2015

Effectiveness of the Graston Technique for Soft Tissue Injuries Such as Bicipital Tendinopathy: A Case Report

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Effectiveness of the Graston Technique for Soft Tissue Injuries such as Bicipital Tendinopathy: A Case Report

By

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A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine and Health Sciences

University of North Dakota

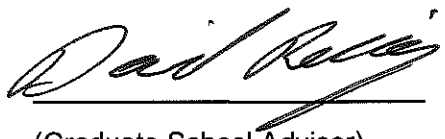
in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota

May, 2015

This Scholarly Project, submitted by Brian Storhaug in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



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ACKNOWLEDGEMENTS

I would like to thank my parents. For being exceptional role models all throughout my life. They have showed me what it truly means to live selfless. For pushing me to being the best I can be. For being a great support system. For offering me guidance no matter the situation. Without them I don't know where I would be today.

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EFFECTIVENESS OF THE GRASTON TECHNIQUE FOR SOFT TISSUE INJURIES SUCH AS BICIPITAL TENDINOPATHY:

A CASE REPORT

Abstract: This case report discusses a unique approach to the treatment of a soft tissue injury, such as bicipital tendonitis, through the approach called the Graston Technique. **Case Description:** A 61 year old Caucasian male received treatment after a diagnosis of bicipital tendonitis. His job was working at a mail office which required repetitive manual labor consisting of moving boxes of varying weight and height in a position of protracted shoulders, extended elbows and supinated wrists. Treatment consisted of stretching the biceps brachii and upper trapezius, Graston, cross friction massage, ultrasound and therapeutic exercise.
Background and purpose: The purpose of this case report is to expand the clinical reasoning for the use of Graston tools on soft tissue. The outcomes were as follows- after the sixth treatment, the patient could sleep through the night without pain. He could put on a jacket and tuck in his shirt behind his back independently and had no issues with neck pain. Shortly after the sixth treatment, the patient fell at home in his driveway and regained the symptoms he complained of at the initial evaluation.
Discussion: Clinicians should be aware of the proper use of the Graston Technique, the courses available for its use, what to expect with the usage of this technique during treatment and the positive outcomes associated with the correct use. Further research should compare Graston technique with deep tissue friction massage as the sole modalities to treat the soft tissue injury.
Key Words: Biceps Brachii—upper trapezius—tendonitis—Graston.

CHAPTER I

BACKGROUND AND PURPOSE

Injuries to the musculoskeletal structures surrounding the shoulder are common and complex. Shoulder injuries may occur from overuse, structural deformity, or dysfunctional biomechanics. Common overuse injuries include swimmers shoulder, rotator cuff tendinosis, subacromial bursa impingement and labral tear. Swimmers shoulder is thought to stem from the amount of strokes taken with each arm causing a sport-specific demand of increased shoulder range of motion and also prolonged which fatigues the shoulder intensive training. Rotator cuff injuries in the elderly are thought to develop from the shape of the acromion, traumatic fall or a progression from impingement. Clients with a rotator cuff injury will likely describe a deep dull aching sensation on the front or side of the shoulder.[1] Subacromial bursa impingement signs are positive if the patient feels pain near 90-100° of shoulder abduction.[2] Impingment syndrome of the rotator cuff is the most common cause of shoulder pain. Usually occurring in athletes or people whose occupation requires frequent arm use in the horizontal or overhead position.[1] The inflammation of the biceps tendon can progress to a musculotendinous tear if not treated properly. Patients with biceps tendinosis develop pain with shoulder flexion or abduction combined with external rotation.[3]

A common overuse injury is inflammation of the biceps tendon or tendinitis. Biceps tendonitis is prevalent in nine percent of assembly workers. There are two types of bicipital tendonitis. First primary biceps tendonitis is inflammation of the biceps tendon in the bicipital groove which only affects five percent of the patients who have this injury.[4] The other type is called secondary biceps tendonitis which is inflammation that may be associated with shoulder pathology such as an impingement or rotator cuff injury. While the definition of tendonitis is an inflammation of a tendon, mounting controversy about the term has developed in recent years. The term tendonitis is no longer widely used due to expanding research on the topic. The newly accepted term is tendinopathy. "For chronic pain symptoms arising from a tender area of mid-substance tendon tissue, the term "tendinopathy" should be applied". [5] When chronic pain symptoms combined with diagnostic imaging showing changes occurring in the tendon fiber structure, the term tendinosis should be used.[5] Tendinosis is merely a continuation of tendonitis with the absence of inflammatory cells. "There is an apparent increase in tenocytes with myofibroblastic differentiation (tendon repair cells) while classic inflammatory cells are usually absent".[6] Tenocytes are fibroblast-like cells, with the primary job of forming mature tendon.

Current knowledge on tissue healing tells us that there are three phases. The first phase, the inflammatory phase, starts at the initial injury spanning up to two weeks. Two days following a lesion to the muscle membrane macrophages- a branch of leukocytes- flush the injured tissue and remove the debris which aides in muscle cell regeneration.[7] The second phase of healing is called the proliferation/repair which

occurs from two weeks up to six weeks. Finally, the third phase which is called the remodeling phase occurs from six weeks up to two years. This particular patient was in the repair phase. During the repair phase "fibroblasts are synthesizing collagen fibers and extracellular matrix components".[8] The type three collagen fibers being laid down during this phase are in a "somewhat random arrangement and the fibers are not fully oriented on the direction of stress".[8] Tendionopathies are a prime model of the disorganized collagen fiber placement. "Histologic descriptions of tendinopathies have demonstrated disordered collagen arrangement together with increased proteoglycan ground substance and neovascularization".[9] Intervention techniques performed by physical therapists attempt to organize and re-align collagen to develop stronger, functional tissues.

