THE EFFECTS OF GRASTON TECHNIQUE® TREATMENT TIMES ON SPRINT PERFORMANCE IN COLLEGIATE WRESTLERS

A Thesis
Submitted to the Graduate Faculty
of the
North Dakota State University
of Agriculture and Applied Science

By

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In Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE

Major Program:
Advanced Athletic Training

April 2016

Fargo, North Dakota

North Dakota State University

Graduate School

Title

The Effects of Graston Technique® Treatment Times on Sprint Performance in College Wrestlers

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Objective: The aim of this study was to provide insight on how treatment times of 5-minutes and 8-minutes of GT® affect a 30-yard sprint performance. **Interventions**: 15 healthy college-aged male wrestlers received two treatments (5-minute and 8-minute) of Graston Technique® separated by approximately 48 hours. After a 5-minute bike warm-up, participants received GT® treatment on both quadriceps muscles. Participants completed a 10-minute active rest followed by a 30-second standing quadriceps stretch, 30 straight leg raises and quadriceps stretch again. Participants then sprinted 3 30-yard sprint tests. **Results**: Significance was found between the baseline (4.63 ± 0.18 seconds) and 5-minute GT® treatment (4.53 ± 0.18 seconds) sprint times; $t(14)=3.34$, $p = 0.005$. No significance was found between the baseline and the 8-minute GT® treatment (4.57 ± 0.19 seconds) sprint times; $t(14)=1.49$, $p = 0.159$. **Conclusions**: Shorter GT® treatments provide a warm-up for the tissue allowing for better tissue function.

ACKNOWLEDGEMENTS

I would like to thank the thesis committee members, Dr. Kara Gange, Dr. Kimberly Overton, and Dr. Nicole German, for their hard work and beneficial suggestions during the development of this research study. I appreciate all the time they have given to this project. I would also like to thank my parents who have supported and encouraged me throughout the years.

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CHAPTER 1. INTRODUCTION

Graston Technique® (GT®) is a method in which stainless steel instruments are used by certified GT® clinicians to aid in the detection and treatment of soft tissue dysfunctions. Graston Technique® is based off the principles of deep transverse friction massage made popular by James Cyriax, M.D. in 1994 (Carey et al., 2010). These instruments have multiple contoured edges and shapes designed to conform to different body surfaces (Carey et al., 2010). The contoured edges of the instruments make it easier on the clinicians to detect abnormalities within the target tissue. The goal of GT® is to enhance musculoskeletal function by improving tissue mobilization (Carey et al., 2010; Stow, 2011).

Clinicians use GT® to treat multiple soft tissue conditions such as tendinosis pathologies, scar tissue restrictions, and sprains/strains. Each of the six stainless steel instruments is specifically designed to detect and eliminate abnormal soft tissue fibrosis. According to Miners & Bougie (2011), GT® is theorized to reduce abnormal fibrous adhesions, increase scar tissue mobility, and facilitate healing within the soft tissue. Graston Technique® stimulates the local inflammatory response and initiates the healing process to repair soft tissue. This occurs by producing micro-trauma that will induce the inflammatory response to assist with realignment of damaged tissue fibers (Stow, 2011; Miners & Bougie, 2011; Carey et al., 2010). In addition, Stow (2011) reports that GT® improves cellularity and collagen fiber alignment, which then helps the active population return to activity in a timely fashion.

During the GT® certification course, it is taught that treatment times can range from 5-15 minutes (Carey et al., 2010). However, research is limited on the treatment times of

GT®. In most of the available GT® research, specific details of the treatment times are not included. Two studies that did include treatment times varied from 40 seconds to 8 minutes (Laudner et al., 2014; Schaefer & Sandrey, 2012). The variation within treatment times could affect the therapeutic benefits of the treatment. It is difficult to fully understand GT® effects when there is limited information on treatment parameters.

Treatment times not only could affect performance, but possible therapeutic benefits as well. However, there are no specific guidelines about GT® use prior to physical activity, like practice and competition. Graston Technique® causes localized trauma to the treatment area; therefore it could have a negative effect on performance. Studies using Swedish massages where treatment times ranged from 9-30 minutes either significantly decreased or had no effect on time for 30-m sprints (Arabaci, 2008; Fletcher, 2010; Wiktorsson – Moller et al., 1983; Goodwin et al., 2007; Arazi et al., 2012). However, no published research has examined the effect of GT® treatment on an athlete's sprint performance or if the length of a treatment affects performance. Examining the effect of the GT® treatment times on sprint performance is important to provide clinicians the proper treatment protocol. Clinicians will also have a better understanding of appropriate treatment length while taking in consideration of practice or competition schedules.

Statement of Problem

Graston Technique® treatments have shown positive effects on a variety of injuries. However, when GT® is used prior to competition and practice, the protocol becomes unclear. The problem is it is unknown if the length of the treatment decreases performance when a GT® treatment is performed prior to practice or competition.

Purpose of Study

The purpose of this study was to determine the effect of GT® treatment times on sprint performance. By researching treatment times, clinicians and certification course instructors will be able to provide better guidance for patients and students, respectively. Clinicians will also have a better understanding of how GT® treatment affects performance.

Research Questions

Does a treatment time of 5 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Does a treatment time of 8 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers?

Definition of Terms

Graston Technique® – specific brand of instrument assisted soft tissue mobilization (Carey et al., 2010; Stow, 2011)

Deep Transverse Friction Massage – form of massage that applies friction to the muscle perpendicular to the length of muscle fibers (Starkey, Brown & Ryan, 2010)

Fibrosis – thickening and scarring of connective tissue (Starkey et al., 2010)

Instrument assisted soft tissue mobilization – therapeutic technique that involves soft tissue mobilization (Baker et al., 2013)

Sprint Performance - the act of running over a short distance with an all-out burst of speed (Kell, 1997)

Importance of Study

There are no current studies that have been performed on treatment times of GT® and its effect on sprint performance. By researching the length of GT® treatment time, an appropriate treatment protocol can be selected by clinicians based on a patient's injury as well as practice/competition schedule.

Limitations

1. Only uninjured subjects were used.
2. The subjects were asked to maintain normal daily living activities; however, no direct measurements were taken.
3. The subjects were to report perceived maximal effort on pre- and post-test sprint performance but no direct measurements were taken.
4. The researcher attempted to maintain a constant medium pressure during GT® treatment, however there may have been variations with pressure since no measurement of the applied pressure were taken.
5. Goniometer measurements of knee extension (-15°-0°) and flexion (120°-140°) were taken to ensure that participants fell between normal limits.

Delimitations

1. The subjects were current wrestlers enrolled at a college between ages of 18-23.
2. The subjects did not have a quadriceps injury on the dominant quadriceps in the past 6 months.
3. The subjects did not have any vascular/contraindicated conditions.

CHAPTER 2. LITERATURE REVIEW

The purpose of this study was to determine the effect of Graston Technique® (GT®) treatment times on sprint performance. By researching treatment times, clinicians and certification course instructors are able to provide better guidance for patients and students, respectively. Clinicians will also have a better understanding of how GT® treatment affects performance. The study was guided around the following research questions: Does a treatment time of 5 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Does a treatment time of 8 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Examining the effect of the GT® treatment times on sprint performance is important to provide clinicians the proper treatment protocol. This literature review was organized into the following areas: massage, instrument assisted soft tissue immobilization, Graston Technique®, sprint performance, and summary.

Massage

Healthcare practitioners have utilized massage in the treatment of illness and injury for thousands of years. There are Chinese writings that date back to 2500 BC that describe the use of this modality for a variety of medical purposes (Brummitt, 2008). Fletcher (2010) defined massage as a mechanical stimulation of tissues by means of rhythmically applied pressure and stretching. The rhythmic stimulation includes gliding, compressing, stretching, percussing and vibrating of the tissues to produce specific responses (Prentice, 2014). However, in the athletic training setting it is more common to focus on a specific area rather than complete a full body massage due to time constraints. The patient will receive the benefits of the massage even if it is applied to a localized area. Goodwin et al.

(2007) proposed there are multiple therapeutic benefits of massage such as: physiological, biomechanical and neurological. These responses can have both a calming as well as a stimulating effect, which in turn may potentially benefit performance (Goodwin et al., 2007). Massage has been considered an integral part of sport preparation, conditioning, and recovery (Cadwell, 2001).

Therapeutic Benefits of Massage

There are many theories of the physiological effects of massage and how it affects performance. However, it still remains anecdotal as to the physiological effects and mechanism associated with massage despite its common use throughout sporting circles (Goodwin et al., 2007; Wiktorsson-Moller et al., 1983; Hemmings, 2001). Claims have been made that massage improves extensibility of connective tissue, relieves muscle tension and trigger points, and increases blood volume while promoting the acceleration of venous blood flow (Fletcher, 2010; Prentice, 2014). Other physiological responses of massage may include a reduction in stress hormone levels, an increase in parasympathetic activity and an increase in skin and muscle temperature (Goodwin et al., 2007). Arabaci (2008) states that massage can also lengthen skeletal muscle, which can have a negative effect on performance by the decline in the number of actin and myosin cross-bridge connections. This has been hypothesized with no evidence that this loss in connections actually occurs to cause a decrease in performance. Performance could also be impaired by musculo-tendinous compliance and dynamic stiffness (Goodwin et al., 2007).

In addition to the physiological effects, massage can also affect the nervous system. There are conflicting ideas based off studies by Goodwin (2007) and Fletcher (2010) of how neurological excitability from massage affects performance. Goodwin (2007) and

Fletcher (2010) state that an increase or decrease in neurological excitability by massage, depending on type of massage technique used, may have an effect on athletic performance. Fletcher (2010) suggests that the stimulation of the nervous system by massage may increase sprint performance, stride length and frequency, along with reducing muscle stiffness. Fletcher (2010) analyzed sprint performance kinematically by measuring step length along with step rate, and angular velocity. After conducting the study, it was found that massage could lead to more compliant tissue, which can decrease step length (Fletcher, 2010). Goodwin et al. (2007) suggests that massage may decrease neuromuscular excitability along with pain and muscle spasm therefore, may influence the muscle's ability to generate force, which could affect performance. However, the physiological responses remain unclear due to inconsistent methods (Goodwin et al., 2007). Goodwin et al. (2007) did not mention any findings on neuromuscular excitability after the research was performed.

