was instructed to resist flexion against a consistent pressure from the PI and continue to resist with a maximal contraction for a total of five seconds. In order to calculate strength measurements, a distance measurement was taken at this time. The PI again palpated the musculotendinous junction where the calf musculature meets the Achilles tendon, and measured superiorly to the popliteal fossa. After pre-test measurements were completed,

testing began and differed for each subject depending on the group that they were randomly assigned to.

*The Graston Technique® Group*

For the group receiving the GT treatment, the subjects were instructed to lay prone and the affected hamstring was exposed. After applying cocoa butter to the posterior thigh, the PI, who is a certified Graston Provider, then began the four-minute therapy. Utilizing the GT1 instrument, the PI applied a sweeping stroke over the entire length of the hamstrings. The strokes, as well as the pressure, remained consistent among all subjects. The GT1 instrument has a single-beveled, concave edge that is typically used for large surface areas and allows for a broader tissue contact than the other GT instruments (see Figure I and II).<sup>6</sup> The PI maintained the pressure by keeping the instrument at a 45-degree angle for the entirety of the treatment.<sup>38</sup> The protocol consisted of 30 strokes per minute from distal to proximal, and then 30 strokes per minute from proximal to distal. This sequence was repeated for the remaining two minutes.



Figure I: The Graston Technique® Instrument Set    Figure II: The Graston Technique® GT1 Instrument

### *Myofascial Decompression Group*

For the group receiving the MFD treatment, the subject was asked to lay prone and the affected hamstring was exposed. Cocoa butter was applied to the hamstring prior to the application of the cups. Six plastic valve cups were placed in two vertical lines of three cups spanning the hamstring muscle group. Using a handheld suction pump, each cup was pumped so that skin filled up half of the cup. The cups remained in place for three minutes where the subject was instructed to remain still and relax (See Figure III). After the three minutes were up, all but one cup was removed. For the remaining minute, the PI glided the cup up and down the hamstring with the suction still in tact.



Figure III: Myofascial Decompression Treatment Protocol

### *Post-Test Measurements*

Immediately following each treatment, all subjects performed the same pre-test measures of hamstring flexibility and strength using the same protocol from the pre-test measurements. A second subjective measure of perceived pain and function was repeated using the PFAQ scale that indicated their pain and function levels at that moment in time. Subjects were also asked to complete the Global Rate of Change (GROC) Scale, which was designed to allow subjects to determine if there were positive or negative changes following the treatment. The scale has a total of 15 phrases, ranging from -7, “a very great deal worse”, to +7, “a very great deal better”, with the option of 0, “about the same”. The GROC is commonly used in clinical research and allows the subject to easily recall their perception of change.<sup>39</sup> Its test-retest reliability was assessed by Costa et al,

and was found to be reproducible when tested on subjects experiencing low back pain.

The full version of the GROC scale can be found in Appendix A.

### *Statistical Analysis*

All data was uploaded into SPSS. Paired samples t-tests and a two-way ANOVA were performed to assess the data to identify overall differences in pre and post-test measurements in flexibility and all strength measurements, which included peak, time to peak, average force, torque and overall strength. The t-tests did not take the type of treatment into account, only the influence of the two groups combined. The two-way ANOVA compared the differences between the two treatment groups and pre/post testing in flexibility, strength and PFAQ scores. A one-way ANOVA was performed for GROC scores, and for user reliability purposes, a correlation was performed for flexibility and strength measurements using the reliability measurements taken during pre-testing. An alpha level of 0.05 was utilized to establish significance.

## CHAPTER IV

### FINDINGS

Data was collected from a total of 20 male cheerleaders ( $21.35 \pm 1.76$  years,  $82.85 \pm 8.36$  kg,  $175.89 \pm 5.93$  cm). Thirteen subjects presented with perceived tightness and/or pain to their left hamstring, while seven subject presented with perceived tightness and/or pain to their right hamstring. Paired samples t-tests were used to compare flexibility and strength for all of the subjects. These tests did not take into account the type of treatment that the subject received, but rather attempted to identify any significant differences in the treatments overall. A summery of the t-test results can be found in Table 1. There was a statistically significant difference found for an overall improvement in range of motion ( $t= -5.41$ ,  $p<0.001$ ), peak force ( $t= -3.26$ ,  $p=0.004$ ), average force ( $t= -3.47$ ,  $p=0.003$ ), torque ( $t= -3.24$ ,  $p=0.004$ ) and strength ( $t= -3.34$ ,  $p=0.003$ ). These results indicate that all of the subjects' affected hamstrings increased in strength and flexibility measurements immediately preceding the treatments, which suggests that there was an overall improvement from both GT and MFD.