The Graston Technique is one type of physical therapy intervention purported to organize collagen and ground substance to improve healing. The Graston Technique initiates the healing process and essentially speeds it up- "this therapy creates a state of touch induced analgesia, inflammation, hyperemia, and increased fibroblast recruitment and activation, which contribute to the repair and regeneration of damaged collagen".[5] Graston performs the breakdown of scar tissue, prevention of adhesion formation and also aids in the orientation of repaired collagen. Graston essentially initiates the inflammation process so that tissue remodeling can occur.[10] The clinician applying a Graston tool to an injured area should feel a "tissue texture abnormality that both the clinician and patient experience and detect palpable sensations such as grit, ridges, or nodules. Often audible sounds are heard when the adhesion is of significant

magnitude".[11] The literature that is available today in physical therapy shows a gap for the use of Graston on a patient showing symptoms of bicipital tendonitis. Trigger thumb, achilles tendonopathy, and tibialis posterior and lateral epicondylitis have been examined in the past. A study on rats using an electron microscope to analyze the fibroblasts following Graston Technique showed proliferation of the fibroblasts which is necessary for tendon healing.[12]

In an article analyzing job professions that potentially cause shoulder dysfunctions, it was reported that "sustained shoulder postures with greater than sixty degrees of flexion or abduction is associated with shoulder disorders".[13] Notably, the patient in this case study worked on an assembly line which required performing repetitive overhead movements by sending boxes down an assembly line. The boxes became continually heavier, upwards of fifty pounds in weight. The onset of the problem occurred when the patient pushed a forty-pound box that gave him the feeling of tearing something.

The purpose of this case is to describe an extensive clinical and evidence informed examination and intervention for a patient with bicipital tendonitis emphasizing the use of the Graston Technique in conjunction with therapeutic exercise and joint mobilizations.

CHAPTER II

CASE DESCRIPTION

The patient in this case report works on an assembly line at a mail office. The patient performs repetitive overhead movements throughout the day. The size of boxes typically moved by the patient weigh up to 50 pounds. The initial complaints by the patient were of a tearing sensation as a overhead movement was being performed. Following initiation of pain, he was seen by an orthopedic surgeon who referred him to physical therapy for conservative treatment.

Examination and Evaluation: This case study describes a patient who worked at a job that required a lot of upper extremity work. The patient's primary position at work was forearms supinated, elbows flexing and extending along with shoulders in the position of protraction and moving into flexion frequently. To assess the patient's upper extremity movement, active range of motion was measured for all shoulder motions. All results were within normal limits with shoulder abduction producing some pain when the patient brought his arm down to his side. Cervical flexion and extension were also within normal limits with cervical extension causing a pinching feeling. Cervical rotation to the left caused pain and rotation to the right caused a stretch sensation that followed the upper trapezius muscle. The functional outcome measure that the patient filled out prior to the appointment was a shoulder pain and disability index, and his score on the

pain scale was a 32/50 (64%) and on the disability scale 46/80 (57.5%). With 0% being no shoulder pain and 100% being the worst score possible, a score of 32/50 on the pain scale is a debilitating score. Patients presenting with shoulder pain and physical dysfunction are suggested to use the SPADI or ASES (American shoulder and elbow surgeons functional assessment). Research done on the use of functional outcome measures reported that SPADI (shoulder pain and disability index) has an ICC greater than 0.85 reliability.[14]

Manual muscle testing was performed in the against gravity position. During the evaluation of the shoulder musculature, shoulder abduction rated a 4/5. Flexion, rated a 4/5 but produced pain in the anterior deltoid area. External rotation, rated at 4/5 also produced pain. Finally, internal rotation was rated at 4/5 and reproduced the pain which matched the patient's primary pain complaint.

The next part of the evaluation was to diagnose his injury. According to *Clinics in Sports Medicine*, palpation of the biceps tendon in the bicipital groove along with Yergason's and Speed's test are the gold standard for identifying biceps pathology. I first performed Yergason's test in the seated position with the elbow flexed at 90° and the forearm pronated. Then I asked the patient to supinate while I held resistance at the wrist. The next test that was performed was Speed's test, which was performed with the patient standing starting with the humerus flexed to 90°, then the patient resists the eccentric movement as I move his humerus into extension. According to *Orthopedic Physical Assessment* (Magee, 2014), the specificity and sensitivity of the Speed's examination test are 55.5% and 68.5%, respectively. For Yergason's, the specificity and

sensitivity are 79% and 37% respectively. Yergason's and Speed's test (figure 7 & 8 in Appendix) were both positive along with palpating the biceps tendon that produced pain. Using a systematic review to test the reliability of shoulder special tests, it was found that with the use of Kappa Statistical analysis Speed's had a moderate reliability score of 0.44 and Yergason's, a fair score of 0.28.[15] The patient was also evaluated using the Spurling's test, which was negative bilaterally. Reverse Spurling, which tests for upper trapezius muscle strain, was positive when side bending to the right. According to a study completed by Murthi AM, Vosburgh CL and Neviaser TJ (2000), upon performing a biceps tenodesis to 80 shoulders, 40% of the shoulders had macroscopic degeneration of the long head of the biceps tendon with 91% having rotator cuff tears. To rule out a rotator cuff injury, the Codman's Drop Arm test was performed, which is done by passively moving the humerus into 90° of abduction then asking the patient to move their arm down to their side in a slow and controlled fashion. The patient in the case study demonstrated a negative Drop Arm Test. To rule out a possible labral tear, O'Brien's and the Crank test were performed. Both tests resulted in positive outomes. O'Brien's is performed by moving the patients arm into 90° flexion, maximal internal rotation and 40° of internal rotation. Next, the clinician applies pressure by attempting to move the arm into extension. The test is positive if the patient feels pain in the internally rotated position, but not when the arm is moved into the externally rotated position and pressure is applied in the direction of extension.

Table 1 Special Tests performed at the shoulder and neck of the patient

Test	Positive/Negative Outcome	Specificity	Sensitivity	Likelihood Ratio
Speed's	(+)	55.5%	68.5%	(+) 1.54 (-) .57
Yergason's	(+)	79%	37%	(+) 2.05 (-) .72
Crank	(+)	98.91%	52.78%	(+) 48.42 (-) .48
Codmans Drop arm	(-)	97.2%	7.8%	(+) 2.78 (-) .95
O'Brien's (Labral Lesion)	(+)	31%	54%	(+) 2.33 (-) .51
Spurling (left side)	(-)	50%	86%	(+) 1.72 (-) .28
Reverse Spurling (Left side)	(+)	74%	50%	(+) 1.92 (-) .67

Diagnosis: The preferred practice pattern for the diagnosis of bicipital tendonitis is musculoskeletal with an ICD-9 code of 726.12. Due to the patient's subjective information when the O'Brien's and Crank Test were performed, it is suspected that a labral or SLAP lesion was present. The preferred practice pattern for the diagnosis of a labral lesion is sprains and strains of the shoulder and upper arm; superior glenoid labrum lesion with an ICD-9 code of 840.7.