Techniques of Massage

A wide variety of massage treatment techniques are available for clinicians to use. Clinicians tend to use a superficial, stimulating type of massage before competition (Fletcher, 2010). The massage techniques that were used in the research were the Swedish massage (Goodwin et al., 2007; Arabaci, 2008) and the Swiss massage (Arazi, Asadi & Hosini, 2012). These techniques included a combination of different strokes: effleurage, friction, pettrissge, vibration and tapotement (Prentice, 2014; Fletcher, 2010; Arazi et al., 2012, Arabaci, 2008). Effleurage is a stroking method that uses light and deep pressure for sedative or venous and lymphatic drainage, respectively (Prentice, 2014). Friction massage creates heat to use on unyielding tissues such as scars, adhesions, muscle spasms and fascia

(Prentice, 2014). Petrissage is a kneading technique that is ideal for loose and heavy tissue areas such as the latissimus dorsi (Prentice, 2014). The next technique that could be utilized is vibration. This consists of rapid movement that produces a quivering effect to help relax and soothe muscle (Prentice, 2014). The final technique is tapotement, which include cupping, hacking and/or pinching movements (Prentice, 2014). According to Fletcher (2010), a fast rate effleurage and petrissage should be used pre-competition to achieve an acute tissue response. Clinicians learn these techniques but there is variability on how the clinicians choose to apply each stroke. It is also difficult to monitor the rate and pressure used since every clinician's rate and pressure are subjective. This makes it difficult to replicate in research.

There are more than 100 variations of massage therapies that are commonly used (Eisenberg, Kessler, Foster, Norlock, Calkins & Delbanco, 1993). This makes it difficult to recreate protocols. A Swiss massage technique was the main massage technique used in the studies, which included effleurage, friction, petrissage, vibration and tapotment manipulations (Arazi et al., 2012; Arabaci, 2008; Goodwin et al., 2007). Fletcher (2010) used some of the same techniques but for a more stimulating, rapid massage. These techniques were applied on right and left lower limb muscles: quadriceps, hamstrings, and gastrocnemius (Fletcher, 2010; Arazi et al., 2012; Arabaci, 2008; Goodwin et al., 2007). The studies used similar massage techniques, but varied among the treatment times. Two studies had treatment lengths of 15 minutes for each limb (Arazi et al., 2012; Arabaci, 2008), whereas Goodwin et al. (2007) had a total treatment time of 15 minutes for both limbs. Fletcher (2010) had a shorter treatment time of 9 minutes for both limbs. There is some variability between the studies on how the massage treatments were administered.

Deep Transverse Friction Massage

Deep transverse friction massage (DTFM) was popularized by James Cyriax, M.D. as a manual treatment technique used for tendon disorders (Joseph, Taft, Moskwa & Denegar, 2012). It is a technique that utilizes forces applied perpendicular to the fibers which separates each fiber and mechanically assists in the alignment of newly formed collagen during healing (Yoon, Yu, Lee, Kwak & Kim, 2011). This technique sets the premise for instrument assisted soft tissue mobilizations techniques such as GT®.

Tendinopathy disorders are commonly treated with deep transverse friction massage. When a patient has a tendinopathy condition, the tissues have an increase of adhesions. These adhesions are made up of disorganized fibers, which can lead to an increase in disorganized type III collagen fibers (Joseph et al., 2012). One way to realign the disorganized fibers is to create a traumatic hyperemia. This causes vasodilation and increases blood flow to the treatment site (Joseph et al, 2012; Pinkelman & Schilling, 2012; Hammond, 2013). In theory, increasing the blood flow will facilitate the removal of chemical irritants (Joseph et al., 2012; Hammond, 2013). Not only will deep friction massage realign tissue but it will also reduce adhesions (Joseph et al., 2012; Pinkelman & Schilling, 2012). With a reduction in adhesions and realignment of tissues, mobility of tissue will increase as well as mechanoreceptor stimulation (Joseph et al., 2012; Pinkelman & Schilling, 2012). There are four major types of mechanoreceptors that provide information to the central nervous system about touch, pressure, vibration and cutaneous tension (Houglum, 2010). These receptors are located in the skin, muscles, tendons and joints (Houglum, 2010). Deep transverse friction massage may provide the mechanoreceptor stimulation needed for tissue repair and healing (Joseph et al., 2012).

Deep Transverse Friction Massage Protocol

There are a variety of treatment protocols among clinicians used when performing deep transverse friction massage (DTFM). Treatment sessions for DTFM can range from 5 minutes to 20 minutes (Nomikos, Nomikos & Kores, 2010). Along with wide ranges in times, there is inconsistency with the number of treatments needed. Vasseljen (1992) applied DTFM combined with ultrasound to the extensor carpi radialis brevis (ECRB) for 10 minutes, 3 times a week for 8 total treatments. They found that this group of patients had significantly larger decrease in pain than compared to the low-level laser group. Two studies completed 12 total treatments (3 times a week for 4 weeks) of 10 minutes each on the ECRB (Nagrale, Herd, Ganvir & Ramteke, 2009; Stasinopoulos & Stasinopoulos, 2006). Similarly, Nagrale et al. (2009) found that deep friction massage improved pain and function better than phonophoresis, which is ultrasound with medication mixed within ultrasound gel. However, Stasinopoulos and Stasinopoulos (2006) found that a supervised exercise program had greater improvements in function and pain than deep friction massage; although deep friction massage still improved function and pain. Although the treatment time was the same, the duration of the treatments varied. In Pinkelman & Schilling's (2012) study, DTFM was applied for 15 minutes to the extensor hallucis longus for tendinosis for a total of 8 treatments. However, it took the patient about a year and a half to be able to return to full participation in a competitive sport (Pinkelman & Schilling, 2012). The varying treatment times can cause different physiological effects, which can affect performance.

Instrument Assisted Soft Tissue Immobilization

Instrument assisted soft tissue immobilization (IASTM) is based off the principles of deep transverse friction massage which was made popular by James Cyriax, M.D. (Carey et al., 2010). Carey et al. (2010) defines IASTM as the use of instruments to achieve the effects and benefits of soft tissue mobilization. The use of instruments allows for greater depth of mechanical force transmission than the force produced by clinicians' hands (Baker, Nasypany, Seegmiller, Baker, 2013). The instruments create vibrations that allow the clinician to detect altered tissue (Baker et al., 2013). IASTM is a beneficial aide to stretching and exercise when treating a variety of musculoskeletal conditions (Faltus, Boggess & Bruzga, 2012).

Physiological Effects of IASTM

There are many benefits that IASTM offers when treating musculoskeletal conditions especially in the healing process. Schaefer & Sandrey (2012) state that IASTM produces a more controlled amount of microtrauma into an area of disarray. Since IASTM creates some microtrauma, it promotes the activation of the alignment of fibroblasts and myofibroblasts in the direction of stress (Carey et al., 2010; Baker et al., 2013). This movement of the tissues from the instruments maintains a balance between collagen synthesis and degradation (Carey et al., 2010). When IASTM is applied to ligaments, the microtrauma increases fibroblast production and promotes the conversion of type III to type I collagen (Schaefer & Sandrey, 2012). Type III collagen is produced in the early stages of healing. It is thinly laid down in a haphazard manner with no organized arrangement, which leaves it weak (Houglum, 2010). Type I collagen replaces type III collagen in the later stages of healing. This collagen produces more cross-links, which makes it stronger and more durable (Houglum, 2010).

Graston Technique®

Graston Technique® (GT®) is an augmented soft tissue mobilization technique that uses specifically designed stainless steel instruments with beveled edges to augment a clinician's ability to perform soft tissue mobilization (Howitt, Wong & Zabukovec, 2006; Miners & Bougie, 2011). GT® is an IASTM technique that incorporates the use of six specifically designed stainless steel instruments to aid the clinician in the detection and treatment of soft tissue dysfunction (Appendix A) (Carey et al., 2010; Laudner et al., 2014; Stow, 2011). GT® is combined with rehabilitative exercises to improve musculoskeletal function (Carey et al., 2010). In the GT® certification course, there are five components of the treatment: soft tissue warm-up, GT® treatment, stretching, strengthening and cryotherapy. In order to achieve the best results from a treatment, it is recommended that the five components should be completed (Carey et al., 2010).

The theory of GT® is based upon the rationale for deep transverse friction massage and cross fiber massage as proposed by Dr. Cyriax (Laudner, Compton, McLoda & Walters, 2014; Miners & Bougie, 2011). Miners & Bougie (2011) theorize that deep transverse friction massage reduces abnormal post injury fibrous adhesions, makes scar tissue more mobile in sub-acute and chronic injury, and facilitates healing in chronically degenerated soft tissues by inducing controlled micro-trauma and facilitating the normal alignment of soft tissue fibers. Even though the theory of GT® was based off the principles of Dr. Cyriax, it was an injured competitive water skier who created the instruments. He had injured his knee, but was not responding to physical therapy. So he took the idea of a deep friction massage and thought of a way to make it easier to apply. With his background as a machinist, he experimented with various shapes of tools to mimic the manual techniques (Stow, 2011). This is how GT® came about and is now used by more than 20,000 clinicians worldwide (Graston Technique Website®, 2015).