**TABLE 1: Descriptive Statistics for all Flexibility and Strength Measurements**

<b>Variable</b>	<b>Measure</b>	<b>Mean</b>	<b>SD</b>	<b>t</b>	<b>Sig.</b>
ROM	Pre	90.13	14.63	-5.41	0.001*
	Post	95.14	15.74		
Peak (N)	Pre	171.98	33.38	-3.26	0.004*
	Post	196.37	43.55		
Time – Peak (Sec.)	Pre	3.25	1.59	-.09	0.93
	Post	3.28	1.18		
Avg. Force (N)	Pre	152.95	31.53	-3.47	0.003*
	Post	173.13	36.79		
Torque (Nm)	Pre	49.82	10.16	-3.24	0.004*
	Post	56.93	13.04		
Strength	Pre	.61	.12	-3.34	0.003*
	Post	.69	.17		

Paired Samples T-test Overall Model N=20. \*indicates significance at  $p < .05$

Paired samples t-tests were also used to compare each of the eight PFAQ scale questions for all of the subjects. A statistically significant difference was found for an

overall improvement in perception of hamstring flexibility ( $t= -3.90, p=0.001$ ), pain in hamstrings ( $t=2.76, p=0.01$ ) and effect on sport performance ( $t=3.18, p=0.005$ ). A summary of these t-tests can be found in Table 2.

**TABLE 2: Descriptive Statistics for all PFAQ Scale Questions**

<b>PFAQ Question</b>	<b>Measure</b>	<b>Mean</b>	<b>SD</b>	<b>t</b>	<b>Sig.</b>
Overall Physical Health	Pre	8.15	0.75	-0.24	0.82
	Post	8.2	0.77		
Overall Muscular Flexibility	Pre	5.65	1.93	-1.41	0.18
	Post	6.1	1.99		
Flexibility of Hamstring	Pre	4.75	1.74	-3.90	0.01*
	Post	6.05	2.01		
Overall Muscular Strength	Pre	7.15	1.31	-1.55	0.14
	Post	7.45	1.39		
Strength of Hamstrings	Pre	6.3	1.49	-2.00	0.06
	Post	7.15	1.63		



Pain in Hamstrings	Pre	2.9	1.97	2.76	0.01*
	Post	1.45	1.70		
Effect on Sport Performance	Pre	3.95	2.65	3.18	0.005*
	Post	2.3	2.00		
Effect on Activities of Daily Living	Pre	2.4	2.23	1.80	0.09
	Post	.69	2.22		

Paired Samples T-Test Overall Model N=20. \*indicates significance at  $p < .05$ .

A two-way ANOVA was used to determine any significant difference between the groups and pre/post measurements in all variables of strength and flexibility, as well as the individual PFAQ scale questions. For the variables of strength and flexibility, no significant findings were identified. A summary of these results can be found on Table 3. For the PFAQ scale questions, there were significant differences found between the pre and post measurements in hamstring flexibility ( $F_{(1,40)} = 4.88, p = 0.03$ ), pain in hamstrings ( $F_{(1,40)} = 6.03, p = 0.02$ ) and effect on sport performance ( $F_{(1,40)} = 4.75, p = 0.04$ ). These interactions indicate that the perception of pain and flexibility was improved following the treatment, however there was no significance found between groups in PFAQ scale questions. Therefore, while there were improvements in the perception of pain and flexibility immediately following treatments, the interactions between groups was not significant. A summary of these results can be found in Table 4.

**TABLE 3: Descriptive Statistics for Flexibility and Strength measurements between groups**

<b>Variable</b>	<b>Interaction</b>	<b>F<sub>1,40</sub></b>	<b>Sig</b>
ROM	Group	0.30	0.59
	Measure	1.01	0.32
	Group*Measure	0.00	0.99
Peak (N)	Group	0.07	0.79
	Measure	3.75	0.06
	Group*Measure	0.00	0.95
Time – Peak (sec)	Group	2.68	0.11
	Measure	0.01	0.95
	Group*Measure	0.01	0.93
Avg. Force (N)	Group	0.15	0.70
	Measure	3.30	0.08
	Group*Measure	0.02	0.88
Torque (Nm)	Group	0.29	0.59
	Measure	3.53	0.07
	Group*Measure	0.00	0.96
Strength	Group	0.05	0.83

	Measure	3.30	0.08
	Group*Measure	0.00	0.98
Peak (N)	Group	0.07	0.79
	Measure	3.75	0.06
	Group*Measure	0.00	0.95

Two-Way ANOVA. N=20, \*indicates significance at <.05

**TABLE 4: Descriptive Statistics for PFAQ Scale Questions between both groups**

<b>PFAQ Question</b>	<b>Interaction</b>	<b>F<sub>1,40</sub></b>	<b>Sig</b>
Overall Physical Health	Group	0.04	0.84
	Measure	0.04	0.84
	Group*Measure	0.04	0.84
Overall Muscular Flexibility	Group	2.37	0.13
	Measure	0.53	0.47
	Group*Measure	0.06	0.81
Flexibility of Hamstring	Group	2.89	0.09
	Measure	4.88	0.03*
	Group*Measure	0.03	0.87

Overall Muscular Strength	Group	0.05	0.82
	Measure	0.47	0.50
	Group*Measure	0.00	1.00
Strength in Hamstrings	Group	0.25	0.62
	Measure	2.89	0.09
	Group*Measure	0.81	0.37
Pain in Hamstrings	Group	0.87	0.36
	Measure	6.03	0.02*
	Group*Measure	0.07	0.81
Effect on Sport Performance	Group	0.11	0.74
	Measure	4.75	0.04*
	Group*Measure	0.35	0.56
Effect on Activities of Daily Living	Group	2.01	0.17
	Measure	2.43	0.12
	Group*Measure	0.00	1.0