Prognosis: The prognosis anticipated for this patient was to return to activities of daily living prior to the injury along with being able to fully participate in his work responsibilities. The optimistic prognosis was predicated on the education of the patient

on correct posture used throughout the day and with restoring glenohumeral and scapulohumeral motion. It was suspected that 6 weeks was ample time to achieve the goals in mind. The frequency and duration of the treatment was set for an anticipated amount of two times a week for six weeks. This patient was a workmen's compensation case and was only allowed 12 visits total. A judgment call was made to span the treatment sessions over a six week period.

Long term goals for the patient were 1. the patient's SPADI score will be less than 19% within six weeks of treatment; 2. the patient will be able to resume normal job tasks as done prior to the injury; and 3. the patient will have no neck discomfort with activity. The short term goals consisted of the patient being able to complete his job with little to no pain in his shoulder within three weeks and also sleep through the night without waking up due to pain. The discharge criteria for this particular patient included being able to sleep with no issues, perform normal tasks at work with no pain and also diminished amounts of crepitus with shoulder motion. To achieve the short and long term goals, the intervention plan included cross friction massage to the biceps tendon, Graston technique to the shoulder and neck musculature, and also strengthening of the scapular stabilizers using a Thera-Band strengthening exercise program. The plan at the initial treatment was to re-evaluate and examine the patient at the third and sixth week mark.

INTERVENTION

For the treatment of this patient, the clinician started with simple cross-friction massage. Cross-friction was completed in the supine position by rubbing over the long head of the biceps tendon near the transverse ligament perpendicular to the direction of the tendon for a total of five minutes to help break down the scar tissue that was bound down to the tendon following the injury. The therapist told the patient to complete cross-friction on himself at home twice a day for five minutes at a time and use ice for 15 minutes thereafter. The patient felt discomfort with the cross-friction technique, but said he felt more limber afterwards. The next treatment started with ultrasound at an intensity of 1.0W/CM2 with a frequency of 3.3 MHz for a total of seven minutes using a combination of hydrocortisone cream and ultrasound gel to warm up the tissue prior to the Graston therapy. The hydrocortisone cream was used for an anti-inflammatory effect while using the ultrasound to drive the topical cream beneath the skin to the injured tissue region. Graston technique is a tool assisted soft tissue mobilization, which has been described as "an innovative, patented form of instrument-assisted soft tissue mobilization that enables clinicians to effectively break down scar tissue and fascial restrictions." (Grastontechnique.com) The technique utilizes specially designed stainless steel instruments to specifically detect and effectively treat areas exhibiting soft tissue fibrosis or chronic inflammation.(Grastontechnique.com) A study using ultrasonography found that the Graston technique effectively decreases the amount of scar tissue. [10] Using that knowledge, my clinical instructor performed the

Graston technique with the G3 and G4 tools to the pectoralis major, biceps brachii and anterior deltoid. (Fig 1 and 2)

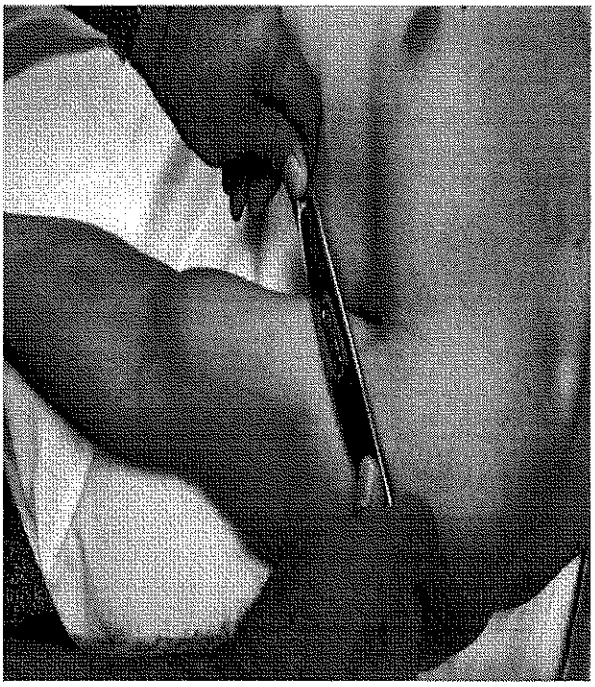


*Figure **Error! No text of specified style in document.**1 Graston with G4 along the biceps*

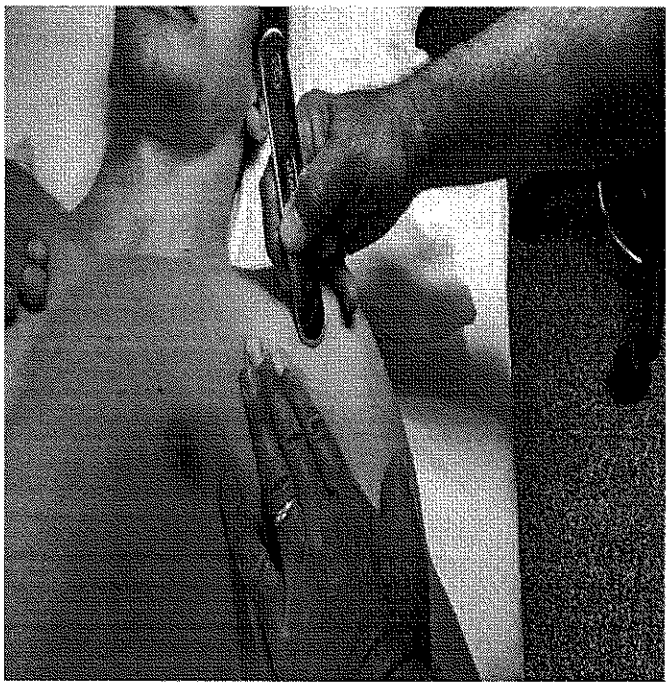


Figure 2 Graston with G3 near the coracoid process to target the short head of the biceps