Instrumentation

The GT® instruments act like tuning forks which allow clinicians to feel abnormalities within the tissue. The clinician is able to isolate adhesions and restrictions and treat them very precisely (Graston Technique Website®, 2015). Carey et al. (2010) also states that the instruments detect and amplify the feel of soft tissue restrictions to the hands of the clinician. The design of the instruments allow for ease of treatment, minimal stress to the clinician's hands and maximum tissue penetration (Graston Technique Website®, 2015). The instruments have either a convex or a concave shape to them (Stow, 2011; Carey et al., 2010). The concave shape allows for the pressure applied to be dispersed over a large area (Stow, 2011). However, the convex shape concentrates the pressure over a smaller surface area (Stow, 2011). The instruments have either a single-beveled edge or a double-beveled edge (Stow, 2011; Carey et al., 2010). The single-beveled edge is used to obtain greater tissue penetration and separation of subcutaneous tissues (Stow, 2011). The double-beveled edge instrument limits depth of tissue penetration (Stow, 2011). The injury and the condition of the tissue will determine which instrument should be used.

There are six stainless steel instruments that clinicians can utilize (Appendix A). The GT 1 instrument has a single bevel, concave treatment edge with two convex knobs (Carey et al., 2010). This is used for large muscle groups where the clinician holds the instrument with two hands (Carey et al., 2010). The GT 2 instrument has two convex knobs where one has a single bevel and the other knob has a double bevel (Carey et al., 2010). Clinicians can use one or two hands when holding this instrument and it is used on smaller muscle groups (Carey et al., 2010). Carey et al. (2010) describes the GT 3 instrument as having a single bevel with a convex treatment edge. It is used for small localization lesion to treat a specific adhesion (Carey et al., 2010). The GT 4 instrument has a single bevel with smaller convex treatment edges at each end (Carey et al., 2010). It is used to scan the muscle for problem areas (Carey et al., 2010). This is typically the first instrument used for treatments. The GT 5 instrument has a single bevel with a concave treatment edge (Carey et al., 2010). It was originally developed for the intercostal regions and is used to scan the tissue and for more aggressive treatments (Carey et al., 2010). The last instrument, GT 6, is similar to GT 2 in shape and function. It has two convex knobs in which one has a single bevel and the other has a double bevel (Carey et al., 2010). This instrument also has a treatment tip and a hook to assist with localized or smaller treatment areas (Carey et al., 2010).

Along with different shapes and sizes of the instruments, clinicians can adjust the direction of application throughout the treatment. During the certification course, it is taught that GT® should be applied in all directions. When instruments are utilized in a multidirectional pattern, it allows the clinician to detect irregularities in the soft tissue texture through the instruments (Carey et al., 2010; Howitt et al., 2006). Adhesions may be felt when scanning in one direction but not the other direction. In the study completed by Laudner et al. (2014), treatment strokes were applied both parallel and perpendicular to the muscle fibers of the posterior axillary border of the scapula at a 45-degree angle to increase range of motion (Laudner et al., 2014). Laudner et al., (2014) based these treatment protocol off of GT® recommendations. This treatment of GT® improved posterior shoulder range of motion (Laudner et al., 2014). Clinicians can also alter the depth of penetration used during treatment by adjusting the angle of the instrument. The ideal instrument angle is 30-60 degrees in which increasing the instrument angle means deeper penetration (Carey et al., 2010; Howitt et al., 2006). Determining what angle to use depends on the condition being treated and what is found from scanning the tissue throughout the treatment.

Indications and Contraindications of Graston Technique®

For many therapeutic treatments there are indications and contraindications that should be considered when choosing an appropriate treatment. Indications are conditions that would benefit from a treatment while contraindications are conditions or situations when a treatment should not be performed. Graston Technique® can be utilized for many different conditions as well as for certain aspects of performance. One of the main indications for GT® include tendinosis pathologies like: rotator cuff tendinosis, tibialis posterior tendinosis, wrist tendinosis, and Achilles tendinosis (Stow, 2011; Carey et al., 2010; Laudner et al., 2014; Schaefer & Sandrey, 2012). Other indications include: epicondylosis, DeQuervain's syndrome, myofascial pain or restrictions, non-acute bursitis, IT-band syndrome, reduced range of motion due to scar tissue, Carpal tunnel syndrome, plantar fasciitis, post-surgical or traumatic scars, chronic or acute sprains/strains, and reflex sympathetic dystrophy (Stow, 2011; Carey et al., 2010; Laudner et al., 2014; Schaefer & Sandrey, 2012). Clinically GT® can be utilized for pre-practice, post-practice or post-competition recovery, or as a petrissage or milking of edema (Carey et al., 2010). There are also precautions to take into consideration before any treatment. These include: cancer, burn scars, kidney dysfunction, rheumatoid arthritis, pregnancy, anti-coagulant medications, varicose veins, acute inflammatory conditions, and inflammatory condition secondary to infection (Carey et al., 2010; Stow, 2011). The contraindications include: open wounds, unhealed fractures, thrombophlebitis, uncontrolled hypertension, patient intolerance or hypersensitivity, hematoma, osteomyelitis, myositis, ossificans, and hemophilia (Carey et al., 2010; Stow, 2011). The clinician should perform a thorough history and examination of a patient's condition in order to determine indications and contraindications.

Physiological Effects of Graston Technique®

According to Stow (2011), the goal of therapy is to provide an optimal environment for healing by modifying physiological responses to injury or enhancing components of normal musculoskeletal function. Graston Technique® attempts to recreate a fibroblastic proliferation, the normal inflammatory response (Carey et al., 2010; Laudner et al., 2014; Schaefer & Sandrey, 2012; Howitt et al., 2006). The inflammatory process restarts the healing process by enhancing the delivery of blood, nutrients, and fibroblasts to the area, thus facilitating collagen synthesis, deposition and maturation (Laudner et al., 2014; Miners & Bougie, 2011). Along with recreating an inflammatory response, GT® can reduce scar tissue and break down existing scar tissue in people with soft tissue restrictions (Laudner et al., 2014; Howitt et al., 2006; Miners & Bougie, 2011). Other physiological effects that GT® can assist with are: to release restrictions in the fascia, to breakdown collagen cross-linkages, to increase blood flow, and possibly to increase regenerative cellular activity (Stow, 2011; Laudner et al., 2014; Papa, 2012).

Treatment Process of Graston Technique®

A thorough examination of the patient's injury and their medical history is needed in order to understand if GT® is an appropriate modality to use. Stow (2011) and Carey et al. (2010) state that the etiology of the injury and type of pathology must be considered before deciding if GT® is appropriate. Once the clinician has decided that a GT® treatment is appropriate, there are five basic components of a GT® treatment that should be implanted. The five components are soft tissue warm-up, treatment, stretching, strengthening and cryotherapy. Stow (2011) recommends that cardiovascular exercise like: a stationary cycle, an upper body ergometer, an elliptical trainer or jogging should be used to warm up target tissue. If the patient is unable to complete a cardiovascular warm-up, ultrasound, diathermy or moist hot packs can be used as well (Stow, 2011). Miners & Bougie (2011) used an active and passive tissue heating treatment by having the participant use a stationary bike in combination with the application of a heat pack for five minutes. It was not mentioned why Miners & Bougie (2011) choose to do active and passive tissue heating. However, when the target tissue is warmed up, the GT® treatment will be more effective.

In the certification course, it was taught that treatment times should be between 5-15 minutes. However, the research is not consistent with this. Most studies included the number of GT® treatments performed but did not provide specific details about treatment time. A study performed by Faltus et al. (2012) used GT® on a quadriceps femoris muscle strain. They used GT® for five sessions over six weeks (Faltus et al., 2012). A case study with trigger thumb completed eight treatment sessions over a four-week period (Howitt et al., 2006). This varied from a chronic Achilles tendinopathy case study, in which there were two in-office GT® treatments for three weeks followed by one session every seven to ten days for an additional three session (Miners & Bougie, 2011). A lateral epicondylopathy case study completed GT® treatments twice a week for two weeks followed by once a week for the next six weeks for a total of ten treatment visits (Papa, 2012). These studies included the number of treatments but did not provide information on treatment times. It is difficult to use this information in clinical practice if treatment times are not included.

There were two studies that did include treatment times. The first study looked at GT® and shoulder range of motion. The total treatment time was 40 seconds for one treatment (Laudner et al., 2014). This single application of GT® produced an increase of range of motion to the posterior shoulder (Laudner et al., 2014). The other study looked at GT® and chronic ankle instability. The treatment for this study included a total time of eight minutes with range of motion exercises (Schaefer & Sandrey, 2012). Schaefer & Sandrey (2012) found improvement in dynamic postural control, range of motion, pain and disability from pretest to posttest. This was done twice a week for four weeks (Schaefer & Sandrey, 2012). It is difficult as a clinician to provide quality care to patients when there are inconsistencies in treatment parameters such as treatment duration.

Stretching and a strengthening program are recommended after the patient receives GT® (Carey et al., 2010). These programs will promote tissue lengthening along with collagen fiber realignment. This helps to prevent the released tissue from becoming restricted (Stow, 2011). The stretching component is used to improve range of motion where the most common type of stretch used is a static stretch. A static stretch occurs when a clinician places the patient’s limb in a maximal stretch for 15 to 30 seconds (Prentice, 2014). A strengthening component is used to restore the patient’s strength back to where it was prior to the initial injury (Carey et al., 2010). Faltus et al. (2012) utilized

GT® in conjunction with a typical stretching and strengthening program for a quadriceps muscle tear. The study had participants do active quadriceps stretches that included prone knee flexion and half-kneeling hip extension while the knee was on the ground (Faltus et al., 2012). Stretches were held for 30 seconds and performed 3 times (Faltus et al., 2012). Along with stretching, GT® training recommends that a strengthening program be implemented as well (Carey et al., 2010). Like stretching, a strengthening program will promote tissue lengthening and collagen fiber realignment to prevent the released tissue from becoming restricted again (Stow, 2011). Faltus et al. (2012) used an eccentrically home exercise program that consisted of 3 sets of 10 of leg extensions and leg press exercises. These exercises were performed 3 days per week (Faltus et al., 2012). When GT® is combined with stretching and strengthening programs, results of the treatment are greatly improved (Carey et al., 2010). However, it is unclear what the effects of a GT® treatment have on an athlete's performance.