Two-Way ANOVA. N=20, \*indicates significance at <.05

The GROC scale was measured to determine if there was a significant difference in how the subjects felt after their treatment in both groups. The subjects were asked to select a single phrase that represented how they felt following the treatment, ranging from -7 to +7. A one-way ANOVA was used to determine any significance in the GROC. For the GT group ( $5.4 \pm 1.17$ ) subjects answered feeling “quite a bit better” on average, and for the MFD group ( $4.3 \pm 1.42$ ) subjects answered feeling “moderately better” on average following the treatment. While there was no significance found between the two groups, ( $F_{(1,20)} = 3.57, p=0.08$ ) these results do indicate that the subjects, on average, had an overall feeling of improvement following both methods.

## CHAPTER V

### DISCUSSION

After reviewing the literature on the different modalities that increase hamstring flexibility, it is evident that much of the research focused more on traditional methods such as static stretching and dynamic warm-ups in part because these methods have been around longer and thus have more research to show for them.<sup>26-28</sup> However in recent years, soft tissue mobilization methods such as the Graston Technique® (GT) and Myofascial Decompression (MFD) have become increasingly popular. With many different techniques to choose from, clinicians must decide what the most effective treatment method is going to be for their patients. Much of the research combined GT and MFD with other modalities and there was very little research found that used these techniques as sole treatment methods. Thus, this study served as a means to establish whether or not GT and MFD can be used as the only treatment method and was designed to determine if either of these methods was more effective than the other.

After an in-depth statistical analysis of the data from this study, it can be implied that both methods, GT and MFD, are effective in improving hamstring flexibility and strength, and decreasing pain. Regardless of treatment group, the subjects experiencing

hamstring tightness and/or pain had improvements in hamstring flexibility and overall strength following the treatment. Perception of pain, flexibility and overall performance were also found to have significant improvements following the treatments. While there were no significant differences between the two groups, these results still prove that both groups were effective when used as the sole treatment method.

Despite the current trend in literature that uses multiple sessions of GT in order to prove to be effective<sup>5,11</sup>, this study was successful in examining the immediate effects of both GT and MFD in regards to hamstring flexibility. The strength component of the study was also unique in that there was no research reviewed that studied the immediate effects of strength following these treatments. Strength increased considerably in both GT and MFD groups, which can be a useful tool for clinicians and coaches, as well as an avenue for future research.

The results of this study in part support the hypothesis that GT would be effective in increasing hamstring flexibility, while MFD would be effective in decreasing perceived pain. However, MFD was also effective in increasing hamstring flexibility and GT was effective in decreasing perceived pain, and there was not a statistically significant difference between the two groups to fully support the hypothesis to be completely true. Also, both MFD and GT were effective in increasing strength, which was against what the hypothesis stated.

### *Limitations*

There were a few limitations that should be recognized in this study so that further research can improve on these restrictions. The biggest limitation to this study was the ability to recruit enough subjects that were experiencing hamstring tightness and/or pain. Since this was a purposeful sampling group, the subjects were meant to only be recruited from the Oklahoma State Cheer team during the 2015-2016 season, which resulted in 20 males with hamstring tightness and/or pain. Future research should include a subject population that is not limited to NCAA male athletes on one particular team. Another limitation to this study was the lack of control group. The small subject population did not allow for multiple groups, and therefore the PI had to forego a control group that did not receive any treatment. Future studies may allow for a control group with more subjects, or compare different treatment methods that may provide more significant differences between the groups. Further limitations that may have taken place were the measurements of the study. Since this study was indented to demonstrate immediate effects of the two treatment methods, there were no follow-up measures or multiple treatment sessions performed.

### *Future Research*

The results from this study imply that compressive and decompressive soft tissue therapies are effective in improving hamstring flexibility and strength, and decreasing pain. This study proved to do so in the form of GT and MFD when used alone and is a stepping-stone for further research to be conducted. While future research should



continue to focus on the effects of compressive versus decompressive therapies, it should consider modifying variables and increasing subject populations. The trends in this study are beneficial for clinicians who are unsure of the proper treatment to use. While current research suggests that both are useful and effective treatment methods, there is room for improvement in future studies.

### *Conclusion*

After reviewing all of the literature on GT and MFD and analyzing the effects that each had in this study, it can be concluded that both treatment methods were effective in increasing hamstring flexibility and strength and decreasing perceived pain immediately following the treatments. While there was not a significant difference between the two groups, it can still be recommended to clinicians that GT and MFD are useful tools to use for their patients suffering from hamstring tightness or pain. This study, while different than previous literature that used these methods in combination with other modalities, still supports the use of these treatments based on the literature reviewed and the effects of this study combined. The results from this study should provide future research with a stepping-stone into the world of compressive versus decompressive soft tissue therapy and their effects on flexibility, strength and perceived pain.