A component of the Graston technique is the subjective "feel" of the underlying tissue. The clinical instructor trained and experienced in using the tools noted that the client's biceps tendon was very "fibrotic" by noticing the bumpy, gritty sensation felt through the tool. He concluded the first treatment when petechiae occurred. The patient noted that he felt much looser after treatment. The third treatment began with an introduction to the shoulder stabilization program utilizing Thera-Bands (Appendix Table 2). After that, ultrasound was used with an intensity of 2.0W/CM2 at a frequency of 3.3MHz with the hydrocortisone cream and ultrasound gel for seven minutes to the area

along the upper one-third of the biceps brachii. Next, the Graston technique was implemented to the anterior deltoid, pectoralis major and biceps brachii insertion with the G3 and G4 tools. Following the treatment, re-assessment of shoulder flexion and abduction resulted in crepitus near the AC joint. The intervention also included grade I and II posterior-anterior glides to the acromioclavicular joint in the seated position with the mobilizing force applied just medial to the acromion on the distal clavicle (Appendix, figure 10). The joint mobilizations to the AC joint should increase mobility of the ligamentous attachment between the coracoid and the clavicle (coracoclavicular ligament). Downward movement of the coracoid process required during glenohumeral elevation causes the ligament to tighten up and will cause the clavicle to posteriorly rotate about 30°. So, to facilitate appropriate clavicular rotation and therefore scapulohumeral elevation, the clavicle can be mobilized at the acromioclavicular joint.[16] Following that, the clinician performed Graston to the tissue surrounding the AC joint. On the fourth treatment, the patient told the therapist that his shoulder felt looser and had less 'clunking' sensations in the shoulder. For this treatment, it was discussed to work on his neck pain and also performing joint mobilizations to the AC joint again. So, the appointment began with grade II and III oscillations for 3 sets of 20 repetitions. Although the patient reported pain during the mobilizations, the physical therapist observed increased movement after an increased number of mobilizations were completed. Next, the neck pain was addressed by first performing a stretch to the left upper trapezius muscle, placing one hand on the acromion and the other on his cranium laterally flexing his head to the right. Then a static stretch was held for about 90

seconds. After the static stretching, joint mobilizations to the AC joint was completed for the same amount that was completed at the beginning of treatment. Following that, contract relax technique was performed to the upper trapezius for roughly three minutes noting that he was continually gaining motion. For the contract relax technique, the therapist passively moved the patient's cervical region into right lateral flexion. Then the patient contracts the left upper trapezius for a 3-5 second hold and relaxes, moving his neck into more right lateral flexion. The reasoning behind the contract relax technique is to utilize the Golgi Tendon organs which are proprioceptors located in the musculotendinous junction sensing tension and load of the muscle. Golgi tendon organ circuit is a stimulation of the Golgi tendon organ (by stretch or active contraction) causing excitation of the antagonist and inhibition of the agonist which allows for more motion through the muscle attempting to be stretched. [17] Palpation along the upper trapezius reproduced his neck pain near the insertion of the upper trapezius at the acromion, so a trigger point release technique was applied by pressing firmly into the tissue nodule. When pressing on the taught muscle nodule, the pressure causes the stuck myosin head from the binding site to release, restoring the sarcomere to the correct functioning length. To determine if you are in fact on a trigger point, the patient will give you the information. Patients with a pain nodule will experience tenderness and increased pain. "Trigger points are described as hyperirritable spots in skeletal muscle that are associated with palpable nodules in taut bands of muscle fibers. Trigger point researchers believe that palpable nodules are small contraction knots and a common cause of pain"[18] At the end of the treatment, manual cervical traction was

performed by having the patient lay supine, grabbing hold of his head and pulling in the cephalic direction within a comfortable range for five minutes. Following that, I performed another round of trigger point release to the upper trapezius and joint mobilizations to the AC joint. He noted his neck felt much looser following treatment. The patient was sent home with an upper trapezius stretch and also a biceps brachii stretch (Appendix figure 9 in). He was a 'no show' for his next treatment, but upon making a phone call; he said he had other obligations to which to attend.

CHAPTER III

DISCUSSION

The patient in this case study had issues going into shoulder flexion, abduction, internal and external rotation. So, in conjunction with the Graston Technique, acromioclavicular mobilizations, stretching of the biceps brachii and upper trapezius to address his neck pain were performed. To help his overall upper extremity weakness therapeutic exercise was discussed and shown to the patient with the use of Thera-Band exercises to improve shoulder stability. The *North American Journal of Sports Physical Therapy* reported the use of Graston Techniques used in the treatment of adhesive capsulitis "strong afferent stimulation and reorganization of collagen, as well as an increase in microcirculation." [19] The Graston Technique is recommended to be completed with exercise.

A 61 year old Caucasian male received treatment after a diagnosis of bicipital tendonitis. He works at a mail office which requires repetitive manual labor including moving boxes of varying weight and height in a position of protracted shoulders, extended elbows and supinated wrists. Treatment consisted of stretching the biceps brachii and upper trapezius, Graston, cross friction massage, ultrasound and therapeutic exercise. Prior to his last appointment, the patient was able to sleep through the night

without pain. He could put on a jacket and tuck in his shirt behind his back independently and had no issues with neck pain. The only goal not achieved was being able to complete his job tasks. Shortly after the sixth treatment, the patient fell at home in his driveway and regained the symptoms he complained of at the initial evaluation.