Sprint Performance

Speed can be defined as the rapidity of movement (Baechle, 1994; Prentice, 2014). The best way to test speed is by sprint tests (Baechle, 1994; Prentice, 2014). Sprinting is the act of running over a short distance with an all-out burst of speed. Sprinting would be classified as an anaerobic sport because of the high level of force produced as well as the recruitment of the fast twitch muscle fibers (Kell, 1997). Fast twitch muscle fibers are used for more explosive movements, which is relevant in the sport of wrestling (Kell, 1997). Wrestling is a high intensity sport that needs the anaerobic capacity to sustain repeated explosive attacks or offensive techniques on the opponent (Kell, 1997).

In order to achieve greater explosive movement, muscular strength is key. The knee flexors and extensors play an important role the mechanics of sprinting (Bracic, Hadzi, Coh & Dervisevic, 2011). The muscles that make up the knee flexors include: rectus femoris, vastus medialis, vastus lateralis, and vastus intermedialis (Starkey, 2010). The knee extensors are active in the early stance, early and middle swing of running (Montgomery, Pink & Perry, 1994). The early stance begins at heel strike and goes until toe off (Montgomery et al., 1994). This is when the early swing phase begins and lasts until the contralateral heel hits the ground (Montgomery et al., 1994). Once the contralateral heel strikes the middle swing phase starts and goes until the ipsilateral hip and knee are extended. Throughout these phases, the knee extensors are active as well. The muscles involved in knee extension are: biceps femoris, semimembranosus and semitendinosus (Starkey, 2010). Sprinting requires these muscles to have the ability to rapidly produce force as well as to have good elastic properties (Bracic et al., 2011).

The goal of GT® is to return the tissue to normal function, which should allow the athlete to perform at their normal level (Stow, 2011). There is a lack of literature examining how GT® affects performance but there are studies on pre-competition massage. There are controversial claims that a pre-event massage treatment can either increase or decrease performance (Weerapong, Hume, & Kolt, 2005). The length or techniques used for the treatments could have an effect on the sprint component of the studies. The most common distance used for sprint tests among the literature was 30 meters (m) (Goodwin et al., 2007; Arazi et al., 2012; Arabaci, 2008). Participants were encouraged to sprint as fast as possible for all 30-m (Arazi et al., 2012; Arabaci, 2008). Intermediate phases 10, 20 and 30 m were assessed and times for these phases were recorded by hand-held chronometer to the 0.001 second (Arazi et al., 2012; Arabaci, 2008). Goodwin et al. (2007) had subjects complete a 10-minute warm-up after the massage treatment, which incorporated a 400-m jog followed by a series of sprint drills and then 3 30-m practice sprints. The subjects rested for 5 minutes after the warm-up and then completed a 30-m sprint (Goodwin et al., 2007). The differences among how the 30-m sprint tests were administered can also affect the outcome of the tests.

As mentioned earlier, there are differences in the literature on whether or not massage can increase or decrease performance (Weerapong et al., 2005). Fletcher (2010), found that there were significantly increased sprint times when a 9-minute rapid, stimulatory massage was performed compared to a traditional warm-up or a combination of traditional warm-up with pre-competition massage prior to sprint tests. Studies that utilized 15-minute Swiss massages also found that 30-m sprint times significantly increased (Arabaci, 2008; Arazi et al., 2012). However, a 15-minute rapid stimulatory massage prior to warm-up had no significant effect on a 30-m sprint performance (Goodwin et al., 2007). There is conflict between how massage affects performance. Furthermore, it is unclear on how a GT® treatment will affect performance due to limited research available.

Summary

Graston Technique® is based off the principles of deep friction massage, which was made popular by James Cyriax, M.D.to detect and aid in the treatment of soft tissue dysfunctions (Carey et al., 2010; Stow, 2011). The goal of GT® is to enhance musculoskeletal function by improving tissue mobilization (Carey et al., 2010; Stow, 2011). GT® stimulates the local inflammatory response and initiates the healing process to repair soft tissue. This occurs by producing micro-trauma that will induce the inflammatory response to assist with realignment of damage tissue fibers (Stow, 2011; Miners & Bougie, 2011; Carey et al., 2010).

There have been multiple studies performed on the physiological aspect of GT® but little information on the length of treatment. During the GT® certification course, it was taught that treatment times range from 5-15 minutes (Carey et al., 2010). In most of the available GT® research, specific details of the treatment time were not included. Two studies that did include treatment time varied from 40 seconds to 8 minutes (Laudner et al., 2014; Schaefer & Sandrey, 2012). Treatment times also vary when looking at massage (Fletcher, 2010; Arazi et al., 2012; Arabaci, 2008; Goodwin et al., 2007). It is difficult to fully understand GT® affects when there is a conflict in treatment parameters.

Massage creates similar physiological effects on the body that GT® produces. If massage can stimulate the nervous system or release trigger points, then muscle stiffness could be positively affected as well as stride length and stride frequency (Flechter, 2010). Baker et al. (2013) found functional benefits of IASTM that included an increase in stride length and stride frequency. The physiological effects massage, deep friction massage and GT® have on the body suggested that these treatments should increase performance. However, studies found that Swiss massages either significantly decrease time or have no effect on 30-m sprint times (Arabaci, 2008; Fletcher, 2010; Wiktorsson – Moller et al., 1983; Goodwin et al., 2007; Arazi et al., 2012). However, no published research has examined how GT® will affect sprint performance.

CHAPTER 3. METHODOLOGY AND PROCEDURES

The purpose of this study was to determine the effect of Graston Technique® (GT®) treatment times on sprint performance. By researching treatment times, clinicians and certification course instructors are able to provide better guidance for patients and students, respectively. Clinicians will also have a better understanding of how GT® treatment affects performance. The study was guided around the following research questions: Does a treatment time of 5 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Does a treatment time of 8 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Examining the effect of the GT® treatment times on sprint performance is important to provide clinicians the proper treatment protocol. This chapter focuses on the experimental design, study population, instrumentation for data collection, procedures, data collection, and analysis procedures conducted to complete the research study.

Experimental Design

The design of this study was a pre-test and post-test format. The independent variable was treatment time (5 minutes and 8 minutes) on the lead leg quadriceps. The treatment time of 5 minutes was used because it is the lowest time recommended in the GT® certification course. The treatment time of 8 minutes was chosen because in the clinical setting it is more realistic that an 8-minute treatment would be used than longer treatments based on personal experience and from talking to other clinicians. Schaefer & Sandrey (2012) performed an 8-minute treatment of GT® for subjects with chronic ankle instability and found improvements in dynamic postural control, range of motion and pain.

An 8-minute treatment is the minimum amount of time required in order for a therapist to bill for therapeutic interventions. The dependent variable was 30-yd sprint test times.

Population of Study

A sample of 15 healthy, male collegiate wrestlers was recruited from a local college for this study. Participants were recruited through email and word of mouth. Participants were excluded from participation if they have any injury to either quadriceps muscles in the previous 6 months as well as if they have any contraindications to GT®. The contraindications included: open wounds, unhealed fractures, thrombophlebitis, uncontrolled hypertension, patient intolerance or hypersensitivity, hematoma, osteomyelitis, myositis, ossificans, and hemophilia (Carey et al., 2010; Stow, 2011). Participants filled out a pre-test questionnaire (Appendix B) to determine if they qualified for this study. IRB approval was obtained prior to data collection. Participants signed a consent form prior to data collection.

Instrumentation

Three of the six GT® instruments were utilized: GT 1, GT 4, and GT 5 (TherapyCare Resources Inc., Indianapolis, IN). GT 1 was utilized because of the large muscle group (quadriceps muscles) that will be tested. GT 4 was used as the “scanner” in the clinical setting since it can detect abnormalities within the tissue. GT 5 has the concave edge that allows clinicians to be able to break up adhesions easier within a larger treatment area. GT 2, GT 3, and GT 6 instruments were used for spot treatments or smaller treatment areas. GT® Emollient (mineral oil, beeswax, Emollient R. Complex) (TherapyCare Resources Inc., Indianapolis, IN) was applied prior to treatment. A digital timer (General, New York, NY) was used to keep track of the time for GT® treatment, active rest, stretching and the rest period between sprint tests.

A Brower Tc-gate timer (Masion Athletics, Austin, TX) was used to time the 30-meter sprint. The timer was stationed at 30 yards and record the time when participants finish the sprint. The sprint test took place on an indoor track. During the pre-test day, the Lange Skinfold Caliper (Beta Technology, Santa Cruz, CA) was used to measure the percentage of body fat in the lead leg quadriceps muscle. The amount of adipose tissue a participant has an effect on the GT® treatment. These skinfold measurements provided researchers more insight as to how GT® affects body types with different amounts of adipose tissue as well as sprint performance. To measure knee flexion and extension, a standard plastic 360° goniometer (The Therapy Connection, Windham, NH) was used for pre-test measurements.

Procedures

Pre-test Day

Each participant was asked to read and sign the informed consent form prior to arriving to the athletic training room where the GT® treatment was administered. The informed consent form was emailed to participants the day before pre-test day. Once the participant has signed the informed consent, they completed a questionnaire. This questionnaire gathered demographic information (age, sex, height, weight, wrestling weight class, years of experience), exposure to Graston Technique®, a list of contraindications of GT®, lower extremity injury history and lead leg in wrestling.