## REFERENCES

1. Sherry MA, Best TM. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. *J Orthop Sports Phys Ther.* 2004;34(3):116-125. doi:10.2519/jospt.2004.34.3.116.
2. Wiktorsson-Moller M, Oberg B, Ekstrand J, Gillquist J. Effects of warming up, massage, and stretching on range of motion and muscle strength in the lower extremity. *Am J Sports Med.* 1983;11(4):249-252.
3. Schroeder AN, Best TM. Is Self Myofascial Release an Effective Preexercise and Recovery Strategy? A Literature Review. *Curr Sports Med Rep.* 2015;14(3). [http://journals.lww.com/acsm-csmr/Fulltext/2015/05000/Is\\_Self\\_Myofascial\\_Release\\_an\\_Effective.16.aspx](http://journals.lww.com/acsm-csmr/Fulltext/2015/05000/Is_Self_Myofascial_Release_an_Effective.16.aspx).
4. Cheatham SW, Kolber MJ, Cain M, Lee M. The Effects of Self-Myofascial Release Using a Foam Roll or Roller Massager on Joint Range of Motion, Muscle Recovery, and Performance. A Systematic Review. *Int J Sports Phys Ther.* 2015;10(6):827-838. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4637917/>.
5. Miners AL, Bougie TL. Chronic Achilles tendinopathy: a case study of treatment incorporating active and passive tissue warm-up, Graston Technique, ART, eccentric exercise, and cryotherapy. *J Can Chiropr Assoc.* 2011;55(4):269-279. [http://okstate.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwnV3JTsMwE LUQB8QFsVM2zamntkrjLA4ShwqxXLjBOflKSCWpQhEqf8SFj-DLmHGSisCNXBLFTmT5JeM39vgNYzwcBcNfNsFaLhIXaB3b0DgtOLehcEma KRMpoVxX44e1UWQUZnkJVRwVT48-3LLp18rnWxs58hvpIjmnIYM0CPvzspyez579c\\_a9X1f0QkR](http://okstate.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwnV3JTsMwE LUQB8QFsVM2zamntkrjLA4ShwqxXLjBOflKSCWpQhEqf8SFj-DLmHGSisCNXBLFTmT5JeM39vgNYzwcBcNfNsFaLhIXaB3b0DgtOLehcEma KRMpoVxX44e1UWQUZnkJVRwVT48-3LLp18rnWxs58hvpIjmnIYM0CPvzspyez579c_a9X1f0QkR).
6. The Graston Technique. The Graston Technique. <http://www.grastontechnique.com>. Published 2009.
7. Laudner K, Compton BD, McLoda TA, Walters CM. Acute Effects of Instrument Assisted Soft Tissue Mobilization for Improving Posterior Shoulder Range of Motion in Collegiate Baseball Players. *Int J Sports Phys Ther.* 2014;9(1):1-7. <http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=98281236&site=ehost-live>.
8. Gehlsen GM, Ganion LR, Helfst R. Fibroblast responses to variation in soft tissue mobilization pressure. *Med Sci Sports Exerc.* 1999;31(4):531-535.
9. Melham TJ, Sevier TL, Malnofski MJ, Wilson JK, Helfst RHJ. Chronic ankle pain and fibrosis successfully treated with a new noninvasive augmented soft tissue mobilization technique (ASTM): a case report. *Med Sci Sports Exerc.* 1998;30(6):801-804.
10. Schaefer JL, Sandrey MA. Effects of a 4-Week Dynamic-Balance-Training Program Supplemented With Graston Instrument-Assisted Soft-Tissue Mobilization for Chronic Ankle Instability. *J Sport Rehabil.* 2012;21(4):313-326. <http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=82505346&site=ehost-live>.
11. Papa JA. Two cases of work-related lateral epicondylopathy treated with Graston