The highlight of this case report was the efficacy of using Graston technique to treat a soft tissue injury such as bicipital tendinosis. In a short amount of time, Graston effectively reduced the patient's reported pain. An MRI was taken following re-injury. It indicated near complete, full thickness disruption of the supraspinatus tendon, moderate tendinopathy of the infraspinatus and subscapularis tendons without additional rotator cuff tearing, shallow broad based subacromial ethesophyte formation and thickening of the coracoacromial ligament. This contributed to mild narrowing of the acromiohumeral space, mild AC joint arthrosis, mild degenerative changes within the superior labrum without labral tearing or SLAP-type lesions. Current research demonstrates the effectiveness of Graston to treat rigger thumb, achilles tendonosis, adhesive capsulitis, tibialis posterior, plantar fascitis and lateral epicondylitis. An article regarding the use of Graston on thirty-five asymptomatic high school aged baseball players showed that after only one treatment with Graston, compared to a control group utilizing no intervention, that there was improvement in horizontal adduction along with glenohumeral internal rotation range of motion. Ninety seconds post-intervention, the baseball players' range of motion was retested and showed 11.1° improvement for horizontal adduction and 4.8° improvement for internal rotation.[20]

In an article from the *Journal of Manipulative and Physiological Therapeutics* for the use of Graston technique along with a home stretching program, ten patients had complaints of plantar heel pain for an average of 32.4 weeks. After roughly six treatments, patients had clinically significant changes in the Numeric Pain Rating Scale and Lower Extremity Functional Score. The study on plantar heel pain is similar to the case report patient's outcome prior to the fall that occurred. There were approximately six treatments and the amount of Graston technique utilized was 15 minutes, which is what was utilized in this case report.[21]

Another study utilizing the use of Graston technique was on knee arthrofibrosis to improve range of motion and quadricep activity. At each treatment, the patient vocalized an improvement in range of motion, strength and function as noted by changes in their activities of daily living. "During the scanning process at visit 3, it was felt that the more superficial adhesions were resolving well and that the deeper structures would be better addressed with activation or function."[22] The patient in this case study showed objective improvements with quad lag improving from 22 degrees at initial evaluation to 3 degrees at the fifth visit. At the fifth visit, the patient was able to walk without a brace or assistive device. Also, the patient demonstrated "normalized level-surface gait pattern".[22]

Deep tissue friction massage "Davidson et al., 36 and Gehlsen et al., 37 using a col- lagenase-induced tendinopathy model on rat Achilles tendons, examined the effect of soft-tissue mobilization on cell and extracellular matrix response. Davidson et al., 36 compared four groups: control, induced tendinitis, tendinitis plus soft-tissue

massage (STM), and STM alone. Groups receiving STM had more fibroblasts present. The STM groups also stained positive for increased fibronectin, an extracellular matrix adhesion protein" [23,23]. "DTFM is theorized to reduce abnormal post injury fibrous adhesions, to make scar tissue more mobile in sub-acute and chronic injury, and to facilitate healing in chronically degenerated soft tissues by inducing controlled microtrauma and facilitating the normal alignment of soft tissue fibers."[5] That statement from Miners brings up the point of when should Graston or DTFM be issued to the patient. Also, DTFM stimulates blood flow to the area of the injured tissue. Since both treatments are shown to facilitate healing in chronically injured tissue, is there a time frame for when either treatments should be used? When comparing DTFM to Graston, there are many similarities.

Another approach used quite often, but was not in this case report, is ART therapy (active release techniques) which is when the therapist applies deep digital tension to the affected site while the tissue is moved passively and actively from a shortened position to a lengthened position.[5] The ART therapy is similar to trigger point release. Also, when treating a patient with tendinosis or tendinopathy, the use of eccentric training causes decreased tendon volume and decreased intratendinous signal when evaluated by a diagnostic image such as an MRI.

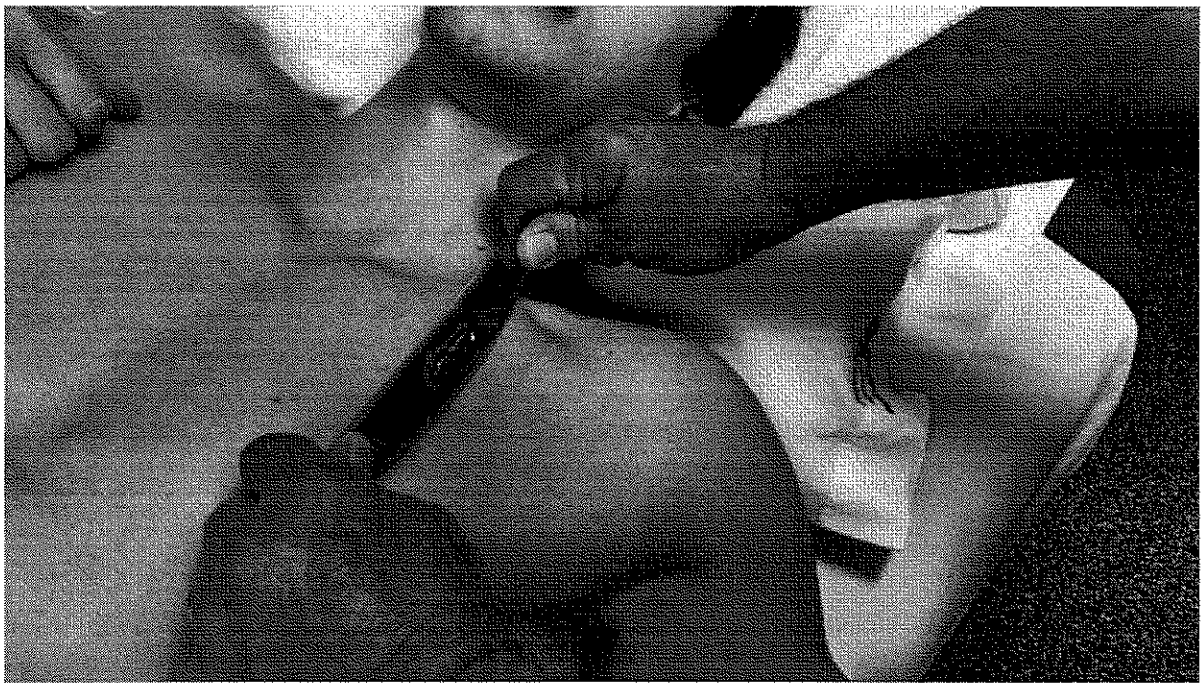
Subsequent studies will need to look at the use of Graston for treatment of tendinopathy solely in comparison to other methods. In the future, having the patient complete the functional outcome on planned treatment numbers will have to occur. Also, an effort should be made in advocating for the patient to receive imaging. Special

tests used during the examination for the biceps tendon were Speeds and Yergasons. Speeds has an accuracy of 56% when compared to arthroscopy.[24] For the Yergasons test, EMG studies have shown activity of the upper and lower subscapularis significantly higher than other muscles, with a 63% accuracy.[24] At this time, there is no research on the inter-rater reliability for the sensation felt when applying treatment over a fibrotic tendon. The gritty, bumpy sensation that is supposed to be felt when performing Graston over a fibrotic tissue comes with clinical experience. The only difference is the identification proposed (gritty sensation) by clinicians using Graston. Future research should include a study on the comparisons between both modalities using ultrasonography to identify the differences at the injured tissue region.