Passive range of motion was assessed for knee extension and flexion bilaterally to rule out any internal derangement that may be present. Range of motion was only assessed prior to GT® treatment to ensure knee extension and flexion are within normal limits. The researcher assessed knee extension with the participant lying supine with a bolster under the ankle. Knee flexion was also assessed with the participant lying supine. The researcher bent the participant's knee to the end range. Then a goniometer measured knee range of motion with the greater trochanter, lateral joint line of knee, and lateral malleolus as reference landmarks. After range of motion was assessed, skin fold tests were taken on the lead leg quadriceps with the participant standing while their heel is on a 3" block. This relaxed the quadriceps muscles while the participant is in slight knee flexion. Three measurements were taken midway down the quadriceps and then averaged to get the body fat percentage.

The participant then warmed up on a stationary bike for 5 minutes. The participant were instructed to have little to no resistance (0-2) on the bike and to keep the revolutions per minute (rpm) at 55±5. There was a 10-minute waiting period to emulate the time between treatment and activity in a normal clinical setting. This included a combination of minimum walking around and sitting until the sprint test.

After the 10-minute waiting period, participants completed a strengthening and stretching component. The participants started with a 30 second quadriceps stretch followed by 1 set of 30 repetitions of straight leg raises and then end with another 30 second quadriceps stretch. This followed the recommended GT® protocol by having the participant stretch, perform a high repetition and low load exercise to fatigue and then re-stretch the target muscle. A straight leg raise was completed with the participant lying supine on a treatment table with both legs straight. The participant slowly lifted their lead leg six inches off the table and hold for 3 seconds before slowly lowering their leg to the table. Participants then completed a standing quadriceps stretch. They did this by standing on their non-lead leg. They flexed their knee of their lead leg and bring it behind them while holding their ankle. Participants tucked their pelvis in while pulling their shin towards the gluteus muscles while making sure the knee is pointing towards the ground. Participants jogged two laps around the 200-meter indoor track. After the warm-up lap, the participant went to the start line for the 30-yard sprint. The participant started from a 2-point stance, in which both feet are in a sprinting stance and arms are at a 90-degree angle off the ground. Participants were instructed to sprint as fast as they can for 30 yards. A timer was stationed at 30 yards and recorded the time. Participants completed three 30-yard sprint tests with 1 minute of active rest between sprints. The average of the tests were used as their baseline time. Ice was offered after the sprint tests. Participants were reminded to not change work out habits until after they have completed the study.

GT® Treatment Day.

Each participant was instructed to warm up on a stationary bike for 5 minutes at the beginning of the session. The participant was instructed to have little to no resistance (0-2) on the bike and to keep the revolutions per minute (rpm) at 50.

After the warm up, GT® Emollient (mineral oil, beeswax, Emollient R. Complex) was applied over the participant’s quadriceps muscle. The participant was supine with the knee extended and quadriceps relaxed. They received GT® over both quadriceps (rectus femoris (RF), vastus medialis (VM), vastus intermedius (VI), and vastus lateralis (VL)) for either 5 minutes or 8 minutes. Participants were randomly assigned to receive a 5-minute or an 8-minute treatment bilaterally for the first treatment day. They received the other treatment length for the second day. For example, participant 1 received an 8-minute treatment on day 1 and received a 5-minute treatment on day 2. There was at least 48 hours between treatment days. The principle investigator who administered the GT® treatment on each of the participants has completed a M1 – Basic Training course that was directed by a certified GT® instructor.

The GT® protocol was developed for this study based off the GT® course. The 5-minute treatment includes the first two minutes utilizing the GT 4 instrument and the last 3 minutes utilizing the GT 1 instrument. The participant's right quadriceps muscle received GT® treatment first followed by the left quadriceps muscle. The GT® administrator started scanning the proximal portion of the quadriceps, using instrument GT 4, in a downward direction over the quadriceps with the convex edge using the sweep stroke. The investigator worked back up the quadriceps, using the convex edge with the sweep stroke and finally, ended with a fanning stroke in a downward direction over the quadriceps for a total of 2 minutes. For minutes 3 and 4, GT 1 was used to complete the sweep stroke going up the quadriceps and down the quadriceps. The swivel stroke was used for the final minute down the quadriceps. The investigator used a moderate pressure applying the treatment to all participants.

The GT® protocol for the 8-minute treatment, which was developed based off the GT® course recommendations, included the first three minutes utilizing the GT 4 instrument, the next two minutes using the GT 5 instrument followed by the GT 1 instrument for the last three minutes. The GT® administrator started by scanning the proximal aspect of the quadriceps, using instrument GT 4, in a downward direction over the quadriceps with the convex edge using the sweep stroke. The investigator worked back up the quadriceps, using the convex edge with the sweep stroke and finally, ended with a fanning stroke in a downward direction over the quadriceps for a total of three minutes. The GT 5 instrument was used with the sweep stroke up and down the quadriceps for the next two minutes. For the last 3 minutes, GT 1 was used to complete the sweep stroke going up the quadriceps and down the quadriceps. Next, the swivel stroke was used for the final minute down the quadriceps. The investigator used a moderate pressure applying the treatment to all participants.

After GT® treatments were administered, the participant rested for ten minutes. This was to mimic a typical clinical situation. Patients tend to receive treatment and then have a break to finish putting equipment on before practice or competition. This 10-minute period included a combination of minimum walking around and sitting until the sprint test to mimic everyday practices.

After the 10-minutes wait period was over, participants completed a strengthening and stretching component. The participants started with a 30 second quadriceps stretch followed by 1 set of 30 repetitions of straight leg raises and then end with another 30 second quadriceps stretch. This followed the recommended GT® protocol by having the participant stretch, perform a high repetition and low load exercise to fatigue and then re-stretch the target muscle. A straight leg raise was completed with the participant lying supine on a treatment table with both legs straight. The participant slowly lifted their lead leg six inches off the table and hold for 3 seconds before slowly lowering their leg to the table. Participants then completed a standing quadriceps stretch. They did this by standing on their non-lead leg. They flexed their knee of their lead leg and brought it behind them while holding their ankle. Participants tucked their pelvis in while pulling their shin towards the gluteus muscles while making sure the knee is pointing towards the ground.

Participants then jogged two laps around the 200-meter indoor track. The participant started from a 2-point stance, in which both feet are in a sprinting stance and arms are at a 90-degree angle off the ground. Participants were encouraged to sprint as fast as they can for 30 yards. Time was recorded at 30 yards. Following the sprint test, the participants were offered an ice pack to fulfill the ice application portion of the GT® protocol. Participants were reminded to not change work out habits until after they have completed each treatment day.

Analysis Procedures

The mean pre and post sprint times for the control group, the 5-minute GT® treatment group, and the 8-minute GT® treatment group were analyzed with a paired samples t-test to assess differences between groups. Descriptive statistics were used to describe age, weight class, years of experience, height, weight, quadriceps adipose tissue thickness and knee extension and flexion. All statistical analysis were calculated by IBM SPSS Statistics version 21 (2013, IBM). P-value will be set as $P < 0.05$.

CHAPTER 4. MANUSCRIPT

Introduction

Graston Technique® (GT®) is a method in which six stainless steel instruments are used by certified GT® clinicians to aid in the detection and treatment of soft tissue dysfunctions. It is based off the principles of deep transverse friction massage made popular by James Cyriax, M.D. in 1994 (Carey-Loghmani, Schrader & Hammer, 2010). Clinicians use GT® to treat multiple soft tissue conditions such as tendinosis pathologies, sprains/strains and scar tissue restrictions.

The goal of GT® is to enhance musculoskeletal function by improving tissue mobilization (Carey et al., 2010; Stow, 2011). According to Miners & Bougie (2011), GT® is theorized to reduce abnormal fibrous adhesions, increase scar tissue mobility, and facilitate healing within the soft tissue. Graston Technique® stimulates the local inflammatory response and initiates the healing process to repair soft tissue. This occurs by producing micro-trauma that induces the inflammatory response to assist with realignment of damaged tissue fibers (Stow, 2011; Miners & Bougie, 2011; Carey et al., 2010). Stow (2011) reports that GT® improves cellularity and collagen fiber alignment, which then help the active population return to activity in a timely fashion.

Graston Technique® has been shown to improve chronic and acute injuries as well as increase range of motion (Laudner et al., 2014; Schaefer & Sandrey, 2012). However, research is limited on the treatment times of GT®. The GT® course recommended that treatments should fall between 5-15 minutes, however, the manual states no more than 8-10 minutes (Carey et al., 2010). The variation within treatment times could affect the therapeutic benefits of the treatment. It is difficult to fully understand GT® effects when there is limited information on treatment parameters.

Along with limited information about treatment parameters, there are no specific guidelines about GT® use prior to physical activity, including practice and competition. Graston Technique® causes localized trauma to the treatment area; therefore it could have a negative effect on performance. In the literature, Swedish massages had either an adverse effect or no effect on 30-m sprint times when treatment times ranged from 9-30 minutes (Arabaci, 2008; Fletcher, 2010; Wiktorsson – Moller et al., 1983; Goodwin et al., 2007; Arazi et al., 2012). However, no published research has examined the effect of GT® treatment on an athlete's sprint performance or if the length of a treatment affects performance. Therefore, the purpose of this study was to determine the effect of two different treatment times (5 minutes and 8 minutes) of GT® will have on sprint performance. The authors hypothesized that participants will have an increase in sprint times after the GT® treatments when compared to a baseline sprint test.

Methods

To determine the effects of GT® on sprint performance, 15 collegiate wrestlers were recruited to participate. The inclusion criteria consisted of being a member of a National Collegiate Athletic Association (NCAA) Division III wrestling team. Participants were excluded if they had a lower extremity injury within the past 6 months or had any contraindications to GT®. These contraindications included: open wounds, unhealed fractures, thrombophlebitis, uncontrolled hypertension, patient intolerance or hypersensitivity, hematoma, osteomyelitis, myositis ossificans and hemophilia (Carey et al., 2010, Stow, 2011). Participants completed a questionnaire to determine if they qualified for this study (Appendix B).