- Technique® and conservative rehabilitation. *J Can Chiropr Assoc.* 2012;56(3):192-200.  
<http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=88935405&site=ehost-live>.
12. Tham LM, Lee HP, Lu C. Cupping: from a biomechanical perspective. *J Biomech.* 2006;39(12):2183-2193. doi:10.1016/j.jbiomech.2005.06.027.
  13. Khan AA, Jahangir U, Urooj S. Management of knee osteoarthritis with cupping therapy. *J Adv Pharm Technol Res.* 2013;4(4):217-223. doi:10.4103/2231-4040.121417.
  14. Rozenfeld E, Kalichman L. New is the well-forgotten old: The use of dry cupping in musculoskeletal medicine. *J Bodyw Mov Ther.* 2016;20(1):173-178. doi:10.1016/j.jbmt.2015.11.009.
  15. Cao H, Li X, Liu J. An Updated Review of the Efficacy of Cupping Therapy. *PLoS One.* 2012;7(2):1-14. 10.1371/journal.pone.0031793.
  16. Stecco C, Macchi V, Porzionato A, Duparc F, De Caro R. The fascia: the forgotten structure. *Ital J Anat Embryol.* 2011;116(3):127-138.
  17. Benjamin M. The fascia of the limbs and back--a review. *J Anat.* 2009;214(1):1-18. doi:10.1111/j.1469-7580.2008.01011.x.
  18. McMurray J, Landis S, Lininger K, Baker RT, Nasypany A, Seegmiller J. A Comparison and Review of Indirect Myofascial Release Therapy, Instrument-Assisted Soft Tissue Mobilization, and Active Release Techniques to Inform Clinical Decision Making. *Int J Athl Ther Train.* 2015;20(5):29-34.  
<http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=109155361&site=ehost-live>.
  19. Mazumdar J, Shriwas JK. A Comparison Between Mulligan Traction Straight Leg Raise Technique vs Muscle Energy Technique on Hamstring Tightness in Asymptomatic Males. *Int J Physiother Res.* 2014;2(2):412-417.
  20. Balani S. Comparing Effectiveness of Sub occipital Muscle Energy Technique Alone, Passive Hamstring Stretching Technique Alone and Combination of Both for Improving Hamstring Muscle Flexibility in Healthy Collegiate Subjects. . Kataria C, ed. *Int J Heal Sci Res.* 2015;5(8):329-336.  
<http://www.scopemed.org/?mno=198471>.
  21. Pratik .A. Phansopkar, Kage V. Efficacy of Mulligan's Two Leg Rotation and Bent Leg Raise Technique in Hamstring Flexibility in Subjects with Acute Non-Specific Low Back Pain: A Randomized Clinical Trial. *Int J Physiother Res.* 2014;2(5):733-741.
  22. Norris CM, Matthews M. Correlation between hamstring muscle length and pelvic tilt range during forward bending in healthy individuals: An initial evaluation. *J Bodyw Mov Ther.* 2016;10(2):122-126. doi:10.1016/j.jbmt.2005.06.001.
  23. Hamilton B. Hamstring muscle strain injuries: what can we learn from history? *Br J Sports Med.* 2012;46(13):900-903. doi:10.1136/bjsports-2012-090931.
  24. Carregaro RL, Coury HJCG. Does reduced hamstring flexibility affect trunk and pelvic movement strategies during manual handling? *Int J Ind Ergon.* 2009;39(1):115-120. doi:DOI: 10.1016/j.ergon.2008.05.004.
  25. Harty J, Soffe K, O'Toole G, Stephens MM. The Role of Hamstring Tightness in

- Plantar Fasciitis. *Foot Ankle Int.* 2005;26(12):1089-1092.  
<http://articles.sirc.ca/search.cfm?id=S-1003975>.
26. Hartig DE, Henderson JM. Increasing hamstring flexibility decreases lower extremity overuse injuries in military basic trainees. / L'augmentation de la souplesse des ischio-jambiers diminue les blessures de fatigue des membres inferieurs chez les jeunes recrues de l'armee. *Am J Sports Med.* 1999;27(2):173-176. <http://articles.sirc.ca/search.cfm?id=S-60954>.
  27. Aguilar AJ, DiStefano LJ, Brown CN, Herman DC, Guskiewicz KM, Padua DA. A dynamic warm-up model increases quadriceps strength and hamstring flexibility. *J strength Cond Res / Natl Strength Cond Assoc.* 2012;26(4):1130-1141. doi:10.1519/JSC.0b013e31822e58b6.
  28. Perrier ET, Pavol MJ, Hoffman MA. The acute effects of a warm-up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility. *J strength Cond Res / Natl Strength Cond Assoc.* 2011;25(7):1925-1931. doi:10.1519/JSC.0b013e3181e73959.
  29. Stow R. Instrument-Assisted Soft Tissue Mobilization. *Int J Athl Ther Train.* 2011;8.
  30. Howitt S, Jung S, Hammonds N. Conservative treatment of a tibialis posterior strain in a novice triathlete: a case report. *J Can Chiropr Assoc.* 2009;53(1):23-31. <http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=36978588&site=ehost-live>.
  31. Papa JA. Conservative management of De Quervain's stenosing tenosynovitis: a case report. *J Can Chiropr Assoc.* 2012;56(2):112-120. <http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=78133220&site=ehost-live>.
  32. Solecki TJ, Herbst EM. Chiropractic management of a postoperative complete anterior cruciate ligament rupture using a multimodal approach: a case report. *J Chiropr Med.* 2011;10(1):47-53. doi:10.1016/j.jcm.2010.07.005.
  33. Arslan M, Yeşilçam N, Aydın D, Yüksel R, Dane Ş. Wet Cupping Therapy Restores Sympathovagal Imbalances in Cardiac Rhythm. *J Altern Complement Med.* 2014;20(4):318-321. 10.1089/acm.2013.0291.
  34. Michalsen A, Bock S, Lütke R, et al. Effects of Traditional Cupping Therapy in Patients With Carpal Tunnel Syndrome: A Randomized Controlled Trial. *J Pain.* 2016;10(6):601-608. doi:10.1016/j.jpain.2008.12.013.
  35. Lauche R, Cramer H, Choi K-E, et al. The influence of a series of five dry cupping treatments on pain and mechanical thresholds in patients with chronic non-specific neck pain--a randomised controlled pilot study. *BMC Complement Altern Med.* 2011;11:63. doi:10.1186/1472-6882-11-63.
  36. Akbarzadeh M, Ghaemmaghami M, Yazdanpanahi Z, Zare N, Azizi A, Mohagheghzadeh A. The Effect Dry Cupping Therapy at Acupoint BL23 on the Intensity of Postpartum Low Back Pain in Primiparous Women Based on Two Types of Questionnaires, 2012; A Randomized Clinical Trial. *Int J community based Nurs midwifery.* 2014;2(2):112-120.
  37. Levine W D, Simmons P B, Koris M, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel

- syndrome. *J Bone Jt Surg Am.* 1993;75:1585.
38. Vardiman JP, Siedlik J, Herda T, et al. Instrument-assisted Soft Tissue Mobilization: Effects on the Properties of Human Plantar Flexors. *Int J Sports Med.* 36(3):197-203.  
<http://search.ebscohost.com/login.aspx?direct=true&db=bxh&AN=BACD201500234664&site=ehost-live>.
39. Kamper SJ, Maher CG, Mackay G. Global Rating of Change Scales: A Review of Strengths and Weaknesses and Considerations for Design. *J Man Manip Ther.* 2009;17(3):163-170. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2762832/>.
40. Costa LOP, Maher CG, Latimer J, et al. Clinimetric testing of three self-report outcome measures for low back pain patients in Brazil: which one is the best? *Spine (Phila Pa 1976).* 2008;33(22):2459-2463.  
doi:10.1097/BRS.0b013e3181849dbe.

## APPENDICES

### Oklahoma State University Institutional Review Board

Date: Friday, April 22, 2016  
IRB Application No ED1674  
Proposal Title: Compressive versus decompressive soft tissue mobilization on hamstring flexibility and pain in male athletes with perceived hamstring tightness

Reviewed and Processed as: Expedited

**Status Recommended by Reviewer(s): Approved Protocol Expires: 4/21/2017**

Principal Investigator(s):

Kristen Barger Jennifer Volberding  
180 Colvin Center  
Stillwater, OK 74078 Stillwater, OK 74078

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The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

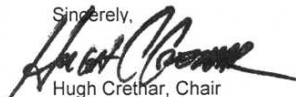
The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Scott Hall (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,



Hugh Crethar, Chair  
Institutional Review Board

**ADULT CONSENT FORM**  
**OKLAHOMA STATE UNIVERSITY**

**PROJECT TITLE:**

*Compressive Versus Decompressive Soft Tissue Mobilization on Hamstring Flexibility and Pain in Male Athletes with Perceived Hamstring Tightness*

**INVESTIGATORS:**

Kristen Barger, ATC, LAT  
Jennifer Volberding, PhD., ATC

**PURPOSE:**

This research study will examine the effects of The Graston Technique compared to Myofascial Decompression on hamstring flexibility, perceived function and pain, and strength.

**PROCEDURES**

In this study you will participate in one treatment session. You will be introduced to the soft-tissue mobilization techniques that will be used in this study (Graston technique and Myofascial Decompression). Briefly, the Graston Technique involves the use of stainless steel instruments applied to the leg in a stroking motion, similar to that of massage. Myofascial Decompression involves the use of plastic cups applied to the leg using a handheld suction pump and will remain suctioned for the duration of the treatment. Each treatment will last 4 minutes in length. You will then be introduced to the hamstring stretch and the manual muscle test used in this study, which involves a light, passive stretch of your affected hamstring using a digital measurement tool (goniometer) and a hamstring strength test using a device to measure your strength (handheld dynamometer). After obtaining consent, you will be randomly placed into either the Graston group or the Myofascial Decompression group. Each subject will fill out a Perception of Functional Ability Questionnaire (PFAQ) prior to treatment. Hamstring flexibility and strength measurements will then be taken, after which you will receive the 4-minute treatment. Immediately following the treatment, hamstring flexibility and strength will be repeated, and you will be asked to fill out the Perception of Functional Ability Questionnaire (PFAQ) as well as the Global Rating of Change questionnaire (GROC).

**RISKS OF PARTICIPATION:**

You may experience mild discomfort and reddening of the skin during the treatment, as well as the potential for a small bruise following the treatment. You will be instructed to verbally indicate your comfort level at all times. If you feel discomfort at any time during the treatment, let the researcher know right away. Lighter pressure will be applied at that time, and you are welcome to withdraw from the treatment session at any time. While redness and bruising is common, it is only temporary and should go away shortly. Applying an ice bag after treatment may help prevent bruising and will be provided to you following the treatment. Any medical treatment that you feel you might need as a result of the effects from participating in this study is your sole responsibility.

Okla. State Univ.
IRB
Approved <u>4/22/10</u>
Expires <u>4/21/11</u>
IRB # <u>ED10-74</u>

**COMPENSATION:**

Participation in this research study is strictly voluntary and there will be not be any compensation offered to participants.

**BENEFITS OF PARTICIPATION:**

This study will provide useful evidence to the researchers about the effects of the Graston Technique and Myofascial Decompression on hamstring flexibility.

**CONFIDENTIALITY:**

Each subject will be assigned a number as they complete their informed consent form which will serve as the only identifier for that subject to insure privacy. The names linking to their numbers on their informed consent form as well as all data collected, will be stored in a locked file cabinet in the PI's office, which only the PI will have access to. Data will include subjects name, age and all measurements collected from the test protocols. Data will be reported as a group and will not be linked to participants.