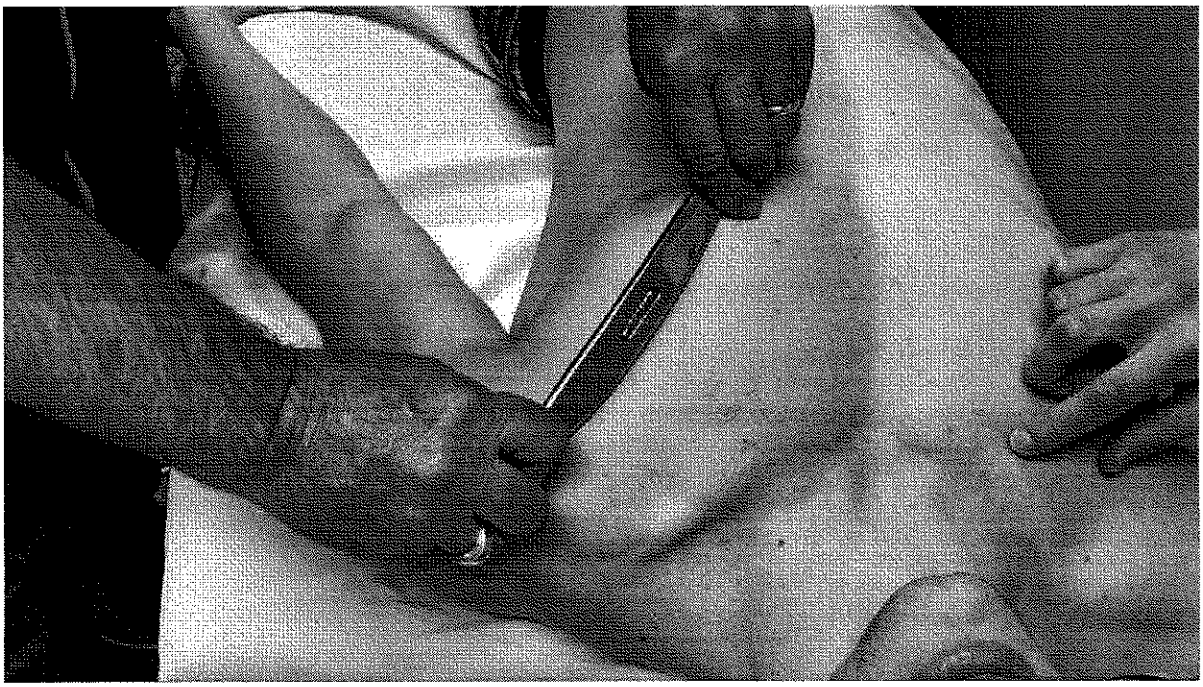
Appendix Table 2 Shoulder Stabilization Program

Exercise	Frequency per week	Repetitions	Sets
Standing Face Pulls (working posterior deltoids)	3	20	2
Standing abduction working middle deltoid to 90°	3	20	2
Tricep Extension	3	20	2
Serratus Anterior Punch outs at 120° of shoulder flexion	3	20	2
External Rotation completed standing elbow flexed at 90°	3	20	2
Internal Rotation completed standing elbow flexed at 90°	3	20	2