This study utilized a repeated measures design in which the independent variable was the GT® treatment time (5 and 8 minutes) and the dependent variable was the 30-yard sprint test times. All participants in this study attended three testing sessions in the athletic training room of a small, private college. The first session was a pre-test day where baseline measurements were assessed. For the next two sessions, participants received either a 5 minute or 8 minute GT® treatment bilaterally and then completed sprint tests. Participants were randomly selected to which treatment they would receive on the first treatment day. Prior to participation, all participants signed an informed consent form approved by the university institutional review board.

On the pre-test day, participants completed a questionnaire (Appendix A) with information on demographics (age, sex, height, weight, wrestling weight class, years of wrestling experience), exposure to GT®, contraindications of GT®, lower extremity injury history and lead leg in wrestling. The questionnaire was used not only to gather demographic information but to exclude participants if needed. Passive range of motion was assessed with a standard goniometer (The Therapy Connection, Windham, NH) for knee extension and flexion bilaterally. This was to rule out any internal derangement that may have been present. Skin fold tests were taken with a skin fold caliper (Beta Technology, Santa Cruz, CA) on the lead leg quadriceps muscle. Measurements were taken midway down the quadriceps with the participant in slight knee flexion and muscles relaxed. A digital timer (General, New York, NY) was used to keep track of the time for GT® treatment, active rest, stretching and the rest period between sprint tests. After the measurements were taken, participants warmed up on a stationary bike for 5 minutes with little resistance (0-2) at a rate of 55±5 RPM. Following the warm up, participants had a 10-minute period of active rest, which included some walking, and some sitting. Activity was not recorded during the active rest. This time period emulated the time between treatment and activity in a normal clinical setting.

After the 10-minute waiting period, participants completed a strengthening and stretching component. The participants started with a 30 second quadriceps stretch followed by 1 set of 30 repetitions of straight leg raises and then ended with another 30 second quadriceps stretch completed bilaterally. This follows the recommended GT® protocol by having the participant stretch, perform a high repetition and low load exercise and then re-stretch the target muscle. The straight leg raise was completed with the participant lying supine on a treatment table with both legs straight. The participant slowly lifted their lead leg six inches off the table and held it for 3 seconds before slowly lowering their leg to the table. Then, they completed this with their non-lead leg. Next, participants completed a standing quadriceps stretch. They performed this by standing on their non-lead leg. They flexed the knee of their lead leg and brought it behind them while holding their ankle. Participants tucked their pelvis in while pulling their shin towards the gluteus muscles while making sure the knee was pointing towards the ground. They switched legs after 30 seconds. Next, the participants jogged two laps around the 200-meter indoor track. After the warm-up lap, the participant went to the start line for the 30-yard sprint. The participant started from a 2-point stance, in which both feet were in a sprinting stance and arms were at a 90-degree angle off the ground. They were instructed to sprint as fast as they could for 30 yards. A Brower Tc-gate timer (Masion Athletics, Austion, Tx) was stationed at 30 yards and recorded the time. The participants completed three 30-yard sprint tests with 1 minute of active rest between sprints. The average of the tests was used as their baseline time. Ice was offered after the sprint tests, however none of the participants accepted ice. Finally, the participants were reminded to keep work out habits the same until after they have completed the study.

For the GT® treatment sessions, the participants warmed up on a stationary bike for 5 minutes with little resistance (0-2) at a rate of 55±5 RPM. After the warm up, GT® Emollient (mineral oil, beeswax, Emollient R. Complex) was applied over the participant's quadriceps muscle. The participant was supine with the knee extended and quadriceps relaxed. They received GT® over both quadriceps (rectus femoris (RF), vastus medialis (VM), vastus intermedius (VI), and vastus lateralis (VL)) for either 5 minutes or 8 minutes. The principle investigator who administered the GT® treatments on each of the participants has completed a M1 – Basic Training course that was directed by a certified GT® instructor.

The GT® protocol developed for this study was based off the GT® course recommendations. The 5-minute treatment included the first two minutes utilizing the GT 4 instrument and the last 3 minutes utilizing the GT 1 instrument (Appendix A). The GT 4 instrument was utilized as the "scanner" to detect abnormalities within the tissues. It has a single bevel, convex edge that can be used with one or two hands. The GT 1 instrument has a single bevel, concave treatment edge with two convex knobs and is used with a two hand grip. The participant's right quadriceps muscle received GT® treatment first followed by the left quadriceps muscle. The GT® investigator started scanning on the proximal aspect of the quadriceps, using instrument GT 4, in a downward direction over the quadriceps with the convex edge using the sweep stroke. The sweeping stroke is characterized by the instrument contact points moving in one direction at the same rate (Carey et al., 2010). The investigator worked back up the quadriceps, using the convex edge with the sweep stroke and finally, ending with a fanning stroke in a downward direction over the quadriceps for a total of 2 minutes. The fanning stroke is characterized by the instrument contact points moving at different rates in an arched path with one end of the instrument serving as a fulcrum of the motion (Carey et al., 2010). For minutes 3 and 4, GT 1 was used to complete the sweep stroke going up and down the quadriceps. The swivel stroke was used for the final minute down the quadriceps. The swivel stroke is characterized by the instrument contact points moving in one direction while the investigator slightly rotates the instrument to target deeper tissue. The investigator used a moderate pressure applying the treatment to all participants.

The GT® protocol for the 8-minute treatment, which was developed based off the GT® course recommendations, included the first three minutes utilizing the GT 4 instrument, the next two minutes using the GT 5 instrument followed by the GT 1 instrument for the last three minutes. The GT 5 instrument has a single bevel with a concave treatment edge. This allows for a more aggressive treatment when desired (Appendix A). The GT® investigator started by scanning on the proximal aspect of the quadriceps, using instrument GT 4, in a downward direction over the quadriceps with the convex edge using the sweep stroke. The investigator worked back up the quadriceps, using the convex edge with the sweep stroke and finally, ended with a fanning stroke in a downward direction over the quadriceps for a total of three minutes. Then, the GT 5 instrument was used with the sweep stroke up and down the quadriceps for the next two minutes. For the last 3 minutes, GT 1 was used to complete the sweep stroke going up and down the quadriceps. Next, the swivel stroke was used for the final minute down the quadriceps. The investigator used a moderate pressure applying the treatment to all participants. After GT® treatments were administered, the participants had an active rest period for ten minutes which included some walking and some sitting. The protocol for the sprint component described for the baseline sprint test was used for the GT® treatment sessions as well.

The mean pre and post sprint times for the control group, the 5-minute GT® treatment group, and the 8-minute GT® treatment group were analyzed with a paired samples t-test to assess differences between groups. Descriptive statistics were used to describe age, weight class, years of experience, height, weight, quadriceps adipose tissue thickness and knee extension and flexion. All statistical analysis was calculated by IBM SPSS Statistics version 21 (2013, IBM). Significance was set as $p < 0.05$.

Results

Among the 15 healthy collegiate wrestlers (18.87 ± 0.92 years), there was 11.73 ± 3.17 years of wrestling experience. The mean adipose tissue of the quadriceps was 12.24 ± 3.09 mm among the participants (Table 1). The mean for left knee extension (-1.27 ± 1.71 degrees) was slightly greater than the mean for right knee extension (-0.47 ± 1.92 degrees) (Table 2). Participants also had slightly greater left knee flexion (136.07 ± 9.87 degrees) than the right knee (134.33 ± 5.74 degrees).

Table 1.

Demographic Information

Characteristic	Mean	Standard Deviation
Age	18.87	0.92
Height (inches)	69.20	3.62
Weight (pounds)	177.93	32.64
Years of Experience	11.73	3.17
Adipose Tissue of Quadriceps (mm)	12.24	3.09

*N = 15

Table 2.

Mean and Standard Deviation of Knee Range of Motion

PROM*	Mean (degrees)	Standard Deviation (Degrees)
Right Knee Extension	-0.47	1.92
Left Knee Extension	-1.27	1.71
Right Knee Flexion	134.33	5.74
Left Knee Flexion	136.07	9.87

*PROM = Passive Range of Motion

Data were then separated into two treatment groups based on which treatment time participants received first. Group 1 received an 8-minute treatment first and then a 5-minute treatment roughly 48 hours later. Group 2 received a 5-minute treatment first and then an 8-minute treatment roughly 48 hours later. The baseline sprint times for Group 1(4.62 ± 0.22 seconds) was not significantly different than the baseline sprint time of Group 2 (4.63 ± 0.17 seconds); $t(6)=-0.07$, $p = 0.946$. Group 1 sprint times for the 8-minute treatment (4.54 ± 0.19 seconds) were slower than the sprint times for the 5-minute treatment (4.52 ± 0.17 seconds) with baseline sprint times of (4.62 ± 0.22 seconds) However, the sprint times for Group 1 between the two treatments were not significantly different; *t*(6)=0.59, *p* = 0.578. Group 2 sprint times for the 5-minute treatment (4.60 ± 0.19 seconds) were slower than the sprint times for the 8-minute treatment (4.55 ± 0.20 seconds) with baseline sprint times of (4.63 ± 0.17 seconds) (Table 3). Like group 1, the differences between sprint times after the two treatment times of Group 2 were not statistically significant; *t*(7)=1.58, *p* = 0.158.

Table 3.