**CONTACTS :**

You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study:

Kristen Barger, ATC, LAT  
Gallagher-Iba Arena  
Department of Athletics – Oklahoma State University  
(630) 965-5268  
[Kristen.barger@okstate.edu](mailto:Kristen.barger@okstate.edu)

Jennifer L. Volberding, PhD, ATC, LAT  
Oklahoma State University – Center for Health Sciences  
1111 West 17<sup>th</sup> St.  
Tulsa, OK 74107  
918-561-8255  
[Jennifer.volberding@okstate.edu](mailto:Jennifer.volberding@okstate.edu)

If you have questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078, 405-744-3377 or [irb@okstate.edu](mailto:irb@okstate.edu)

**PARTICIPANT RIGHTS:**

I understand that my participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time, without penalty.

**CONSENT DOCUMENTATION:**

I have been fully informed about the procedures listed for this study. I am aware of what I will be asked to do and of the benefits of my participation. I also understand the following statements:





- I affirm that I am 18 years of age or older
- I understand that my participation in this study is completely voluntary
- I understand that even though the risks are minimal, the administration of the Graston Technique and Myofascial Decompression may be uncomfortable throughout the treatment session, and may leave soreness and/or bruising afterward
- I have no current conditions that would be a contraindication to receiving treatment

I have read and fully understand this consent form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my participation in this study.

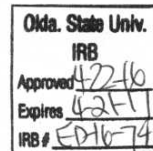
\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Date

I certify that I have personally explained this document before requesting that the participant sign it.

\_\_\_\_\_  
Signature of Researcher

\_\_\_\_\_  
Date



**COACHES CONSENT FORM  
OKLAHOMA STATE UNIVERSITY**

**PROJECT TITLE:**

*Compressive Versus Decompressive Soft Tissue Mobilization on Hamstring Flexibility and Pain in Male Athletes with Perceived Hamstring Tightness*

**INVESTIGATORS:**

Kristen Barger, ATC, LAT  
Jennifer Volberding, PhD, ATC

**PURPOSE:**

This research study will examine the effects of The Graston Technique compared to Myofascial Decompression on hamstring flexibility, perceived function and pain, and strength.

**PROCEDURES**

In this study the athlete will participate in one treatment session. They will be introduced to the soft-tissue mobilization techniques that will be used in this study (Graston technique and Myofascial Decompression). Briefly, the Graston Technique involves the use of stainless steel instruments applied to the leg in a stroking motion, similar to that of massage. Myofascial Decompression involves the use of plastic cups applied to the leg using a handheld suction pump and will remain suctioned for the duration of the treatment. Each treatment will last 4 minutes in length. The athlete will then be introduced to the hamstring stretch and the manual muscle test used in this study, which involves a light, passive stretch of the affected hamstring using a digital measurement tool (goniometer) and a hamstring strength test using a device to measure strength (handheld dynamometer). After obtaining consent, subjects will be randomly placed into either the Graston group or the Myofascial Decompression group. Each subject will fill out a Perception of Functional Ability Questionnaire (PFAQ) prior to treatment. Hamstring flexibility and strength measurements will then be taken, after which they will receive the 4-minute treatment. Immediately following the treatment, hamstring flexibility and strength will be repeated, and subjects will be asked to fill out the Perception of Functional Ability Questionnaire (PFAQ) as well as the Global Rating of Change questionnaire (GROC).

**RISKS OF PARTICIPATION:**

Athletes may experience mild discomfort and reddening of the skin during the treatment, as well as the potential for a small bruise following the treatment. They will be instructed to verbally indicate their comfort level at all times. They are welcome to withdraw from the treatment session at any time. While redness and bruising is common, it is only temporary and should go away shortly. Applying an ice bag after treatment may help prevent bruising and will be provided to subjects following the treatment.

**COMPENSATION:**

Participation in this research study is strictly voluntary and there will not be any compensation offered to participants.

Oklahoma State Univ.
IRB
Approved 4/22/16
Expires 4/21/17
IRB # ED1674

**BENEFITS OF PARTICIPATION:**

This study will provide useful evidence to the researchers about the effects of the Graston Technique and Myofascial Decompression on hamstring flexibility.

**CONFIDENTIALITY:**

Each subject will be assigned a number as they complete their informed consent form which will serve as the only identifier for that subject to insure privacy. The names linking to their numbers on their informed consent form as well as all data collected, will be stored in a locked file cabinet in the PI's office, which only the PI will have access to. Data will include subjects name, age and all measurements collected from the test protocols. Data will be reported as a group and will not be linked to participants.

**CONTACTS :**

You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study:

Kristen Barger, ATC, LAT  
Gallagher-Iba Arena  
Department of Athletics – Oklahoma State University  
(630) 965-5268  
[Kristen.barger@okstate.edu](mailto:Kristen.barger@okstate.edu)

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I, \_\_\_\_\_ give Kristen Barger my permission to utilize the male athlete on the Oklahoma State University Cheer team as subjects for this study.

\_\_\_\_\_  
Signature of Coach

\_\_\_\_\_  
Date



I certify that I have personally explained this document before requesting that the coach sign it.