Appendix Figure 3 Graston Tools

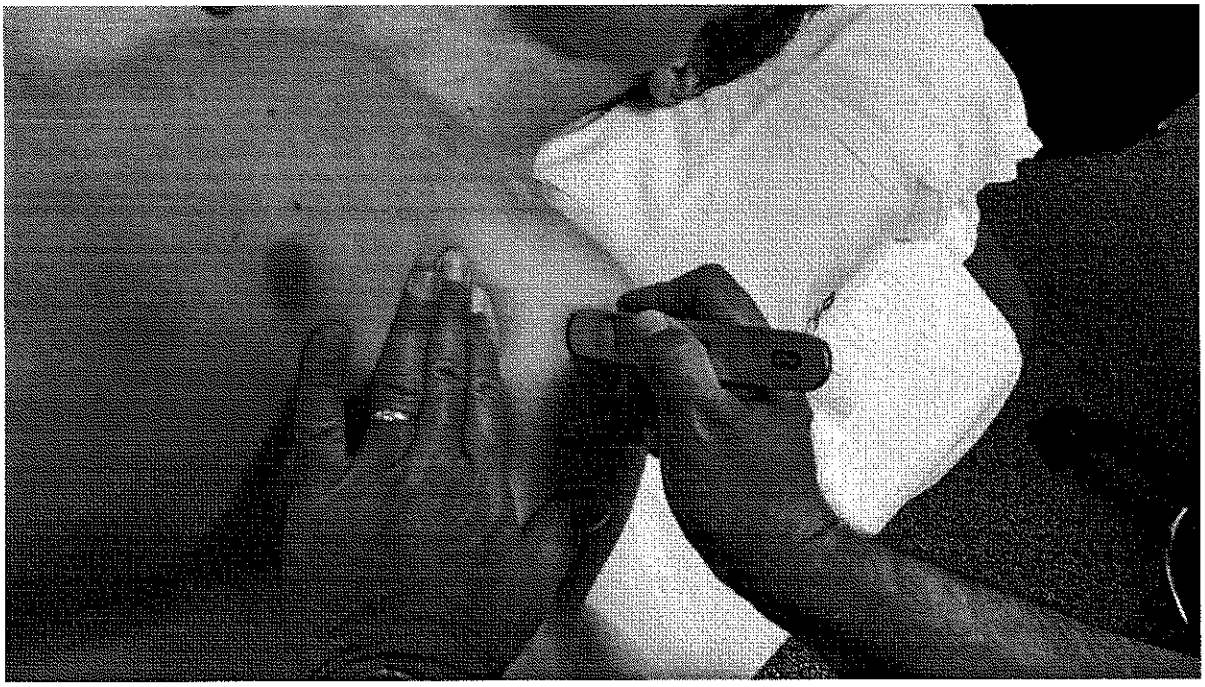


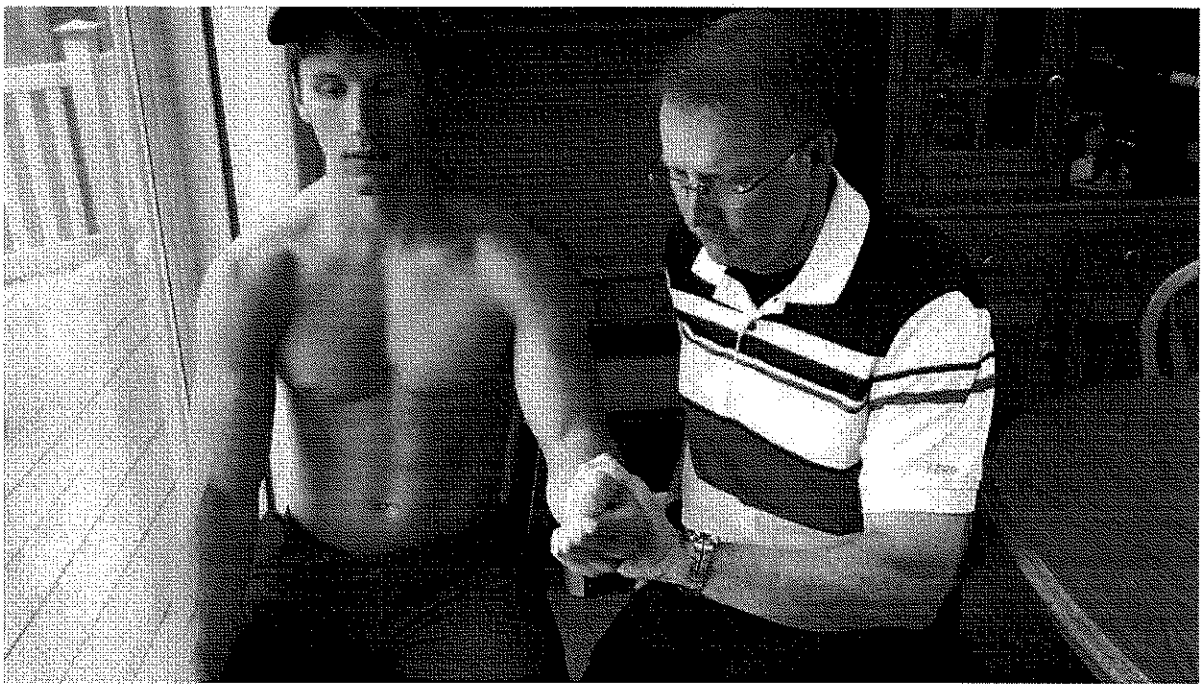
Appendix Figure 4-G4 tool moving from origin to insertion of pectorialis major



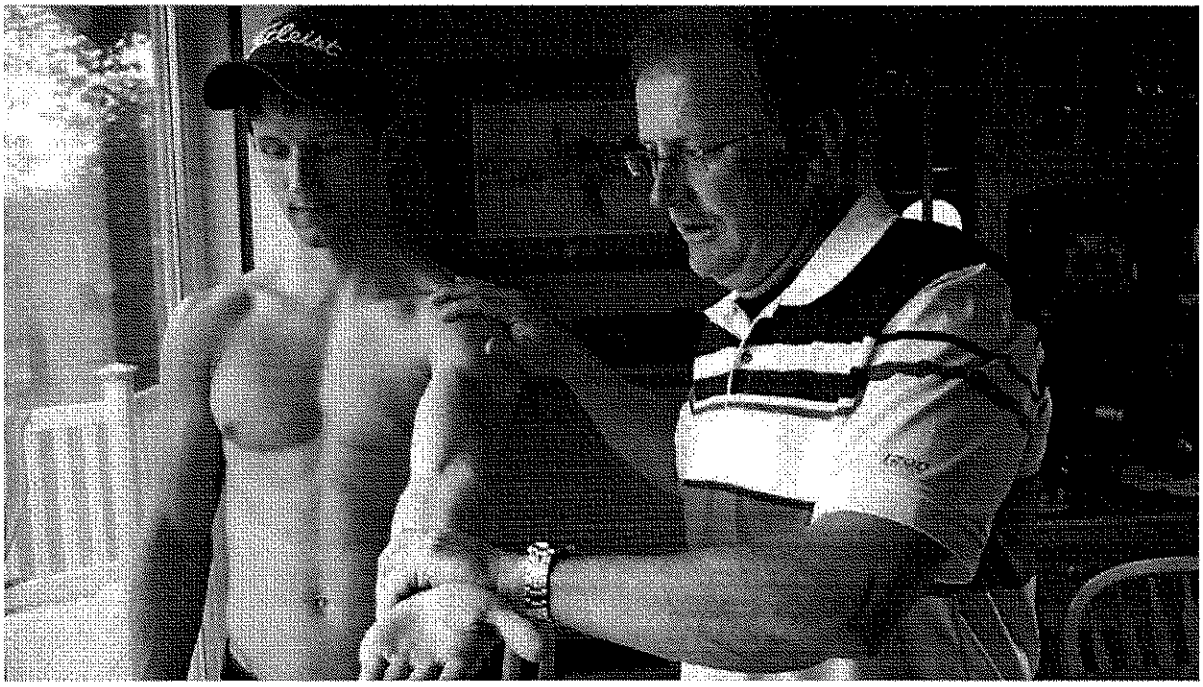
Appendix Figure 5- G4 tool used moving from insertion to origin

Appendix Figure 6- G3 tool used moving along the transverse humeral ligament in the horizontal direction