Mean and Standard Deviation of Sprint Times

Number of Subjects	Treatment	Sprint Times (Seconds)
15	Baseline Sprint*	4.63 ± 0.18
15	Post 5-Minute Treatment Sprint*	4.53 ± 0.18
15	Post 8-Minute Treatment Sprint	4.57 ± 0.19
7	Group 1 Baseline Sprint	4.62 ± 0.22
7	Group 1 Post 8-Min Treatment Sprint	4.54 ± 0.19
7	Group 1 Post 5-Min Treatment Sprint	4.52 ± 0.17
8	Group 2 Baseline Sprint	4.63 ± 0.17
8	Group 2 Post 5-Min Treatment Sprint	4.60 ± 0.19
8	Group 2 Post 8-Min Treatment Sprint	4.55 ± 0.20

*Significant difference between sprint times

The data were also calculated with the participant's sprint times combined. The sprint times for the 5 minute GT® treatment (4.53 ± 0.18 seconds) were not significantly faster than the sprint times following the 8 minute GT® treatment (4.57 ± 0.19 seconds) when compared to baseline sprint times (4.63 ± 0.18 seconds) (Table 3). There was a significant difference in sprint times between the baseline sprint times and the 5 minute GT® treatment in healthy participants; $t(14)=3.34$, $p = 0.005$. There was not a significant difference in sprint times between the baseline sprint times and the 8 minute GT® treatment; $t(14)=1.49$, $p = 0.159$.

Discussion

This study is the first to look at how two GT® treatment times affect sprint performance. Graston Technique® is an instrument assisted soft tissue mobilization technique that enables clinicians to detect and effectively treat abnormalities within the tissue. This technique is based off the deep transverse friction massage that was made popular by James Cyriax M.D. (Laudner et al., 2014). There is no known study comparing treatment times of GT® and its effects on sprint performance. The results of this study indicate that a 5-minute treatment of GT® significantly increased a 30-yard sprint performance when compared to baseline sprint tests. There was no significant effect on a 30-yard sprint performance after an 8-minute treatment when compared to baseline sprint tests.

Clinically, it is unknown how instrument assisted soft tissue mobilization treatments prior to activity affect performance. Researchers have looked into how pre-competition massage affects performance, however there are inconsistent findings. Fletcher (2010), reported there were significantly increased sprint times when a 9-minute rapid, stimulatory massage was performed compared to a traditional warm-up or a combination of traditional warm-up with pre-competition massage prior to sprint tests. However, Goodwin et al. (2007) performed a 15-minute rapid stimulatory massage on participants prior to warm-up. They reported that 30-m sprint times after massage (4.41 ± 0.27 seconds) had no significant difference than sprint times after rest (4.39 ± 0.28 seconds). This conflicts with studies that utilized 15-minute Swiss massages which found adverse effects on 30-m sprint times (Arabaci, 2008; Arazi et al., 2012). Arabaci (2008) reported a 2.5 ± 2.5 second difference between 30-m sprint before massage (4.27 ± 0.16 seconds) and after massage (4.37 ± 0.18 seconds). Their participants completed three different interventions (massage, stretching and rest) on three nonconsecutive days over one week (Arabaci, 2008).

When looking at the current study between GT® treatment times and sprint performance, no statistically significant difference existed between the baseline sprint times of groups 1 and 2. Therefore, the baseline sprint times did not skew the results of the sprint times after the two GT® treatments. The physiological effects of a shorter GT® treatment can help warm-up the tissue. The participants completed a warm-up before the GT® treatment however, a GT® treatment can assist in the warm-up process and promote mobility of the soft tissues (Carey et al., 2010). The goal of a warm-up is to prepare the body physiologically for physical activity (Prentice, 2014). When participants have a GT® treatment prior to physical activity it increases the circulation within the musculature which increases tissue temperature (Goodwin et al., 2007; Prentice, 2014). Tissue temperature can alter mechanical properties within the tissue like increasing the elasticity and decreasing the viscosity of the muscle (Prentice, 2014). This, in turn, means the tissue can shorten and lengthen more rapidly, which may improve performance (Prentice, 2014).

Graston Technique® can be used as a secondary warm-up, however if the treatment is too long it could have negative effects on performance. Participants had statistically significant faster sprint times after a 5-minute GT® treatment when compared to baseline than after an 8-minute GT® treatment when compared to baseline sprint times. A Graston Technique® treatment is used to break up soft tissue restrictions (Carey et al., 2010). However, the longer treatment time results may indicate that the soft tissue is breaking down more, which results in slower sprint performances. It is hypothesized that GT® produces localized micro-trauma to the treatment area (Laundry et al., 2014). When this micro-trauma occurs, microvascular and capillary hemorrhaging is produced (Laundry et al., 2014). As the treatment time increases, the micro-trauma increases as well. By having greater tissue damage, this could translate to adverse effects to sprint times. Healthy participants were utilized for this study, therefore, it is unclear how much micro-trauma was induced. Although, sprint times significantly decreased after a 5-minute treatment when compared to baseline sprint times, there was no significant difference between baseline sprint times and after an 8-minute GT® treatment. The micro-trauma that was created with an 8-minute treatment was not enough to affect sprint times. However, when pushing the end range of the recommended GT® treatment time, micro-trauma may be great enough to cause slower sprint times.

Micro-trauma created by GT® initiates the inflammatory response allowing the tissue to heal more effectively. When the tissue heals properly it allows for greater function of that tissue. With most therapeutic treatments in the clinical setting, it takes multiple treatments to be effective with healing and performance. This was reflected in this study when comparing sprint times of the second GT® treatment to the sprint times of the first GT® treatment, no matter which treatment time was first or second. Although, sprint times were not statistically significant, it can be said they were clinically significant meaning that it is relevant when it comes to competitive sports. The first treatment of GT® is used to evaluate the tissue and assess the patient's response to the treatment (Carey et al., 2010). The first treatment is also initiating the healing process and breaking down adhesions. The second treatment allows the clinician to focus more on the GT® treatment and continue to build stronger tissue. Schaefer & Sandrey (2012) examined the effects of GT® treatments twice a week for four weeks on participants with chronic ankle instability. After the four weeks, they found improved function and range of motion within participant's ankles (Schaefer & Sandrey, 2012). With multiple treatments of GT®, not only do physiological responses improve, but this study suggests it may also be reflected in sprint performance.

With any study, there are a few limitations that occur throughout the study. One limitation was that only healthy participants were used. Since GT® is used to break down adhesions within the injured tissue, it may have started breaking down healthy tissue. This could have affected the results of the sprint times. Another limitation was that there was a predetermined GT protocol that was used for all participants. In the clinical setting, there may be spots or areas that require more attention with the instruments. However, in order to ensure consistency throughout all participants, the predetermined protocol was used. The participant's activity level was not monitored throughout the study. Participants had scheduled workouts for certain days during off-season, which could have affected their sprint performance due to muscle soreness or fatigue. Future studies should investigate the effects of GT® treatments over an extended period of time and how it affects performance. In addition, standardizing the activity levels should be taken into account by either documenting the activity levels of participants or have participants refrain from activity.

Conclusion

Our findings revealed that the 5-minute GT® treatment had statistically significantly faster sprint times than the 8-minute GT® treatment when compared to the baseline sprint tests in healthy participants. However, when compared within each group, the overall second GT® treatment had faster sprint times than the first GT® treatment sprint times. Clinically, multiple treatments should be used in order to achieve performance benefits as well as therapeutic benefits. Shorter treatment times should be used prior to practice or competitions to maintain or enhance performance. When first starting a GT® treatment, longer treatment times may be more beneficial and then decreasing treatment times for future treatments. The longer treatment times may have a greater impact on sprint times when used on injured subjects. However, it is unknown how a GT® treatment will affect sprint performance when used on injured subjects.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the effect of Graston Technique® (GT®) treatment times on sprint performance. By researching treatment times, clinicians and certification course instructors are able to provide better guidance for patients and students, respectively. Clinicians will also have a better understanding of how GT® treatment affects performance. The study was guided around the following research questions: Does a treatment time of 5 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Does a treatment time of 8 minutes of Graston Technique® affect a 30-yard sprint performance in collegiate wrestlers? Examining the effect of the GT® treatment times on sprint performance is important to provide clinicians the proper treatment protocol. This chapter provides a brief summary, discussion, recommendations regarding utilization of findings, recommendations for future research and the conclusion.

Graston Technique® (GT®) is a method in which stainless steel instruments are used to assist in the detection and treatment of soft tissue dysfunctions. Graston Technique® has shown positive effects on a variety of injuries but remains unclear on how the length of a treatment will affect performance. A sample of 15 healthy college-aged male wrestlers (18.9 ± 0.9 years) who had no lower extremity injuries in the past 6 months participated in this study. Participants received two treatments of Graston Technique® on two separate days. After a 5-minute bike warm-up, participants received either a 5-minute GT® treatment or an 8-minute GT® treatment on both quadriceps muscles. They were randomly selected as to which treatment they would receive first. Participants completed a 10-minute active rest followed by a 30 second standing quadriceps stretch, 30 straight leg raises and quadriceps stretch again. Then, participants sprinted three 30-yard sprint tests. The three 30-yard sprint times (in seconds) for each baseline, post-5 minute and post-8 minute GT® treatment, were averaged and used for data analysis.

Data were then separated into two treatment groups, Group 1 and Group 2, based on which treatment time participants received first. Group 1 received an 8-minute treatment first and then a 5-minute treatment roughly 48 hours later. Group 2 received a 5-minute treatment first and then an 8-minute treatment roughly 48 hours later. The baseline sprint times for Group 1 was not significantly different than the baseline sprint times of Group 2. However, there was a significant difference in sprint times between the baseline sprint times and the 5 minute GT® treatment. There was not a significant difference in sprint times between the baseline sprint times and the 8 minute GT® treatment. Likewise, no significance was found between Group 1 sprint times for the 8-minute treatment and the sprint times for the 5-minute treatment; however, sprint times were slower after the 8-minute treatment than after the 5-minute treatment. Group 2 sprint times after the 5-minute treatment were slower than the sprint times after the 8-minute treatment; however, there was no significant difference.