\_\_\_\_\_  
Signature of Researcher

\_\_\_\_\_  
Date

Okla. State Univ.	
IRB	
Approved	4/22/16
Expires	4/21/17
IRB #	ED-16-74

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Subject #: \_\_\_\_\_

### Perceptions of Functional Ability Questionnaire

In the following questionnaire you will be asked to rate your overall physical health, muscular flexibility, and muscular strength. You will also be asked to rate these relative to a affected body part. You will also be asked to rate your pain and ability to perform sport specific activities or activities of daily living.

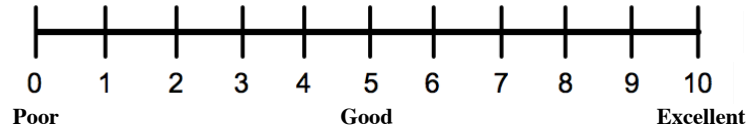
Please indicate if this is the first or second time you have completed this survey

First (Pre)

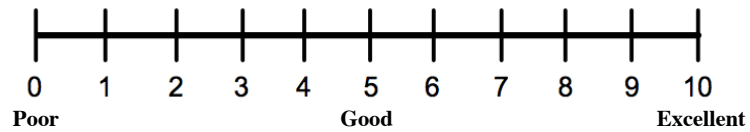
Second (Post)

Please rate the following by circling the most appropriate number

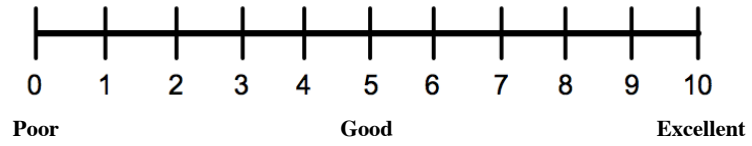
1. At this moment how would you rate your overall physical health?



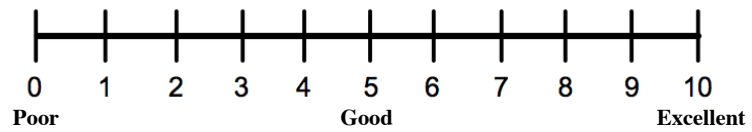
2. How would you rate your overall muscular flexibility?



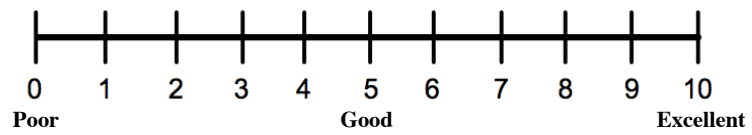
3. How would you rate the muscular flexibility of the affected hamstring?



4. How would you rate your overall muscular strength?



5. How would you rate the muscular strength of the affected hamstring?



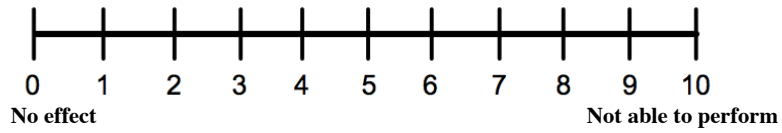
6. How would you rate your pain in the affected hamstring?



7. How does the affected hamstring affect your sport/skill performance?



8. How does the affected hamstring affect your activities of daily living?



Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Subject #: \_\_\_\_\_

**GLOBAL RATING OF CHANGE**

Please rate the overall condition of your hamstring from the start of treatment to now:

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- |  |   |   |
|--|---|---|
| <input type="checkbox"/> A very great deal worse (-7)            | <input type="checkbox"/> About the same (0) | <input type="checkbox"/> A very great deal better (+7)            |
| <input type="checkbox"/> A great deal worse (-6)                 |   | <input type="checkbox"/> A great deal better (+6)                 |
| <input type="checkbox"/> Quite a bit worse (-5)                  |   | <input type="checkbox"/> Quite a bit better (+5)                  |
| <input type="checkbox"/> Moderately worse (-4)                   |   | <input type="checkbox"/> Moderately better (+4)                   |
| <input type="checkbox"/> Somewhat worse (-3)                     |   | <input type="checkbox"/> Somewhat better (+3)                     |
| <input type="checkbox"/> A little bit worse (-2)                 |   | <input type="checkbox"/> A little bit better (+2)                 |
| <input type="checkbox"/> A tiny bit worse (almost the same) (+1) |   | <input type="checkbox"/> A tiny bit better (almost the same) (-1) |



## VITA

KRISTEN M BARGER

Candidate for the Degree of

Master of Science

Thesis: COMPRESSIVE VERSUS DECOMPRESSIVE SOFT TISSUE THERAPY ON  
ACUTE HAMSTRING FLEXIBILITY AND PAIN IN MALE ATHLETES WITH  
PERCIEVED HAMSTRING TIGHTNESS

Major Field: Athletic Training

Education:

Completed the requirements for the Master of Science in Athletic Training at  
Oklahoma State University, Stillwater, Oklahoma in July, 2016

Completed the requirements for the Bachelor of Science in Athletic Training at  
University of Iowa, Iowa City, Iowa in May 2013