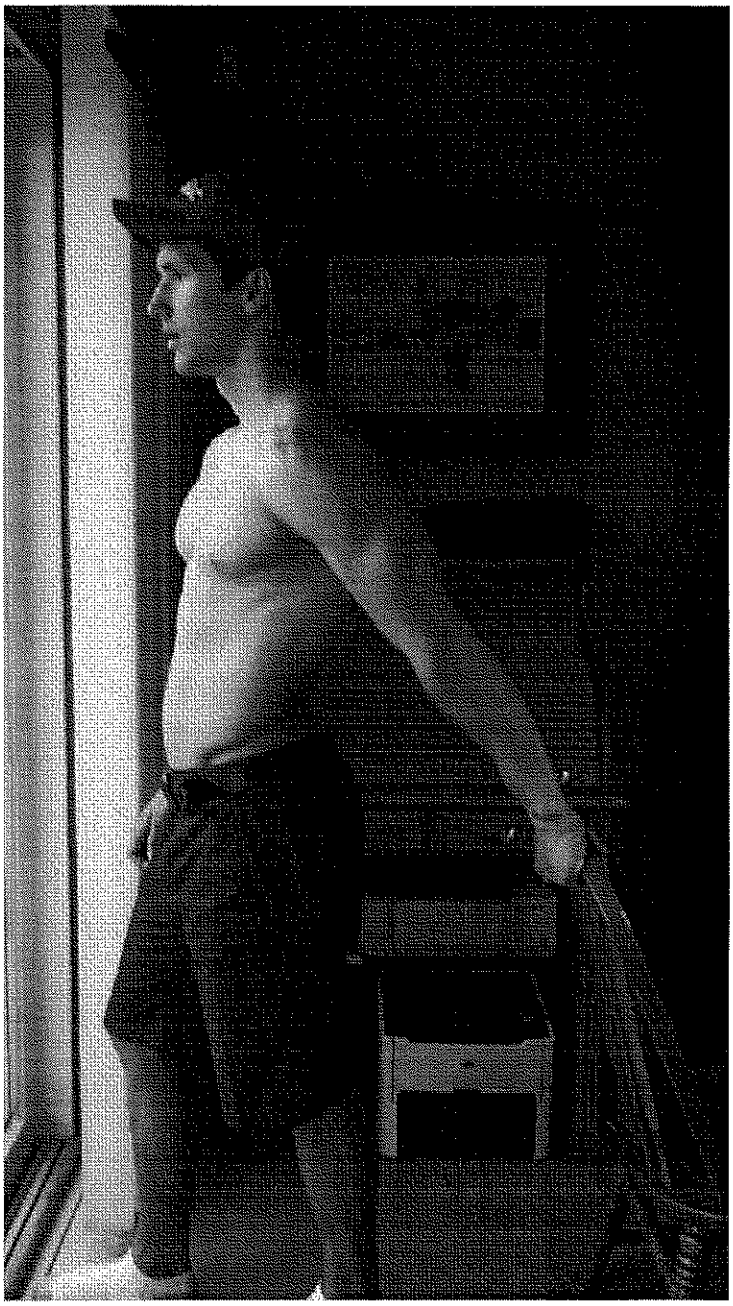




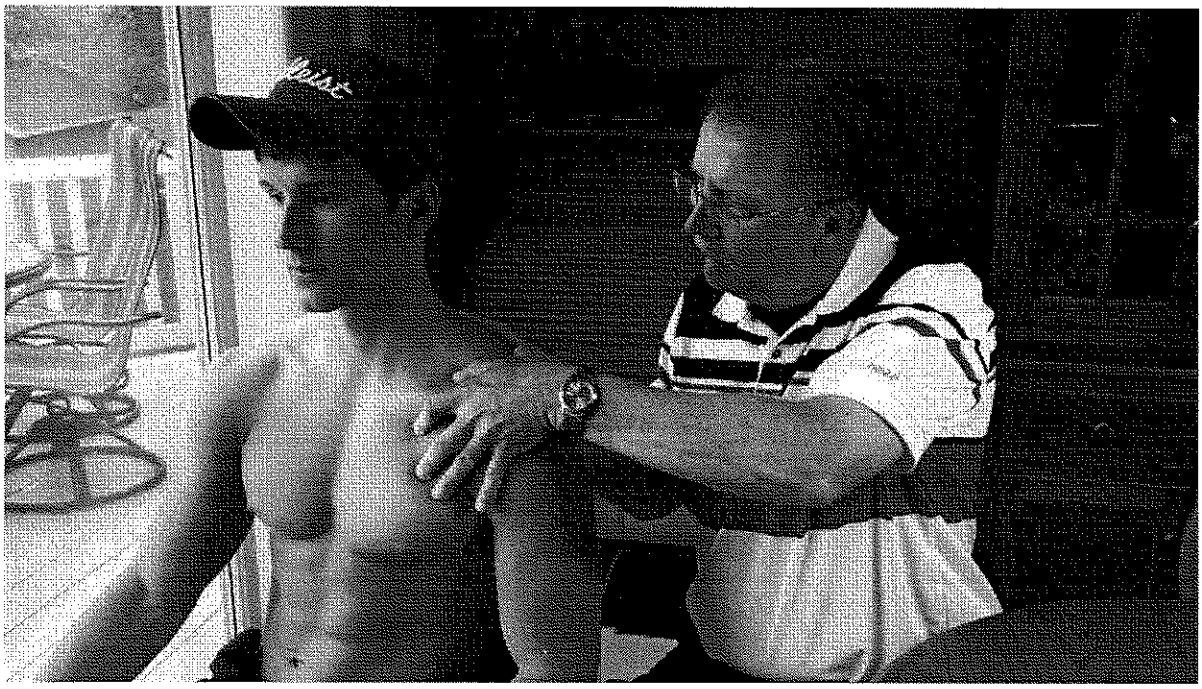
Appendix Figure 7- Yergason's Test therapist applies a resistance into flexion and external rotation. Hand placements located at the elbow and just proximal to the wrist joint.



Appendix Figure 8- Speed's Test- Patient attempts to move the arm into shoulder flexion in the externally rotated position while the therapist applies resistance.



Appendix Figure 9- Biceps Brachii Stretch. Patient grabs a hold of a solid surface with the arm extended and the forearm in the pronated position. Steps forward for added stretch.



Appendix Figure 10- AC Joint Mobilization posterior-anterior glides were completed just medial to the acromion on the distal clavicle grade two and three oscillations in the seated position

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