Discussion

This is the first study to examine how two Graston Technique® (GT®) treatment times affect sprint performance. While the literature is limited in studies on IASTM and performance, researchers have looked into how pre-competition massage affects performance. Graston Technique® and Swiss massage have similar treatment goals but vary in technique. With Swiss massage, the clinician is using their hands to apply the strokes and adjust pressures to achieve treatment goals. When administering a GT®

treatment, clinicians use the instruments to apply pressure. The design of the instruments allows for maximum tissue penetration as well as minimal stress to the clinician's hands (Graston Technique Website®, 2015). With this deeper penetration and increase in pressure from the GT® instruments, the micro-trauma could increase more than with a Swiss massage. Therefore, treatment times should be shorter with GT® than massage to positively affect sprint performance. It is recommended that GT® treatment times are not longer than 8-10 minutes (Carey et al., 2010). In this study, an 8-minute treatment did not statistically affect sprint performance. Goodwin et al. (2007) found similar results but performed a 15-minute rapid stimulatory massage prior to warm-up. The 15-minute massage was performed on the calves, hamstrings and quadriceps muscles where each muscle group received a 2.5 minute treatment. The authors reported no significant difference in sprint times after massage treatment (4.41 ± 0.27 seconds) than after rest (4.39 ± 0.28 seconds). With shorter massage and GT® treatment there are some physiological effects that are occurring within the tissue but not enough to cause an increase in sprint times.

When looking at the current study between GT® treatment times and sprint performance, there was no statistically significant difference between the baseline sprint times of groups 1 and 2. Therefore, this suggests that any changes in sprint time are truly from a GT® treatment and not due to differing baseline sprint times between Group 1 and Group 2. The participants completed a warm-up before the Graston Technique® treatment, however, a GT® treatment can assist in the warm-up process and promote mobility of the soft tissues (Carey et al., 2010). The goal of a warm-up is to prepare the body physiologically for physical activity (Prentice, 2014). When participants have a GT®

treatment prior to physical activity it increases the circulation within the musculature which increases tissue temperature (Goodwin et al., 2007; Prentice, 2014). Tissue temperature can alter mechanical properties within the tissue like increasing the elasticity and decreasing the viscosity of the muscle (Prentice, 2014). This means the tissue can either lengthen or contract more rapidly, which may improve performance (Prentice, 2014).

In addition, GT® can be used as a secondary warm-up. However, if the treatment is too long it could have negative effects on performance. Participants had statistically significant faster sprint times after a 5-minute GT® treatment when compared to baseline than after an 8-minute GT® treatment when compared to baseline sprint times. A GT® treatment can be used to break up soft tissue restrictions (Carey et al., 2010). However, the longer treatment time could indicate that the soft tissue is breaking down more, which results in slower sprint performances. It is hypothesized that GT® produces localized micro-trauma to the treatment area which initiates the inflammatory response (Laundry et al., 2014). The inflammatory process delivers blood, nutrients and fibroblasts to the treatment area (Laudner et al., 2014). However, to start this inflammatory response, micro-trauma occurs within the tissue to produce microvascular and capillary hemorrhaging (Laundry et al., 2014).

As the treatment time increases, the micro-trauma increases which could lead to adverse effects on sprint performance. This holds true in two studies that utilized 15-minute Swiss massages (Arabaci, 2008; Arazi et al., 2012). Arabaci (2008) found a 2.5 ± 2.5 second difference between 30-m sprint before massage (4.27 ± 0.16 seconds) and after massage (4.37 ± 0.18 seconds). The participants completed three different interventions (massage, stretching and rest) on three nonconsecutive days over one week (Arabaci, 2008). Similarly, Fletcher (2010) reported significantly increased sprint times when a 9-minute rapid, stimulatory massage was performed compared to a traditional warm-up or a combination of traditional warm-up with pre-competition massage prior to sprint tests. There was a 2.74% significant decrease in sprint times after a traditional warm-up was completed when compared to only pre-competition massage (Fletcher, 2010). When combining the traditional warm-up and pre-competition massage, there was a 2.44% significant decrease when compared to the pre-competition massage (Fletcher, 2010). Although a maximum GT® treatment of 8 minutes produced no adverse effects on sprint performance, adverse effects on sprint performance may occur as the treatment time increases over 8 minutes due to the micro-trauma created in the tissue.

The micro-trauma created with a GT® treatment initiates the inflammatory response, allowing the tissue to heal more effectively. When the tissue heals properly it allows for greater function of that tissue. The micro-trauma promotes the realignment of fibers of disorganized tissue (Carey et al., 2010; Baker et al., 2013). With fibers realigning, there are more cross-links, which make the tissue stronger and more durable (Houglum, 2010). As with many therapeutic treatments in the clinical setting, it takes multiple treatments to be effective with healing and performance. This was reflected when comparing sprint times of the second GT® treatment to the sprint times of the first GT® treatment. Although, sprint times were not statistically significant, it can be said they were clinically significant. Clinically significance refers to performance being relevant in the competitive athletics where one hundredth or thousandth of a second can be the difference between first and second place. The first treatment of GT® is used to evaluate the tissue and assess the patient's response to the treatment (Carey et al., 2010). The first treatment is also initiating the healing process and breaking down adhesions. The second treatment allows the clinician to focus more on the GT® treatment and continue to build the stronger tissue. Schaefer & Sandrey (2012) examined the effects of GT® treatments twice a week for four weeks on participants with chronic ankle instability. They performed either an 8-minute GT® treatment or 8-minute sham GT® treatment at each session followed with a stretching and strengthening component. The GT® instruments that were utilized were GT2, GT3, GT4 and GT5. The stroke patterns that they chose to use were dependent on which instrument was being used. After four weeks, they found improved function and range of motion within participant's ankles (Schaefer & Sandrey, 2012). Although this present study did not last for 4 weeks, improved function was found on healthy participants after two GT® sessions.

In addition, there have been multiple case studies that have looked at conservative rehabilitation and GT®. Some of these pathologies include: lateral epicondylopathy, trigger thumb, and chronic Achilles tendinopathy (Papa, 2012; Howitt et al., 2006; Miners & Bougie, 2011). These case studies all reported improved function or decreased pain after 6-10 treatments (Papa, 2012; Howitt et al., 2006; Miners & Bougie, 2011). However, these case studies do not provide details of the GT® treatment such as: length of treatment, instrumentation, and types of strokes used. Multiple treatments of GT® not only improve physiological responses but improves functional movements, like sprint performance.

Recommendations Regarding Utilization of Findings

Graston Technique® is a treatment that can be used for many different soft tissue injuries as well as any population. One of the main goals of GT® is to provide an optimal environment for healing or to enhance components of normal musculoskeletal function (Stow, 2011). Based on the results of this study, GT® can clinically improve sprint performance after a 5-minute and an 8-minute treatment in healthy people. Graston Technique® can assist with the warming up the tissue prior to activity. A 5-minute treatment is recommended prior to activity; however, the injured patient may not receive as many physiological benefits with a shorter treatment. It is recommended that the first couple GT® treatment focuses on evaluating the tissue and finding abnormalities within the tissue (Carey et al., 2010). This could lead to longer treatment times. When an athlete is first injured, the injury may keep the athlete out of competition. However, as the therapy and healing progresses and the athlete begins to return to activity, GT® treatment times should be shorter before practice. These shorter treatments should focus on soft tissue abnormalities (Carey et al., 2010). When deciding on a treatment time for GT®, the clinician should take into consideration the goal of the treatment. The shorter treatments break down the tissue less than longer treatments based on sprint performance. However, when determining treatment parameters of GT®, decisions should be based on the patient's injury.

Recommendations for Future Research

Future research is essential to continue to contribute to the limited literature on GT®. This current study only used healthy males so future studies should include females and injured patients. Future studies should also investigate the effects of GT® treatments over an extended period of time and how it affects performance as well as including different treatment times. In addition, standardizing the activity levels should be taken into account by either documenting the activity levels of participants or have participants refrain from activity. Research should also look at how GT® treatment times can affect other muscle groups in respect to not only sprint performance but other physical aspects such as agility, strength or power.

Conclusion

The main conclusion of this study was that after two treatments of GT®, sprint performance had clinically increased in healthy participants. It is recommended by GT® that multiple sessions are used in order to achieve treatment goals. This promotes tissue alignment, which makes the tissue stronger and more functional. However, when longer treatment times are used, the intensity increases which may affect performance. This is the first study to look at how Graston Technique® treatments affect sprint performance. A 5-minute treatment can act as a warm-up for the tissue and improve sprint performance whereas an 8-minute treatment starts to break down the tissue and has no effect on sprint performance. Although athletic performance should not determine the length of a rehabilitative treatment, it should be considered. Athletes may not want their muscles fatigued prior to competition or a competitive practice so clinicians may want to adjust treatment times accordingly. The main goal of GT® is to improve soft tissue dysfunction which in turn will improve function.

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APPENDIX A. GRASTON TECHNIQUE® INSTRUMENTS

*1st Row: GT1; 2nd Row Left: GT6; 2nd Row Right: GT5; 3rd Row Left: GT2; 4th Row Left: GT3; 4th Row Right: GT4

APPENDIX B. PRE-TEST QUESTIONNAIRE

Age______________________ Gender_________________________

Weight Class_______________ Years of Experience_______________

Have you heard of Graston Technique before? Yes No

Have you ever received a Graston Technique treatment? Yes No

Have you had an injury to your lower extremity in the past 6 months? Yes No

What is your lead leg while wrestling? Right Left

Contraindications (Circle Y if you have any of the following conditions)

Cancer	Y	burn scars	Y
kidney dysfunction	Y	rheumatoid arthritis	Y
anti-coagulant medications	Y	varicose veins	Y
open wound	Y	unhealed fractures	Y
thrombophlebitis	Y	uncontrolled hypertension	Y
hypersensitivity	Y	hematoma	Y
osteomyelitis	Y	myositis	Y
ossificans	Y	hemophilia	Y

Height__________________ Weight_____________________

Quadriceps Skin Fold Test ____________ ____________ ____________

Knee Extension _______ ___________ Knee Flexion ________ _________

Sprint #1 _________________ __________________ __________________

Sprint #2 _________________ __________________ __________________

Sprint #3 _________________ __________________ __________________

Participant number ______________